Measuring and Estimating an IoT Project

IoT – The Internet of Things

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https://itconfidence2016.wordpress.com
Dr. Thomas Fehlmann

- 1981: Dr. Math. ETHZ
- 1991: Six Sigma for Software Black Belt
- 1999: Euro Project Office AG, Zürich
- 2001: Akao Price 2001 for original contributions to QFD
- 2003: SwissICT Expert for Software Metrics
- 2004: Member of the Board QFD Institute Deutschland – QFD Architect
- 2007: CMMI for Software – Level 4 & 5
- 2011: Net Promoter® Certified Associate
- 2012: Member of the DASMA Board
- 2013: Vice-President ISBSG
- 2016: Academic Member of the Athens Institute for Education and Research
Goals of the Presentation

✓ G1. IoT Projects are different from traditional Software Development
✓ G2. Functional Size matters, but not for cost
✓ G3. Cost Drivers are Fun, Social Ranking, Safety and Security
1. What is the Internet of Things? Why does it matter?
2. IoT Frameworks
3. Customer Driven Approach
4. Cost Estimation
1. What is the Internet of Things? Why does it matter?
2. IoT Frameworks
3. Customer Driven Approach
4. Cost Estimation
The Vision – Intelligent Things

I don’t want this to happen again!

I

Measuring an IoT Project
What is the IoT? Why does it matter?
The Internet of Things (IoT)

- By end of the decennia, 50 Mia things like fridges, kitchen appliances and other intelligent things will connect to the Internet
- They will be able to order milk when finished, turn light on or off when needed, and run washing machines during periods of low electricity rates
- They will drive autonomous cars, avoid traffic jams, prevent traffic hazards
- What is their future value for business?
The Internet of Things (IoT)

By end of the decennia, 50 Mia things like fridges, kitchen appliances and other intelligent things will connect to the Internet.

They will be able to order milk when finished, turn light on or off when needed, and run washing machines during periods of low electricity rates.

They will drive autonomous cars, avoid traffic jams, prevent traffic hazards.

What is their future value for business?

Everybody will be writing software.

Accelerate your transition to a software-driven company.

Measuring an IoT Project

What is the IoT? Why does it matter?

Paul Maritz, CEO Pivotal

(Illustration Christoph Fischer; © NZZ November 3, 2014)
The Architecture of the Web of Things

- The Web of Things (WoT) is a set of software architectural styles and programming patterns.
- The Web of Things reuses existing Web standards used in the
  - programmable Web (REST, HTTP, ...)
  - semantic Web (JSON-LD, Microdata)
  - real-time Web (e.g., Websockets), and
  - social Web (e.g., oAuth or social networks)

http://de.wikipedia.org/wiki/6LoWPAN
I’m the Programmer!

- Programming framework
  - Ease of use
  - Graphical
  - Transparent

- The code is the truth
  - I want to see my C/C++

- I’m better than others
  - I need Metrics
Measuring an IoT Project

I’m the Programmer!

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  - Ease of use
  - Graphical
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  - I want to see my C/C++

- I’m better than others
  - I need Metrics

What is the IoT? Why does it matter?

```c
#include "mbed.h"

DigitalIn button1( SW2 );  // Right Button on ARM Board
DigitalOut led( LED1 );

int main()
{
    led = 1;  // red (RGB LED use inverse logic
               // 1 = OFF, 0 = ON)

    while ( true )
    {
        if ( button1 == 0 )  // Button pressed
            led = 0;
        else
            led = 1;
    }
}
```

The WeMo Slow Cooker Channel goes well with

- Amazon Alexa
- IOS Location
- Email
- Date & Time

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The Vision – My Kitchen Helper

- He knows what I intend cooking
  - By reading recipes
- Watches temperatures while I’m off
  - Reading e-Mails, during phone calls...
- Prepares my shopping list
  - Knows what I need and what’s missing
- Does shopping in e-Shops
  - I’ll pick up the shopping bag at the next stop
- Tells oven and boiling plates what’s on tonight
The Vision – User’s Requirements

- My kitchen is my castle – I do the Kitchen Helper Programming!
  - I don’t want anybody else controlling my cooking
- I buy appliances and write my own collaboration software
  - I expect suppliers to provide intelligent kitchen appliances
- Programming must be straightforward and easy to use
  - I expect suppliers to provide programmable kitchen appliances
- Suppliers must endorse open standards
  - Otherwise, I look for other offers
- Suppliers must guarantee **Safety** and **Security** of their products
The Vision – Constraints

- The Kitchen Helper Framework must be a collaborative approach between
  - Grocery and Diary e-Shops
  - Cooking sites publishing Cooking Recipes
  - Kitchen Appliance Software Providers

We want Open Standards!
However, Complexity is Roaring...

