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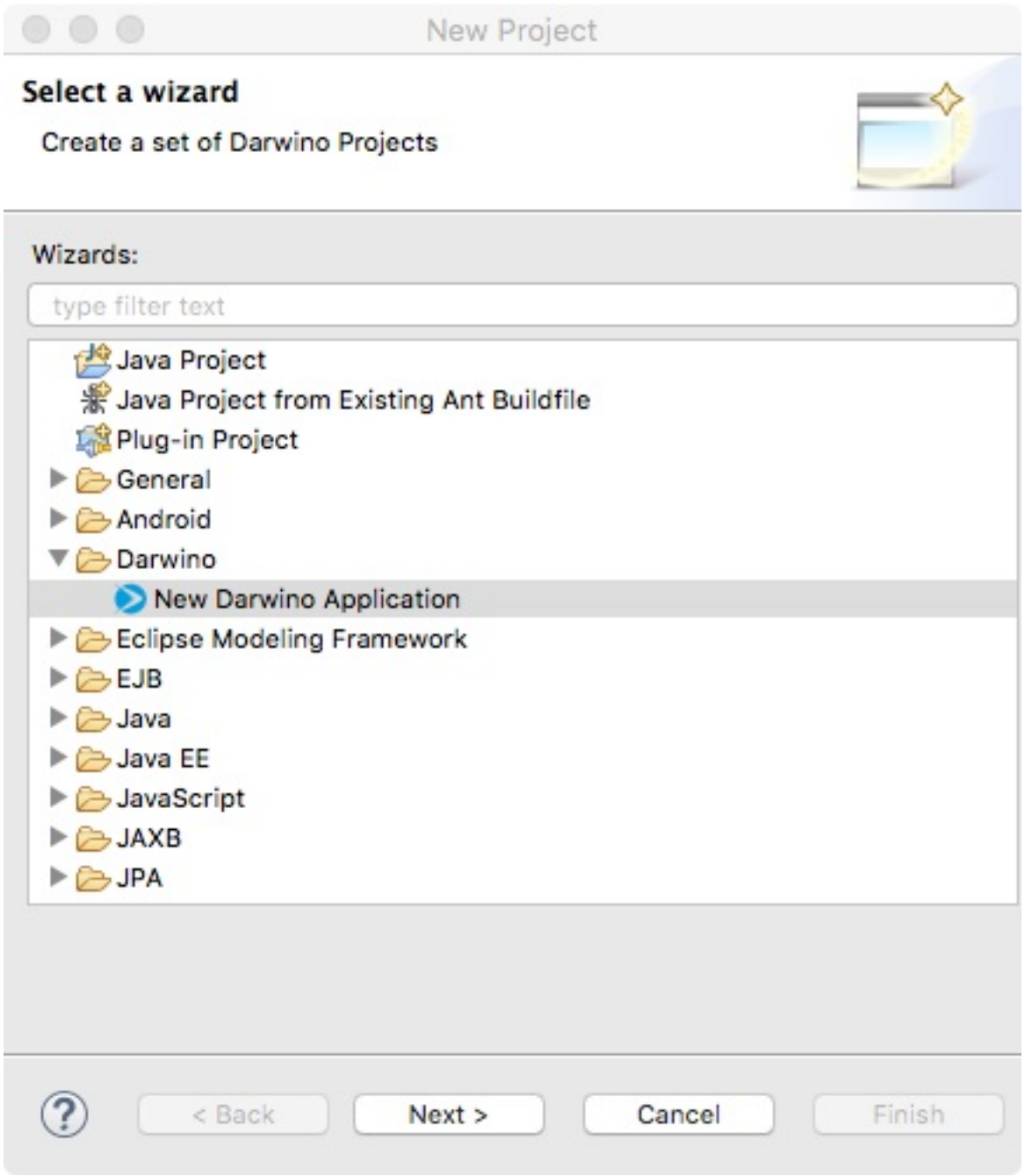
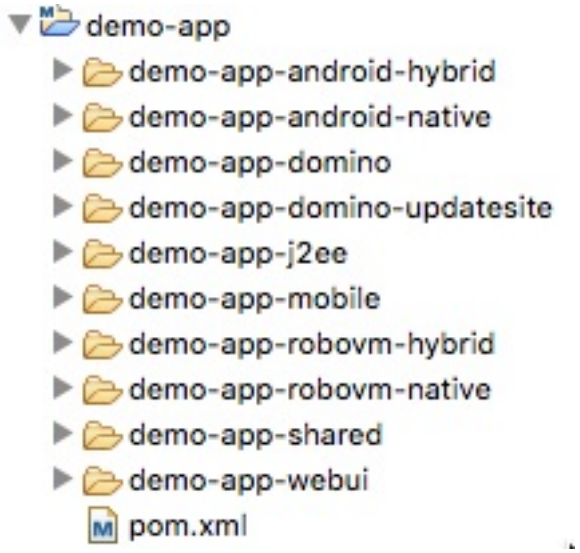
# Introduction

# Using the Studio - Creating your first Darwino application

The Darwino application wizard is the first step in creating a Darwino application.

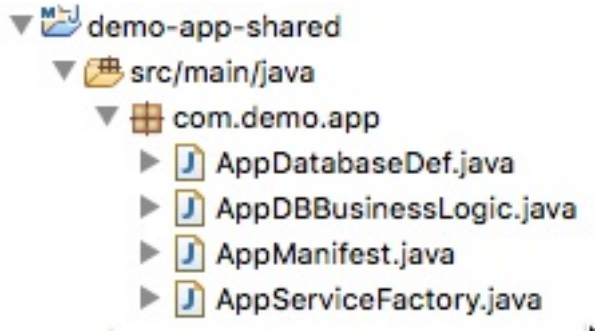



The Wizard generates a set of Maven projects. The top project is the container for the other projects.




Which projects are generated depends on the options that were selected in the wizard.

- -shared: This project contains the Java code that is shared by all the platforms.




-- ++AppDatabaseDef.java++ defines the metadata of the JSON store. Since the store is located inside the database as a JSON file, you won't need this Metadata definition. (I need to verify and elaborate on this.)

The first time replication runs, the tables will optionally be created automatically. It can also check to ensure that the tables are at the required level. If the database and the DATABASE_VERSION are equal, it will proceed. If the table version is higher than expected, an error will be raised. If the table version is lower, you can upgrade the tables (if autodepoly was selected), or raise an error.

-- ++AppDBBusinessLogic.java++ provides the means to handle database events. Examples include the Document events (create, edit, delete) and database replication events.

-- ++AppManifest.java++ defines the options for the Darwino application layer. The options defined here are shared among all platforms. For example, the getDatabases()

method returns the database names used by the application, and getLabel() returns the database label for J2EE.

-- ++AppServiceFactory.java++ - In a Darwino app, all of the business logic is isolated into services that can be exposed as web services. By default it provides you with a set of services, such as the JSON store, but it also allows you to create your own services. It is in AppServiceFactory where custom application services are defined.

The wizard generates a very basic, example skeleton service that is ready to use.

There is also the RestServiceBinder which is where we define which elements match to which services.

- -webui: This project is generated when the wizard is instructed to create a J2EE or hybrid app. It contains the web artifacts that are consumed by the web application. It's not under "shared" because we can have apps that are not web apps, for example pure backend apps on the server, or native apps for mobile devices.

  It is a basic skeleton using web technologies and AngularJS. AngularJS is not a requirement, but it is recommended. The index.html file that's generated includes AngularJS code, but you can delete it and use whatever framework you like.

  The web resources are packaged under a folder called darwino-inf under src/main/resources (a Maven convention for where to put resources).

  Darwino comes with a custom service that is able to read the resources inside that directory and act as though they were part of your J2EE project and part of your mobile assets.

- -j2ee: This is a J2EE wrapper to this project. It includes the Java in the Java runtime and it includes the web resources in the runtime.

  The pom.xml defines the dependencies of the project. In our case, it shows that we're including the demo-app-shared and demo-app-webui, thus all the content in both projects will be included.

  In the web.xml, we can point to Darwino artifacts, which are either servlets or filters. Several of these are of particular importance. The DarwinoJ2EEFilter handles on-the-fly transformation of url requests, allowing the folder structure to vary without requiring code modifications to accommodate the changes, and making urls

platform-independent).

Defined in web.xml: -- DarwinoAppResourcesServlet -- DarwinoJ2EEFilter: When a request comes in, this is the first filter to be activated. It retrieves the current context and puts it on the stack so it becomes available to the application. It does this for every URL. -- DarwinoGlobalPathRewriterFilter serves to translate the $darwino-libs keyword in urls to the correct path, rewriting file system paths on the fly. This makes the url completely platform-independent. -- Darwino services: for example, built-in services like the JSON store, or custom (user-created) services served by the DarwinoServiceDispatcher filter.

In order for the highest level, the Darwino application, to have the context it needs available, at application initialization the com.demo.app.AppContextListener is triggered before anything else. It provides the application with access to all of its environment information. As a listener, it cannot pass parameters, but the application can have global parameters, so the listener uses global parameters to pass context information

Authentication The wizard generates code allowing the use of J2EE authentication, but that requires the J2EE server to be connected to your directory of users and every web application server has its own mechanism for doing that; this does not lend itself to true portability. Also, J2EE authentication lacks granularity.

Darwino comes with its own authentication filter than you can choose to use. This allows us to use our own user directory regardless of the application server.

There are two other files in WEB-INF that are critical in solving the problem of configuring application parameters such as database connections and logging. Rather than storing this configuration within the application itself, we can externalize the configuration. This allows configuration changes to be made without recompilation. It’s up to the developer to decide where these files are stored, but, in keeping with J2EE convention, Darwino stores these files in the WEB-INF directory.

- darwino-beans.xml These are Java objects, and, as managed beans, the platform will automatically create instances of these objects when needed. Contains sections for: -- Database access -- IBM Connections endpoint -- HttpTracer – allows tracing of all aspects of the communication between client and server -- Static directory of users

Each bean has a type and a name, and can have an alias list, which can include the alias “default”.

- darwino.properties There is an API in Darwino to get these property values.

- -mobile: This project doesn’t run anywhere. It is is a container for resources that are common to both mobile platforms (iOS and Android). AppMobileManifest.java is like AppManifest, but specifically for mobile devices. It adds a set of options that are very specific to mobile devices. The wizard provides only the basic skeleton. The developer puts the common mobile code and resources here.

- -android-hybrid: Depending on wizard choices, you can have an android-hybrid and/or and android native. Typically you’ll choose one and not both. We are not showing android native in the demos. This project depends on all the others except the J2EE app. It includes all the android assets, such as the AndroidManifest.xml. It is exactly like a project generated with the Android wizard, except it includes a set of dependencies on the Darwino project.

  AndroidApplication.java launches the Darwino application as the first thing it does. DarwinoApplication.java contains two very important objects: -- DarwinoApplication is a singleton that acts as the entry point for all of the objects of the Darwino application, including the manifest, and it enables the triggering of Darwino application actions such as replication. -- DarwinoContext, which is generated by the Darwino runtime. It has a different behavior depending on the platform, but gives access to the same information.

