The OpenDOF Project

An Open Distributed Object Framework
For The
Internet of Things

Bryant Eastham
Demonstration Preparation

1. Scan to download the application

2. From the application, scan to configure

For help with the demo, go to http://elc2015.opendof.org/help
Panasonic and IoT
IoT Platform Requirements

- Secure
- Interoperable
- Flexible
- Scalable
- Reliable

More information about these five principles can be found at http://opendof.org.
• Today, Panasonic announces the formation of the OpenDOF Project.
• Java code released, C99 and C# to follow.
• All protocol specifications are open.
• Patent non-assertion on libraries and any implementation of the specifications.
• Work with the AllSeen Alliance on gateways.
Demonstration
Terminology

• DOF (Architecture and Specifications)
  – Distributed
  – Object
  – Framework
  – Specifications

• OpenDOF (Open source implementations)
Terminology

• **Object** is a distributed set of uniquely identified capabilities, bound to an Object Identifier

• **Interface** is a defined set of items (properties, methods, events, exceptions) bound to an Interface Identifier

• **Identity** is a unique persona associated with a secret and permissions

• **Domain** is a centrally managed set of identities
Object Identifiers (OID)

- Globally unique, no registration required
- Standard text representation

[3:bryant.eastham@us.panasonic.com]

[2:{d0 67 e5 43 f8 ff}]
Interface Identifiers (IID)

- Globally unique through registration
- Standard text representation

[Diagram showing a Registry with Unique identifier branches: 1:{01} and 2:{01 07}]

Copyright (c) 2015, OpenDOF Project, Inc.
Item Identifiers (ItemID)

• Unique within a single interface
• Represents an item type and data type
  – Property, Method, Event, Exception
• Defines syntax (wire format)
• Includes semantic meaning
  – Not all booleans are the same
Putting It All Together

• **Bindings** are OID plus IID
• Operations require binding and ItemID
• Context allows a short alias for the binding
Putting It All Together

Item 1 of the status interface of my computer

1 [1:{01}] [2:{d0 67 e5 43 f8 ff}]
01 05 01 02 06 d0 67 e5 43 f8 ff

Item 1 of the status interface of my computer, previously assigned alias 8

1 [1:{01}] [2:{d0 67 e5 43 f8 ff}]
01 08
Security Model

• Domains contain all security information
  – Identities (users, devices)
  – Secrets (keys, passwords)
  – Permissions
Security Model

• Each interaction typically requires two permissions
  – Permission for the request
  – Permission for the response
Security Model

• Identities are granted permissions
  – As requestors
  – As providers
  – As both requestors and providers (bridge or gateway)
API Introduction

• High-level API
  – Hides much of the lower level protocol detail
  – Removes fine-grained control over packets

• Written for the most general case
  – Not always the most scalable

• APIs are hard – they never please everyone
import org.opendof.core.oal.*;
DOF.Config dofConfig;
DOFSystem.Config sysConfig;
DOFCredentials user;

user = DOFCredentials.Password.create(
    DOFObjectID.Domain.create( "[6:bar.com]" ),
    DOFObjectID.Identity.create( "[3:foo@bar.com]" ),
    "password" );
dofConfig = new DOF.Config.Builder().build();
sysConfig = new DOFSystem.Config.Builder()
    .setCredentials( user ).build();

DOF dof = new DOF( dofConfig );
DOFSystem system1 = dof.createSystem( sysConfig );
DOFSystem system2 = dof.createSystem( sysConfig );
Result

domain data (centralized)

U = [3:foo@bar.com]

[6:bar.com]

system1

system2

user

domain identifier

identity
Example – Instantiate An Object

```java
import org.opendof.core.oal.*;
DOFObjectID oid;
DOFObject requestor, provider;

oid = DOFObjectID.create( "[2:{d0 67 e5 43 f8 ff}]" );
requestor = system1.createObject( oid );
provider = system2.createObject( oid );
```

OID = unique identifier
Result

U = [3:foo@bar.com]

U

[6:bar.com]

