# RESTful services and OAUTH protocol in IoT

by Yakov Fain, Farata Systems

# Farata Systems and SuranceBay





← http://easy.insure

# The three parts of this presentation

- One approach to integrating consumer devices in the business workflow
- Live demo: integration of a blood pressure monitor
- A brief review of REST, OAUTH, Websockets and their roles the demo application.

# Internet of Things (IoT)

IN THE SENATE OF THE UNITED STATES

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Mrs. FISCHER (for herself, Mr. BOOKER, Ms. AYOTTE, and Mr. SCHATZ) submitted the following resolution; which was referred to the Committee on

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## RESOLUTION

Expressing the sense of the Senate about a national strategy for the Internet of Things to promote economic growth and consumer empowerment.

Whereas the Internet of Things currently connects tens of billions of devices worldwide and has the potential to generate trillions of dollars in economic opportunity;

Whereas increased connectivity can empower consumers in nearly every aspect of their daily lives, including in the fields of agriculture, education, energy, healthcare, public safety, security, and transportation, to name just a few;

Whereas businesses across our economy can simplify logistics, cut costs in supply chains, and pass savings on to consumers because of the Internet of Things and innovations derived from it;

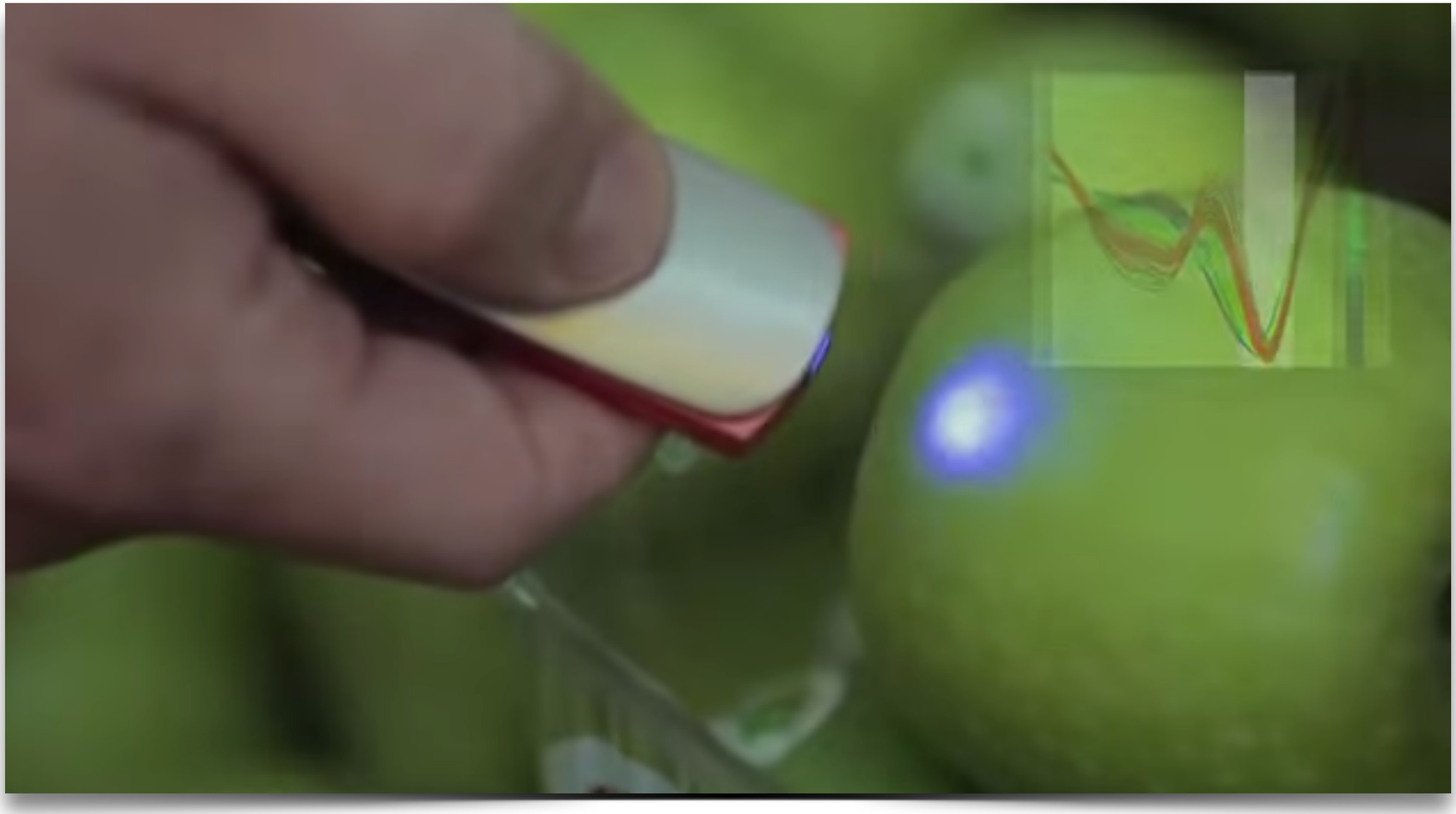
The original: http://1.usa.gov/1aLM2vq

# Yesterday's Sensors (Things)

- 18 years ago. Telephony.
- I've been programming IoT!

# Today's Sensors

SCIO: a molecular sensor that scans physical objects and receives instant information to your smartphone.

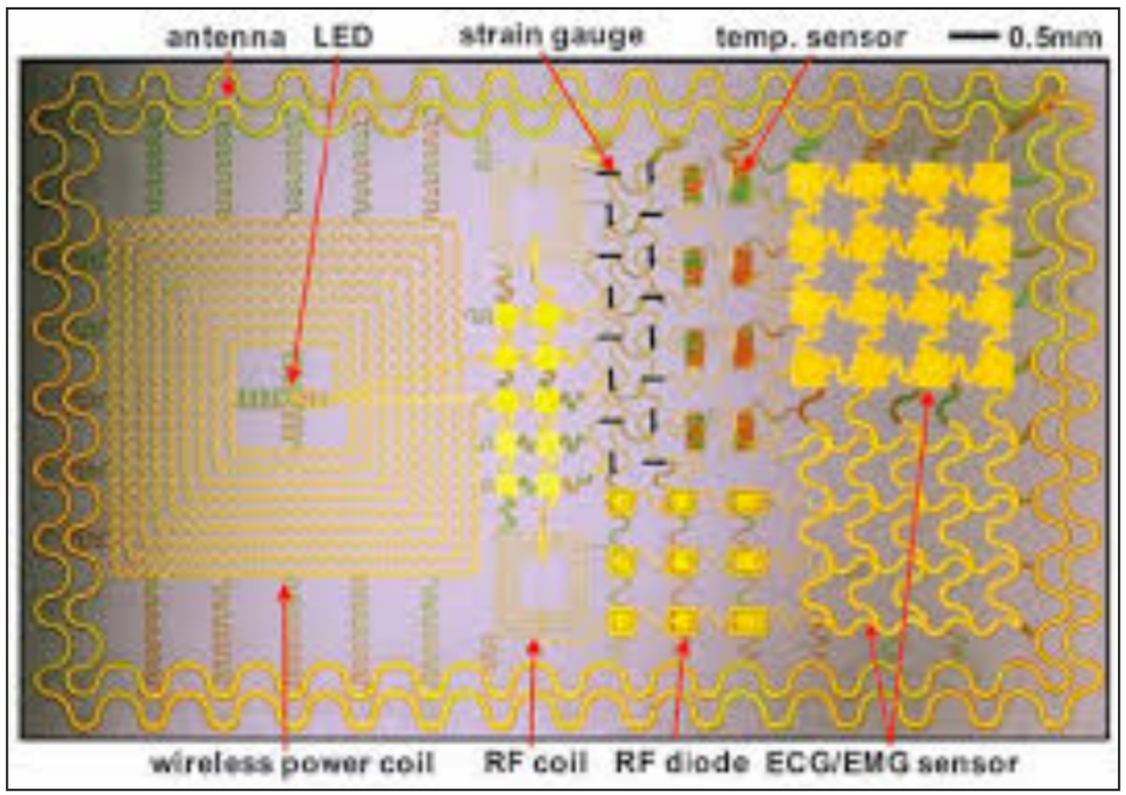


http://www.consumerphysics.com/

# Tomorrow: Streachable Wearables

epidermal electronics

## Tattoo-like 'electronic skin' wear detects heart attacks, epilepsy, skin dehydration




Here is a tattoo-like thin wearable device that can detect heart attacks, Parkinson's disease or epilepsy attacks, store your body information and deliver medicine to your body, besides collecting patient health, treatment and monitoring at one time.

