ICEAA

ISBSG
IT Confidence 2016

4° International Conference on
IT Data collection, Analysis and Benchmarking
Los Angeles, CA (USA) – September 7, 2016

Measuring and Estimating an IoT Project

IoT – The Internet of Things

Dr. Thomas Fehlmann
Euro Project Office AG, Zürich, Switzerland

euro project office
Master your project.

https://itconfidence2016.wordpress.com

ISBSG
IT Confidence 2016

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

- ✓**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

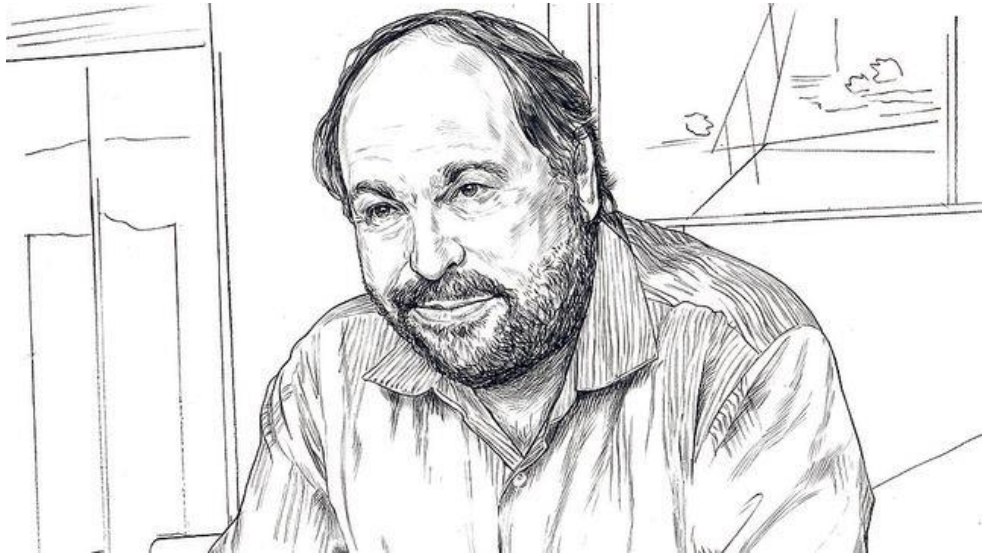
1. **What is the Internet of Things? Why does it matter?**
2. IoT Frameworks
3. Customer Driven Approach
4. Cost Estimation

The Vision – Intelligent Things

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?

Paul Maritz

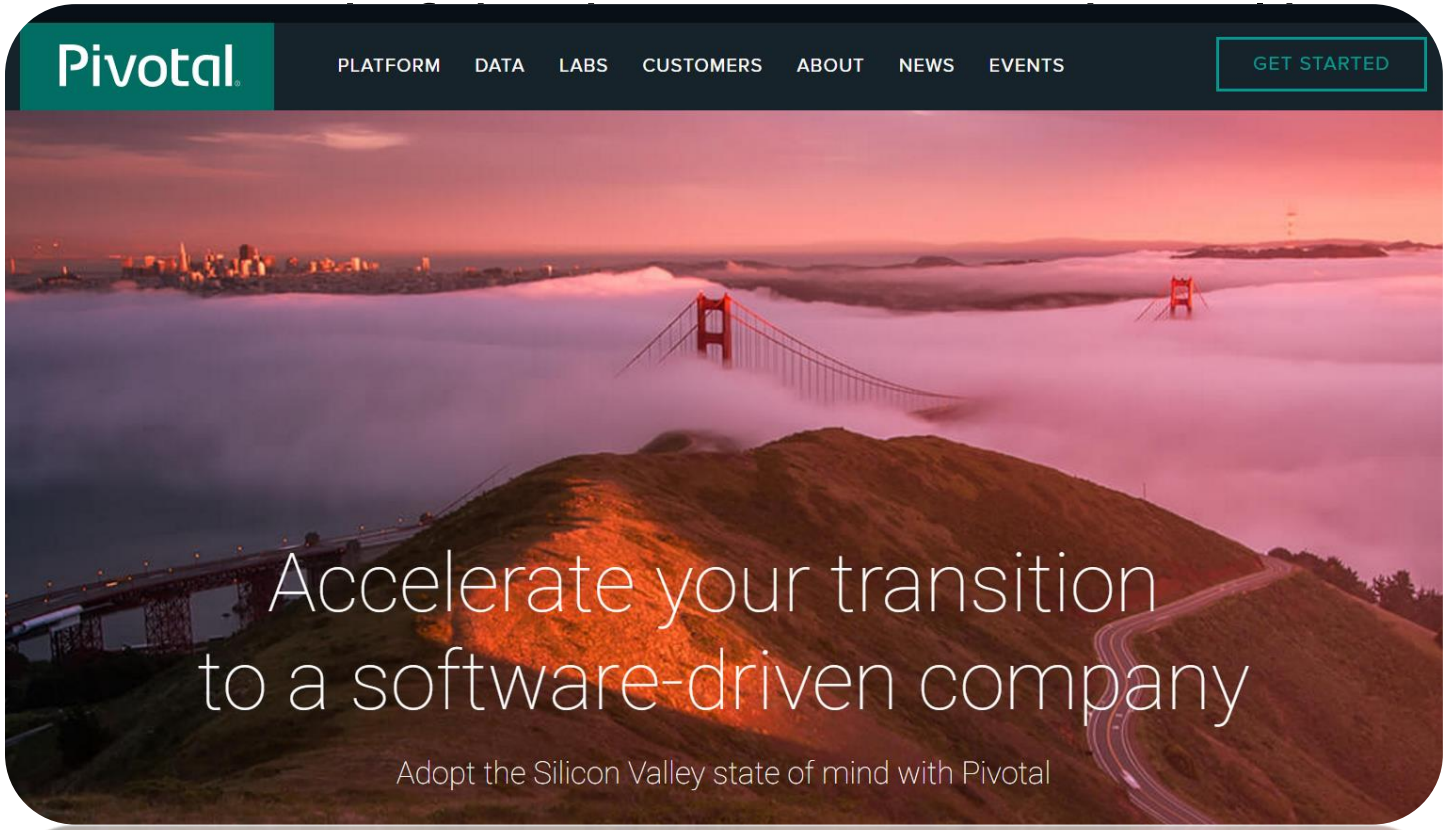


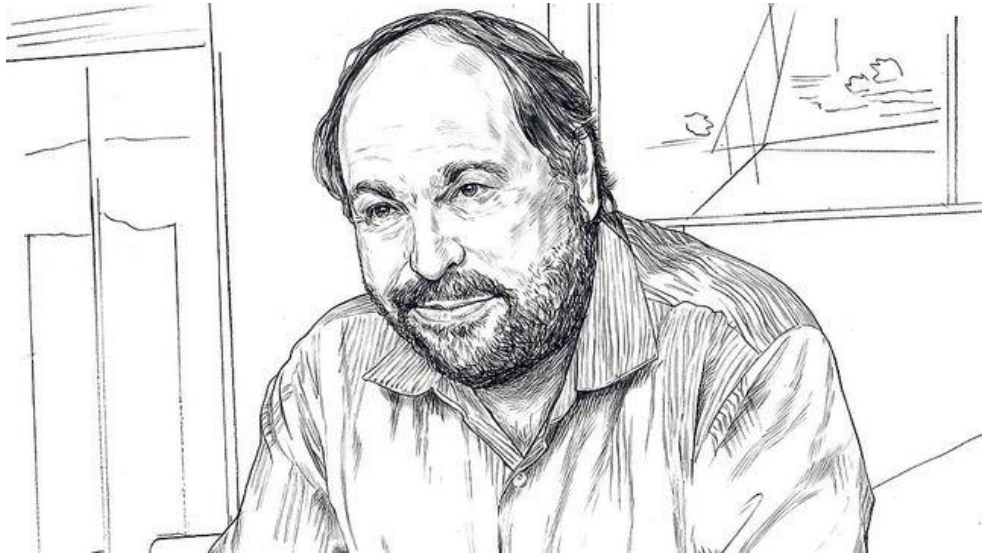
(Illustration Christoph Fischer; © NZZ November 3, 2014)

The Internet of Things (IoT)