U

{P}

requestor

provider
Example – Provide An Interface

```java
import org.opendof.core.oal.*;

DOFOperation provide;

provide = provider.beginProvide(Status.DEF,
       new ProvideListener() );

private class ProvideListener extends DOFObject.DefaultProvider {
       public void get( Provide op,
                           DOFRequest.Get request,
                           Property property ) {
           request.respond( new DOFUInt8( 0 ) );
       }
}
```
import org.opendof.core.oal.*;
DOFOperation interest;
DOFQuery query;

interest = system1.beginInterest( oid, Status.IID,
DOFInterestLevel.WATCH );
query = new DOFQuery.Builder()
    .addFilter( oid, Status.IID )
    .build();

system1.beginQuery( query, new QueryListener() );

class QueryListener implements DOFSystem.QueryOperationListener {
    public void interfaceAdded( query, oid, iid ) …
    public void interfaceRemoved( query, oid, iid ) …
    public void providerRemoved( query, oid ) …
}

Network request

Local request
Result

O = [2:{d0 67 e5 43 f8 ff}]
s = [1:{01}]
Example – Get From Provider

```java
import org.opendof.core.oal.*;
DOFResult<DOFValue> result;
int timeout = 5000;

result = requestor.get( Status.VALUE, timeout );
int value = DOFType.asInt( result );
```

Interactions include
- Session (end-to-end tunnel)
- Property get/set/subscribe
- Method invoke
- Event register
\[ O = [2:\{d0 \ 67 \ e5 \ 43 \ f8 \ ff\}] \]
\[ s = [1:\{01\}] \]
\[ Os1 = 1 [1:\{01\}] [2:\{d0 \ 67 \ e5 \ 43 \ f8 \ ff\}] \]

\[ U = [3:\text{foo@bar.com}] \]
O = [2:{d0 67 e5 43 f8 ff}]
s = [1:{01}]
Os1 = 1 [1:{01}] [2:{d0 67 e5 43 f8 ff}]

all interactions are validated based on user and permissions before being accepted

users, credentials, and permissions are centrally stored and managed
O = [2:{d0 67 e5 43 f8 ff}]
s = [1:{01}]
Os1 = 1 [1:{01}] [2:{d0 67 e5 43 f8 ff}]

U = [3:foo@bar.com]

O = [6:bar.com]

Os1: 0
Os: ?
U: ?
O = [2:{d0 67 e5 43 f8 ff}]
s = [1:{01}]
Os1 = 1 [1:{01}] [2:{d0 67 e5 43 f8 ff}]

U = [3:foo@bar.com]

all responses are validated based on user and permissions before being accepted
Result

O = [2:{d0 67 e5 43 f8 ff}]
s = [1:{01}]
Os1 = 1 [1:{01}] [2:{d0 67 e5 43 f8 ff}]
Supported Interactions

- **Properties**
  - Get/Set/Subscribe
- **Methods**
  - Invoke
- **Events**
  - Register
- **Synchronous and asynchronous**
Example – Start A Server

```java
import org.opendof.core.oal.*;
DOFServer server;
DOFServer.Config config;
DOFAddress me;
int timeout = 10000;

me = InetTransport.createAddress( "0.0.0.0", 3567 );
config = new DOFServer.Config.BuildSecureStream( me, user );
server = dof.createServer( config );
server.start( timeout );
```

plugin that implements the transport – fully extensible

convenience method – stream and datagram
Example – Open A Connection

```java
import org.opendof.core.oal.*;
DOFConnection connection;
DOFConnection.Config config;
DOFAAddress other;
int timeout = 10000;

other = InetTransport.createAddress("host", 3567);
config = new DOFConnection.Config.BuildSecureStream(other, user);
connection = dof.createConnection(config);
connection.connect( timeout );
```
Result

U = [3:foo@bar.com]

[6:bar.com]
What Is Next?

• Scalability to millions of connections
  – Distributed routing problem for discovery

• Optimizations
  – Handling failover for redundant connections
  – Minimizing state updates without too much memory
Questions & Answers