Researchers in the US have created an 'electronic skin' that can store and transmit data about a person's movements, receive diagnostic information and release drugs into skin, which has been altered considerably to detect heart condition too.

Source: http://bit.ly/1uu0srr

A thing is a thing,

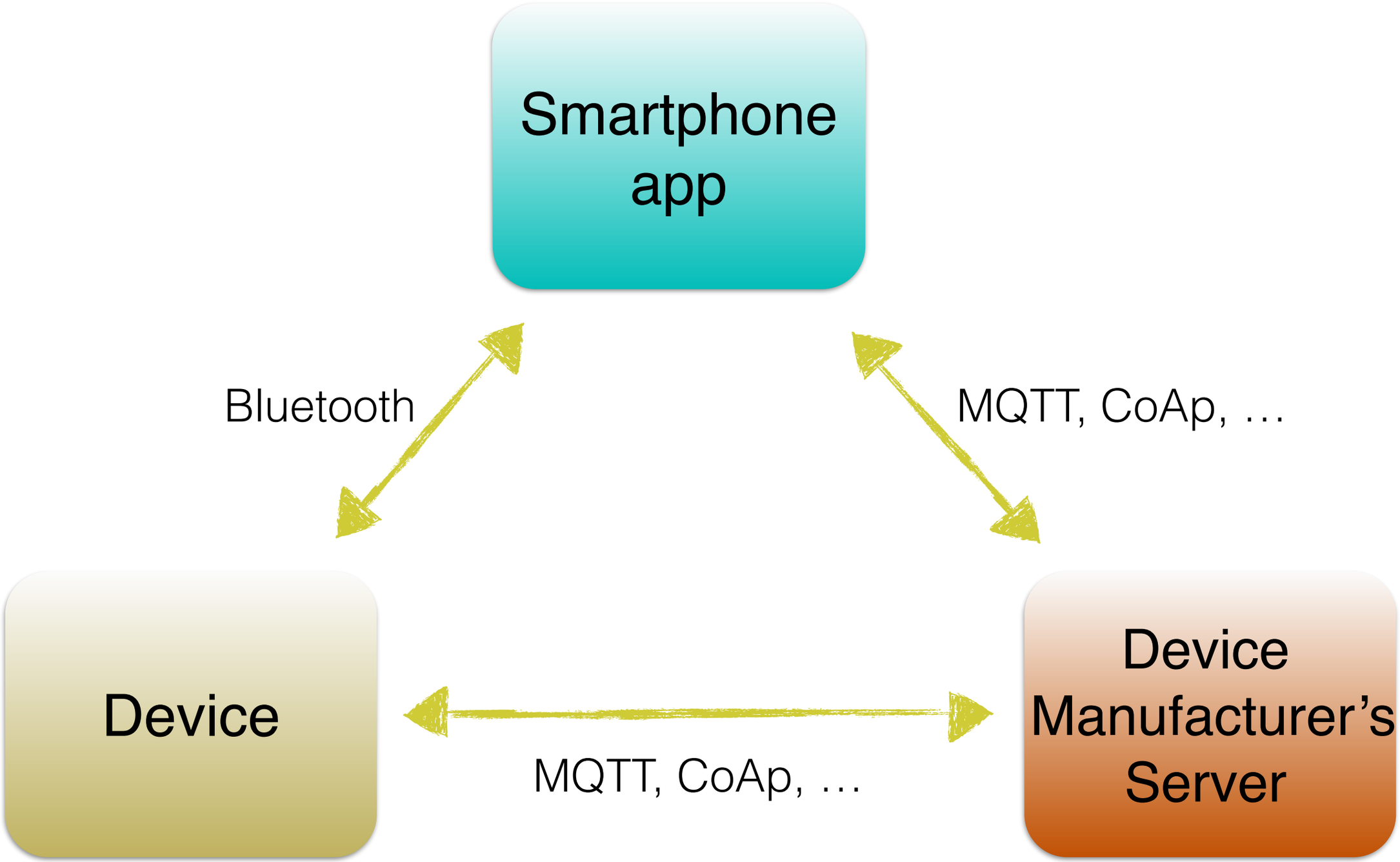
not what is said of that thing.

The Birdman movie

A thing is a thing +

an app + an API + a Web site.

# Typical Consumer Device Setup



# Low-Level IoT Approach

Learn and implement IoT protocols: MQTT, XMPP, AMQP,  CoAp,…

Program Raspberry Pi, or Arduino

Learn HomeKit and HealthKit from Apple

# High-Level IoT

Create custom-made solutions using standard technologies to integrate things into an existing business workflow.

HEALTH CARE

# Data problems found with 2 million ObamaCare sign-ups, document shows

Published June 04, 2014 · Associated Press

1.4K


A man looks over the Affordable Care Act signup page on the HealthCare.gov website.Reuters

# Why?

# Why?

# Manual Data Entry

# A POC App

- Integrate consumer devices into one of the **insurance business workflows**
- Leverage existing software technologies
- Create a standard-based application layer that connects things

# Your Server in the Middle

- Create a software layer as a proxy for all communications with IoT devices .
- Find the use-cases for data-gathering devices in your business applications.
- Being in the middle allows having valuable data for analisys.

# The Use Case: Integrating Scale and Blood Pressure Monitor into insurance workflow


IHealthLabs Blood Pressure Monitor


Fitbit Scale Aria

# Medical Examiner's Report

**Banner Life Insurance Company**
3275 Bennett Creek Avenue
Frederick, Maryland 21704
(800) 638-8428

ICC08 LU-1267 (10/08)

**PART 3**
**Medical Examiner's Report**

Name of Proposed Insured _____ Date of Birth _____

**Instructions to the Examiner -**

This examination, once begun, is the property of the Company, and must not be destroyed or suppressed. Please weigh and measure this applicant. Explain all positive findings under Remarks.

The questions which appear below are intended only as a basis for the examination. The Company relies on its examiners to observe and report all information bearing on the acceptance of a proposed insured, even though not specifically requested on this form.

Please mail blood and urine specimens promptly.

1. Height (in shoes) _____ ft. _____ in.
   Weight (clothed) _____ lbs.

   a. Did you weigh? Yes ☐ No ☐
   b. Did you measure? Yes ☐ No ☐
   If No, please explain _____
   _____

2. Measurements (males only)
   Chest (full inspiration) _____ in.
   Chest (forced expiration) _____ in.
   Abdomen (at umbilicus) _____ in.