Everybody will be writing software

Paul Maritz, CEO Pivotal





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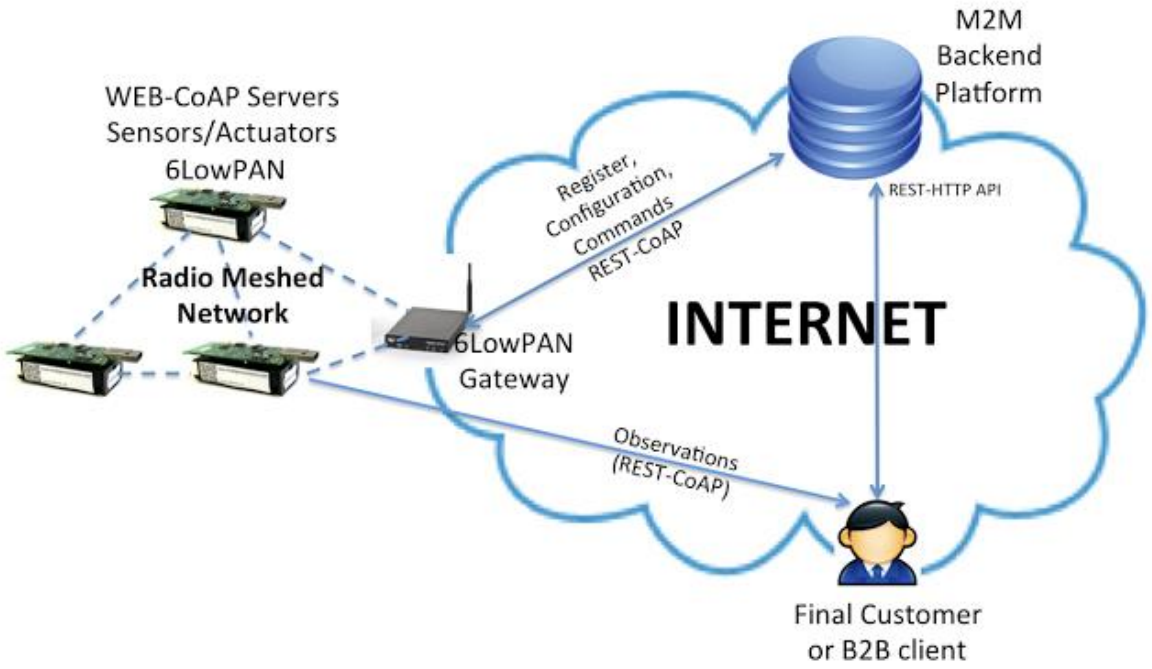
The Architecture of the Web of Things

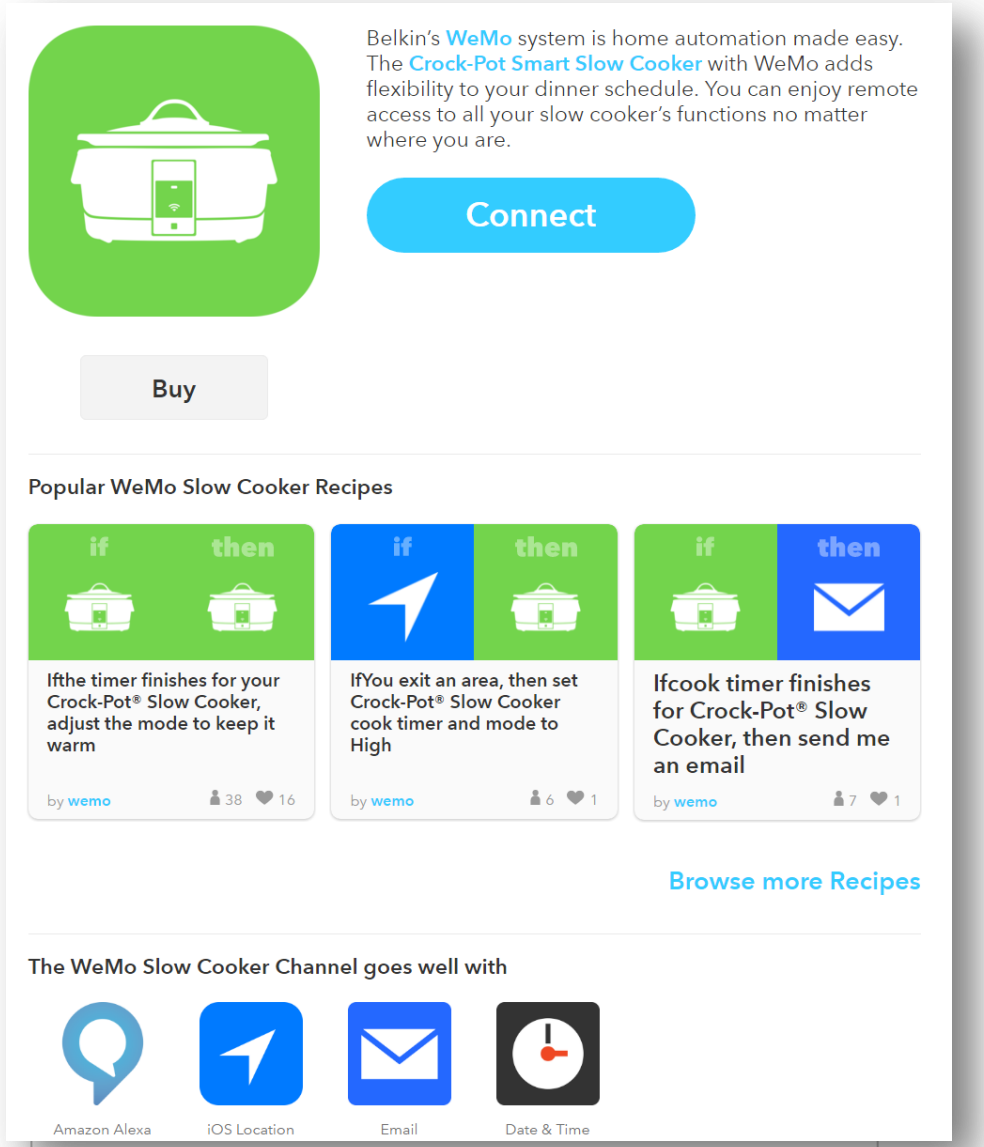


- The Web of Things (WoT) is a set of software architectural styles and programming patterns
- The Web of Things reuses existing Web standards used in the
  - programmable Web (REST, HTTP, …)
  - semantic Web (JSON-LD, Microdata)
  - real-time Web (e.g, Websockets), and
  - social Web (e.g., oAuth or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

http://en.wikipedia.org/wiki/Web_of_Things
http://de.wikipedia.org/wiki/6LoWPAN
http://en.wikipedia.org/wiki/Constrained_Application_Protocol