  A mobile environment is single-user, while the server environment is multi-user. In both cases, there will be one Darwino application which is exactly the same regardless of the user, however the DarwinoContext on the J2EE server is the context of the current request (“Who is the user for this request? What is the contextual environment–the execution environment–of this request?”). On the server, there is one new DarwinoContext created per request. On the mobile device, none of this applies.

  Of course, if you want to just use the JSON API to get this context info, you can, but these objects make the job much easier.

  DarwinoServiceDispatcher: this is the class that is used by the HTTP Server to dispatch the services. By default, all services are enabled, but with

DarwinoServiceDispatcher we can selectively enable and disable services.

MainActivity –creates the canvas on which the application runs.

SplashScreenActivity provides the splash screen.

- -robovm-hybrid: This is the iOS version of the app. We're writing Java for iOS, but Java is not supported natively by iOS, so we rely on 3rd-party frameworks. We currently support only RoboVM, but we may support more in the future, such as Intel INDE.

  Just as we generate an Android wrapper, we generate a RoboVM one. It just like what you'd get if you generated it with a RoboVM widget. The contained classes match those of the android-hybrid, with MainViewController equating to MainActivity.

# Platform object

Darwino applications execute on multiple platforms, including iOS, Android, JVM, and a Web Container. Your code must handle differences in these platforms. The Darwino Platform Object manages these platform differences so that you do not have to worry about them.

Darwino is built to be platform agnostic, and exposes everything in the architecture as pluggable. The foundation of this capability is the Darwino Platform object, which encapsulates all platform-specific functionality. When working with multiple-platform development, even simple tasks such as logging are managed differently depending upon on which platform the application is currently running. The Darwino Platform object allows you to interact with platform capabilities such as logging in an abstract manner, without having to determine the execution platform.

> NOTE: The Darwino platform (com.darwino.commons.Platform) is instantiated as a singleton object.

The plaform object provides several default services. Developers can extend the platform object using custom services and extensions.

> The Platform object is the entry point for all services, and the Platform object makes all services available from anywhere in your application. Further, any library can contribute services, as Darwino services are POJOs, and do not need to extend any particular interface.

# Platform Configuration

In order to maintain platform agnosticism, Darwino does not depend on the use of fixed configuration files, extensions can be the Platform object that provide access to configuration properties.

# Services and extensions

There are two elements in the platform: services and extensions. A service is a singleton. For a particular class of service, there will be ONE implementation. If there are multiple implementations, you will get a runtime error.

# Services

Services and extensions differ in that an extension can have multiple implementations and they can all work together at the same time, like, for example, a database connection. You can have a connection to postgres and a connection to DB2 and use both of them within the same app. An extension is like a service but it can have multiple instances that are non-exclusive.

# Extensions

To define extensions, there is the notion of plugins. A plugin is a class that can be provided by libraries or by your application directly, and they can register services and extensions to the platform.

The Darwino wizard will generate a skeleton plugin for your application that you can use to override or add to the default platform implementation.

# Logging

Darwino provides its own logging library for each platform, and dynamically chooses the appropriate one for current platform. This make it completely transparent to the developer; your logging code will be fully cross-platform.

```
// General logging
Platform.log("Logging {0} unconditionally", "My Message");
Platform.log(new Exception(),"Logging an Exception, {0}", "Here it is");
```

Platfom.log is the basis, but it can also use the more powerful concept of log groups.

# Managed Beans

A key component of the Darwino Architecture is the concept of managed beans. This concept is borrowed from, although different from, Spring and JSF. Managed beans are manageable resources – java objects that are instantiated by the platform when needed, and destroyed when they go out of scope.

Darwino uses managed beans primarily as a generic way to configure the platform.

## Configuring Managed Beans

Managed beans are provided by extension points. By default, the platform looks for managed beans configured in a file called darwino-beans.xml in the Tomcat server home/conf directory. However, you can define your managed beans location as a custom extension.

The set of managed beans is typically configured using the darwino-beans.xml file, but can also be provided from other sources. Managed beans are configured using the following xml structure:

```
<bean type="[defined bean type]" name="[unique bean name]" class="[full class name]" alias "
    <property name='[property name]'>[property value]</property> //list of properties
</bean>
```

Managed bean configurations can instantiate multiple sets of bean objects lists simply by using a list tag as follows:

```
<bean type="[defined bean type]" name="[unique bean name]" class="[full class name]" alias "
    <list name = "[list name]">
        <bean class='[class name]'>
            //property list for instance
        </bean>
        <bean class='[class name]'>
            //property list for instance
        </bean>
        <bean class='[class name]'>
            //property list for instance
```

```
            </bean>
            //etc.
        </list>
    </bean>
```

As you can see, this structure is intentionally generic. While the bean type must be defined based upon a definition, the remainder of the definition is completely generic. This allow for any type of object to be defined as a bean, and managed by the platform.

If a call is made to a managed bean, the platform checks to see if the object exists and, if not, it instantiates the object according to this definition file, using the class name and configured property definitions. This leads to a very flexible and generic manner in which Darwino applications can be defined.

## Scope of Managed Beans

Managed beans have a defined scope. By default, if you do not provide a scope, the scope will be considered global, which means that the bean will be a singleton object, with a single instance for the entire application. Other scope choices are:

- **None:** A new instance of the bean is created on every call to the bean. The bean object is discarded after every call.
- **Request:** A new instance of the bean is created on every request, meaning the developer can call the bean, then call multiple methods on the same instance of the bean. Once the bean object is out of scope, it will be discarded,
- **Session:** A new instance of the bean is created and persisted for each session. Once the session is discarded, the bean object is discarded.
- **Application:** A new instance of the bean is create for each calling application in a particular class loader.

# JSON library and data binding

A lot of Darwino is based on top of JSON, and particularly the JSON store. Darwino uses its own library for JSON because there is no standard JSON library in Java. There are libraries available, but they tend to be poor performers, cumbersome, or just heavy-weight. Their dependencies make for heavy mobile app code. The Darwino library is based on top of one written at IBM. It is 100% compatible with the JSON standard, and has been optimized for JSON parsing, and it includes JSON extensions.

In standard JSON, we have key/value pairs. Keys must be wrapped in double quotes. JavaScript, though, allows single quotes or key names with no quotes at all. The Darwino JSON parser is permissive and allows those. When it serializes, it does so according to JSON standard, but when it reads, it is permissive.

```
 // A JSON parser is available through a Factory
JsonFactory f = JsonJavaFactory.instance;
JsonObject jo = (JsonObject)f.fromJson("{a:11, b:12, c: 13}");

// Json objects/arrays have easy to use methods
_formatText("JSON Object, compact: {0}",jo.toJson());
_formatText("JSON Object, pretty: {0}",jo.toJson(false));

// Or this can be done through a factory
_formatText("JSON Object, compact: {0}",f.toJson(jo));
_formatText("JSON Object, pretty: {0}",f.toJson(jo,false));
```

## Command Insertion

Standard JSON has no provision for inserting commands. While command insertion is available in JavaScript, it is not in JSON. The Darwino JSON parser permits commands when reading, but does not, by default, emit them.

In Darwino, the JSON implementation supports JavaScript-style comments as an extension, and the parser can read inside these comments. This feature enables reading and writing commands embedded in the JSON.

A typical use case for this is a progress bar. When the client tells the server that it supports commands, the server can emit comments in the JSON that describe activity

progress. The client can use those progress comments to display a progress bar.

## JSON Compression

We can also emit compressed, binary JSON in place of text. Darwino does not use this externally, as when writing to a file or to a database, but it can be used when communicating via HTTP. For example, when the client is replicating with the server, it uses a REST API that is based on JSON. If the client sends the server a header saying that the client understands the binary form of JSON, then it can compress the data. Values are compressed, and names can be sent once and subsequently only pointed to. Also, this removes the need for parsing the data.

## JSON Query Language

There is a query language for JSON, so you can apply a query to a JSON document and get a result.

# (Must expand on this topic with some details about the query language)

# HttpClient

Because a lot of activities in a Darwino are based on services, we need a means to connect to those services. We need to connect to them from Java, and not only from the browser. The Darwino HttpClient is very easy to use. It has classes for authentication and for handling JSON. For example, to call a REST service, pass some parameters, and get a result back, all that is required is to call getAsJson(). It will handle the job of composing the proper URL and processing the result.

```
String url = "http://localhost/playground.nsf/playground/$darwino-jstore";
HttpClient c = ((HttpClientService)Platform.getService(HttpClientService.class))
                      .createHttpClient(url);

// Call the information service and interpret the result as JSON
//    <base-url>
Object r = c.getAsJson(StringArray.EMPTY_ARRAY);
_formatText("JSON Store information: {0}",r);

// Call the user service and interpret the result as JSON
//    <base-url>/user
Object r2 = c.getAsJson(new String[]{"user"});
_formatText("JSON Store User: {0}",r2);
```

The Darwino HttpClient is built on top of the platform's own client; the developer doesn’t have to worry about the underlying HTTP client (for Apache, regular JVM client, OkHttp).

The HttpClient also handles GZIP, ChunkedPost, and multi-part MIME.

# Darwino application objects

## Application

The Darwino application is a singleton. There is one and only one running instance. The Application instance is the entry point for all of the application options, including the manifest (the Application's getManifest() method will return the manifest object).

It is through the Application object that we can perform application-wide actions such as triggering replication.

# Manifest

The Application Manifest generated by the Darwino wizard defines the options for the Darwino application layer. The options defined here - such as the database names used in replication, the label and description of the application, and the application's url - are shared among all platforms.

```
DarwinoApplication app = DarwinoApplication.get();
DarwinoManifest mf = app.getManifest();

_formatText("Label: {0}",mf.getLabel());
_formatText("Description: {0}",mf.getDescription());
_formatText("Main Database: {0}",mf.getMainDatabase());
```

# Context

The Darwino Context provides the application with access to all of its environment information, including the user identity and the properties of the execution environment.

The Context has a different behavior depending on the platform, but it provides access to the same information.

```
DarwinoContext ctx = DarwinoContext.get();

_formatText("User: {0}",ctx.getUser());
_formatText("JsonStore Session: {0}",ctx.getSession()!=null);
```

# Darwino DB API

# Concepts

The Darwino database is a NoSQL store for storing JSON documents and related attachments. It is actually a database of JSON documents, and you can attach binary pieces to any document.

Built on top of existing relational databases, it provides the benefits of a mature, well-established technology. Is it fully transactional, and it scales to very large datasets.

Darwino takes advantage of the latest NoSQL additions, such as native JSON and data sharding.

Another benefit of using relational databases as the groundwork is that you can use any existing tool that can connect to a relational database to access the data. You can use BI tools, reporting tools, or other big-data analysis tools, like IBM Watson, and they will directly understand the database format.

One of the key points of the JSON store is that there is a single implementation that works everywhere: servers (Windows, Linux, OS X, etc…), and mobile devices. The same code runs in both environments. Moreover, these disparate environments can replicate data.

# Server

Even on a mobile device, you have the Server. The server is the entry point to the database. All database operations starts from there. The Server is, in effect, the database itself; the Server encapsulates the connection to a physical RDBMS. It points to your DB2, your SQL Server, your PostgreSQL, or to your SQL Lite. When you connect to an RDBMS on the server, you will specify the JDBC path and user password that the runtime can use to access the data.