3. Blood Pressure (record 3 readings)

| | | | |
|---|---|---|---|
| Systolic | | | |
| Diastolic | | | |

4. Pulse At rest _____
   Describe any irregularities (number per minute, etc.)
   _____
   _____

5. Are blood and urine specimens being collected and mailed to the lab? Yes ☐ No ☐

# Medical Examiner's Report

Legal & General AMERICA

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   If N
   _____

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3. Blood Pressure (record 3 readings)

| | | | |
|---|---|---|---|
| Systolic | | | |
| Diastolic | | | |

minute, etc.)

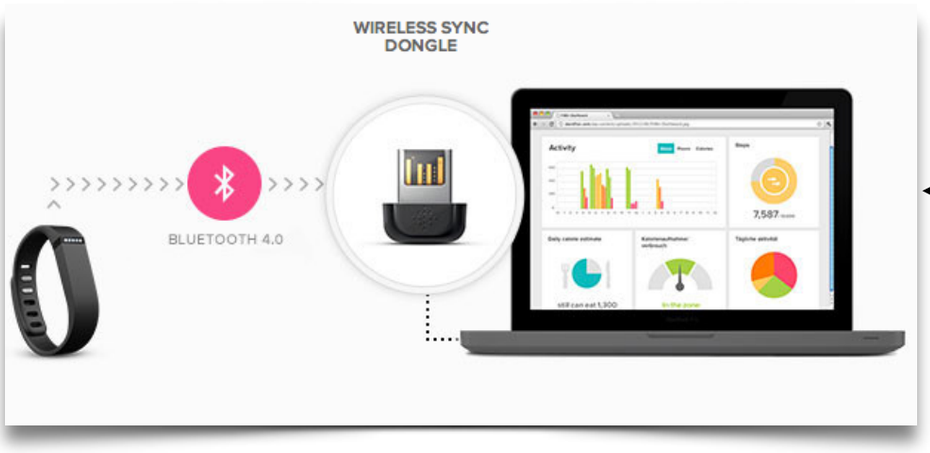
5. Are blood and urine specimens being collected and mailed to the lab? Yes ☐ No ☐