- What are the possible effect caused by Failure?
  - Wrong shopping? No dinner?
  - Boilerplate overheating?
  - Blasting the house?
- Where to start Measuring?
  - Which requirements?
  - What NFR scenarios?
- Benchmarking with What??
  - Any data out there?
1. What is the Internet of Things? Why does it matter?
2. IoT Frameworks
3. Customer Driven Approach
4. Cost Estimation
A Framework is a model of
- Functionality
- Building Blocks
- Software

Users can build own apps
- Based on the functionality and the building blocks of the framework
IoT Frameworks consist of
- Sensor/actuator stubs
- Interface library
- Integrated Development Environment (IDE)

IoT Framework reward system
- People need to get appraisal
- Must ask the Community
- Social entitlement
More than one model is needed

- COSMIC Model as an IDE interface
- IFPUG Model to explain guests what she/he achieved
In IoT – as nowadays everywhere else – software size measurement is automated
1. What is the Internet of Things? Why does it matter?
2. IoT Frameworks
3. **Customer Driven Approach**
4. Cost Estimation
Measuring an IoT Project

Customer Driven Approach – Customer’s Requirements

➢ I’m a Grocery Store and want loyal customers
   ▪ Having fun with us
   ▪ Loving IoT programming as a game
   ▪ Coming back to buy our stuff

➢ I need help from Collaborators
   ▪ Cooking Communities
   ▪ IoT Programmers
   ▪ Kitchen Manufacturers
   ▪ ... and the home cooking people
The Analytic Hierarchy Process (AHP) allows determining Business Drivers’ priorities among various Stakeholders

- Grocery Shops
- Cooking Community
- Kitchen Manufacturer
- Kitchen User

### AHP Priorities

<table>
<thead>
<tr>
<th>Kitchen Framework</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grocery Shop</td>
<td>1</td>
<td>1/5</td>
<td>2</td>
<td>1/3</td>
<td>16%</td>
</tr>
<tr>
<td>Cooking Community</td>
<td>5</td>
<td>1</td>
<td>1/2</td>
<td>1/3</td>
<td>23%</td>
</tr>
<tr>
<td>Kitchen Manufacturer</td>
<td>1/2</td>
<td>2</td>
<td>1</td>
<td>1/2</td>
<td>20%</td>
</tr>
<tr>
<td>Kitchen User</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>41%</td>
</tr>
</tbody>
</table>

### Ranking

<table>
<thead>
<tr>
<th>A</th>
<th>4</th>
<th>0.31</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>2</td>
<td>0.44</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>0.37</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>0.76</td>
</tr>
</tbody>
</table>
Measuring an IoT Project

Customer Driven Approach – Analytic Hierarchy Process

### AHP Priorities

#### A Grocery Shop
- A01 Increase Turnover
- A02 Promote High-end priced Food
- A03 Customer Loyalty

#### B Cooking Community
- B01 Collect New Recipes
- B02 Promote Specialities
- B03 IoT Programming
- B04 Contribute to Community
- B05 Get Reward

#### C Kitchen Manufacturer
- C01 Extra Appliance Value
- C02 Willing to Recommend
- C03 Low Maintenance Cost

#### D Kitchen User
- D01 Surprise Friends
- D02 Cook without Stress
- D03 Everything in Stock
- D04 Get High Esteem
- D05 Stay in Control

---

**AHP Priorities**

**Ranking**

**Profile**

**Weight**

**Grocery Shop**

- A01 Increase Turnover: 2
- A02 Promote High-end priced Food: 3
- A03 Customer Loyalty: 1

**Cooking Community**

- B01 Collect New Recipes: 2
- B02 Promote Specialities: 1
- B03 IoT Programming: 1
- B04 Contribute to Community: 3
- B05 Get Reward: 5