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



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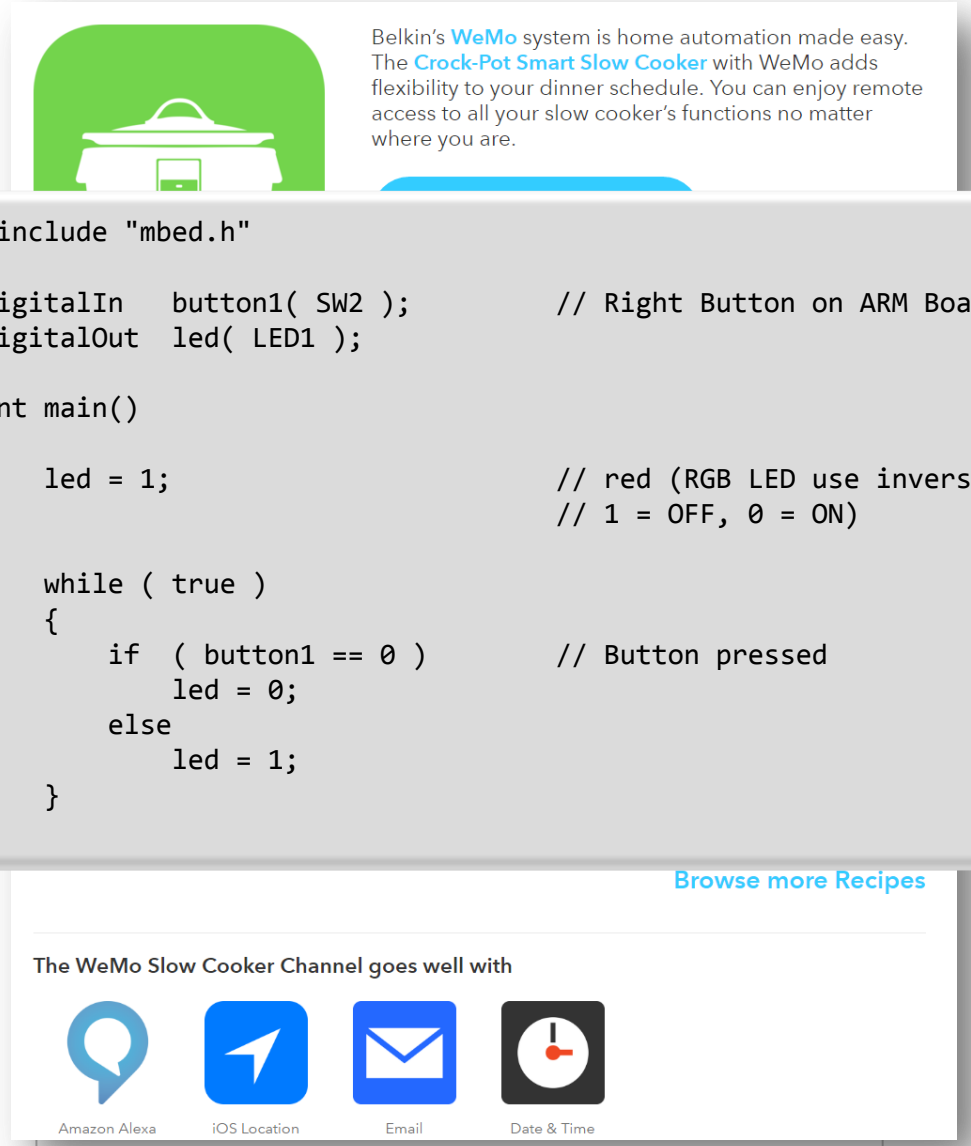



```
1  #include "mbed.h"
2
3  DigitalIn   button1( SW2 );          // Right Button on ARM Board
4  DigitalOut  led( LED1 );
5
6  int main()
7  {
8      led = 1;                         // red (RGB LED use inverse logic
9                                       // 1 = OFF, 0 = ON)
10
11     while ( true )
12     {
13         if  ( button1 == 0 )         // Button pressed
14             led = 0;
15         else
16             led = 1;
17     }
18 }
```

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

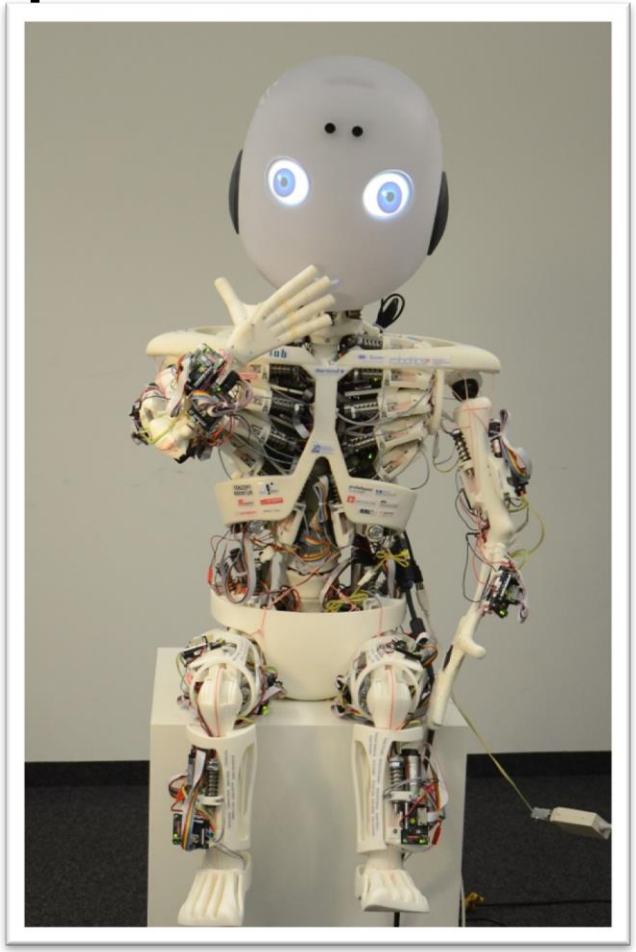


Bild Roboy © ZHAW School of Engineering, Rolf Pfeifer

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

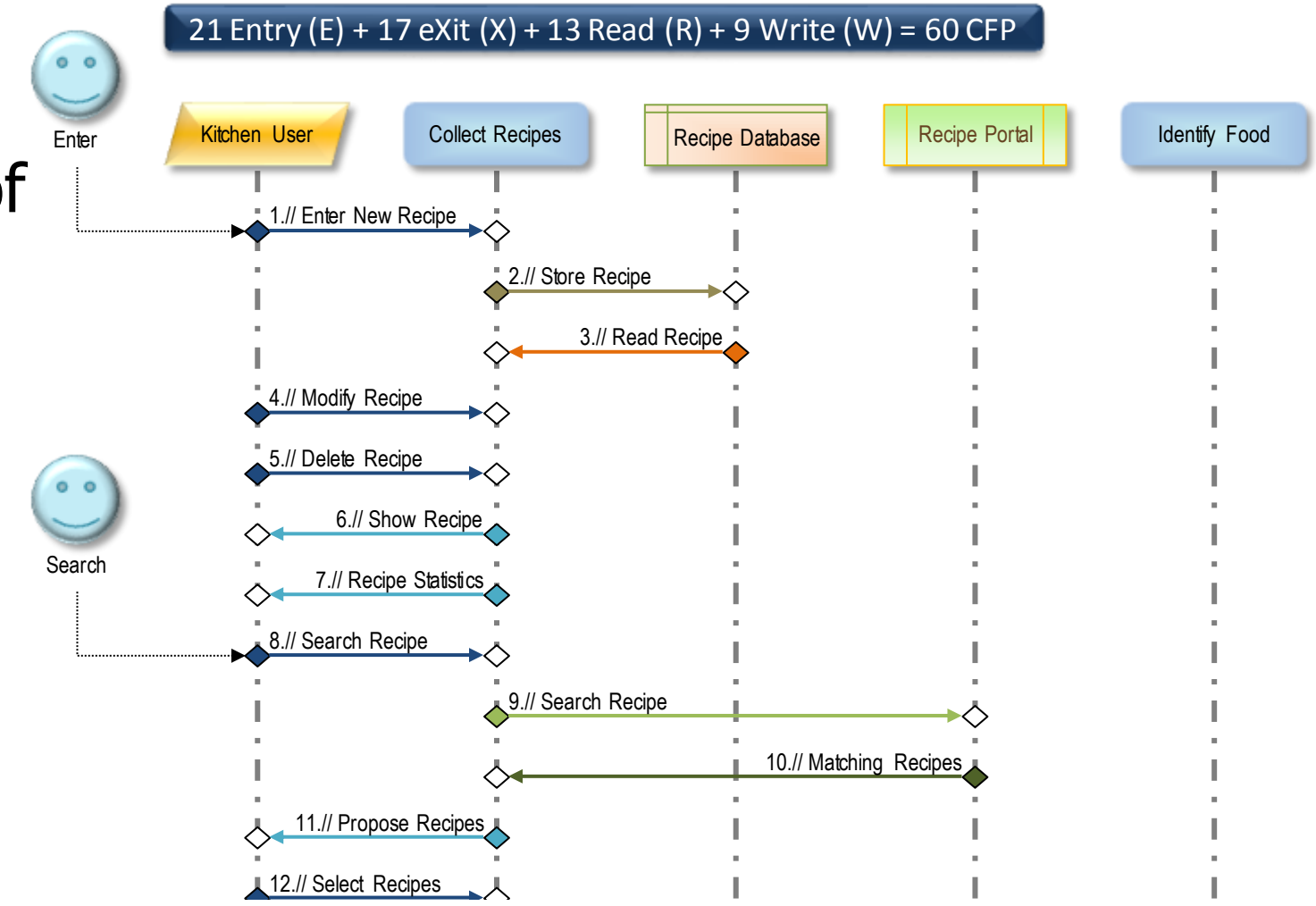
We want Open Standards!