# Session

When you want to do this through a Darwino server, you have to do it through a Session object, and a Session object is related to a particular user. The reason for the Session object is to allow different users to share the same server, as in a web application supporting multiple simultaneous users.

The app itself will use one database server but multiple Sessions. The Session, created from the user's ID, is what will be used by the runtime to apply security to the data. This is an important concept because the server connects to the physical relational database with one single user and password, which means that this user and password can access all of the data. The security is then applied by the Darwino runtime through the Session object.

# Database

Then comes the organization of the data. The data are organized into databases; but we should not confuse that with the relational database file. Here, it's a document database. A database is a set of documents with common characteristics.

# Stores

The store is a container for JSON documents. That allows you to put documents into different "buckets" that have different characteristics, such as different indexing strategies. For example, in a CRM application, you may have one document that is a Customer, and another that is a Product. You would not want to apply the same indexes to these documents. You can specify further customization for a store, such as whether full-text search is enabled.

## Pre-defined stores

In the database definition are four pre-defined stores. These stores are created automatically by Darwino and can be utilized as-is, but they can also have their definitions overridden and customized (by adding indexes or fields, for example). It is always possible to create specific stores for these stores' purposes; these pre-defined stores exist as a convenience.

- _default: This store can act as a placeholder. There is no index or field extraction for this store by default, but it can be used for quick-and-dirty storage of data.

- _local: This store is identical to the _default store, except that it is never replicated. It is useful for, among other things, storing device-specific data on a mobile device.
- _comments: The social data Comments are stored here by default. Storing comments here instead of inside the documents themselves avoids having the documents marked as modified every time a user adds a comment. It also avoids replication conflicts on the documents when multiple comments are added in a short period of time. Also, because comments can be complex, even including attachments, storing them here avoids making the documents overly complex.
- _design: Not currently used, this is a special store used to store design elements of the application.

# Document

Then, there is the document. In Darwino, a document is four things:

- JSON data. It's not necessarily a JSON object; it could be a JSON array. Most of the time it will be a JSON object; making it a JSON object is a best practice, because doing so is necessary to allow use of features such as tagging, or reader/editor security. These are system fields added at the root of the document, thus implying that the root object is a document.
- metadata.: the UNID, creation date, last modification date, creator name, last modifier name. There are also several replication-related metadata items, but these are generally not of interest to the developer. These include the last replicated time and the sequence ID used in detecting replication conflicts.
- Potentially, a set of binary attachments. The attachments consist of binary data identified by name, and with an associated MIME type so that consumers can know what to do with the data. A single Darwino document can have multiple attachments, but the attachment name is the key so there cannot be two attachments with the same name in a single document. Attachments are generally stored in the relational database, in a dedicated table, and referenced from the document. Now, this can be customized and the files can be stored elsewhere, like the file system or a content management system. In addition to the attachment name and pointer, Darwino also stores a length and a size, plus some replication-related information, and an ETag used is to minimize downloads.
- A set of social data. Darwino, by default, it social-enabled. You can rate a document, you can share a document, you can vote for a document, you can tag a document. The social data is ABOUT the document, but it is not stored IN the

document. The social data is stored in a separate table, and it is user-based: if five users rate a document, there will be five records in the social table, one per user, all referencing that document. The table is replicated along with the documents. There is one exception to this separation of the social data from the document's JSON data: tags. Tags are stored in both the document and the social table. In the document, the tags are stored in the field called "_tags", making them easy for an application to edit. When the document is saved, the values are copied to the social table.

## Document Hierarchy

Documents can be organized hierarchically. Every document can have a reference to a parent document. That reference is stored in the document's "_parentid" field. This field is accessible for read/write through the API.

The parent document must be in the same database as the child. There is a specific syntax for this field: when the parent is in the same store, then the value is just the parent document UNID. When the parent is in a different store, then the syntax is UNID:STOREID.

> Note: The system does not enforce the validity of the parent. This can lead to document pointing to non-existent parent. In this case, they are called "orphan" documents.

Darwino also has the concept of a "sync master" document. If a document has a sync master sdefined, then when that sync master is modified, and only when the sync master is modified, the child document will be subject to replication along with the sync master.

> Note: While typically it would be, a sync master does not have to be an ancestor of the documents that refer to it as their sync master. There are other relationships beside parent/child that can benefit from the sync master technology; for example, all documents associated with a particular project could be linked in thso way, whether or not they are hierarchically related.

## Document security

Darwino implements multi-level security. You can assign security to the Server object; you can control who can and cannot access the server. At the database level, you can

assign an ACL. In the ACL, you can define who can access the database, manage the database, read documents, create documents, delete documents, and edit documents. At the Document level, you can maintain a list of users who can read or read/write the document.

# UNID

Documents have two identifiers: the UNID and the docID. The UNID is a string provided either by the API when creating the document or, if it's empty, then it is generated automatically by the system. When you create the document, you can pass the ID or allow it to be generated. A UNID must be unique per store; this is enforced by a database unique index. When there are two replicas, for example one on the server and one on a mobile device, the UNIDs will match.

> Note: The parentID is used to identity the document's parent. It is the UNID of the parent.

# docID

The docID is an integer that is unique inside the database. It is generated by the system; you cannot specify it when you create the document, and it cannot be changed. Being an integer makes it much more efficient in database operations than a string such as the UNID.

However, the docID is not universal; it won't be the same in two different replicas. Because of this, you should not store it for programmatic use and try to rely on its always applying to that document. docID are used internally because in the database each document maps to a set of relational tables; the relations between these tables are expressed most of the time through the docID because it's much more efficient than the UNID.

# Darwino DB API

# Defining and deploying the database

A Darwino database is actually a set of tables within a relational database. The schema of these tables does not depend on the Darwino application. You can create tables, for example, at the application level and the actual database schema will always be the same. The schema is defined by Darwino. This is important because in some organizations altering tables' schema is strictly controlled. They require that a new DDL be submitted for the administrator to apply. With Darwino, no new table definitions are necessary… UNLESS you want to add additional indexes.

# Configuring the database using managed beans

There are two very important points in the Darwino philosophy here.

The first is that Darwino is built in layers, and you pick the the layer you want to use. It's better and more effective when you pick the highest-level one.

The second is that there is nothing that is hard-coded. Everything is provided by extension points. Extension points can rely on managed beans. For example, the connection to the database is defined through beans. But this is not the only way to define your connection. There is an extension point for defining your connection, and one default implementation of the extension point is looking for beans. Everything in Darwino is built upon extensions, and to find the extensions there is the notion of a plugin. A plugin is a class that can be provided by your application or by a library and that add implementation for extensions. Extensions can be contextual to a platform or not. For example: the location where managed beans are found is provided by an extension point, because on a mobile device you won't find the beans at the same place as on a J2EE server. On the server, this is done via the J2eePlatform.java plugin.

# Darwino DB API

# Documents

# CRUD operations

It is possible to perform create, read, update, and delete operations on documents. At the base, the Darwino API is a Java API. There is also a JavaScript API which is a JavaScript flavor of the Java API. To do CRUD operations, you get the session and from that the database and store, and there you create, read, update, and delete documents. As long as you're using the Java API locally, you can execute a series of operations within a transaction. At the session level, you can query whether the session supports transactions. If it does, you can start a transaction, perform a set of operations on documents, and then roll back the changes if needed. This is familiar to users of many relational databases, but is alien to Domino and mongoDB.

There are three ways, in Darwino, to access documents:

- The Java API. This API talks directly to the database whenever it is a JDBC-based database, or is SQLite.
- REST services, which operate on top of the Java API. The set of REST services in Darwino support everything the Java API allows in regard to document operations EXCEPT transactions. Because REST is stateless, transactions, which are stateful, cannot be supported.
- REST services wrapped for particular languages. Darwino provides two wrappers to assist in REST service work: a Java wrapper and a JavaScript wrapper. The Java wrapper is the Java API, but instead of being implemented to deal directly with the JDBC driver locally, it deals with the REST services. Nonetheless, it is the exact same API. The only difference is how you get access to the session. The JavaScript wrapper in intended for use in a JavaScript environment such as a browser or a server-side JavaScript environment like node.js. In the future there could be other wrappers, just as PHP bindings, Ruby binding, etc…

# Access to the JSON content

The JSON document in Darwino is more than a JSON object; it has several components:

- JSON content – typically a JSON object, but it could also be a JSON array. IT is unusual for it to be anything other than a JSON object, because only the JSON object supports use of system data that can be of use to Darwino.
- optionally, attachments
- metadata – For example, the unid and the docid, modification date and modification user, etc… These metadata are not modifiable manually by normal operations.
- system data that can be modified – For example, a list of tags. System fields are actually fields in the root of the JSON content object, but their names start with an underscore. optionally, transient property fields that can contain data we want to pass to document events but never want to store in the document. They are never saved. They can be set and read at the document level, but they are never persistent. A typical use of this is when you want to pass information to an event handler without having this information be part of the document.

  Methods are provided for accessing the JSON content in all data types. They all take a String as their sole parameter, and return the value of the requested JSON field, assuming that the content is a JSON object. These methods cannot access hierarchical data, but they are very convenient for accessing fields that are at the root of the document.

- getString(), getInt(), getLong(), getDouble(), getBoolean(), and getDate()

  In addition, there is a method for executing JSONPath (XPath for JSON) expressions. JSONPath simplifies the extraction of data from JSON structures. It permits dot notation and bracket notation, and allows wildcard querying of member names and array indices. It is documented here. JSONPath expressions can be executed in Darwino via the jsonPath method:

- jsonPath(Object path)

# Managing attachments

Every document can have a set of attachments. The methods for working with attachments are at the document level. Working with attachments is optimized; the

attachments are loaded only when needed. When you create or update an attachment, nothing actually happens until you save the document. If the document save is part of a global transaction, then the work is postponed until the transaction is executed.

Document methods for Attachments:

- getAttachmentCount() returns the number of Attachments
- getAttachments() returns an array of Attachments
- getAttachment() returns the Attachment
- attachmentExists() – returns a boolean
- createAttachment(String name, Content content) – populates the content of the Attachment with the specified Content object, which can be Base64Content, ByteArrayContent, ByteBufferContent, EmptyContent, FileContent, InputStreamContent, or TextContent.
- deleteAllAttachments() – removes all Attachments

Attachment methods:

- getName()
- getLength()
- getMimeType() returns the MIME type of the content. If it wasn't set when it was created, the system will base the returned value on the extension of the attachment's filename. If there is no interpretable extension, it will assume binary.
- update(Content content) updates the content of the attachment
- getContent() returns the content of the attachment as a Content object.
- getInputStream() returns the content of the attachment as an InputStream There are three "readAs" methods intended for convenience, but are not meant to be used with large attachments. They are not as efficient as working with an InputStream:
- readAsBase64()
- readAsString()
- readAsString(String encoding)

The Content object has four methods:

- getMimeType()
- getLength()
- createInputStream()
- copyTo(OutputStream os) A Content object is an accessor to the data; it is not the data itself. This means that when creating attachments, the Content object does not

actually load the data into memory until the document is being saved. Until then, it merely points to the data. This is an important performance consideration.

# Document Metadata - System data in the JSON document

Data describing the document itself, such as tags and other social data, and reader/editor names, are stored in system fields, the names of which start with an underscore character.