**Kitchen Manufacturer**

- C01 Extra Appliance Value: 2
- C02 Willing to Recommend: 1
- C03 Low Maintenance Cost: 3

**Kitchen User**

- D01 Surprise Friends: 3
- D02 Cook without Stress: 4
- D03 Everything in Stock: 1
- D04 Get High Esteem: 4
- D05 Stay in Control: 5

---

**AHP Priorities**

**Ranking**

**Profile**

**Kitchen Framework**

**Weight**

**Grocery Shop**

- A01 Increase Turnover: 1/5
- A02 Promote High-end priced Food: 1/3
- A03 Customer Loyalty: 1/3

**Cooking Community**

- B01 Collect New Recipes: 1/2
- B02 Promote Specialities: 1/3
- B03 IoT Programming: 1/3
- B04 Contribute to Community: 1/2
- B05 Get Reward: 1/2

**Kitchen Manufacturer**

- C01 Extra Appliance Value: 2
- C02 Willing to Recommend: 1
- C03 Low Maintenance Cost: 1/3

**Kitchen User**

- D01 Surprise Friends: 2
- D02 Cook without Stress: 3
- D03 Everything in Stock: 3
- D04 Get High Esteem: 4
- D05 Stay in Control: 5

---

**Extra Appliance Value**

- Willing to Recommend: 4

**Low Maintenance Cost**

- Get Reward: 5

**Surprise Friends**

- Cook without Stress: 3

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### My Framework Project Strategy

#### Top Business Drivers

**Kitchen Framework**

<table>
<thead>
<tr>
<th>Top Business Drivers</th>
<th>Attributes</th>
<th>Weight</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Grocery Shop</td>
<td>Customer come back, Find special food</td>
<td>14%</td>
<td>0.35</td>
</tr>
<tr>
<td>B Cooking Community</td>
<td>Be unique, Feel special</td>
<td>10%</td>
<td>0.25</td>
</tr>
<tr>
<td>C Kitchen Manufacturer</td>
<td>Get famous, for new ideas, A special kitchen</td>
<td>10%</td>
<td>0.24</td>
</tr>
<tr>
<td>D Kitchen User</td>
<td>Better than, competition, Kitchen helper helps!</td>
<td>9%</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>Feel cool, Make friends envious</td>
<td>17%</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>Earn praise</td>
<td>15%</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26%</td>
<td>0.64</td>
</tr>
</tbody>
</table>
Selecting User Stories for Building the Framework

- Functional User is the IoT Programmer
- Assembles its personal kitchen helper in order to have fun with good food

<table>
<thead>
<tr>
<th>User Stories</th>
<th>As a ... [functional user]</th>
<th>I want to ... [get something done]</th>
<th>such that ... [quality characteristic]</th>
<th>so that ... [value or benefit]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Q001 Libraries</td>
<td>IoT Programmer</td>
<td>find relevant libraries to my kitchen IoT</td>
<td>I can talk to intelligent kitchen appliances</td>
<td>plug-ins are ready for use</td>
</tr>
<tr>
<td>2) Q002 IDE</td>
<td>IoT Programmer</td>
<td>get help when programming</td>
<td>the IDE proposes relevant functions</td>
<td>I save on time when programming</td>
</tr>
<tr>
<td>3) Q003 Functionality</td>
<td>IoT Programmer</td>
<td>use intelligent kitchen appliances</td>
<td>they provide the needed functionality</td>
<td>people love to talk with me about it</td>
</tr>
<tr>
<td>4) Q004 Safety</td>
<td>IoT Programmer</td>
<td>be sure I cannot harm anybody with my programs</td>
<td>all components are fail safe</td>
<td>I can connect whatever comes to my mind</td>
</tr>
<tr>
<td>5) Q005 Security</td>
<td>IoT Programmer</td>
<td>be sure nobody gets unauthorized access to my home</td>
<td>I can see who’s trying to get in</td>
<td>all components are private and secured</td>
</tr>
<tr>
<td>6) Q006 Loyalty</td>
<td>Grocery Shop</td>
<td>get returning customers</td>
<td>they come back because satisfied</td>
<td>I don’t need an expensive IoT support</td>
</tr>
<tr>
<td>7) Q007 Recommendations</td>
<td>Kitchen Manufacturer</td>
<td>provide more intelligent appliances than competition</td>
<td>customers recommend</td>
<td>I’ll stay in the market</td>
</tr>
<tr>
<td>8) Q008 Get Likes</td>
<td>IoT Programmer</td>
<td>get many likes for my programs</td>
<td>I become famous</td>
<td>I can continue programming</td>
</tr>
<tr>
<td>9) Q009 Good Food</td>
<td>Kitchen User</td>
<td>eat good food</td>
<td>it makes me happy</td>
<td>I enjoy life</td>
</tr>
</tbody>
</table>
Now we go to our friends, colleagues and business partners
- Proposing collaboration for building the framework
- Explaining them mutual interest
- Win-Win Situation

