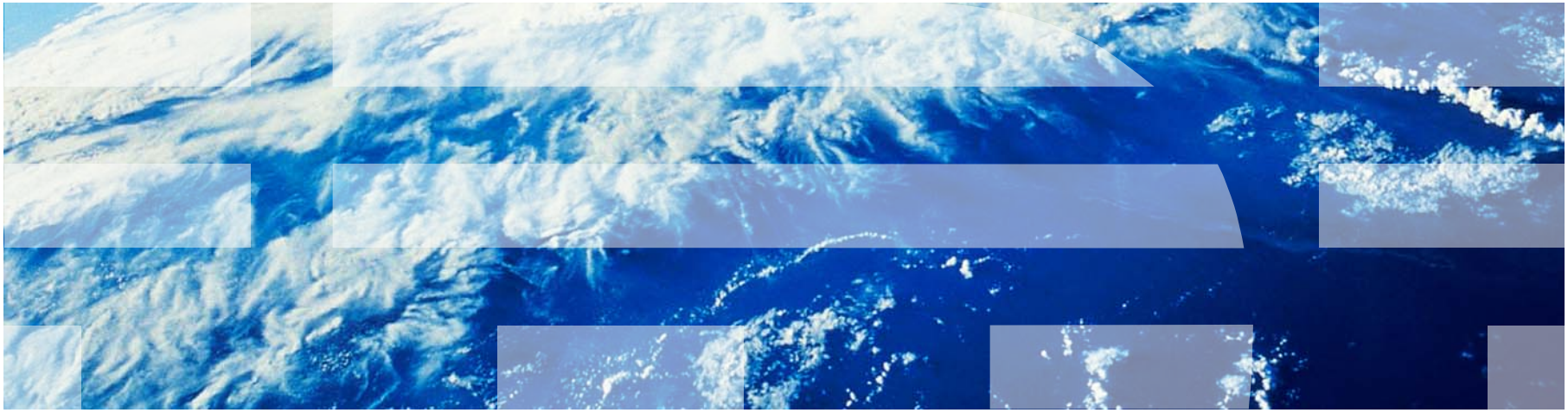
IBM Worklight V6.1.0
Getting Started

Developing dynamic, collaborative mobile applications with MQ Telemetry Transport



17 March 2014

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Agenda

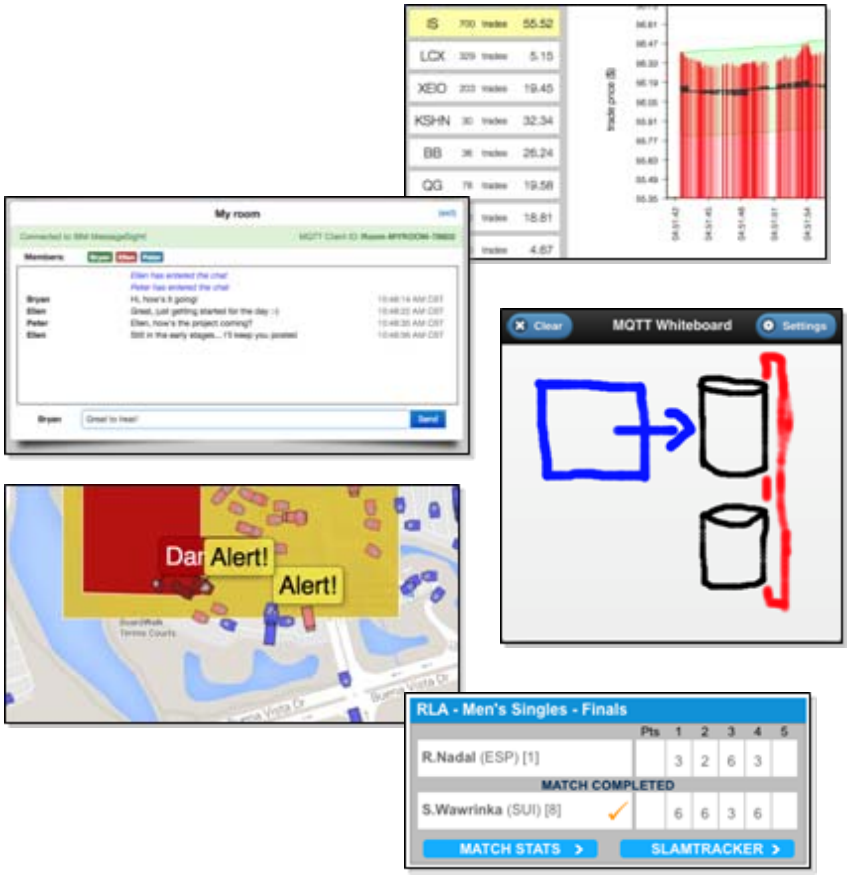
- Getting started with MQ Telemetry Transport
- Building a collaborative application (Whiteboard)
- Connecting to an MQTT broker
  - Mosquitto
  - IBM MessageSight