However, Complexity is Roaring…

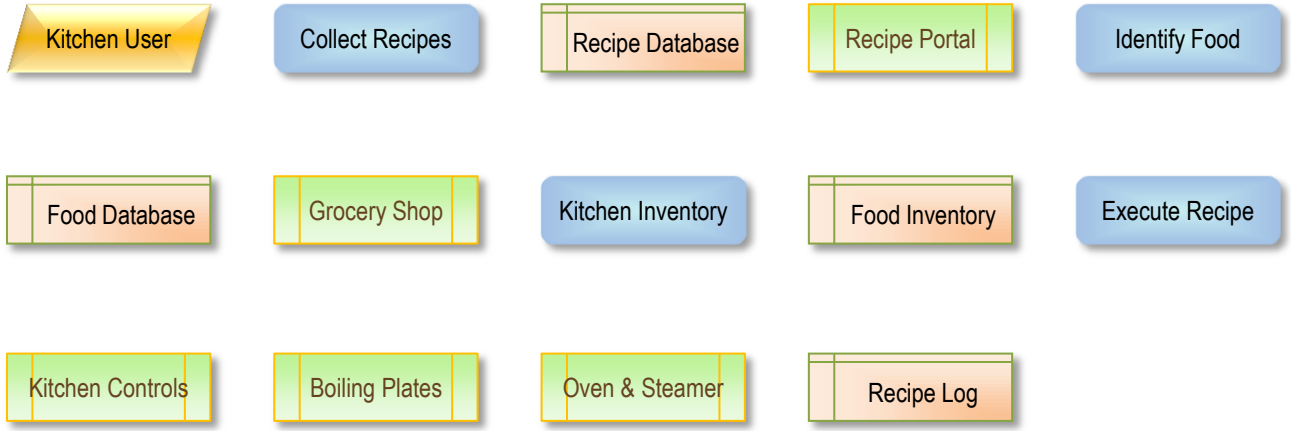
- What are the possible effect caused by Failure?
  - Wrong shopping? No dinner?
  - Boilerplate overheating?
  - Blasting the house?
- Where to start Measuring?
  - Which requirements?
  - What NFR scenarios?
- Benchmarking with What??
  - Any data out there?

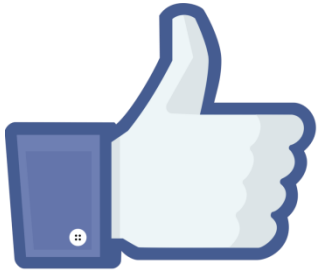
1. What is the Internet of Things? Why does it matter?
2. **IoT Frameworks**
3. Customer Driven Approach
4. Cost Estimation

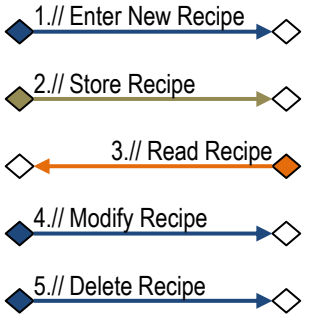
- A Framework is a model of
  - Functionality
  - Building Blocks
  - Software
- Users can build own apps
  - Based on the functionality and the building blocks of the framework



- 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

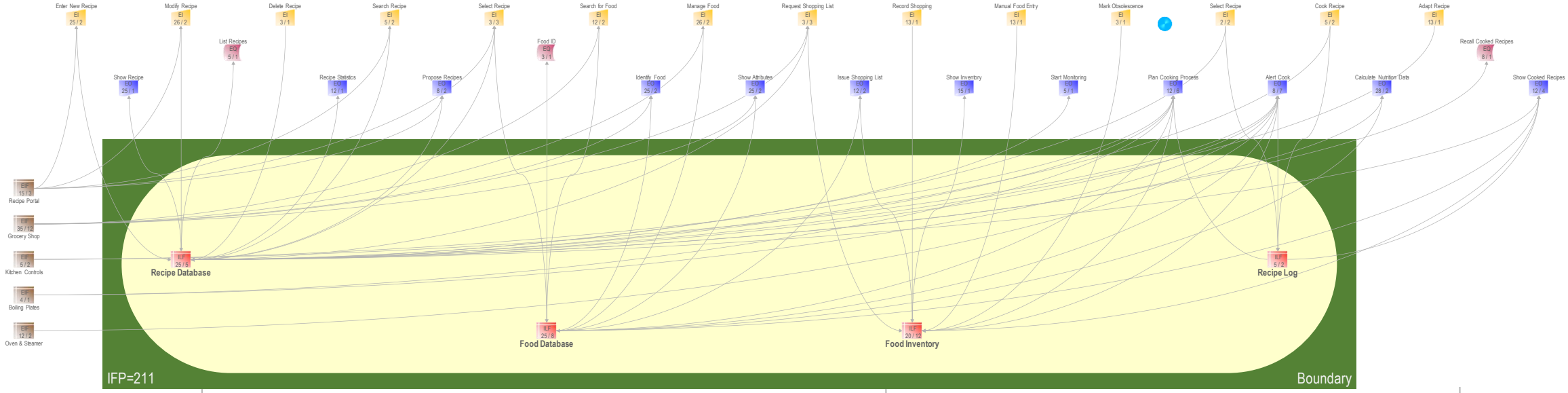


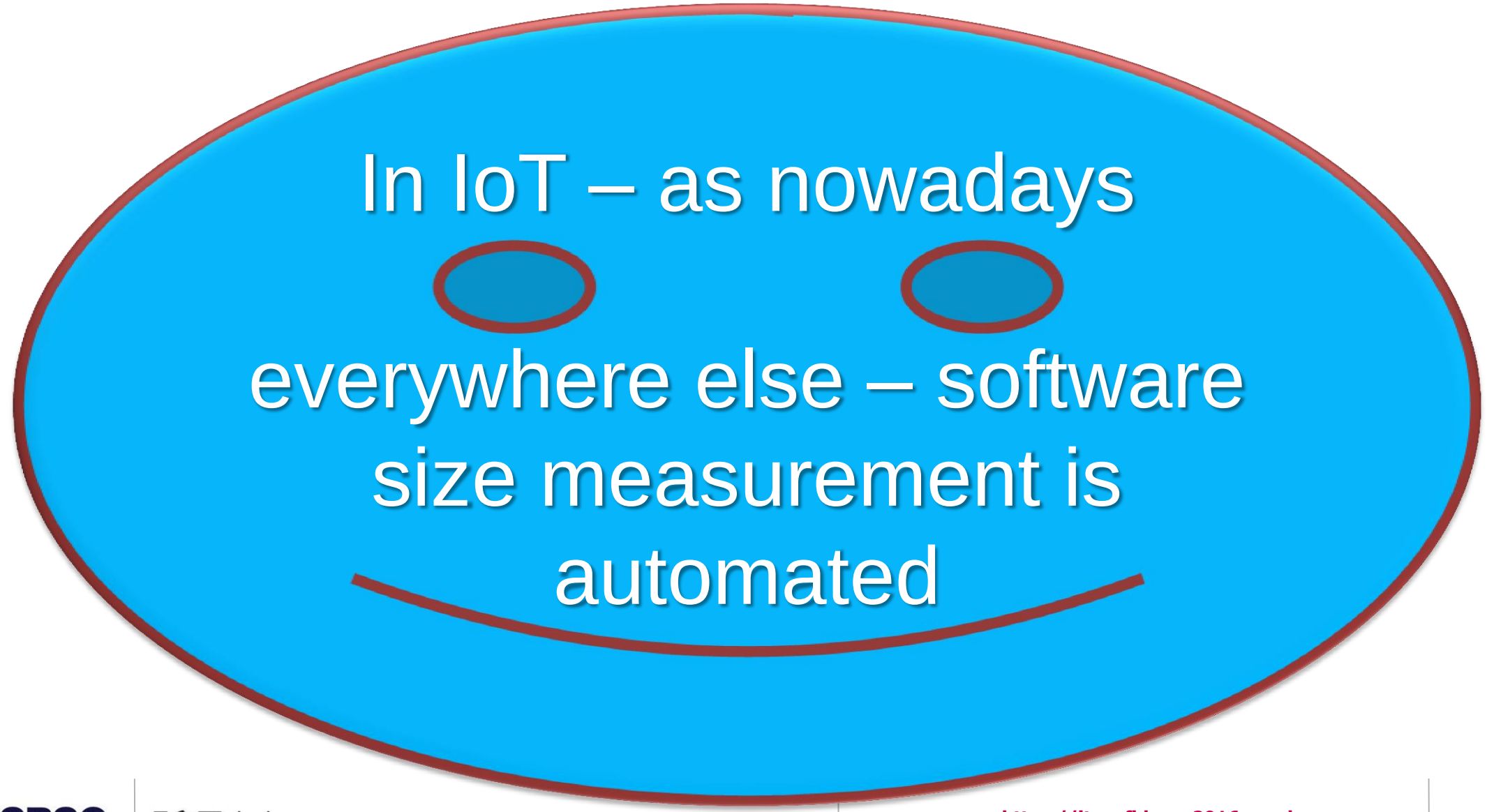




Wow! A Kitchen Helper with 211 Function Points!