They are enthusiastic
- However, they have a question:
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Customer Driven Approach – The Big Question

However, there is One Big Question:

What does it cost?
1. What is the Internet of Things? Why does it matter?
2. IoT Frameworks
3. Customer Driven Approach
4. Cost Estimation
Design Solution by Cost

- Do an Estimation QFD
- Matrix Top Business Drivers against User Stories
- Fill in every cell how much you want to spend on it in terms of effort or money
- Use ratio scale – a 9 means three times as much as a 3
- All are relative values!

### Measuring an IoT Project

<table>
<thead>
<tr>
<th>Top Business Drivers</th>
<th>Q001 Libraries</th>
<th>Q002 IDE</th>
<th>Q003 Functionality</th>
<th>Q004 Safety</th>
<th>Q005 Security</th>
<th>Q006 Loyalty</th>
<th>Q007 Recommendations</th>
<th>Q008 Get Likes</th>
<th>Q009 Good Food</th>
<th>Achieved Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>A03 Customer Loyalty</td>
<td>0.35</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>B03 IoT Programming</td>
<td>0.25</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td></td>
<td></td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>B04 Contribute to Community</td>
<td>0.24</td>
<td>7</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td></td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>C01 Extra Appliance Value</td>
<td>0.23</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td></td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>C02 Willing to Recommend</td>
<td>0.42</td>
<td>9</td>
<td>3</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>D01 Surprise Friends</td>
<td>0.36</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>D04 Get High Esteem</td>
<td>0.64</td>
<td>9</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>0.60</td>
<td></td>
</tr>
</tbody>
</table>

#### Solution Profile for User Stories

- Total Business Impact: 300

#### ISO 16355

- Convergence Gap
  - 0.10 Convergence Range
  - 0.20 Convergence Limit

- https://itconfidence2016.wordpress.com
Minimize Convergence Gap
- Small means user stories cover requirements

Total Business Impact
- Sum of all cell values 300
- Corresponds to project cost for providing the framework

Calibrate
- Identify functional entries
- Count their functional size
Effort Prediction is based on previous projects
- ISBSG data base
- Reference projects

Need to know
- NFR Extension Factor for functional vs. non-functional Story Cards (work units)
- Team Size
- Sprint Duration

**Cost Estimation by Quality Function Deployment (QFD)**

<table>
<thead>
<tr>
<th>Effort Prediction</th>
<th>Reference</th>
<th>Manual</th>
<th>Selected</th>
<th>ISBSG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Delivery Rate (PDR):</td>
<td>4.50 h/CFP</td>
<td>4.50 h/CFP</td>
<td>4.50 h/CFP</td>
<td>4.50 h/CFP</td>
</tr>
<tr>
<td>NFR Extension Factor (CFP/Impact):</td>
<td>1.33%</td>
<td>7</td>
<td>1.33%</td>
<td>7</td>
</tr>
<tr>
<td>Team Power:</td>
<td>5</td>
<td>6.0 Days</td>
<td>7</td>
<td>6.0 Days</td>
</tr>
<tr>
<td>Average Sprint Duration:</td>
<td>13.3 Days</td>
<td>8.0 h</td>
<td>60 CFP</td>
<td>8.0 h</td>
</tr>
<tr>
<td>Hours per Day:</td>
<td>8.0 h</td>
<td>101 CFP</td>
<td>8.0 h</td>
<td>101 CFP</td>
</tr>
<tr>
<td>Reference Functionality:</td>
<td>60 CFP</td>
<td>300</td>
<td>60 CFP</td>
<td>300</td>
</tr>
<tr>
<td>Predicted Functionality:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted Impact:</td>
<td>300</td>
<td></td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predicted</th>
<th>FUR Size</th>
<th>PDR</th>
<th>Hours</th>
<th>NFR Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional</td>
<td>101.00 CFP</td>
<td>4.50 h/CFP</td>
<td>455 h</td>
<td>402.10 CFP</td>
</tr>
<tr>
<td>Non-functional</td>
<td>402.10 CFP</td>
<td>4.50 h/CFP</td>
<td>1809 h</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>503.10 CFP</td>
<td>4.50 h/CFP</td>
<td>2264 h</td>
<td></td>
</tr>
</tbody>
</table>