Getting started with MQ Telemetry Transport

- MQ Telemetry Transport (MQTT) is a lightweight messaging protocol that is designed for Internet of Things (IoT) and mobile connectivity.
- MQ Telemetry Transport provides:
  - Reliable message delivery over unreliable connections
  - Secure message delivery to the enterprise
  - One-to-many message delivery (publish/subscribe)
  - Near real-time push of data from server (no polling)
  - Minimal footprint on-the-wire (only 2-byte header)
  - Reduced battery usage

Getting started with MQ Telemetry Transport (1 of 3)

- MQ Telemetry Transport allows for real-time data push from server to mobile devices, making it ideal for dynamic mobile applications.
- Examples:
  - Stock ticker
  - Chat application
  - Collaboration apps
    - (Whiteboard sharing)
  - Real-time emergency alerts
  - Live match score updates



Getting started with MQ Telemetry Transport (2 of 3)

- MQTT client libraries are available in Java™, C, JavaScript™, C++, Python, Objective-C, and many other programming languages.
- The Eclipse Paho project (http://www.eclipse.org/paho/) provides many open source MQTT clients (http://git.eclipse.org/c/paho).
- IBM provides MQTT clients in a Mobile Messaging & M2M Client Pack, available from the IBM Messaging community on developerWorks.
- This module uses the Eclipse Paho JavaScript MQTT client for publish/subscribe messaging in the IBM Worklight® application.

Getting started with MQ Telemetry Transport (3 of 3)

- The MQTT clients have a simple API for publish/subscribe messaging
- The following examples use the Eclipse Paho JavaScript MQTT client to **Connect** to an MQTT broker, **Subscribe** to an MQTT topic, **Receive** and process messages from the broker, and **Publish** a message on an MQTT topic.

Connect

```
function connect() {
  client = new Messaging.Client(hostname, port, clientId);
  client.onMessageArrived = onMsgCallback;
  client.onConnectionLost = onConnLostCallback;
  client.connect({ onSuccess: onSuccessCallback });
}
```

Subscribe

```
function subscribe(topic) {
  client.subscribe(topic);
}
```

Publish

```
function publish(topic, data) {
  var msg = new Messaging.Message(data);
  msg.destinationName = topic;
  client.send(msg);
}
```

Receive

```
function onMsgCallback(msg) {
  var topic = msg.destinationName;
  var data = msg.payloadString;
  console.log(topic, data);
}
```

Agenda

- Getting started with MQ Telemetry Transport
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Building a collaborative application

- In this module, you build a dynamic application (Whiteboard) with Worklight and MQ Telemetry Transport that lets users draw on a shared canvas in real time. You do this in two steps:
  - **Build the Worklight application**
    - First, implement “single-user” mode.
    - The application captures touch/click events and lets you paint on the canvas.
  - **Implement collaboration using an MQTT client and server**
    - You add a JavaScript MQTT client to the Whiteboard application that communicates with other clients through an MQTT server.
    - MQTT server options are covered in a subsequent slide.
    - **Note**: MQTT data does not use the IBM Worklight security and authentication mechanism.