# Response documents

The parentid field contains the unid of a document's parent, if there is one. This is how a hierarchy of documents if defined in Darwino. The data integrity of this relationship is not enforced; it is possible to have "orphan" documents– documents with a parentid that is not valid.

# Synchronization master document

Darwino implements "functional replication". This means that selective replication can be based on changes to an ancestor document, as opposed to the current document. The synchronization master for a document is the document that is checked for changes when the replicator is testing for selective replication eligibility. For example, child document might use the root parent document as their synchronization master. Then, when the root document changes, and only when it changes, will the child documents replicate as well.

There is an option for the save() method that forces the master document to update when a document referring to it as master is updated. There are options at the Store definition level as well.

It is not necessary for a synchronization master to be an ancestor; other document relationships could benefit from the ability to specifically define under what circumstances they will replicate as a group. For example: a customer and all the documents related to this customer, or all documents related to a particular project.

# Darwino DB API

# Cursors and queries

Cursors facilitate the selection of document sets from the database, and the extraction of data from the selected documents. You specify what you want to extract, and then you process the result. When you process the result, there is only the current entry in memory; it doesn't load everything into memory and iterate through that set. The cursor lets you step through the results one by one. The exception is when it is done through HTTP. Because HTTP is stateless, results are paged and multiple documents are loaded at one time. When it's local, though, it is able to deal directly with database cursors. This is for performance reasons.

> Note: A cursor is forward only. You cannot browse the resultset backwards.

A cursor consumes a database connection; thus, it has to be recycled when it's done. To avoid reliance on the intermittent garbage collector, Darwino provides a callback to the cursor. The Cursor calls this cursor handler for every result. For example, when iterating through a result set, you call find(), passing a CursorHandler. The CursorHandler has one method, which is handle(), which handles the CursorEntry. The cursor is allocating the database connection, executing the SQL query, calling the CursorHandler for every result, and then closing and recycling the database connection.

There are methods designed for dealing with the subset of documents that are represented in the collection. For example:

- deleteAllDocuments(int options) – Will delete all of the documents not by iterating through and deleting each one-by-one, but instead will generate a SQL query to do the job in one fell swoop.
- markAllRead(Boolean read) and markAllRead(Boolean read, String username) will mark the cursors documents as read, either by the current user of by a particular username.

# Query and extraction language

To calculate aggregate data, such as average, minimum, and maximum, pass an aggregate query to the cursor. For example:

```
{ Count {$count: @manufacturer”}, Sum: {$sum: “@released”}, Avg: {$avg: “@released”}, Min: {
```

When a cursor runs, it calls the cursor handler with all of the cursor entries. In the cursor entry are the key and the value, accessible via getKey() and getValue(). What these two represent depends on the source of the cursor. A cursor executed on a store will have documents as its result, the key will be the unids of the documents, and the value will be the JSON of the documents. If, instead, the cursor was executed on an index, then the key will be the key of the index, and the value will be either the value that’s stored in the index or the JSON value from the corresponding documents, depending on an option applied to the cursor.

> (Question: Must provide examples of query options. Where is this best documented?)

# Executing a query

A cursor is created at either the store or the database level. The store’s openCursor() method returns a cursor on which you then apply the selection condition. The Cursor methods return the cursor itself, which means that the methods can be stacked. For example:

```
Cursor c = index.openCursor().ftSearch(“version”).orderByFtRank().range(0,5)
```

This will perform a fulltext search on “version”, order the result by rank, and return the first five entries.

## Cursor Options

It is possible to query by tags. This is done by passing a list of tags and specifying via the TAGS_OR option whether to perform an “and” or an “or” with the tags. DATA_READMARK adds a flag to every cursor entry indicating whether the entries have

been read by the user executing the query. DATA_WRITEACC adds a flag indicating whether the current user can edit the documents.

## Hierarchies in Cursors

The query engine natively understands Darwino document hierarchies, and the Cursor takes advantage of that by allowing cursor queries to apply to only root documents and not the associated response documents. In other words, a cursor query can test for values in the root documents, and then return the matching root documents along with their responses, regardless of whether the responses match the query condition or not. The CursorEntry objects returned by the cursor will have an indentLevel property (an int) that identifies where they lie in the hierarchy, with 0 indicating a root document.

The range() method which, given a number to skip and a number to return, will return a subset of a curser's entries, can be controlled via the Cursor options (by specifying RANGE_ROOT) to apply the skip and limit parameters only to the root documents, and to then return all associated response documents, without regard to the limit parameter.

## Cursor Sorting Options

orderBy(String…fields) sorts cursor results by field. This can be an extracted field or a system field (for example, _unid or cuser). If the RDBMS supports JSONQuery, then a JSON reference can be used can be used, such as a JSON field name or a direct path to a JSON field. Optionally, the sort order can be specified by appending a space and the text "asc" or "desc" to each field/path value. For example: .orderBy("@state desc", "unid") will sort by state descending, then by unid ascending (that being the default).

The fulltext rank can also be used for specifying the order in a cursor, by use of the orderByFtRank() method.

The ascending() and descending() methods can be applied to both the orderBy() and the orderByFtRank() method results.

## Categorization

In a cursor, categorization is based on the sort order. If no order is specified, and if there is no index, the unid is used. Categorization is completely dynamic, being based on the sort order which is not fixed.

The .categories(int nCat) method takes as its parameter the number of category levels to apply.

It is also possible to request that the documents not be extracted in the cursor; in this case, the result will consist only of the categories. This is equivalent to "GROUP BY" in SQL.

Another option is to extract categories while skipping the highest level categories. For example, extract two categories, but start at the second-level category, returning levels two and three.

### Browsing the entries:

There are two ways to execute a cursor:

- Call find(), passing a Cursorhandler. It will execute the query, returning the entries one-by-one and calling the Cursorhandler for each.
- Call findOne(), if you are sure there will be only one entry returned, or if you are interested only in the first. There is no need to pass the callback Cursorhandler.

There are equivalent methods, different in that they extract the document object, allowing it to be updated and saved back to the database. Extracting a whole document has an extra cost compared to just loading the cursor entries.

The count() method will return the number of entries in the cursor. Behind the scenes, Darwino executes a SELECT count(*) on the table, which can be costly on large data sets.

## Optimizing queries

The query language is robust, with a lot of operators, and is optimized for the underlying database system. It will attempt to use only native database functions when constructing its SQL; if necessary functions not supported by the database, it will still use those that ARE supported for parts of the query. For example, if there is an “AND” in the query, and only one condition is directly supported by the database, the query language will execute that part of the query first and only then iterate through the results one-by-one.

The query language’s API makes it so the cursor can be queried to determine whether a

particular query is supported by the database. It compiles the query and answers whether it can generate SQL for the query, or it can generate partial SQL, or it cannot generate SQL.

> (Question: The data extraction language is important. Is there documentation available that would help me do it justice here?)

# Darwino DB API

# Accessing and storing social data

There is a set of social data that can be associated with any document. There are three kinds of social data:

- Comments: Darwino creates a default store for the comment data. Keeping comments out of the documents themselves prevents unnecessary updates to the documents which then must replicate and could result in conflicts. Moreover, comments can contain full JSON content with attachments.
- Tags: The tags are stored as an array in the _tags field in the document. The tags can be queried, and the store can return a list of tags that can be used, for example, to create a tag cloud.

  Private tags, visible only to their creator, can be stored as read-protected response documents associated with the document being tagged. Because they are read-protected, they will be private to that user. Because the store's list of tags respects this security, only the private tag's creator will see such a private tag in a tag cloud.

- User-dependent values, which are handled at the store level. These don't require that the document be loaded for them to be applied, and they are stored externally to the documents in order to avoid unnecessary document modification, replication conflicts, and excessive data in the documents (there can be a lot of ratings and read flags): -- Ratings: With the rate() method, a document is assigned an integer value associated with a user. Appropriately, only one rating per document per user is stored. There are three methods for retrieving rating data:

  - getRate() – Given a unid and userName, returns that user's rating for the document
  - getRateAvg() – Given a unid, returns the average rating from all users for the document
  - getRateSum() - Given a unid, returns the sum of all ratings for the document, for example to count votes where ratings would be defined by the application to range, say, from -1 to 1.

-- Sharing: With the share method, a unid and username sets a Boolean flag indicating whether the document has been shared by that user. It is similar in concept to a Facebook “like”. Two methods exist to interrogate shares:

- isShared() – Returns a Boolean indicating whether the document is shared by a specified username
- getShareCount() – returns the number of shares by all users as an integer

-- Read: While not specifically social, the read flag is functionally similar to the other social data. At the store level, the readMarkenabled option enables the auto-flagging of documents as being read when they are loaded. This applies only to documents that are actually loaded; their being included in a query result is not sufficient to mark them as read. A document load() option can also prevent the flag from being set, when necessary. There are three methods in the store to enable manipulation and querying of the read flags: -- isRead() returns the read value for the specified document and username -- markRead() - Given a unid, a Boolean, and a username, sets the read flag for that document and user. -- getReadCount() – returns the number of reads for the specified document.

There are two ways to access this social data. The methods at the store level require the unid and the username, in addition to any flags being set, to identify the document. The same methods are available in the Document object, where they do not require those two identifying parameters. Which set of methods you choose will depend on the context. If you have the document loaded, then use the Document methods, if just for simplicity. If you’re in a view, use the Store methods since they will be significantly more efficient (they will not require loading the documents).

This social data can be used in extracted fields in the documents, making it easy to created indexes based on their values for querying and sorting.

# Darwino DB API

# Registering and handling events

At the Server Object level, you can register an ExtensionRegistry. This registry provides a set of functions – currently a set of five:

- BinaryStore: When Darwino stores attachments, they can be stored inside the database, or apart from the database. The BinaryStore is an interface that facilitates storing the attachments outside of the database by providing a set a CRUD methods.
- DocumentEvents: When an operation is being performed on a document, the runtime will call the methods in the DocumentEvents: -- postNewDocument – called right after a document has been created, so that you can, for example, change document values. -- postLoadDocument – called right after a document has been loaded. -- querySaveDocument– called immediately before a document has been saved. It is possible to cancel the save from within this event simply by throwing an exception. The exception can include the reason for the save cancellation. -- postSaveDocument – called immediately after a document has been saved. -- queryDeleteDocument – called before a document is deleted, EXCEPT when a group of documents is being deleted. Group deletes are performed directly by a SQL statement, and for performance reasons, and so this event is not raised. -- postDeleteDocument – called after a document delete, except, as with queryDocumentDelete, when a group of documents has been deleted. IN such a scase, you could add a trigger at the relational database level to, for example, log the deletion in a queue for processing.

  Note that these events are also raised when called via HTTP.

  Transient properties set at the document level can be accessed from within these events, despite the fact that these properties are never saved.

- SynchronizationEvents: As synchronization is taking place, this set of events will be raised, allowing customization of the synchronization actions. Like the DocumentEvents, code here can manipulate values or cancel the action altogether.