336 h/Sprint --> 7 Sprints
Measuring an IoT Project

Cost Estimation by QFD – Improved

- Ask your team
  - Let them fill out Story Cards
  - Every User Stories yields 1 – 6 Story Cards

- Every Story Card
  - fits into one sprint
  - has assigned
    1) Story Points, by the team
    2) Functional Size, automatically, and
    3) Business Impact, by the sponsor

Story Points by the Team

Cost Estimation by QFD – Improved

- Let them fill out Story Cards
- Every User Stories yields 1 – 6 Story Cards
- Every Story Card
  - fits into one sprint
  - has assigned
    1) Story Points, by the team
    2) Functional Size, automatically, and
    3) Business Impact, by the sponsor

Story Points by the Team

Cost of FUR for Customer Needs

Business Impact NFR

ISBSG Benchmark

Functional Size

Total Estimate $
Sample Functional Story Card

Q001-01F: Set up Kitchen Library

Story Points: 13  Name: Belle
Functional Size: 2  Sprint: #01 - Overture
Business Impact:  

As an IoT Programmer, I want to find relevant libraries to my kitchen IoT, such that I can talk to intelligent kitchen appliances, so that plug-ins are ready for use.

Create data model and implement access routines in Github

IoT Repository  Test Stubs  Kitchen Appliance Intelligence

100. Publish IoT Interface
101. Publish Test Stub
Sample Non-Functional Story Card, containing some functionality

**Q001-02Q: Kitchen Intelligence**

- **Name:** Fritz
- **Sprint:** #01 - Overture
- **Story Points:** 8
- **Functional Size:** 5
- **Functional Size:** 5

**Business Impact:**
- B03: 6
- B04: 6
- C01: 3
- C02: 3
- D04: 3

As an IoT Programmer, I want to find relevant libraries to my kitchen IoT, such that I can talk to intelligent kitchen appliances, so that plug-ins are ready for use.

Create IoT code needed to make kitchen appliances intelligent.
Sample purely Non-Functional Story Card

**Story Card for IDE**

**Q002-01Q: Create IoT Brand**

- **Story Points:** 13
- **Name:** Sunny
- **Functional Size:** 0
- **Sprint:** #02 - Introduzione
- **Business Impact:** A03: 6

As an IoT Programmer, I want to get help when programming, such that the IDE proposes relevant functions, so that I save on time when programming.

Make the Kitchen Helper a brand name by viral promotion.
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Cost Estimation by QFD – Initial Buglione-Trudel Matrix

Business Drivers

A03: Customer Loyalty
B03: IoT Programming
B04: Contribute to Community
C01: Extra Appliance Value
C02: Willing to Recommend
D01: Surprise Friends
D04: Get High Esteem

User Story Priorities

Functional Story Cards

User Stories

Q001 Libraries
Q002 IDE
Q003 Functionality
Q004 Safety
Q005 Security
Q006 Loyalty
Q007 Recommendations
Q008 Get Likes
Q009 Good Food

Business Driver Goal Profile / Achieved Response Profile

Convergence Gap
0.30

Functional Coverage (ISO/IEC 19761)

y = Ax

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Cost Estimation by QFD – Final Buglione-Trudel Matrix

- Business Drivers
  - A03: Customer Loyalty
  - B03: IoT Programming
  - B04: Contribute to Community
  - C01: Extra Appliance Value
  - C02: Willing to Recommend
  - D01: Surprise Friends
  - D04: Get High Esteem

- User Story Priorities

- Functional Story Cards
  - Q001 Libraries
  - Q002 IDE
  - Q003 Functionality
  - Q004 Safety
  - Q005 Security
  - Q006 Loyalty
  - Q007 Recommendations
  - Q008 Get Likes
  - Q009 Good Food