Building a collaborative application

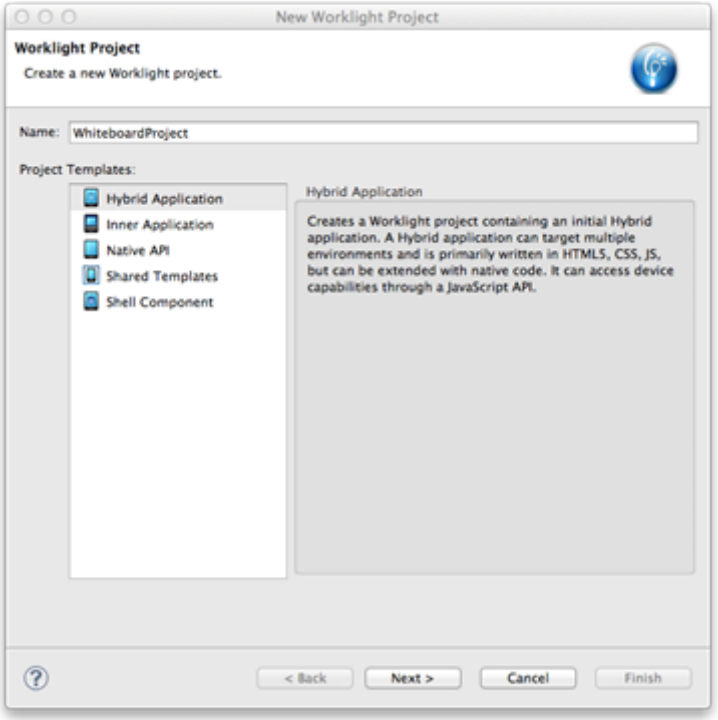
- The Whiteboard application uses MQTT messaging to provide a shared canvas for all users.
- Each Whiteboard will publish all drawing actions as MQTT messages on a topic unique to the application session.
- Each Whiteboard will also subscribe to the set of all drawing topics, and draw others' actions based on this data.
- With MQTT publish/subscribe messaging capabilities, the real-time collaborative experience can scale to many connected applications.