-- queryCreateDocument -- postCreateDocument -- queryUpdateDocument -- postUpdateDocument -- queryDeleteDocument -- postDeleteDocument

In addition, there are events related specifically to synchronization conflicts. Code here can customize the action to be taken during conflicts.

conflictAction – raised when the runtime has detected a synchronization conflict, this event provides information about the conflict, including what changed in the source document and what is in the target document. Code here will return an ConflictAction, which will be one of the following: -- DEFAULT – the default handler should be applied -- SOURCE – the source should win -- TARGET – the target should win -- CUSTOM – call the handleConflict method, where the conflict can be handled by custom business logic. For example, in an HR application where several people interviewing an applicant each have access to a different section of the document. In this case, you would choose to merge the different sections.

- FieldFunction: Functions used when extracting fields from documents or computing indexes are registered here.
- InstanceFactoryImpl: A database can have multiple instances, each with its own security configuration; in other words, there is per-instance security. That instance security is dynamic, based on business logic.

> NOT CORRECT! Must discuss: By default, a database has just one instance; the instance factory is the means to create more. Once the instance factory has been implemented and the instance is created based on the database and the instance name, the contribute() method of the instance is the mechanism for adding roles and groups to the user context.

For example, the ACL of a database, and the reader/writer fields in the documents, may specify that only the members of a particular group may have access to the data. It is the job of the instance's contribute() method to add to the current user their list of roles and groups; this list is determined dynamically depending on business logic, and that logic is free to make use of any directories and database data available to it.

There is a default implementation of the ExtensionRegistry called DefaultExtensionRegistry. Use this to associate particular document event handlers with specific database stores. Once you create an instance of the DefaultExtensionRegistry, its registerDocumentEvents() method can be used to define specific cases of the document events. By specifying the database and store, you define which document

events you want to override; for example here you would code your custom querySaveDocument event.

```
Public class AppDBBusinessLogic extends DefaultExtensionRegistry {
    registerDocumentEvents(“<My Database Id>”, “<My Store Id>”, new DocumentEvents() {
        @Override
        public void querySaveDocument(Document doc) throws JsonException {
        }
    });
}
```

You can register events globally, and at the at the database level, and at the store level. If an event is registered at the store level, that is one that will be called for documents in that store. If, instead, there is no event registered at the store but there is one registered at the database, then the database registration will be in effect. The most-local (most precise) registration is the one that is used.

This is also the case for registered field functions.

# Darwino DB API - Security

# Database security

Darwino implements multi-level security. You can assign security to the Server object; you can control who can and cannot access the server. At the database level, you can assign an ACL. In the ACL, you can define who can access the database, manage the database, read documents, create documents, delete documents, and edit documents.

# Document security

At the Document level, you can maintain a list of users who can read or read/write the document. Document security is based on a simple set of rules involving fields specifying read-only and read/write access. Entries in these fields can be the names of users, roles, and groups.

There are four types of document security fields:

- reader
- writer
- excluded reader
- excluded writer

The same principles apply to both readers/writers and excluded-readers/excluded-writers.

## 1 - Entries

Each entry can be:

- a person
- a group
- a role
- everybody, *

An entry can be read-only (reader field) or read/write (writer field). A writer entry is automatically a reader as well. If an entry appears in both the readers and writers, then it is a writer.

## 2 - Security behavior

If there are no entries attached to a document, then there is no document security. The user's access to the documents will be determined solely by the higher levels (database and server). If there is at least one entry (reader or writer, or both), then there is document security. If everybody should be a reader and while writers should be limited, the solution is the following:

- writers entries should contain the limited list
- reader should contain one entry: everybody *

## 3 - Storing readers/writers

Readers are stored in the _readers field, while writers are in _writers. These fields can directly contain an array of entries (see "1 - Entries") or an object containing several arrays, one per property.

For example:

```
{
_readers: ['carol', 'ted'],
_writers: ['alice']
}
or
{
_readers: {
        field1: ['carol', 'ted'],
        field2: ['bob']
},
_writers: ['alice']
}
```

Having sub-objects is the preferred method, as it allows a finer-grained management of the entries. For example, a workflow engine can add a field containing the participants for the current step, and this can be removed after the step is completed.

## 4 - Helpers

There is a Java class, SecurityHelper, that can be used to manipulate these fields. They are used, for example, in the CRUDSEC.java unit test.

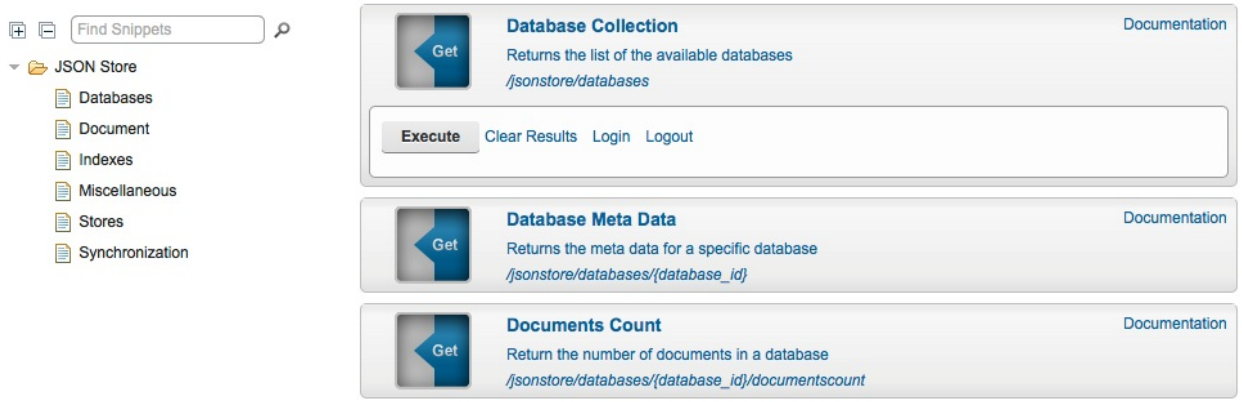
Regarding excluded-readers and excluded-writers: Darwino, when composing a SQL query, adds a subquery to exclude what is not allowed to be seen. This incurs a cost. To avoid this when possible, there is a database property indicating whether document security should be enabled. When it is not enabled, generated queries can avoid the step of running the subquery. A result of this is that if the flag is not set, readers and writers on documents will be ignored in all of the database's stores. Options for this property are: no document security, reader/writer security only, ereader/ewriter security only, and all security features.

# Darwino DB API

# REST API

All of the features of the JSON store are exposed through REST services, and the REST services are wrapped in the various language binders. The REST services are optimized for performance and designed to be easy to use. They execute in different environments, server-side and in the mobile device, and can be coded once and run in multiple platforms.

In the Darwino Playground is an API Explorer; this can be used to experiment with the REST Services' capabilities. All of the services are covered there, with documentation for all of their parameters.




The Darwino framework allows the REST services, available by default, to be disabled at the database level, or to be overridden and enhanced. By overriding the service factory, is it possible to permit access dynamically based on the database, store, and current user.

There is also a DocumentContentFilter interface for the REST services that allows dynamic filtering of the document data that is being produced, typically for security purposes. Along with that is a feature of the API that allows reconciliation of filtered documents upon save, so that if a section was filtered for presentation, that filtered data is not lost from the document when saving.

The REST services can be extended to accommodate JavaScript components, jqGrid

for example, that expect the JSON they're consuming to be in a particular format. One way to satisfy such a component would be to transform the JSON client-side, but that is not particularly convenient or efficient.

Using Darwino's JsonStoreServiceExtension, custom REST services can be defined and the existing REST services' output can be modified. Being server-side, the Java API can most efficiently render the JSON as needed before it is emitted.

# Darwino DB API

# Darwino API over HTTP

The entire JSON store API is exposed through REST services. Everything is supported except transactions, due to the stateless nature of HTTP. There are wrappers for Java and JavaScript, with more to follow.

You start with the session, and from the session you get access to all of the functions, and it’s either going locally or it’s going remotely through REST services. If you are going to be generating a lot of database accesses, you should do that on the server through custom REST services in order to minimize the number of remote calls. It is good to avoid using the Darwino API to perform a lot of remote database transactions. As a general rule, put the business logic server-side and call it through REST services.

# JavaScript APIs

# 1 Loading the Javascript files

For every Java interface in Darwino, there is a corresponding JavaScript interface. The JavaScript implementation's source is compacted and compressed into one file: Darwino.js. This is the one file to include in applications; there is no reason to include the non-compressed files.

```
<script src="$darwino-libs/Darwino/Darwino.js"></script>
```

Note: While it won't break anything to load the JavaScript library more than once, it should be avoided because the browser will waste time loading and parsing it.

The JavaScript API can be explored in the "JavaScript Snippets" section of the Darwino Playground.

# JavaScript APIs

# 2 Generic APIs

Darwino uses the namespace “Darwino”. Everything that belongs to Darwino is within the Darwino object. This cannot be changed.

Included in the darwino.js is Darwino.jstore, which is an entire JSON store API. This is the entry point when you want to use the JavaScript wrappers for the JSON data store.

You can directly call the JavaScript services, or you can use these wrappers, or you can use both. It’s a matter of convenience.

From darwino.jstore, you can call createRemoteApplication(), passing it a url for where the Darwino runtime is running (for example: “$darwino-jstore”). This returns a pointer to the remote server. From that, you can call createSession(). With no parameters, it creates a session for the anonymous user, or, if logged in, for the current authenticated user. Passed a username and password, it will create a session on behalf of the specified user. Every operation performed from that session will use the rights and identity of the session’s user.

Once you have the session object, you have the exact same API capabilities that you have in Java. There are, however, several details that are specific to JavaScript:

- The system constants (for example “SYSTEM_READERS” and “SYSTEM_WRITERS”) that are defined in Java are also defined in JavaScript. They are accessible through standard dot notation, as in: Darwino.jstore.Database.STORE_COMMENTS

- JSONPath is implemented in JavaScript as it is in Java.

- Another point specific for JavaScript is the way we handle binary content. Because JavaScript is restricted to manipulating the binary data as Base64, it is more efficient to do such work on the server in Java via REST services and just display the value, or values, or links inside the HTML. JavaScript is not designed for this.

- Synchronous vs. Asynchronous calls To create an application that is responsive and not often blocking the user you have to use asynchronous JavaScript, which means that when you call a service you're not blocking the UI thread. The entire JavaScript Darwino API allows you to do asynchronous calls. You may choose to do either synchronous or asynchronous calls, but synchronous calls should be used only when the application demands them. Asynchronous is the default; if you want to do synchronous calls, you have to pass parameters, either at the session to change the default (session.Async(false);) or with each individual call.

  By default, when you call a JavaScript function that triggers a call to a service, what it returns is a promise. The latest generation of browsers supports promises, but because not all browsers do Darwino provides an A+ Compliant version that is backwards-compatible with older browsers.

  A promise is a call that will eventually be executed. For example, session.getDatabase() will return a promise. The promise itself has a "then" method which takes as its parameters a function to execute upon successful completion of the promise, and a function to execute in the case of failure.

  Promises can be chained.

  Some functions, such as getDatabase(), will return a promise, while others, such as getStore() will return a real value. There is no way to differentiate between the two type other than the fact that if a function has a parameter called "header" then it is an asynchronous function and will return a promise.