- 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

- 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

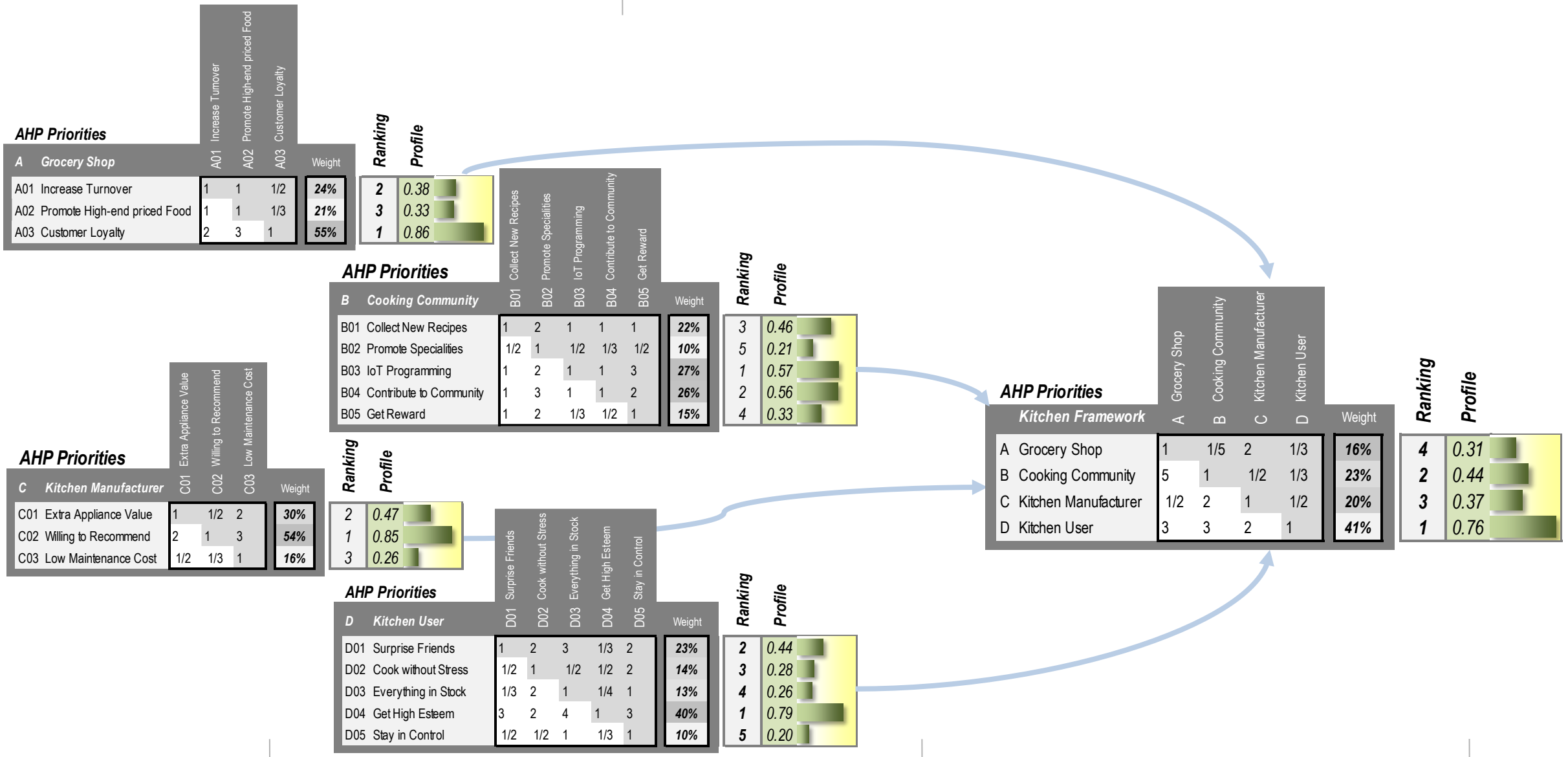
- The Analytic Hierarchy Process (AHP) allows determining Business Drivers' priorities among various Stakeholders
  - Grocery Shops
  - Cooking Community
  - Kitchen Manufacturer
  - Kitchen User

AHP Priorities

Kitchen Framework	A Grocery Shop	B Cooking Community	C Kitchen Manufacturer	D Kitchen User	Weight	***Ranking***	***Profile***
A Grocery Shop	1	1/5	2	1/3	***16%***	***4***	*0.31*
B Cooking Community	5	1	1/2	1/3	***23%***	***2***	*0.44*
C Kitchen Manufacturer	1/2	2	1	1/2	***20%***	***3***	*0.37*
D Kitchen User	3	3	2	1	***41%***	***1***	*0.76*

Measuring an IoT Project

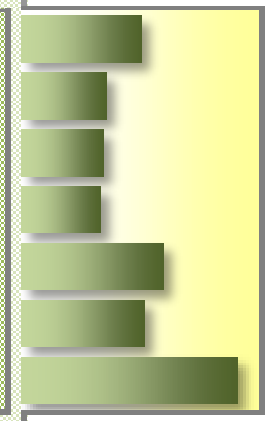
Customer Driven Approach – Analytic Hierarchy Process



➢ My Framework Project Strategy

Top Business Drivers
Kitchen Framework

	Top Business Drivers	Attributes		Weight	Profile
A Grocery Shop	A03 Customer Loyalty	*Customer come back*	*Find special food*	*14%*	*0.35*
B Cooking Community	B03 IoT Programming	*Be unique*	*Feel special*	*10%*	*0.25*
	B04 Contribute to Community	*Get famous*	*for new ideas*	*10%*	*0.24*
C Kitchen Manufacturer	C01 Extra Appliance Value	*Better than*	*competition*	*9%*	*0.23*
	C02 Willing to Recommend	*A special kitchen*		*17%*	*0.42*
D Kitchen User	D01 Surprise Friends	*Feel cool*	*Kitchen helper helps!*	*15%*	*0.36*
	D04 Get High Esteem	*Earn praise*	*Make friends envious*	*26%*	*0.64*