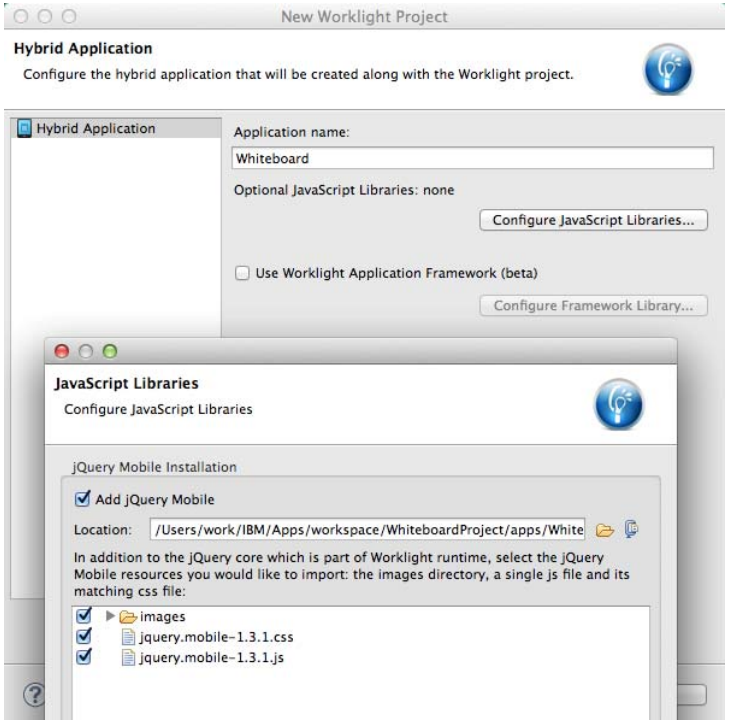
Building a collaborative application

- This scenario cannot efficiently be implemented by using traditional polling (HTTP) or mobile push notifications.
  - To provide a real-time experience, drawing actions should be reflected on other canvases within milliseconds.
  - HTTP polling is high-bandwidth (each request requires a new client connection) and results in poor latency.
  - Push notifications minimize bandwidth, but are inappropriate for small in-application updates.
  - MQTT publish/subscribe messaging minimizes bandwidth and latency: an MQTT connection is established once from client to server, and messages are pushed directly to the application with low latency.

Whiteboard – Create Project

- Create a **WhiteboardProject** project with a Hybrid Application named **Whiteboard**. Add the jQuery Mobile 1.3.1 library, obtained separately.
  - For more information, see the **Working with UI frameworks** module.





Whiteboard – Build UI

- Add a header, a canvas, and a button to clear the canvas.

index.html

```
<!DOCTYPE HTML>
<html>
  <head>
    <meta charset="UTF-8">
    <title>Whiteboard</title>
    <meta name="viewport" content="width=device-width, initial-
scale=1.0, maximum-scale=1.0, minimum-scale=1.0, user-scalable=0">
    <link rel="shortcut icon" href="images/favicon.png">
    <link rel="apple-touch-icon" href="images/apple-touch-icon.png">
    <link href="jqueryMobile/jquery.mobile-1.3.1.css"
rel="stylesheet">
    <link rel="stylesheet" href="css/main.css">
    <script>window.$ = window.jQuery = WLJQ;</script>
    <script src="jqueryMobile/jquery.mobile-1.3.1.js"></script>
  </head>
  <body style="display: none;">
    <div data-role="page" id="page">
      <div data-role="header" id="header" data-position="fixed">
        <h3>MQTT Whiteboard</h3>
        <a onclick="app.clear()" class="ui-btn-left" data-
role="button" data-icon="delete" data-theme="b">Clear</a>
      </div>
      <canvas id="whiteboard"></canvas>
    </div>
    <script src="js/initOptions.js"></script>
    <script src="js/main.js"></script>
    <script src="js/Whiteboard.js"></script>
    <script src="js/messages.js"></script>
  </body>
</html>
```

main.css

```
/* Reset CSS */
a, abbr, address, article, aside, ……
{
  margin: 0;
  padding: 0;
}

body {
  margin: 0 auto;
}

canvas {
  position: absolute;
}
```

Whiteboard – Capture Events

- Capture touch events, and draw on the canvas.

main.js

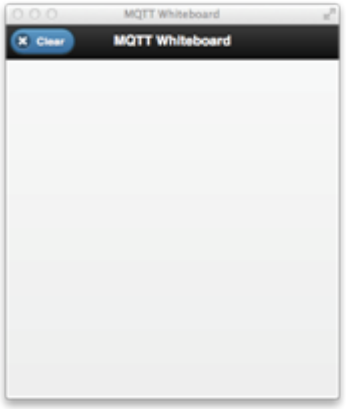
```
function wlCommonInit(){
  window.app = new WhiteboardApp();

  $("#whiteboard").on("vmousemove", function(event) {
    if (app.drawOn) {
      var x = event.pageX;
      var y = event.pageY - $("canvas").offset().top;
      app.draw(x, y, app.size, app.color);
    }
    event.preventDefault();
  });
  $("#whiteboard").on("vmousedown", function(event) {
    var x = event.pageX;
    var y = event.pageY - $("canvas").offset().top;
    app.draw(x, y, app.size, app.color);
    app.drawOn = true;
  });
  $("#whiteboard").on("vmouseup", function(event) {
    app.drawOn = false;
  });
  $("#whiteboard").bind("tap", function(event) {
    event.preventDefault();
  });

  $(window).resize(function() { resize(); });
  resize();
}
```