  The Darwino Playground is a resource for examples of synchronous and asynchronous calls and promise handling.

```
 var s = "";

session.getDatabase("playground",null,function(database) {
  var store = database.getStore("pinball");

  // The document is loaded asynchronously
  store.loadDocument("1000", null, function(doc) {
      s += ">> Document\n"
      s += "  Unid: "+doc.getUnid()+"\n"
      s += "  Id: "+doc.getDocId()+"\n"
      s += "  Json: "+doc.getJsonString()+"\n"
      darwino.Utils.setText("content","{0}",s);
  });
```

```
  // This document does not exist
  // So the function is only called in case of success
  // Nothing happens in case of an error
  store.loadDocument("1000FAKE", null, function(doc) {
      s += "!!! Should never be displayed as the document does not exist\n"
      darwino.Utils.setText("content","{0}",s);
  });

});

s += "Loading document...\n"

darwino.Utils.setText("content","{0}",s);
```

# Developing a Darwino J2EE Web Application

To support a Darwino J2EE application, you need to have an application server such a Tomcat or WebSphere that supports the Servlet API.

Darwino provides a broad set of features and support services to a web application. It is possible to create an application that makes use of Darwino DB without using the other services that Darwino provides, such as creating connections and handling replication, but by using the pre-built services in the full Darwino package, the programmer will avoid a lot of unnecessary work.

# 1 Application initialization

The Darwino application object should be initialized before anything else. In order to create the application, the context listener must be included in the web.xml:

```
<!—Application initialization -->
<listener>
    <listener-class>
        demoApp.app.AppContextListener
    </listener-class>
</listener>
```

The listener is called when the application is started, and again when it is stopped. The listener will create the application object, and destroy it when it is no longer needed. It can also be used to initialize the relational database by creating the tables, assuming that th eRDBMS user has the rights to modify the database schema.

```
<context-param>
     <param-name>dwo-auto-deploy-jsonstore</param-name>
     <param-value>true</param-value>
</context-param>
```

In practice, the developer will create their own class, extending AbstractDarwinoContextListener, where they will handle their application’s initialization needs, and refer to that class in the web.xml so that it is called.

The DarwinoServiceDispatcher By default, a set of services is created by Darwino, such as the service to access the JSON store. This is done by the service dispatcher. It is possible to override the dispatcher. It contains a set of methods that can be disabled or added to.

```
Protected void initServicesFactories(HTTPServiceFactories factories) {
  addResourceServiceFactories(factories);
  addLibsServiceFactories(factories);
  addJsonStoreServiceFactories(factories);
  addSocialServiceFactories(factories);
  addApplicationServiceFactories(factories);
}
```

It is also possible to register custom services by using an extension point.

# Darwino Application filter

The Darwino context should be created when a request comes in, and it should be deleted when the request is satisfied. In order to provide the context for an application request, a J2EE filter specified in the web.xml is called. This filter must be specified immediately after authentication (if Darwino is handling authentication) in the web.xml file so that it is executed before any others. Only in this way can subsequent filters have access to the context created here.

```
<!-- Filter for creating the Darwino Application, Context and DB session -->
<!—The filter must be first so all the other filters can access the app -->
<filter>
    <filter-name>DarwinoApplication</filter-name>
    <filter-class>com.darwino.j2ee.application.DarwinoJ2EEFilter</filter-class>
</filter>
<filter-mapping>
    <filter-name>DarwinoApplication</filter-name>
    <url-pattern>/*</url-pattern>
</filter-mapping>
```

The filter is executed before all else when a request comes, and last when a request is handled. Because this is first in line, it can do processing before the request is even seen by the servlet, and then again after the request is processed.

The filter is typically executed for all requests, but the filter mapping allows the filter to be executed conditionally.

# Darwino libs and URL rewriting

The DarwinoRewriting filter transforms some urls such as “$darwino-libs” into an actual path. This remapping enables platform independence without requiring code changes to accommodate different platform configurations.

This filter can also perform HTML rewriting. When the HTML is served to the client, it can be transformed. This is useful in CDN scenarios, where the urls being sent to the client may need to be modified to point to alternate locations.

```
<filter-name>DarwinoRewriting</filter-name>
<filter-class>com.darwino.j2ee.servlet.resources.DarwinoGlobalRewriterFilter</filter-class>
</filter>
<filter-mapping>
    <filter-name>DarwinoRewriting</filter-name>
    <url-pattern>/*</url-pattern>
</filter-mapping>
```

# Serving application resources

In order to determine which requests should be handled by Darwino services, this filter analyzes the incoming requests, looking to see if there are internal services to handle them, and delegates them to Darwino if appropriate and passes them along if they are not.

This service is for serving 'static' resources, like HTML, CSS, JavaScript, etc... It ensures that it works on all the platforms, including J2EE and mobile. It serves the resources located in the platform specific directories (ex: web app for J2EE, assets for Android...) but also the ones packaged in the jar files under /DARWINO-INF/resources. (META-INF/resources cannot be used on Android).

Also, depending on the execution mode (development vs. production, as defined at the Platform object level), it can choose to load the minified version of the files or the full commented one. The minified versions have a ".min" inserted to their path, like myfile.min.js or mytheme.min.css.

```
<filter-name>DarwinoServices</filter-name>
<filter-class>DWOTPL_PAGEAGENAME.app.DarwinoServiceDispatcher</filter-class>
</filter>
<filter-mapping>
    <filter-name>DarwinoServices</filter-name>
    <url-pattern>/*</url-pattern>
    <!—DarwinoRewriting can trigger a forward -->
    <dispatcher>REQUEST</dispatcher>
    <dispatcher>FORWARD</dispatcher>
</filter-mapping>
```

# Enabling GZIP compression

Not all web servers implement GZIP. You can use this filter to have Darwino process GZIP requests and return GZIP content. This can work for requests as well as response content.

```
<filter-name>GZipFilter</filter-name>
<filter-class>com.darwino.j2ee.servlet.gzip.GZipServletFilter</filter-class>
</filter>
<filter-mapping>
    <filter-name>GZipFilter </filter-name>
    <url-pattern>/*</url-pattern>
    <dispatcher>REQUEST</dispatcher>
    <dispatcher>FORWARD</dispatcher>
</filter-mapping>
```

# Enabling CORS

To have Darwino implement the CORS (Cross-Origin Resource Sharing) standard, enable this filter. This provides support for cross-site access controls.

```
<filter-name>Cors</filter-name>
<filter-class>com.darwino.j2ee.servlet.cors.CORSFilter</filter-class>
</filter>
<filter-mapping>
    <filter-name>Cors</filter-name>
    <url-pattern>jsonstore/*</url-pattern>
    <dispatcher>REQUEST</dispatcher>
    <dispatcher>FORWARD</dispatcher>
</filter-mapping>
```

# Authentication and Authorization

Security can be done at the web application server level, for example with J2EE's Container security or WebSphere's Administration Console. Alternatively, it can be handled via Darwino's authentication filter.

Darwino's authentication filter provides basic authentication and form-based authentication, and it can work with a directory implemented as a Darwino database.

> (Provide examples)

# Developing a Darwino Mobile Application

# General information about mobile application

Creating a mobile application in Darwino is like creating a J2EE application, except that instead of building a project that generates a WAR, you build a project that generates whatever the mobile device is expecting: an APK in the case of Android, or an IPA for iOS.

Because Darwino uses the Android and RoboVM SDKs, the projects that the Darwino wizard generates for those platforms must include what those SDKs are expecting.

When creating a mobile app, the wizard offers a choice of either native app or hybrid app.

# Mobile Manifest

Contains the information consumed by the mobile applications, for example: replication.

# Hybrid applications

A hybrid app will include all of the Darwino services, including the embedded HTTP server. This is what allows the app to provide a true offline experience with the exact same code running on the server and the mobile device.

This is better than a straight Apache Cordova application, although this framework can be used if desired.

# Writing a Hybrid specific service

A hybrid app can be extended by providing services. The services will be available whenever the app is running on the server or locally. It is also possible to create services that are very specific to a hybrid app. For example, accessing the camera is something that makes sense only on a mobile device. To enable this sort of feature, it is possible to create actions that can be triggered from the web app and execute in the native code of the app.

The JavaScript API contains an object called darwino.hybrid that enables this action mechanism. Its isHybrid() function returns a Boolean indication whether the code is running in a hybrid app. isHybridAndroid() and isHybridIos() do a similar but more specific evaluation. These functions are always available, without regard to whether the code is running in a mobile or a web app.

## exec()

The exec() function is the equivalent of the shell() function found in a variety of other languages; it allows the calling of external functions. In this case, “external” means device-native activities. Exec() provides the bridge between the HTML side of the app and the native code.

exec() has four arguments: a verb, a set of arguments to be passed to the verb, a callback, and a Boolean specifying whether it should run asynchronously or not.

It is possible to create custom actions, and there is a set of predefined actions, including:

- switchToLocal
- switchToRemote
- switchToWeb
- synchronizeData
- startApplication
- openSettings

Registering actions is done in AndroidHybridActions, which itself is registered as an extension in AndroidPlugin, via te registerCommands() method. The equivalent methods exist for iOS, and other OS-specific implementations can be provided.

This makes it possible to register command with a name. For example, to create a command that takes a picture and attaches it to a document, implement the execute method in the AppCommand class using the context to pass the necessary parameters, such as the docID. Because multiple processes may execute commands simultaneously, instance variables shoudn't be used for storing data; commands should be called with their own local context.

## RPC callbacks

In addition to exec(), it is possible to implement an RPC callback. RPC functions execute synchronously, and they can return a value. Unlike the commands, these functions are only available to hybrid apps.

## JavaScript functions

As with registering commands, it is possible to register JavaScript functions. This is done via the registerFunctions() method in the JavaScriptFunctionExtension class. These functions are the ones called by the RPC mechanism described above.

# Settings

exec() is a way for the web side of the app to communicate with native device code. The converse of that is done via registered listeners. For example, the settings listener will notify the app when something has changed in the device settings. The app could then use isDirty() to see if the settings have changed since the last refresh (after replication occurs, for example), and then read and set settings as required. Several functions are provided to assist in this:

- addSettingsListener()
- setSettings()
- getProperty()
- getMode()
- isDirty()
- setDirty()

# Developing for Android

When creating a hybrid app for Android, the wizard generate the classes required by the Android SDK, including AndroidApplication.java, AndroidHybridActions.java, and SplashScreenActivity.java. It also generates the same classes used by the J2EE applications. One exception of interest is the DarwinoServiceDispatcher, which in this case inherits from DarwinoHttpServer.

The wizard’s output for a native app is smaller; there is no HTTP server included. The wizard will generate the DarwinoApplication class and the MainActivity, but it will leave creating the UI to the developer.

# Developing for iOS --- RoboVM

This wizard generates an iOS project that utilizes the RoboVM SDK. As with Android apps, the generated project contains the core classes required for a basic application, including DarwinoServiceDispatcher and MainViewController.

# Business APIs

# General information

The business APIs are an integral part of the core Darwino environment. These APIs encapsulate a set of services, providing an easy-to-use, platform-independent interface to assist in coding common business application functions.

There are currently two business APIs: The User Service and the Mail Service. This set of APIs is architected to grow over time. Eventually, it will cover the whole gamut of social services: file sharing, communities, etc...

# User Service Overview

This user service has two functions: authentication and providing information about users. This service is used throughout the Darwino platform. For example, when creating a session, Darwino will utilize the User service to determine the roles and groups needed to assign the proper security.