➢ 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

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

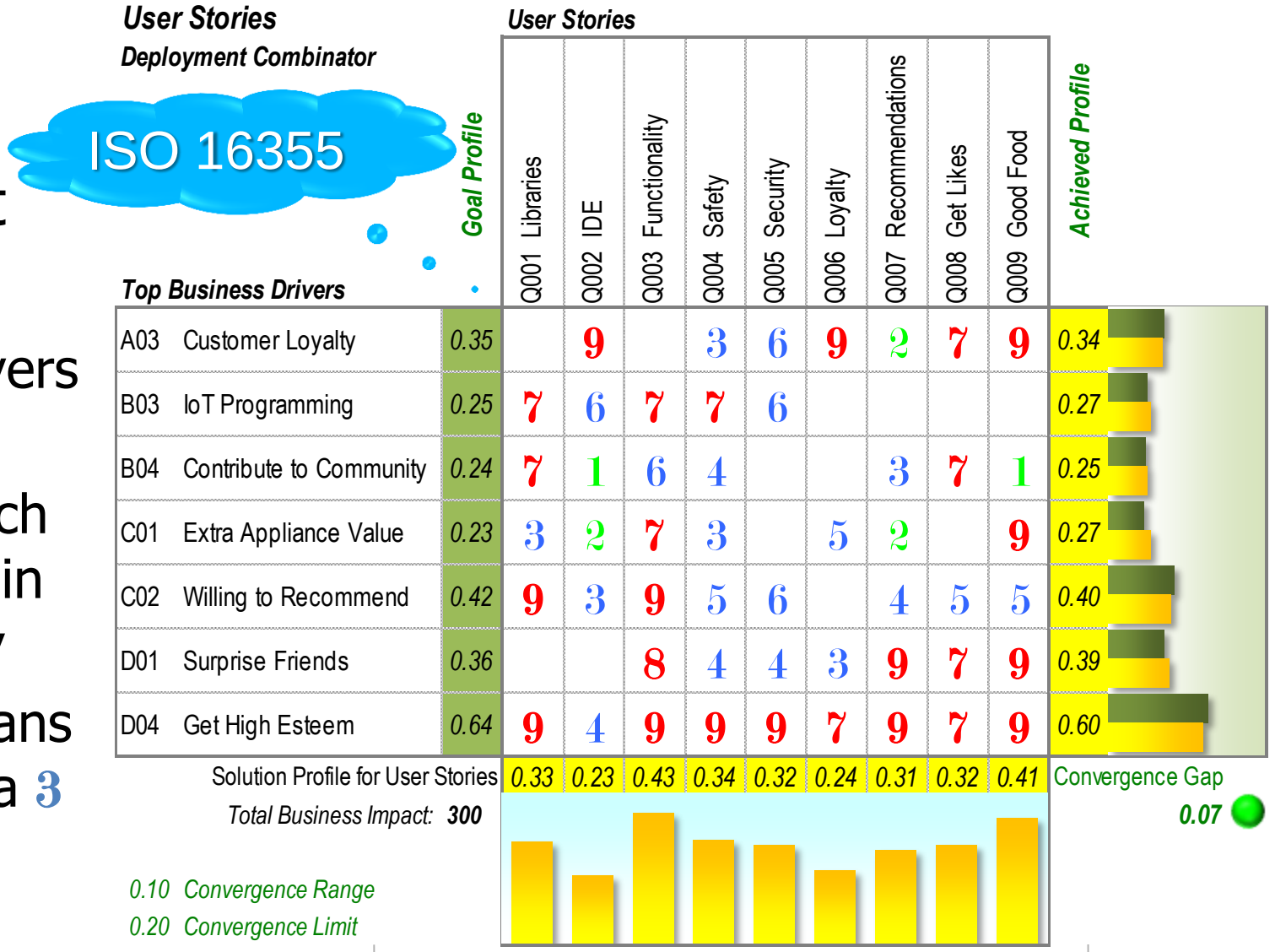
- Now we go to our friends, colleagues and business partners
  - Proposing collaboration for building the framework
  - Explaining them mutual interest
  - Win-Win Situation

- They are enthusiastic
  - However, they have a question:

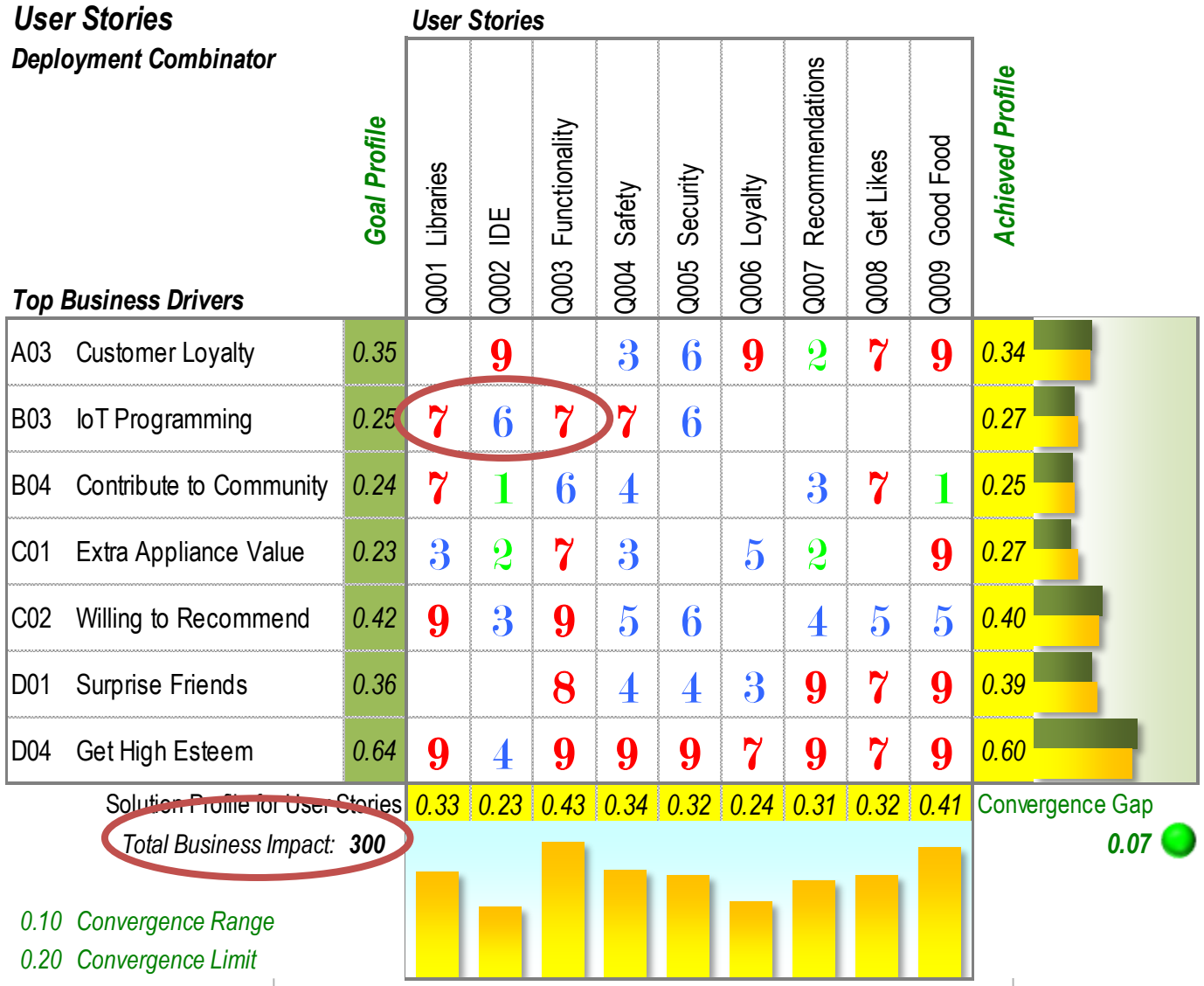

What
does
it
cost?

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!