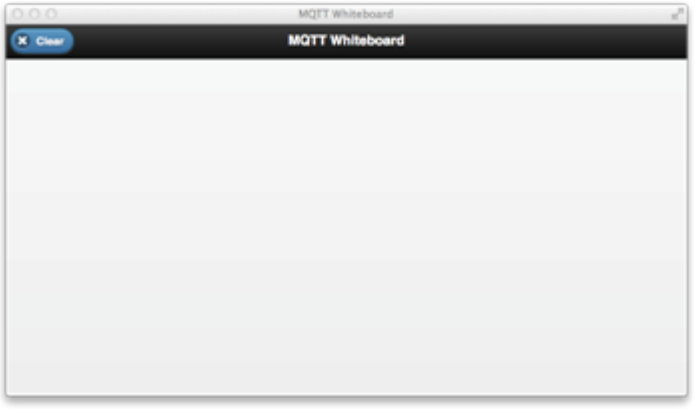
Whiteboard – Capture Events

- Adjust the canvas size to fill available space when the screen resizes.

main.js (cont.)

```
var resize = function() {
  var winSize = {
    width: window.innerWidth ||  document.body.clientWidth,
    height: window.innerHeight || document.body.clientHeight
  };
  // make canvas fill space under header
  $("canvas").css("top", $("#header").innerHeight() + "px");
  $("canvas")[0].width = winSize.width;
  $("canvas")[0].height = winSize.height - $("#header").innerHeight();
}
```





Whiteboard – Drawing

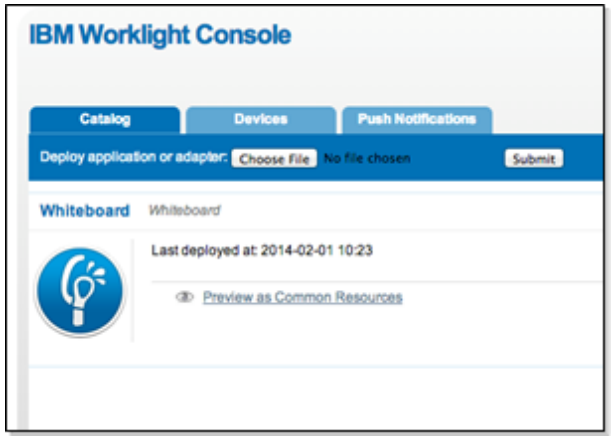
- Define a new object that performs canvas drawing actions.

Whiteboard.js

```
var Colors = [
  "rgb(255,0,0)", "rgb(0,170,0)", "rgb(0,0,255) »,
  "rgb(0,0,0), "rgb(0,255,255)", "rgb(127,255,212)",
  "rgb(139,69,19)"];

function WhiteboardApp() {
  this.size = 8;
  this.color = Colors[Math.floor(Math.random() * Colors.length)];
  this.drawOn = false;
  this.canvas = $("canvas")[0];
}

WhiteboardApp.prototype.draw = function(x, y, size, color) {
  var context = this.canvas.getContext("2d");
  for (var i = 1; i <= size; i+=2) {
    context.save();
    context.beginPath();
    var alpha = 1.0 - Math.pow(i/size, 2);
    context.globalAlpha = alpha;
    context.strokeStyle = color;
    context.arc(x, y, i, 0, 2*Math.PI);
    context.stroke();
    context.restore();
  }
}

WhiteboardApp.prototype.clear = function() {
  var context = this.canvas.getContext("2d");
  context.clearRect(0, 0, this.canvas.width, this.canvas.height);
}
```

Whiteboard – Run the Application

- Before you add collaboration through MQTT messaging, test the application by deploying it to your local Worklight Server.
  - Select **Run As > Run on Development Server**.
  - Open http://localhost:10080/WhiteboardProject/console.
  - Select **Preview as Common Resources**.
  - Click/tap to draw on the canvas.