# User Information

User information is generally not managed by Darwino; it is stored somewhere else, such as in an LDAP directory or, in the case of Domino, in the NAB. The User service provides access to the external, central directory. There may also be peripheral information about users. For example, the primary user directory may be in Domino, while other information, such as the user's photograph, is stored in IBM Connections or Facebook. The User Service is architected to simplify working with such distributed user information. One directory is considered the main directory, and additional data can come from zero or more secondary directories.

The directories that work with the User Service are implemented as managed beans, and they are full extensible. Darwino provides beans for several LDAP directories, the IBM Domino directory, and a static directory for development purposes.

User information takes two forms: information about a user, and a query.

To work with the User Service:

```
    return Platform.getService(UserService.class);
```

The User Service provides a set of function for finding users and retrieving details about users. Because multiple directories may be referenced, there could be multiple IDs for a single user. Nonetheless, there must be only one canonical distinguished name (DN). With this in mind, there are two operations available to find a particular user:

```
public User findUser(String dn) throws UserException;
```

This method returns the User object corresponding to the provided DN.

```
public User findUserByLoginID(String id) throws UserException;
```

These methods find the user that best matches the provided ID. The ID can be a DN, an

email address, a short name, a common name, etc…

findUserByLoginID() does not identify a user with certainty; only findUser() can do that.

There are also several functions for returning lists of users:

- findUsers() returns a list of users based on the provided String array of DNs.
- query() takes an LDAP query (allowing ANDs and ORs) and returns a List of all matches across all directories.
- typeAhead() performs a simple “starts with” query and returns a List of all matches across all directories.

Once you have the User object, you can use its methods to query a provider for user details stored there. For example:

- getDN()
- getCN()
- getGroupCount()
- getGroups()
- getRoleCount()
- getRoles()
- getAttribute()

# User Authentication

To use the UserService for user authentication, simply get the UserAuthenticator object using getAuthenticator() with the provider name as the parameter. The UserAuthenticator that is returns provides the authenticate() method for performing the authentication with the username and password. Authenticate() will return the user's DN if authentication was successful.

When the web application authentication mechanism is being used, the J2EE server returns the user's principal (a DN). This principal is used by the UserService to create the User object. This User object represents the user throughout Darwino; there is no other user identity.

On the mobile device, the implementation is different due to the lack of the LDAP API. The UserService goes through HTTP on mobile. All of the features of the UserService are available through REST. There is a shell Java implementation that encapsulates the REST services to provide easy access to the full array of UserService functions.

Darwino has the ability to cache, on the mobile device, the user information. Furthermore, a developer can provide a list of users whose information should be prepopulated in the cache via a background operation.

# User Service Providers

Directories are made available to the UserService by registering them by name as providers. Registered providers are included when searching via the query() and typeAhead() functions.

It is also possible to get user information from a specific provider. The User object's getUserData method, given the name of a registered provider, will return a UserData object. The UserData object has a getAttribute() method for retrieving value of the specified attribute, and a getAttributes() method to return all of the User's attributes.

For retrieving binary user data, there is the getContent() method which returns the binary data of the specified type, such as "photo" or "payload". Whereas attributes are cached, content data is not; it is always retrieved from the provider when it is requested.

Because it is possible to have multiple providers registered, user data may be spread across multiple directories, and there could even be duplications. For example, the user's photo could exist in multiple providers' sources. To accommodate this, the findAttribute() and findContent() methods will search exhaustively across all registered providers, starting with the current user object and stopping when they find the specified data. The developer doesn't have to be concerned about where the data is actually stored.

Another issue that can result from having multiple registered providers is the need to map a user's identity across providers. The UserProvider object includes the UserIdentityMapper() method, with converts between a user's DN and the provider's username format.

# Mail Service

The Mail Service is a basic interface for sending emails. There is currently no REST service support for the Mail Service, and it is not supported on mobile.

To send a simple email, create a MailMessage object and set the mail parts via the MailMessage methods, then call send().

```
MailService mailService = Platform.getService(MailService.class);

MailMessage m = new MailMessage();
m.setFrom("playground@darwino.com");
m.setTo("darwinounit2@gmail.com");
m.setSubject("Simple email");
m.setContentText("This email is a simple one");
mailService.send(m);
```

HTML body content can be created via the setContentHTML() method: m.setContentHTML(“Here is **bold** and *italic*.”);

To send more complicated messages, the MailMimePart class allows the creation of MIME content from text:

```
MailMimePart ht = new MailMimePart();
ht.setContent(new TextContent("Alternate <b>HTML</b> email representation",TextContent.UTF_E
```

Attachments are also supported:

```
MailMimePart at = new MailMimePart();
at.setContent(new TextContent("This one is <b>HTML</b>",TextContent.UTF_ENCODING,HttpBase.MI
at.setName("Attachment.html");
m.addMimePart(at);
```

To send images, pass the image string as BASE64 to setContent() and supply a filename for the attachment:

```
MailMimePart at1 = new MailMimePart();
String IMAGE = "R0lGODdhAAGAAKIAAP38+/3h3cjN5P3HwgAAAP8AoP8AGv8EIywAAAAAAAGAAAAD.....";
at1.setContent(new Base64Content(IMAGE,HttpBase.MIME_IMAGE_PNG));
at1.setName("Attachment.png");
m.addMimePart(at1);
```

# Installing Darwino on a Domino server

Darwino is able to synchronize with a variety of database systems, Domino included. It does this by means of a synchronization service running on the Domino, supported by database adapters that define the field mapping between replicating databases.

There are various support considerations, primarily to do with replication. The darwino.sync service runs on the Domino server to handle inbound replication requests and outbound scheduled replications. It makes Domino appear to the outside world like a Darwino server. It will provide the list of changes since last replication with the requesting server, and then handle the necessary Domino <-> JSON data transformations.

To support this, there is a set of Darwino-enablement plugins (found in the Domino repository in the Darwino space on GutHub. It contains:

- The NAPI, which is the C API bindings
- The replicator code
- Supporting libraries
- Connections for an XPages application to deal with the replicator and Darwino databases generally

This is installed in basically the same way that an application would be installed. In the Domino server's Update Site database, choose "Import Local Update Site…" and select the site.xml file. Once the import is complete, restart the HTTP task.

# Creating and configuring the Synchronization database

In the repository is a darwinosync.ntf file. The Darwino replicator expects there to be a database based on this template, and named darwinosync.nsf, in the root of the Domino data directory. The default title for this database is “Darwino Sync Admin”.

There is no proper Notes UI for this database; it is intended to be maintained via its XPages UI. This database serves several purposes:

- It acts as a repository for the replication history stubs. When Darwino replicates with Domino, a stub document will be created here to record the adapter name, foreign server identity, database, and replication time. These documents are keyed by server name, allowing the database to be replicated among Domino servers without confusion as to the identity of the replicating Domino servers’ identities.
- It holds the replication adapter definitions. Adapters map the incoming Darwino field definitions to Domino fields. Beyond mapping fields one-to-one, it defines the rules for transforming data from one database system to another. For example, JSON lacks the concept of a date, and so dates coming into Domino need to be recognized as such and stored in a Notes DateTime field. It is also possible to do arbitrary transformations.
- It defines the replication schedule used by the Darwino replicator service when replicating out from Domino to Darwino. For outbound replication, the service is controlled by Replication Schedule documents that will be familiar to anyone who ever configured replication in a Domino Connection document.

(We should have a screen shot of a Replication Schedule document, but only after the UI is settled.)

# Customizing the data transformation

The database adapters are written in Groovy, using a DSL (Domain Specific Language). It is essentially a set of hooks that are provided to the Groovy environment and that are executed to build the adapter. This allows the adapters to defined in a natural and flexible way. There are several benefits to using Groovy for the adapter definitions:

- Groovy is a straightforward scripting language that runs on top of the Java virtual machine. It was designed from the start to be a friendlier way to write Java, and it lends itself to writing Domain Specific Languages. In this case, everything about the adapter scripting language is focused on the writing of database adapters.
- Groovy's closures, with their names parameters, are ideal for creating easy-to-read, concise, and extensible data definitions.

```
def commonDoc = {
  field “from”, type:NAMES
  field “text”, flags:MULTIPLE
  field “body”, type:RICHTEXT
}
form(“Topic”, commonDoc)
```

There are two ways to deploy the adapters:

- Install them as you would install any other plugin on Domino (Screenshot of a Adapter Definition in Eclipse here)
- Define them in the Synchronization database by creating an Adapter Definition document (Screenshot of a Adapter Definition document here)

# Utility Libraries

Darwino comes with a set of general utility classes. These classes are located in a variety of projects. A few of the most noteworthy are described here.

# StringUtil

In dwo-commons is StringUtil. It consists of routines to simplify handling Strings.

For example, throughout Darwino a null string and an empty value are considered as equivalent. This is similar to how JavaScript handles the two. For convenience and simplicity, Darwino brings this approach to Java via the isEmpty() and isNotEmpty() functions in StringUtil.

# AbstractException and AbstractRuntimeException

All of the Java exceptions that are thrown by Darwino inherit directly or indirectly from these classes. Darwino's exception classes provide additional features on top of the classes provided by Java, in particular for debugging. They implement and enforce an exception-chaining pattern; every time an exception is caught in Darwino and another exception is thrown, the original exception is passed as a parameter to the new exception.

```
public AbstractException(Throwable nextException) {
    this(nextException, nextException==null?””:nextException.getMessage() );
}
```

To enforce this behavior, all of the constructors of Darwino exceptions must have this parameter. It may be null, but it must be present; a conscious decision is required to omit the passed exception.

A clear benefit of this exception passing is that stack traces are more informative than they would be otherwise.

# Messages

The Messages class provides a simple mechanism for accumulating information about errors and warnings. A Message consists of a severity int and a message String. The Messages that are accumulated can then be handled as a group, perhaps for presentation to the user.

# Profiler

There is a profiler bundled with Darwino. There is no UI provided, but beyond the Java interface there is a REST service that can provide access to the profiler data. This is an application profiler, as opposed to a low-level profiler. It provides the ability to add hooks into application code to monitor high-level routines and then to dump that collected information later.

# HttpClient

The HttpClient service is an easy-to-use implementation that is JSON-friendly. Methods such as getAsJson() (which parses the value and returns it as a JSON object), putAsJson(), deleteAsJson(), and postAsJson() simplify working with REST services. Because it works the same on all Darwino platforms, code implementing it doesn't have to be concerned with platform-specific differences.

# Tasks

A task is a piece of code that can be executed synchronously or asynchronously. Darwino's task framework encapsulates the standard task execution implementation of each supported platform, allowing application code to remain unconcerned with the particulars of each platform.

When code executes a Task, it has access to the TaskExecutorService. Which enables passing parameters to tasks. Thus, tasks can run with different contexts. When the tasks's execute() method is called, it is passed a TaskExecutorContext. This context contains the parameters.

If the platform's task executor maintains progress information about its tasks, the Darwino's TaskExecutorService can provide that progress information to the context. Darwino provides progress dialogs for the various platforms.

The TaskExecutorContext includes an updateUi() method with a Runnable that allows the backend task to update the user interface as needed. The UI task is then executed in the UI thread, which is required on client apps.

There is also a task scheduler. It allows one-time executions and scheduling by periodic intervals, and it supports time ranges (for example, "run hourly between 7:00am and 5:00pm").