**Removing Manual Entry**

# A Typical IoT Workflow

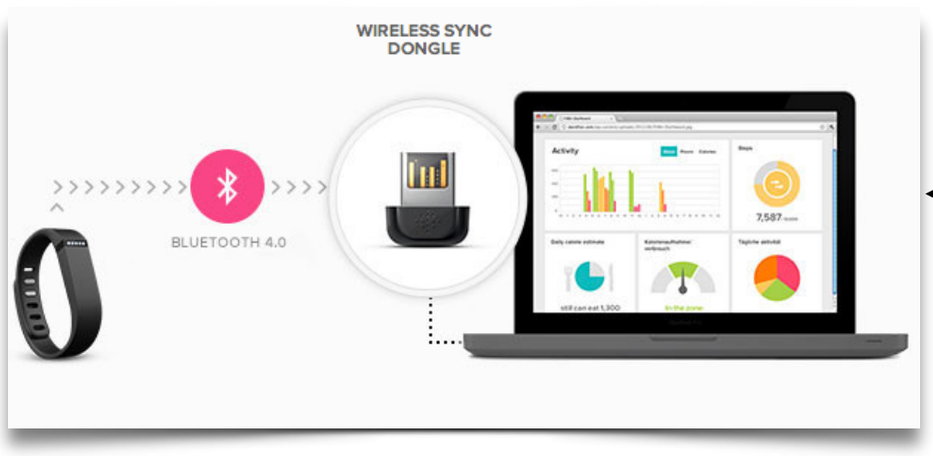

XYZ protocol

DeviceVendor.com




XYZ protocol

# A Typical IoT Workflow


XYZ protocol

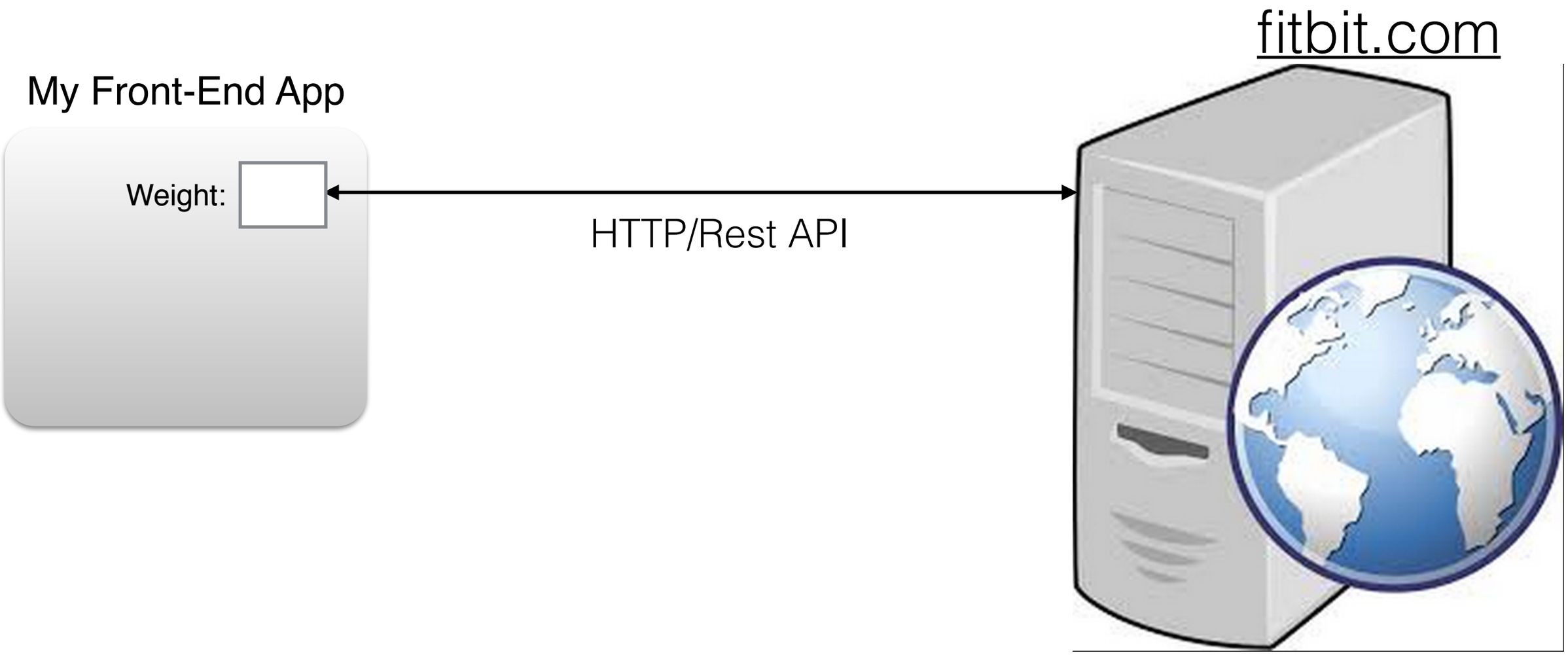
XYZ protocol

DeviceVendor.com

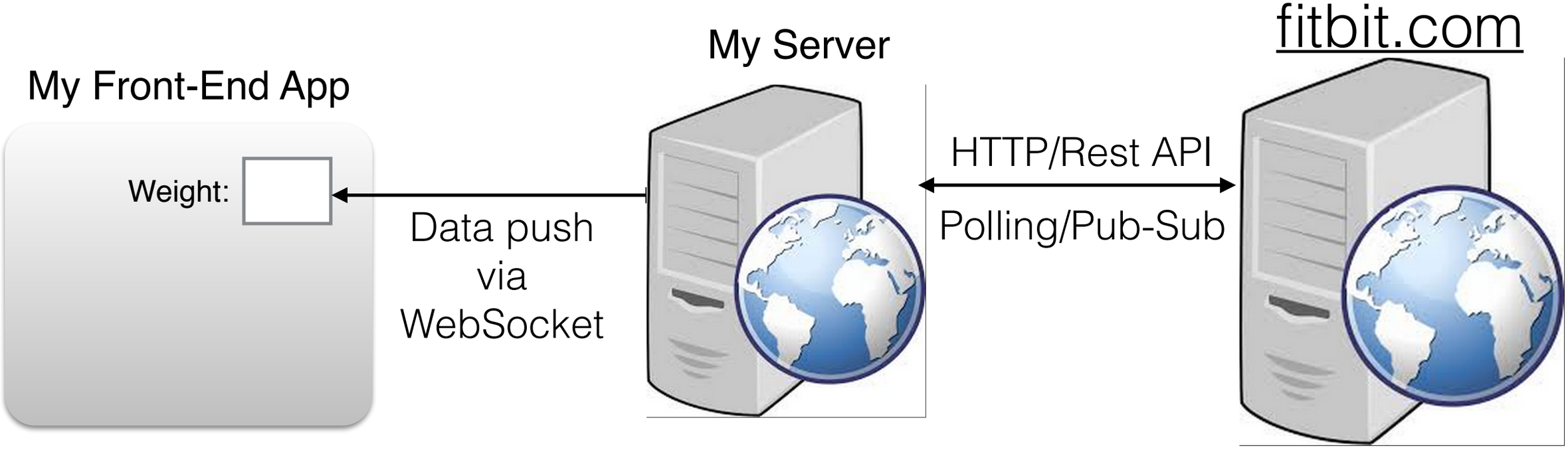
We're not interested in XYZ

Our server will communicate with the vendor's server using standard protocols

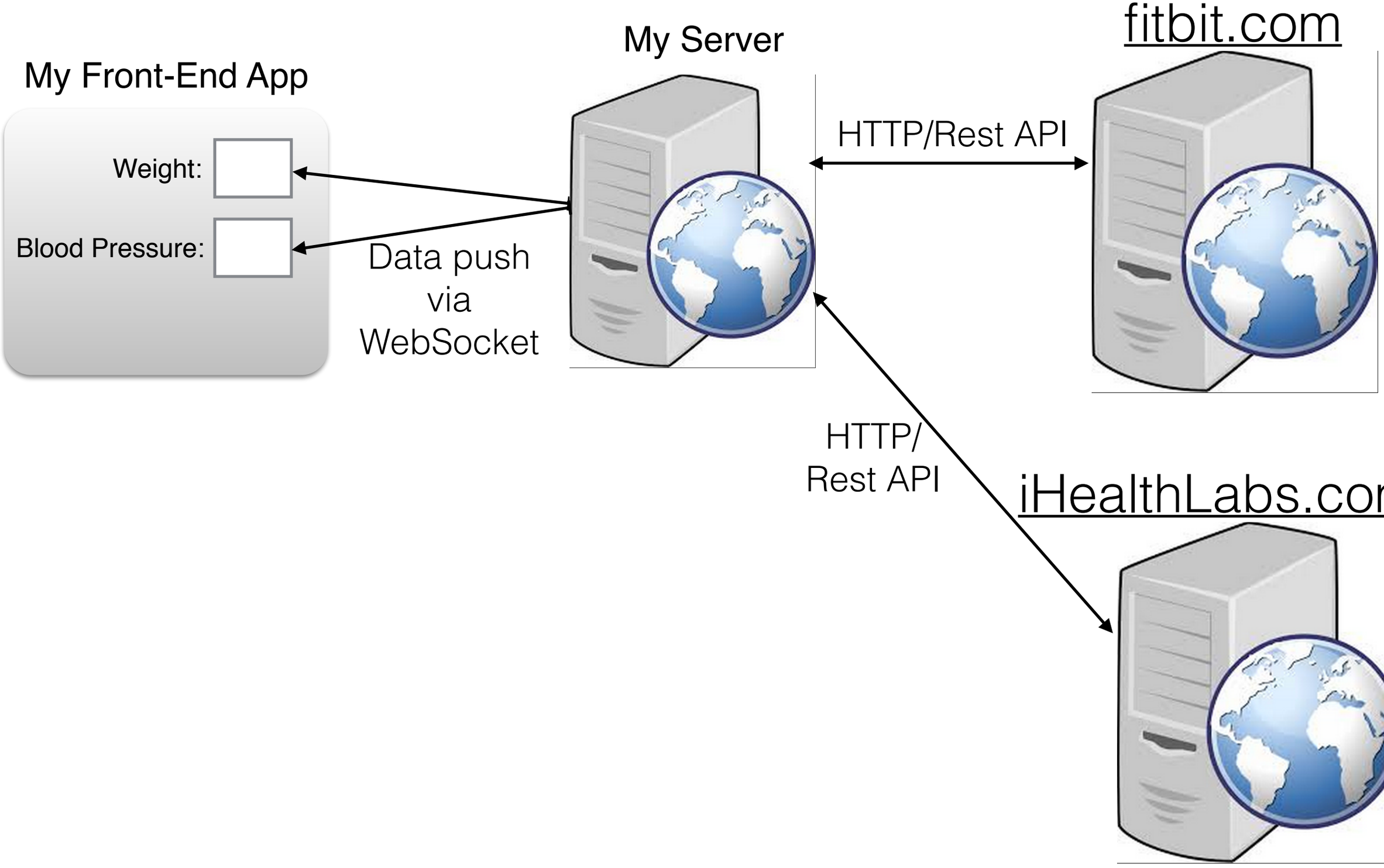
# Integrating With Fitbit Scale: Take 1.