Whiteboard – Adding collaboration

- You can now add collaborative features to the application with publish/subscribe MQTT messaging. You will add an MQTT client to the Whiteboard application and connect to an MQTT broker when the application loads.
- To create a shared canvas, each Whiteboard client publishes **draw** and **clear** actions on a topic unique to the client. The type of action, and options, are described in the MQTT message payload as JSON data.
- Example: **draw**
  - `Topic: whiteboard/<clientId>`
  - `Payload: {“type” : “draw”, “x” : “127”, “y” : “53”, “color”: “rgb(255,0,0)”}`
- Example: **clear**
  - `Topic: whiteboard/<clientId>`
  - `Payload: {“type” : “clear” }`
- When another Whiteboard client receives this message, `WhiteboardApp.draw()` or `WhiteboardApp.clear()` is called with the parameters from the JSON message.

Whiteboard – Add MQTT client

- Add the Eclipse Paho JavaScript MQTT client to the project:
  - `WhiteboardProject/apps/Whiteboard/common/js/mqttws31.js`
- Load the .js file in `index.html`:

index.html

```
<html>
  <head>
    ...
  </head>
  <body style="display: none;">
    ...
    <script src="js/initOptions.js"></script>
    <script src="js/main.js"></script>
    <script src="js/mqttws31.js"></script>
    ...
```

- On application load, invoke **connect** the client (defined next).

main.js

```
function wlCommonInit(){
  window.app = new WhiteboardApp();
  app.connect();
  ...
```

Whiteboard – Add MQTT client

- When you initialize and connect the MQTT client, you specify the following configuration parameters and connection options.

MQTT Client Configuration	
host	The DNS name or IP of the MQTT broker host
port	The port number for the host
clientId	A unique MQTT identifier for this client (1 to 23 characters)
onMessageArrived	A callback that is called when a message is delivered to the client
onConnectionLost	A callback that is called when the connection has been lost

Connection options	
keepAliveInterval	A period of inactivity (seconds) after which the client will disconnect
onSuccess	A callback that is called after a successful connection to the broker
onFailure	A callback that is called after an unsuccessful connection to the broker

Whiteboard – Add MQTT client

- Add the configuration parameters, callbacks, and connection options, and connect the MQTT client (you will define the callbacks shown in red next).
- If you do not have an MQTT broker available, see **Connecting to an MQTT broker** later in this module for details about how to find your own broker.

Whiteboard.js

```
function WhiteboardApp() {
  ...
  this.host = ”< My MQTT broker IP >";
  this.port = “< My MQTT broker port >”;
  // generate a 6-character alpha-num unique
ID
  this.uuid = Math.random().toString(36).
    slice(2).substring(0, 6);
  this.clientId = "whiteboard-"+this.uuid;
  this.client = new Messaging.Client(
    this.host,
    this.port,
    this.clientId);
}
```

```
WhiteboardApp.prototype.connect = function() {
  this.client.onMessageArrived = (function(self) {
    return function(msg) { self.onMsg(msg); }
  })(this);
  this.client.onConnectionLost = function() {
    alert("Connection lost!");
  };
  var connectOptions = new Object();
  // extend keep-alive to one hour
  connectOptions.keepAliveInterval = 3600;
  connectOptions.onSuccess = (function(self) {
    return function() { self.onConn; }
  })(this);
  connectOptions.onFailure = function() {
    alert("Failed to connect!");
  };
  this.client.connect(connectOptions);
}
```

Whiteboard – Add callbacks

- Next, implement the **onMsg** and **onConn** callbacks.
- When the MQTT connection succeeds, you will subscribe to the wildcard topic of all Whiteboard applications: `whiteboard/+`