# 3 Tracer

The HttpTracerService can trace all of the requests that are coming to the server. As long as the requests are being served by the HttpService, the tracer (a managed bean) can be told precisely what should be traced. Tracing can be restricted to specific urls and particular types of data (headers, details, content)

# Mapping between a Darwino DB and a relational database

A Darwino database is mapped to a set of relational tables. These tables store all of the documents for all of the stores in all of the instances of the database.

To optimize the performance of the database, one would add indexes depending on the nature of the queries that are being performed. There is an art to this optimization; besinde application-specific factors, there may be considerations related to the underlying database engine… Postgres, DB2, and MySQL could have different optimizations.

There is one set of relational tables per Darwino database. If the names of the tables depend on the database name, the definition of the tables is static for a given version of Darwino. This allows the tables to be created once by a DBA, and then used as-is, even when the application evolves.

For performance reasons, indexes on columns can be added. As the platform doesn't know most of the queries executed by the application, it predefines a minimal set of indexes to speed up the generic access to the database (get a document by ID, index by key, synchronization...). But it is up to the application developer to track the requests being emitted by the database and then add additional indexes as required.

On the database systems that support native JSON access, JSON access indexes can also be added. Please refer to your database system documentation for best practices.

# Darwino application tables

The prefix of Darwino's table names is the name of the Darwino database. This restricts us to names that are compatible with the rules of the relational database system. The suffix is always an underscore followed by three characters. Let’s take a look:

- _dsg: The Design table. This includes the lists of fields, stores, indexes, etc… This is “generally” only one record in this table, with the value “DATABASE” in its “type” column. The “name” is empty, and the “json” column contains the definition of the

database. When you initialize a Darwino database, it will create this set of tables and store the database definition in that single record in the _dsg table. In the database definition is a field called “version”. When you initialize the database, the version will be “1”. Every time the database definition changes, increment the number (Question: is the incrementing automatic?). This is important in Darwino because the application is disconnected from the database, so it is possible to have a database design that is not at the level expected by the application. When your code is opening the database, it will open this record from the _dsg table, extract the version value, and do a compare. If it’s a match, it will open the database, return a handle, and off you go. In another case, the application may be expecting to work with an higher version of the database. When opening, you specify how to update. One choice is to upgrade the database by running a function that you provide to give the new database definition. If, on the other hand, the application is expecting a lower level of the database, it will fail. The application will not be able to update the database because it won’t know how. In AppDatabaseDef.java, the loadDatabase method does the job of checking the version number and returning either null or a handle to the open database. If the runtime itself has been updated, the “tableVersion” in the database definition comes into play. It is not managed by the application; it is managed by the runtime.

- _doc: The document table
    - docid – autogenerated key value. This is dependent on the database and on the instance in the database. instanceid – identifies the instance within the database that “contains” this document
    - storied – along with the docid and instanceid, define the unique primary key of a document.
    - unid – The document's unique identifier
    - repid – ID of the server where this document was last created/modifed. This helps tracking where the doc comes from, and optimizing replication by not sending a document back to where it changed.
    - pstoreid – a pointer to the store of the parent document
    - parent – a pointer to the parent document
    - smstoreid – pointer to the syncmaster store
    - smunid – pointer to the syncmaster document
    - seqid – sequence number used internally in replication
    - updid – Internal replication version ID
    - udate – the last replication time of the document. This is updated automatically
    - sftdel – soft delete flag, not currently implemented

    - cdate – creation date of the document
    - cuser – the user that created the document
    - mdate – the date of last modification
    - muser – the user that last modified the document
    - rsec – used internally to support reader fields
    - rsed – used internally to support writer fields
    - json – the JSON data of the document
    - sig – a signature for the document, not used
    - changes – used internally to support replication
    - cdatets – an easily readable and queryable copy of the creation date in timestamp format
    - mdatets – an easily readable and queryable copy of the modification date in timestamp format

      Note: the date fields are stored as integers. They are the Java date converted to a long. They represent the number of milliseconds since the 1/1/70. This is to accommodate the precision required for replication, and the requirement that the dates be completely compatible with all possible relational database systems.

- _bin table: Used to store binary data associated with documents, but outside of the documents. It is used to support features similar to Domino's DAOS, but storing the binary data still inside the database instead of in the file system. Here data is stored with a computed key based on the hash of the file's contents, and can be shared between multiple documents pointing to the same bin record.

- -dov table: This stores the list of fields extracted from documents. The extracted data is stored in one of four columns, one for each possible data type; they are named ftxt, fnum, fbol, and fdat.

- _idx: This is where in indexes are stored.

- _idv: Like the _dov table, but for the index level, because we can store field at the index level.

- _lck: This is for document locking… not used.

- _rep: Stores the replication information. It stores the last replication date for one replication profile. The last replication date is stored in the target of a replication.

When pushing replication changes, the first step is to ask the target for the last replication time. The target checks this table and returns the value. The source then composes the list of changes and sends that. This is because you want to base the replication on the target's clock.

- _sec: Stores the reader and writer information. For every document, it stores the entry name and whether it's read-only or read/write.
- _sed: Like the security table, but for ereaders and ewriters.
- _stu: This is the deletion stub table, used during replication to convey that a document has been deleted.
- _tag: Stores the social data tags. It is indexed by the docid, and there is one row for every tag.
- _usr: The user-related social data, such as the rating and sharing information, as well as whether the document has been read and when it was last read. It also stores the replication time information for this data.

# Database definition class

(dbnameDatabaseDef.java)

- setACL() is used to set the access levels of people, groups, and roles (who can read, edit, create documents, etc…). These access rights can be resolved dynamically. In particular, they can be resolved for an Instance.
- setDocumentSecurity(int documentSecurity) determines how readers and writers filed will be handled. Choices include no reader/writer security, reader only, writer only, etc (need full list)
- setInstanceEnabled(boolean instanceEnabled) – are Instances allowed or not.
- setPreventRestAccess(Boolean preventRestAccess) – Darwino provides a set of REST services so that data can be read and written via REST services. Disabling REST services prevents raw REST access to document data, ensuring that all access be through the appropriate business logic. If this is disabled, then even if REST services are deployed, before serving the data Darwino will check this and deny access.
- setReplicaID - internal

- setReplicationEnabled(Boolean replicationEnabled) – If replication is enabled, Darwino records more data to support replication, including deletion stubs. This overhead can be avoided by disabling replication.
- setSoftDeleteEnabled – not implemented
- setTableVersion – internal
- setTimeZone – Darwino stores dates in ISO 8601 format, by default using GMT as the time zone. Setting this value will override that default. Dates will be stored instead using the specified time zone. There is never a loss of certainty; Darwino always stores the values with a time zone; this merely determines with zone is used as the default.

  Stores Physically, a store is nothing; it is just a concept. It is actually just a logical collection of documents in a database. There is not one table per store; instead stores are implemented as a column value in each document. Every document in a database is identified by its UNID and its storeID; together, these two fields define the document's key. This way of implementing stores limits the actions needed to maintain the database's DDL. Stores can have several options:

  - setAnonymousSocial(Boolean anonymousSocial) – Enabling this allows tracking of the social activities of the anonymous user; for example, tracking when anonymous reads a document. This defaults to false, since there are few cases where it would be desired.
  - setBinaryStore(String binaryStore) – This is an extension point that determines how attachments in the store will be saved. By default, attachments are stored in the _att table, which has as its primary key the docid and the attachment name, and it has a column called "data" which is a byte array. Some database systems don't perform well with large numbers of large byte arrays, so this setting exists to allow this default to be overridden, and a different binary store can be used, for example the file system. (In such a case, the binkey (binary key) column could be used to store the file system path that points to the attachment's storage location.) Domino developers should recognize the similarity to DAOS in this example.
  - setFTSearch(_FtSearch ftSearch) – Specifies which fields in the JSON document are being indexed.

  - setFtSearchEnabled(Boolean fulltextEnabled) – Enables full text search of the documents in the store. Darwino uses the full text search engine provided by the host database. This results in maximum performance and low overhead. It

is possible to test at run time, using the Store-level method isFtSearchEnabled(), whether the database supports full text search, so the UI can be adjusted accordingly. None of the databases know, now, how to do full text search on the JSON documents. The _fts table contains the names and values of the fields that you wish to fulltext index.

- setLabel(String label) - User-friendly label displayed to the user.
- setPreventRestAccess(Boolean preventRestAccess) – If REST access is enabled at the database level, it can be prevented at the store level.
- setReadMarkEnabled(Boolean readMarkEnabled) – This applies to the social data read marks, and is set to false by default. If enabled, when a document is read by a user who is not anonymous (unless setAnonymousSocial is enabled), that document is marked as read by that user. This option exists so that the write operation required at every read to support read makrs can be avoided.
- setTaggingEnabled(Boolean taggingEnabled) – Enabling this allows Darwino to maintain an array of tags for each document. You can search documents a tag or a combination of tags. There is also a well-optimized function at the store level that returns a tag cloud.
- The addField() method adds fields that can be extracted for querying.
- setFields() has two forms. The simple form takes the name of a field as its parameter and it indexes that field. The other form takes an array of FieldNodes.

> ```
> (Question: when to use addField() vs. setFields()? This whole section is pre
> ```

- addQueryField() has five forms. The first takes one parameter, that being that name of the field. It will use that value both as the field name and as the path to the data. The next takes three parameters: the field name, the data type, and a Boolean determining whether the field is multiple. The third adds a specification of the path in the JSON. The fourth form takes a single parameter, this being a callback fieldFunction, which itself has several parameters: the field name, the data type, the multi Boolean, the name of a registered callback function and a

JSON path to the data in the JSON document which acts as the parameter to the referenced callback function. The fifth form is like form #4, but uses a Darwino query language statement in place of the function name and parameter. By allowing a callback function or query result, the function allows sophisticated processing to be called when creating the field value, which can then be used in a query.

INDEXES In Darwino, an index is the MAP action in MAP/REDUCE. It allows fast access to data, as well as pre-computing of some data (ex: number of children, social data...) and then querying these data. It associates a key with a value for a selected set of documents. The value can be computed from the actual JSON document.

The store.addIndex() method creates an index based on a subset of the data in the JSON documents. Once you add the index, you define the keys and the values to extract fmor the JSON document.

When you execute a query on the index using the Darwino API, you can choose either to return the values in the index, or the JSON value in the document itself.

For example, index.keys("_unid") will set the unid as the key. index.valuesExtract("\"$\"") will specify the root of the JSON value as the value to extract. This is using the the query language (or "extraction language").

When specifying the keys, you can say whether the keys are unique or not. This is done by calling the setUniqueKey(Boolean uniqueKey) method. setUpdateWithUserData() specifies whether the index should be undated when a document's social data, which is stored outside of the document, is changed, even if the document itself has not been changed. An example of this would be if you are tracking ratings for documents and you wish to display the average rating for each document. Rather than recalculate the average every time you query the index, you would store the rating average every time the ratings are changed. By default, the index is not updated when the social data changes.

setUpdateWithUserData() can also be used to store the number of response documents (children) in a parent document. But this is like recalculating the index of a parent document, while a child is updated (parentId). So there is an option to the save() method that forces the parent document, or the sync master, to update as well.