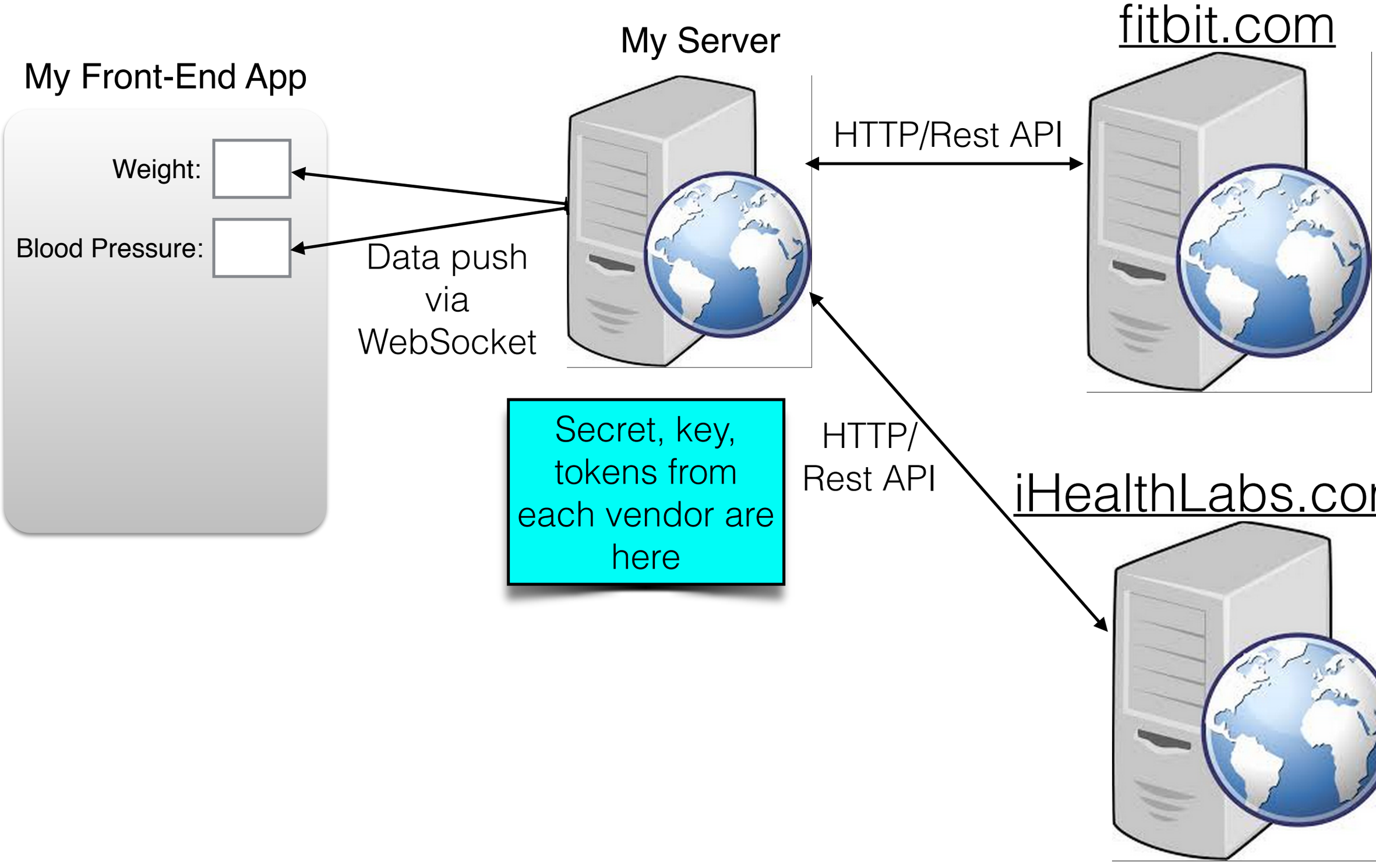
# Integrating With Fitbit Scale: Take 2.



# Integrating With Fitbit and iHealthLabs.



# Adding OAuth Authentication



# Final Architecture

My Front-End App

Weight:

Blood Pressure:

Data push via WebSocket

My Server

HTTP/Rest API

fitbit.com

Secret, key, tokens from each vendor are here

HTTP/ Rest API

iHealthLabs.com

- Vendor's consumer app

# Demo

## Measuring Blood Pressure

# The Players of our Demo App

- RESTful Web services
- OAuth authentication and authorization
- WebSocket protocol
- Front end development in Dart, deployed as JavaScript
- JSON data format
- Back-end in Java using Spring Boot with embedded Tomcat
- Gradle for build automation

# REST API

## REpresentational State of Transfer

# REST Principles (by Roy Fielding)

- Every resource on the Web has a unique ID (a unique URI)
- Use uniform interface: HTTP **Get, Post, Put, Delete.** Separation of concerns.
- A resource can have multiple representations (text, JSON, XML, PDF, etc.)
- Requests are stateless – no client-specific info is stored between requests
- You can link one resource to another(s)
- Resources should be cacheable
- A REST app can be layered



# Selected HTTP Request Methods

- GET Safe, Idempotent, cacheable <- Retrieve
- PUT Idempotent <- Update
- DELETE Idempotent <- Delete
- POST None of the above <- Create

**Idempotent**: regardless of how many times a given method is invoked, the end result is the same.

# Java EE 7: JAX RS 2.0

- Rest Endpoint - a POJO, typically deployed inside WAR
- Has Client API
- Message Filters and Entity Interceptors (e.g. Login Filter, encryptions et al.)
- Async processing on both client and server
- Validation



# Selected JAX-RS Annotations

- @ApplicationPath - defines the URL mapping for the application packaged in a war. It's the base URI for all @Path annotations.
- @Path - a root resource class (POJO),that has at least one method annotated with @Path.
- @PathParam - injects values from request into a method parameter (e.g. Product ID)
- @GET - the class method that handles HTTP Get. You can have multiple methods annotated with @GET, and each produces different MIME type.
- @POST - the class method that handles HTTP Post
- @PUT- the class method that handles HTTP Put
- @DELETE - the class method that handles HTTP Delete
- @Produces - specifies the MIME type for response (e.g. "application/json"). The client's Accept header of the HTTP request declares what's acceptable. The client gets 406 if no methods that produce required is found.
- @Consumes - specifies the MIME types that a resource can consume when sent by the client. If a resource is unable to consume the requested MIME type, the clients get HTTP error 415.
- @QueryParam - if a request URL has parameters, each param will be placed in the provided Java variable.



# Java EE Rest Endpoint

```
// The endpoint URL path
@ApplicationPath(“iotdemo")
public class MyIoTApplication extends Application {
}


// The endpoint handling blood pressure
@Path("/ihealth")
public class BloodPressureService {

  // …
  // The method to handle HTTP Get requests
  @GET
  @Path("/bp")
  @Produces(“application/json")
  public String getBloodPressureData() {
    // The code to get bp and prepare JSON goes here
    return bloodPressure;
  }
}
```

==========

**A sample REST request:**
“https://iHealthLabs.com:8443/iotdemo/ihealth/bp"



FARATA

# Spring Rest Endpoint

```
// The endpoint handling blood pressure
@RestController
@RequestMapping("/ihealth")
public class HealthLabsController {


// …
// The method to handle HTTP Get requests
@RequestMapping(value="/bp", method = RequestMethod.GET,
                                produces = "application/json")
public Measurement getBloodPressureData() {
    // The code to get blood pressure goes here
    return bloodPressure;
  }
}
```



FARATA

# OAuth

Authorizing an app to act on behalf of the user

# Authorization and Authentication

- **Authentication** is verifying the identity of the user.
  Is he who he says he is?

- **Authorization** is figuring out what resources the logged in user can access.

For example, the owner of the device can see only the blood pressure measurments taken from his device.

# OAuth Players

- The server with user resources
- The authorization server
- The client app that wants to acccess user resources