Whiteboard.js

```
WhiteboardApp.prototype.onConn = function() {
  this.client.subscribe("whiteboard/+");
}

WhiteboardApp.prototype.onMsg = function(msg) {
  var topic = msg.destinationName;
  var payload = msg.payloadString;

  // make sure the topic matches whiteboard/*
  if (topic.indexOf("whiteboard/") == 0) {
    var sourceUUID = topic.split("/")[1];

    // do not process own actions
    if (sourceUUID == this.uuid) { return; }

    var data = JSON.parse(payload);
    if (data.type == "draw") {
      this.draw(
       data.x, data.y,
       this.size, data.color, true);
    } else if (data.type == "clear") {
      this.clear(true);
    }
  }
}
```

You must differentiate between **draw** and **clear** actions that come from other Whiteboards and those that our Whiteboard initiates.

For actions that you initiate, you will want to publish an MQTT message. If you receive the action *from* an MQTT message, you will not want to republish this action as a new message.

Whiteboard – Publish actions as MQTT messages

- Next, you create and publish MQTT messages for our **draw** and **clear** actions

Whiteboard.js

```
WhiteboardApp.prototype.draw =
  function(x, y, size, color, fromOutside) {
  ...
  if (!fromOutside) {
    this.publishDraw(x, y, color);
  }
}

WhiteboardApp.prototype.clear =
  function(fromOutside) {
  ...
  if (!fromOutside) {
    this.publishClear();
  }
}
```

MQ Telemetry Transport provides three qualities of service for delivering messages between clients and servers:

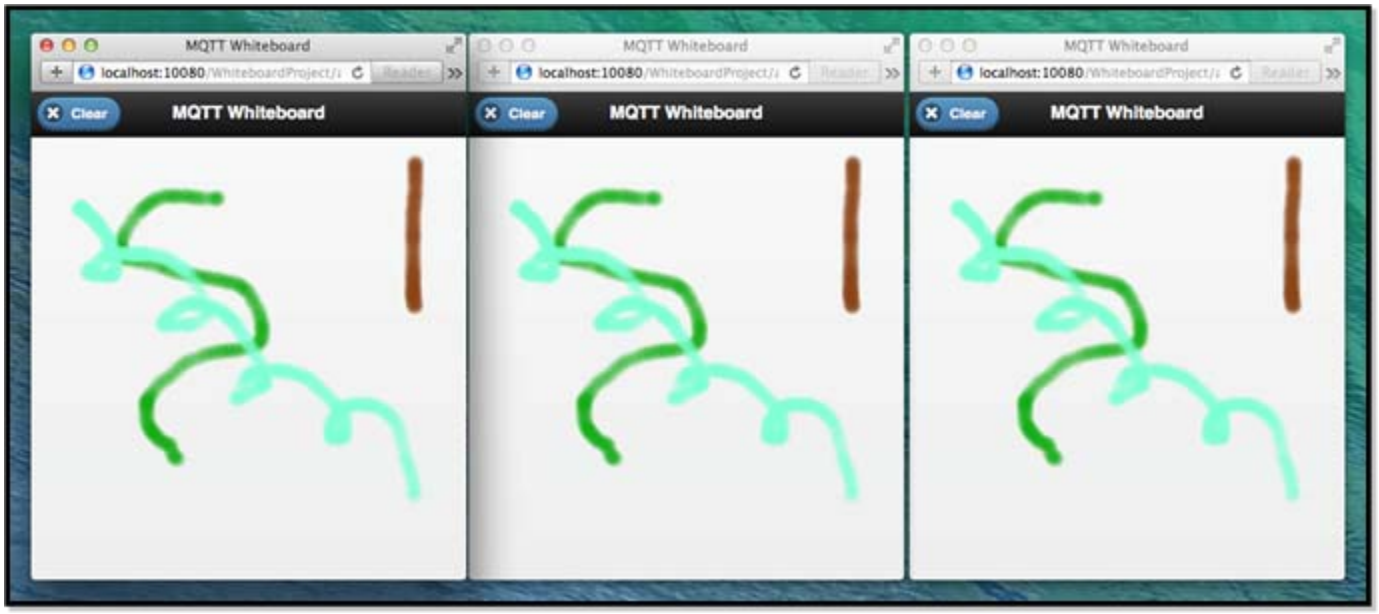
QoS 0 = “at most once”
QoS 1 = “at least once”
QoS 2 = “exactly once”