- Convergence Gap: 0.02
- Functional Coverage (ISO/IEC 19761):
  \[ y = Ax \]
Retrospective

- Development Team, and
- Sprints

### Development Team

<table>
<thead>
<tr>
<th>Nickname</th>
<th>Full Name</th>
<th>E-Mail</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fritz</td>
<td>Fritz Wunderlich</td>
<td><a href="mailto:Fritz.Wunderlich@concertgebouw.nl">Fritz.Wunderlich@concertgebouw.nl</a></td>
<td>Conductor</td>
</tr>
<tr>
<td>Susi</td>
<td>Susanne Fast</td>
<td><a href="mailto:susi@fast.ch">susi@fast.ch</a></td>
<td></td>
</tr>
<tr>
<td>Heidi</td>
<td>Adelheid Van der Heide</td>
<td><a href="mailto:vanderheide@bluewin.de">vanderheide@bluewin.de</a></td>
<td></td>
</tr>
<tr>
<td>Yoo</td>
<td>Juri Iuruschenko</td>
<td><a href="mailto:JI@git.ur">JI@git.ur</a></td>
<td></td>
</tr>
<tr>
<td>Jean</td>
<td>Jhabi Muhammad</td>
<td><a href="mailto:muih.ben.judi@arab.sy">muih.ben.judi@arab.sy</a></td>
<td>Communicator</td>
</tr>
<tr>
<td>Sunny</td>
<td>Sunnyboy Mgluglu</td>
<td><a href="mailto:mglugly@mycompany.sa">mglugly@mycompany.sa</a></td>
<td>Designer</td>
</tr>
<tr>
<td>Belle</td>
<td>Bella Lombarda</td>
<td><a href="mailto:bella@lo.it">bella@lo.it</a></td>
<td></td>
</tr>
</tbody>
</table>

Team Size: 7

### Sprints

<table>
<thead>
<tr>
<th>Sprint ID</th>
<th>Label</th>
<th>Description</th>
<th>Start Date</th>
<th>Duration</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>#01 - Overture</td>
<td>Overture</td>
<td>Planning &amp; Initial Setup Sprint</td>
<td>2016-10-24</td>
<td>8.0 Days</td>
<td>2016-11-04</td>
</tr>
<tr>
<td>#02 - Introduzione</td>
<td>Introduzione</td>
<td>Proof of Concept</td>
<td>2016-11-07</td>
<td>5.0 Days</td>
<td>2016-11-11</td>
</tr>
<tr>
<td>#03 - Allegretto</td>
<td>Allegretto</td>
<td>Functionality</td>
<td>2016-11-14</td>
<td>5.0 Days</td>
<td>2016-11-18</td>
</tr>
<tr>
<td>#04 - Funèbre</td>
<td>Funèbre</td>
<td>Doom day approaching</td>
<td>2016-11-21</td>
<td>5.0 Days</td>
<td>2016-11-25</td>
</tr>
<tr>
<td>#05 - Scherzo</td>
<td>Scherzo</td>
<td>Just some better stuff</td>
<td>2016-12-01</td>
<td>7.0 Days</td>
<td>2016-12-09</td>
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<tr>
<td>#06 - Alla Marcia</td>
<td>Alla Marcia</td>
<td>Now it goes forward</td>
<td>2016-12-12</td>
<td>5.0 Days</td>
<td>2016-12-16</td>
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<tr>
<td>#07 - Finale</td>
<td>Finale</td>
<td>Additional Stuff, not to be tracked</td>
<td>2016-12-19</td>
<td>5.0 Days</td>
<td>2016-12-23</td>
</tr>
</tbody>
</table>

Average Sprint Duration: 5.7 Days
Measuring an IoT Project is straightforward

Estimation is difficult

- Many Unknowns
  - Safety
  - Security
  - Reliability
  - Social Impact

Estimation means Simulation

- Carrying out the project
- Uncovering customer’s needs
Customer Orientation is key for estimation
- What do they want?
- What do they need?

Involve the team!

Quality Function Deployment is a mature technique to make customer’s needs the base of your estimate

The ISBSG database converts QFD analysis into budget numbers
Measuring an IoT Project

Measuring and Estimating an IoT Project – Conclusions

Questions?