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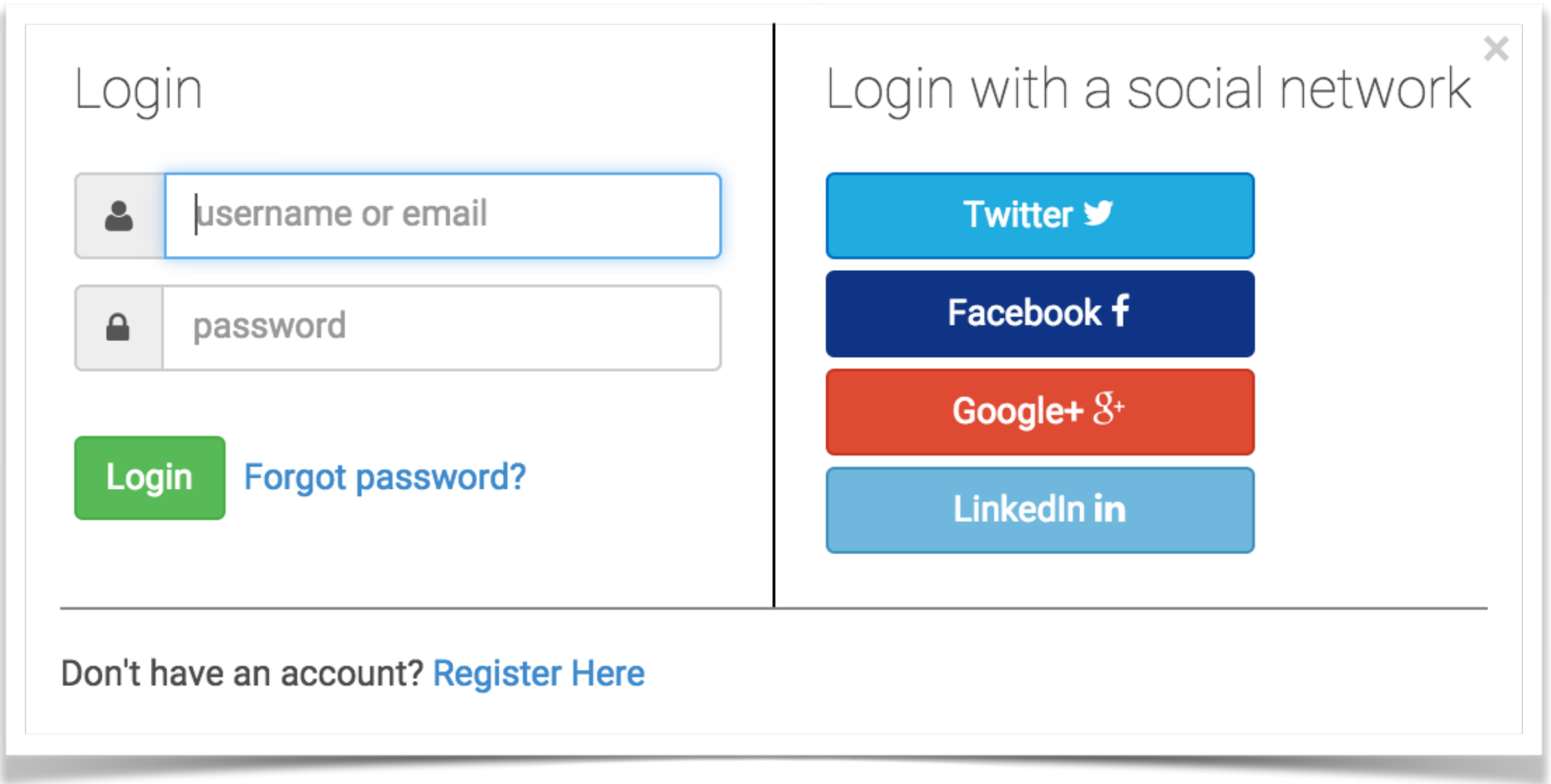
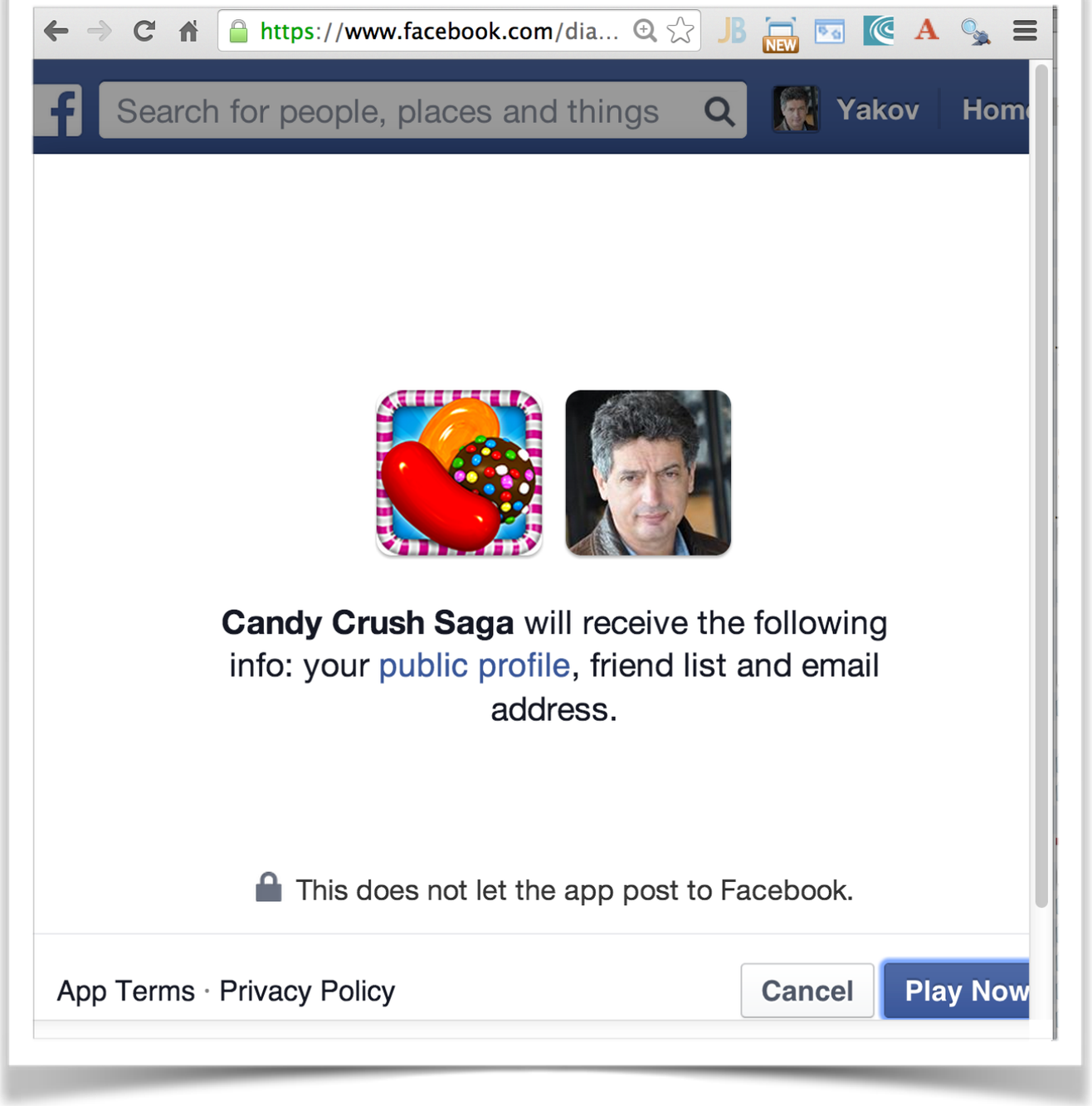
The two servers may be created and run by different  vendors