A **retained** message is retained on the MQTT server and transmitted to new subscribers to the message topic.

```
WhiteboardApp.prototype.publishDraw = function(x, y,
color) {

  var topic = "whiteboard/” + this.uuid;
  var data = JSON.stringify({
    type: "draw",
    x: x,
    y: y,
    color: color,
  });

  var msg = new Messaging.Message(data);
  msg.destinationName = topic;
  msg.qos = 0;
  msg.retained = false;

  this.client.send(msg);
}

WhiteboardApp.prototype.publishClear = function() {

  var topic = "whiteboard/” + this.uuid;
  var data = JSON.stringify({
    type: "clear"
  });

  var msg = new Messaging.Message(data);
  msg.destinationName = topic;
  msg.qos = 0;
  msg.retained = false;

  this.client.send(msg);
}
```

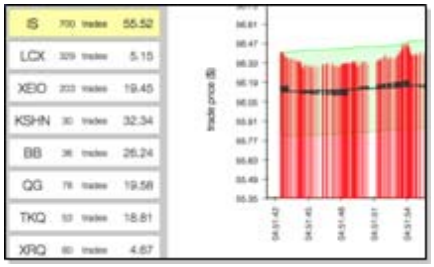
Whiteboard – Putting it all together

- Deploy to the Worklight development server again, and open the application in two (or more) windows.
- Draw in one Whiteboard, and MQTT messages are published to all other subscribing Whiteboard applications.



Extending the collaboration scenario

- This collaboration scenario can be modified and extended to build other types of real-time applications:
  - **Stock ticker**: clients subscribe to trade data for an exchange (for example, MarketData/NYSE/IBM) and update in real time.
  - **Chat application**: clients publish and subscribe on a topic for a particular chat room (for example, chat/room123/user1).
  - **Real-time emergency alerts**: clients subscribe to a topic for their particular geographic location, and emergency services publish alerts onto these topics (for example, emergency/<X>/<Y>/alert).



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Connecting to an MQTT broker

- An MQTT server is required to broker messages between MQTT clients. To support JavaScript MQTT clients (such as Eclipse Paho), the MQTT server must implement the WebSocket transport.
- Several MQTT servers are available, both open source and commercial.
  - Development MQTT servers:
    - Mosquitto (open source, multi-platform)
    - IBM MessageSight for Developers (virtual appliance image)
  - Enterprise MQTT servers:
    - IBM MessageSight (appliance)

Mosquitto

- Mosquitto is an open source, lightweight implementation of MQ Telemetry Transport V3.1, part of the Eclipse Paho messaging project.
- The Mosquitto broker is available for many different platforms (Windows, OS X, Linux distributions).
- More information:
  - http://mosquitto.org
  - http://projects.eclipse.org/projects/technology.mosquitto
- Download Mosquitto:
  - http://mosquitto.org/download/

IBM MessageSight for Developers

- IBM MessageSight for Developers is a virtual IBM MessageSight appliance image.
- MessageSight is a low-latency, reliable, and scalable messaging server with strong security and easy management.
- The developer image can be run with virtualization software such as VMWare, Oracle VirtualBox, and KVM.
- More information:
  - http://ibm.com/messagesight
  - https://www.ibmdw.net/messaging/messagesight/
  - http://www.youtube.com/watch?v=kcEDoRqhkhA

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