- 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

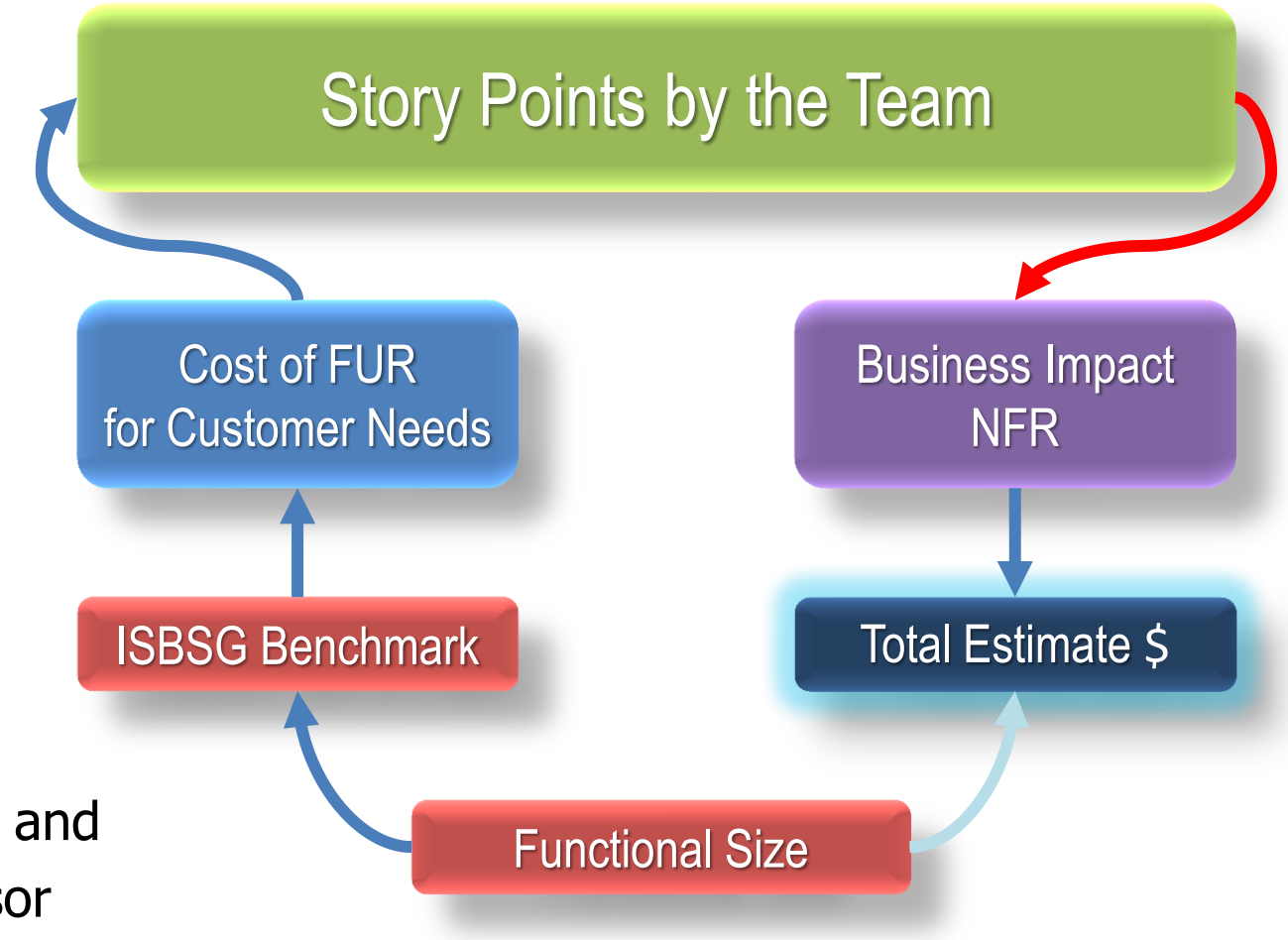


- Effort Prediction is based on previous projects
  - ISBSG data base
  - Reference projects
- Need to know
  - NFR Extension Factor for functional vs. non-functional Story Cards (work units)
  - Team Size
  - Sprint Duration

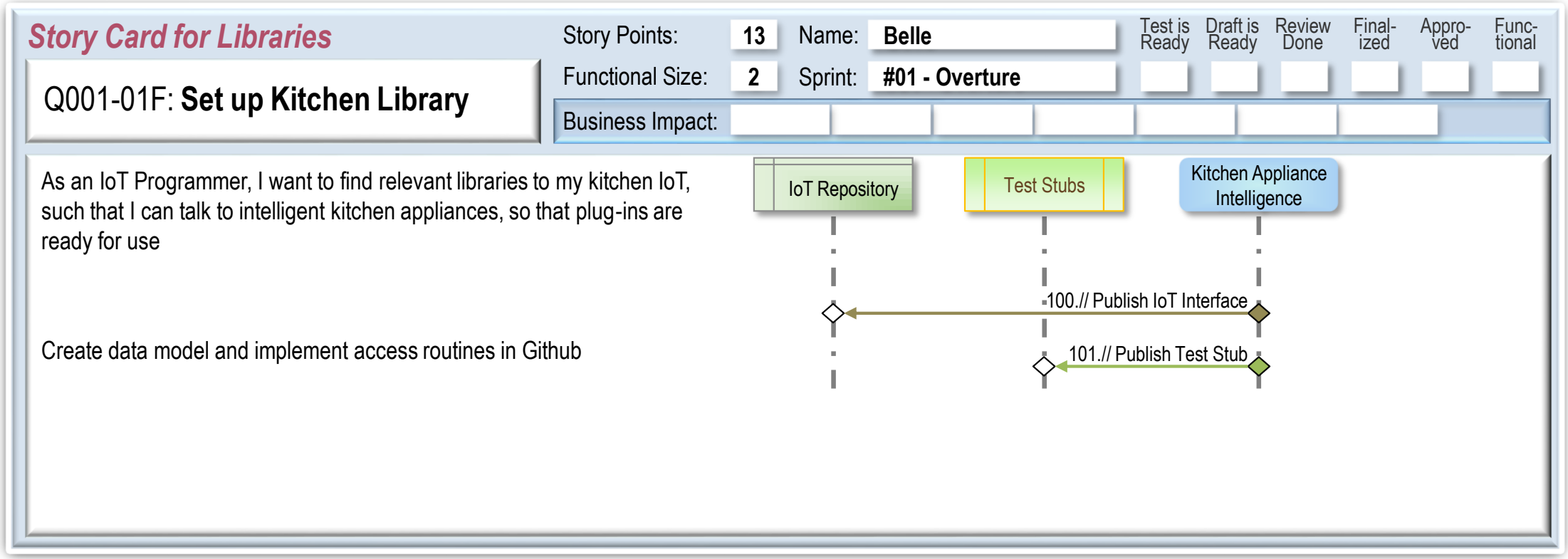
Effort Prediction	***Reference***	***Manual***	***Selected***	***ISBSG***
Project Delivery Rate (PDR):	4.50 h/CFP		4.50 h/CFP	*4.50 h/CFP*
NFR Extension Factor (CFP/Impact):	1.33%		1.33%	
Team Power:	5	7	7	
Average Sprint Duration:	13.3 Days	6.0 Days	6.0 Days	
Hours per Day:	8.0 h	8.0 h	8.0 h	
Reference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

Predicted	FUR Size	PDR	Hours	NFR Size
Functional	101.00 CFP	4.50 h/CFP	455 h	402.10 CFP
Non-functional	402.10 CFP	4.50 h/CFP	1809 h	
Total	**503.10 CFP**		**2264 h**	
		336 h/Sprint -->	**7**	**Sprints**

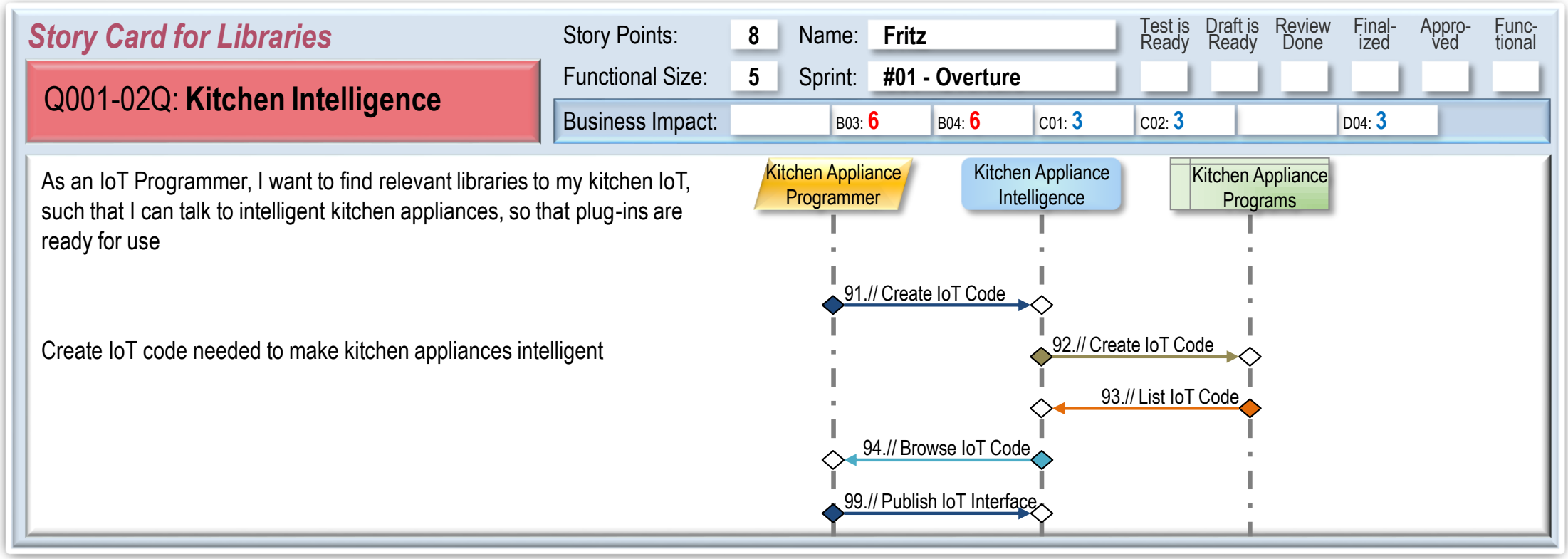
- Ask your team
  - Let them fill out Story Cards
  - Every User Stories yields 1 – 6 Story Cards
- Every Story Card
  - fits into one sprint
  - has assigned
    1) Story Points, by the team
    2) Functional Size, automatically, and
    3) Business Impact, by the sponsor