# Using Multiple Authorization Servers

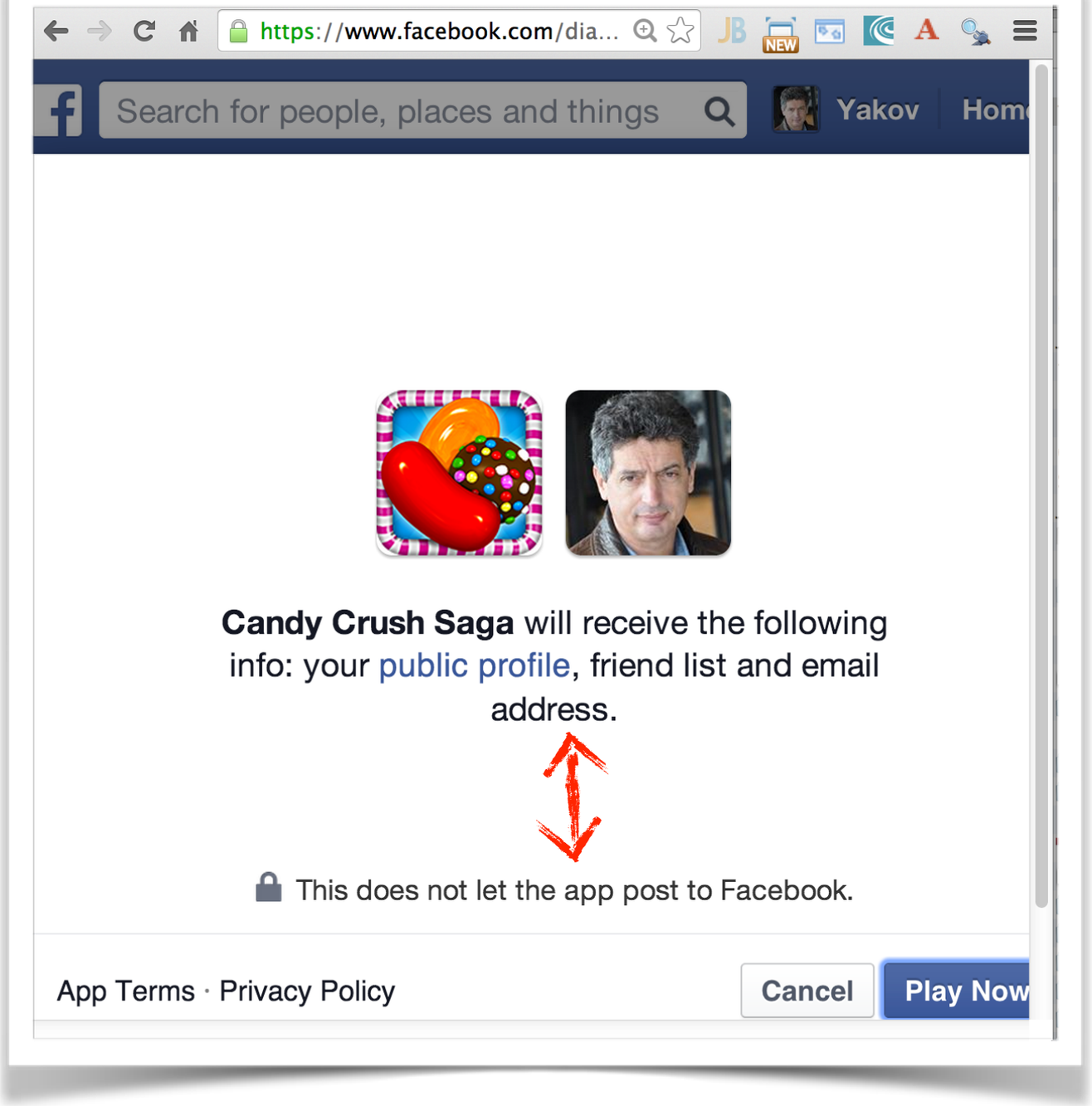


# Authentication and authorization with Facebook




# Using Facebook to login to Candy Crush

# Authentication and authorization with Facebook




You don’t want to give your Facebook password to Candy Crush

# OAuth 2 Access Token

A client app needs to aquire an access token that can be used on behalf of the user.

# A Sample OAuth 2 Workflow

- **My company** registers the app with the thing's vendor providing a **redirect URI** for successful and failed logins and gets a **client id** and a **secret**.

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- My app (not the browser) generates a session-based random state and sends the request to the thing's vendor:

  https://<auth_server>/path?clientid=123&redirect_uri=https//
  myCallbackURL&response_type=code&scope="email user_likes"&state=7F32G5

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- **My app** receives temporary auth code from the thing's vendor, regenerates state and compares with the received one:

  https://myCallbackURL?code=54321&state=7F32G5

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- ,My app makes another request adding the secret and exchanging the code for the authorization token:

  https://<auth_server>/path?clientid=123&client_secret=…&code=54321&redirect_uri=https//myCallbackURL&grant_type=authorization_code

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- **The thing's vendor** redirects the user to my app and provides the authorization token.

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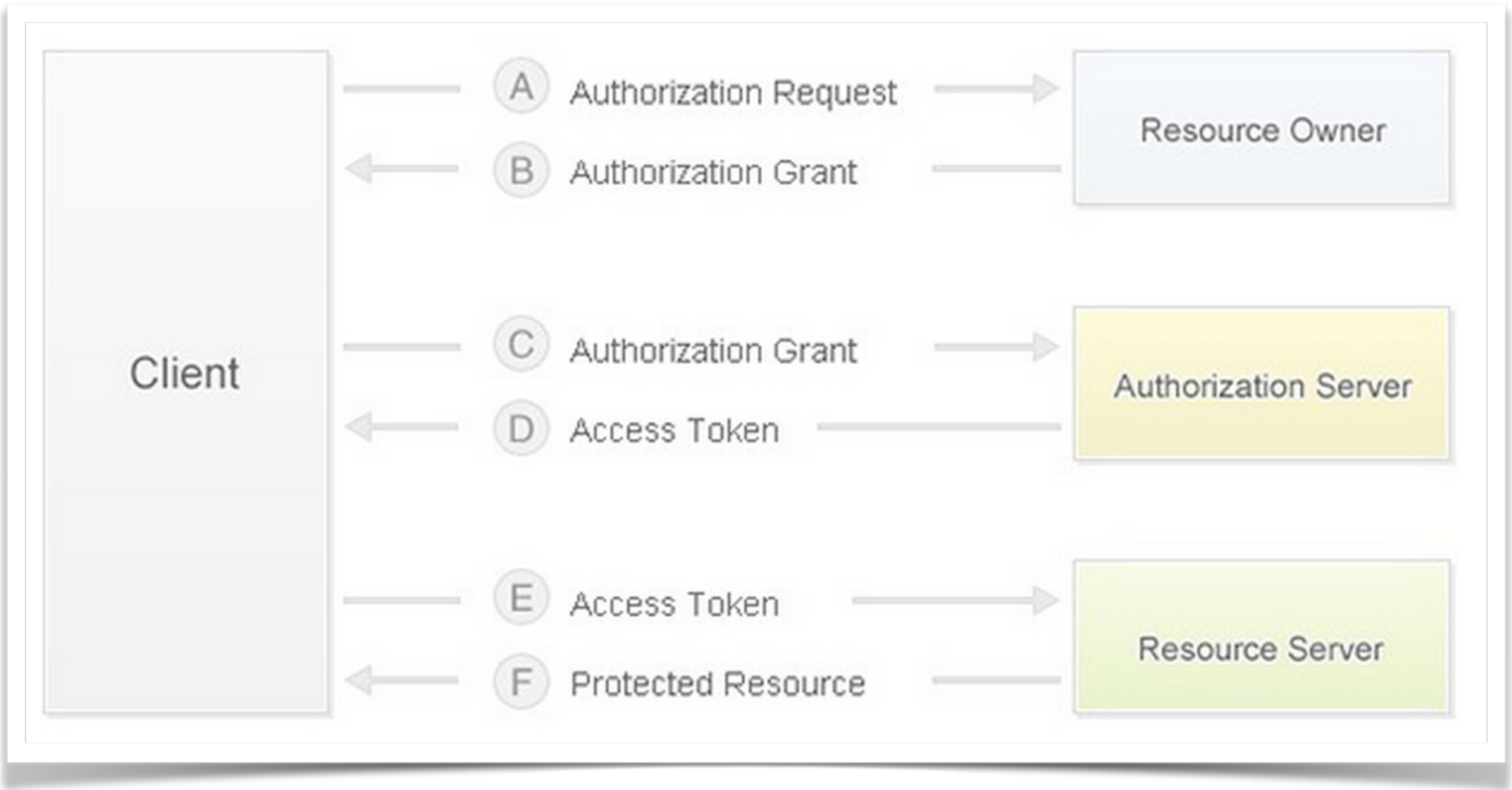
- **The thing's vendor** redirects the user to my app and provides the authorization token.

- **My app** starts invoking the vendor's API using the token.

# iHealthLabs Authorization



# Access and Refresh Tokens

- The OAuth 2 server returns the **authorization token**. It expires after certain time interval. iHealtLabs sends the token in JSON format that expires in 10 min.

- The OAuth 2 server also provides a **refresh token** that the application uses to request a new token instead of the expired one.

# WebSocket Protocol

Bi-directional communication for the Web

# HTTP Hacks for Server's push

- HTTP is request-based and high-overhead protocol
- Hacks for achieving the server-side "push":
  - Polling
  - Long Polling
  - HTTP Streaming
  - Server-Side Events (SSE)



# Monitoring AJAX requests

https://www.google.com/finance?q=AAPL

Google AAPL

Finance **Apple Inc.** (NASDAQ:AAPL) Add to portfolio

Company
Summary
News
Option chain
Related companies
Historical prices
Financials

**113.08** +1.30 (1.16%)
Real-time: 11:23AM EST
NASDAQ real-time data - Disclaimer
Currency in USD

| | | | |
|---|---|---|---|
| Range | 111.97 - 113.49 | Div/yield | 0.47/1.66 |
| 52 week | 70.51 - 119.75 | EPS | 6.43 |
| Open | 112.16 | Shares | 5.86B |
| Vol / Avg. | 12.99M/50.32M | Beta | 0.92 |
| Mkt cap | 663.18B | Inst. own | 62% |
| P/E | 17.59 | | |

g+1 7.6k

Elements Network Sources Timeline Profiles Resources Audits Console AngularJS

Preserve log Disable cache

Filter All Documents Stylesheets Images Media Scripts XHR Fonts TextTracks WebSockets Other Hide data URLs

| Name / Path | Method | Status / Text | Type | Initiator | Size / Content |
|---|---|---|---|---|---|
| getprices?q=AAPL&x=NASD&i=120&p=25m&f=d,c,v,o,h,l&df=cpct&auto=1&ts=1419265315339&ei=qk... /finance | GET | 200 OK | text/plain | Other | 359 B 617 B |
| channel?VER=8&SID=A77C764226E2BA1&RID=29572&AID=151&zx=y49rttmj3t6u&t=1 /finance/qs | POST | 200 OK | text/plain | d=0:150 Script | 71 B 13 B |
| getprices?q=AAPL&x=NASD&i=120&p=25m&f=d,c,v,o,h,l&df=cpct&auto=1&ts=1419265375384&ei=qk... /finance | GET | 200 OK | text/plain | Other | 374 B 656 B |
| channel?VER=8&SID=A77C764226E2BA1&RID=29573&AID=212&zx=39z7odxoqnoy&t=1 /finance/qs | POST | 200 OK | text/plain | d=0:150 Script | 68 B 13 B |
| channel?VER=8&SID=A77C764226E2BA1&RID=29574&AID=276&zx=dax4ov6c72o1&t=1 /finance/qs | POST | 200 OK | text/plain | d=0:150 Script | 69 B 13 B |
| getprices?q=AAPL&x=NASD&i=120&p=25m&f=d,c,v,o,h,l&df=cpct&auto=1&ts=1419265435487&ei=qk... /finance | GET | 200 OK | text/plain | Other | 363 B 615 B |

6 / 10 requests | 1.3 KB / 173 KB transferred

# What's WebSocket

- Standardized full-duplex low overhead protocol.
- Client-side API: Web browsers come with `window.WebSocket` object.
- Server-side API: Java EE 7, Spring, etc.



# Apps for Websockets

- Live trading/auctions/sports notifications
- Controlling medical equipment over the web
- Chat applications
- Multiplayer online games

# WebSocket Protocol

- STANDARD PROTOCOL: WebSocket is a standardized technology (RFC6455).

- CLIENT-SIDE API: the `window.WebSocket` object. No plugin required

- SERVER-SIDE API exists for various platforms.

- WebSocket is included in Java EE 7 spec (JSR 356)

# WebSocket Workflow

- Establish a connection
- Send messages in both directions at the same time (Full Duplex)
- Close the connection
- All modern browsers support WebSocket protocol

http://caniuse.com/websockets

# WebSocket Client/Server handshake

- Client sends UPGRADE HTTP-request
- Server confirms UPGRADE
- Client receives UPGRADE response
- Client changes `readyState` property of WebSocket object to open



# Web Browser WebSocketClient

- Initiate the connection to the server's endpoint by creating an instance of WebSocket object providing the URL of the server
- Write an `onOpen()` callback function
- Write an `onMessage()` callback function
- Write an `onClose()` callback function
- Write an `onError()` callback function

# JavaScript Client

```
if (window.WebSocket) {
    ws = new WebSocket("ws://www.websocket.org/echo");

    ws.onopen = function() {
        console.log("onopen");
    };

    ws.onmessage = function(e) {
       console.log("echo from server : " + e.data);
    };

    ws.onclose = function() {
       console.log("onclose");
    };
    ws.onerror = function() {
       console.log("onerror");
    };

} else {
   console.log("WebSocket object is not supported");
}
```



# Java EE WebSocket Server's APIs

1. Annotated WebSocket endpoint

Annotate a POJO with `@ServerEndpoint`, and its methods with `@OnOpen`, `@OnMessage`, `@OnError`, and `@OnClose`

2. Programmatic endpoint

Extend your class from `javax.websocket.Endpoint` and override `onOpen()`, `onMessage()`, `onError()`, and `onClose()`.



# HelloWebSocket Server

The server-side push without client's requests

```
@ServerEndpoint("/hello")
public class HelloWebSocket {

  @OnOpen
  public void greetTheClient(Session session){
     try {
        session.getBasicRemote().sendText("Hello stranger");

     } catch (IOException ioe) {
        System.out.println(ioe.getMessage());
     }
  }
}
```

# Code Fragment with Websockets in Spring

```
public class WebSocketEndPoint extends TextWebSocketHandler {
    private final static Logger LOG = LoggerFactory.getLogger(WebSocketEndPoint.class);

    private Gson gson;
    private WebSocketSession currentSession;

    @Override
    public void afterConnectionEstablished(WebSocketSession session) throws Exception {
        super.afterConnectionEstablished(session);

        setCurrentSession(session);
    }

    public boolean sendMeasurement(Measurement m) {
        if (getCurrentSession() != null) {
            TextMessage message = new TextMessage(getGson().toJson(m));

            try {
                getCurrentSession().sendMessage(message);
            } catch (IOException e) {
                e.printStackTrace();
                return false;
            }

            return true;
        } else {
            LOG.info("Can not send message, session is not established.");
            return false;
        }
    }
```



# Deploying with Spring Boot

- Java EE Rest services are deployed in WAR under external Java Server
- Spring Boot allows creating a standalone app (a JAR) with an embedded servlet container.
- Starting our Restful server: **java -jar MyJar**.
- We used a default: Tomcat. To use other server exclude Tomcat in build configuration and specify another dependency. Here's a sample section from Gradle build:

```
dependencies {
   compile("org.springframework.boot:spring-boot-starter-web") {
        exclude module: "spring-boot-starter-tomcat"
   }
   compile("org.springframework.boot:spring-boot-starter-jetty")
}
```

# What about security?

- Device vendors should take security very seriously.
- We don’t deal with security between the thing and its vendor.
- We just use OAauth state attribute, and the OAuth provider must check that the received redirect_uri is the same as provided during the app registration.
- IoT integration apps are as as secure as any other Web app (owasp.org).

# Contact Info

- I work for Farata Systems: faratasystems.com
- email: yfain@faratasystems.com
- Twitter: @yfain
- Personal blog: yakovfain.com