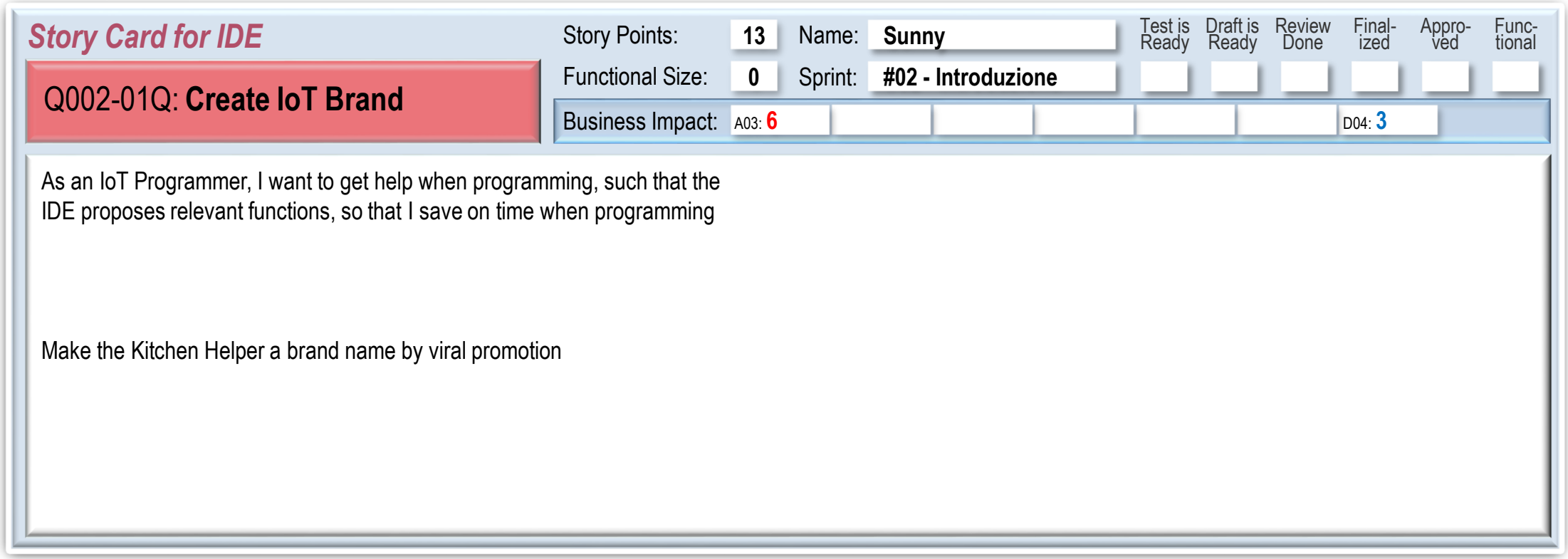
➢ Sample Functional Story Card



➢ Sample Non-Functional Story Card, containing some functionality



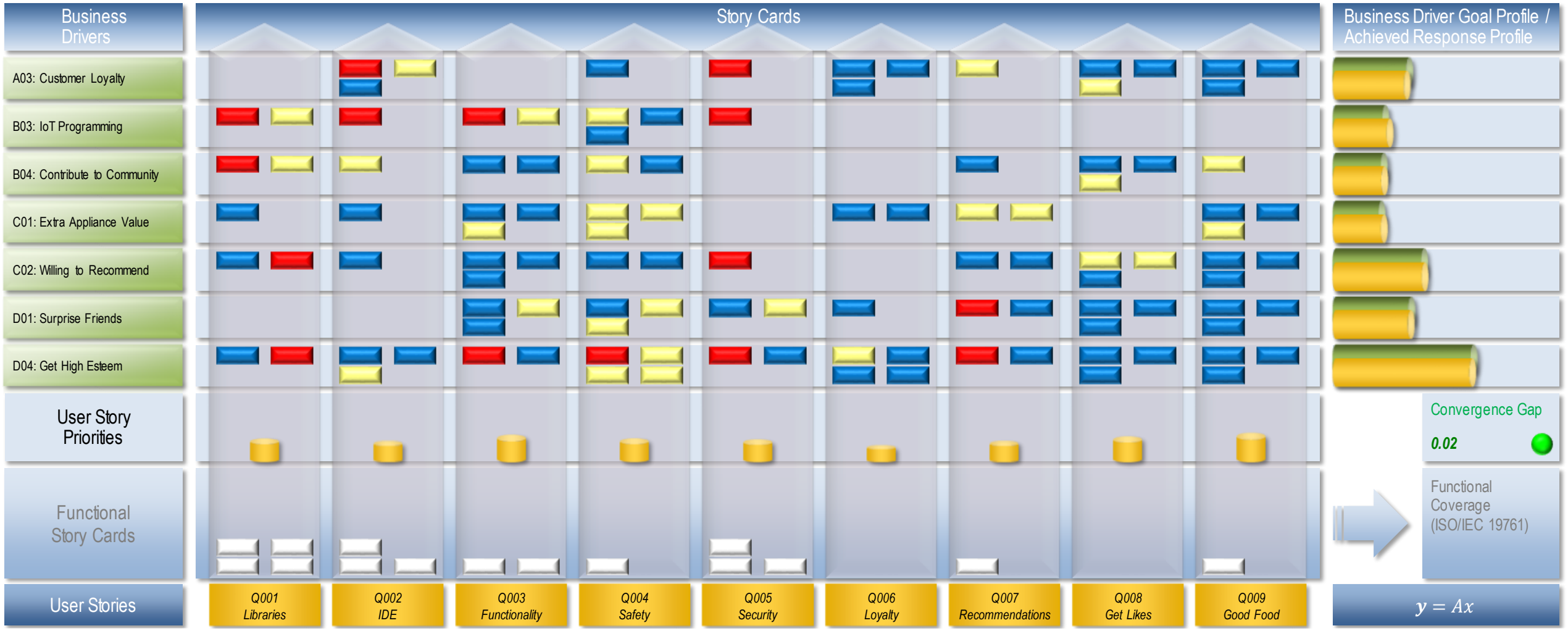
➢ Sample purely Non-Functional Story Card



Measuring an IoT Project

Cost Estimation by QFD – Initial Buglione-Trudel Matrix

Cost Estimation by QFD – Final Buglione-Trudel Matrix



Retrospective

Development Team

	Nickname	Full Name	e-Mail	Role
1)	***Fritz***	Fritz Wunderlich	Fritz.Wunderlich@concertgebouw.nl	Conductor
2)	***Susi***	Susanne Fast	susi@fast.ch	
3)	***Heidi***	Adelheide Van der Heide	vanderheide@bluewin.de	
4)	***Yoo***	Juri Iuruschenko	Ji@git.ur	
5)	***Jean***	Jhabi Muhamad	muhi.ben.judi@arab.sy	Communicator
6)	***Sunny***	Sunnyboy Mgluglu	mglugly@mycompany.sa	Designer
7)	***Belle***	Bella Lombarda	bella@lo.it	

Add Row | Del Row

Team Size: 7

- Development Team, and
- Sprints

Sprints

Start Date: 2016-10-24 Montag, 24. Oktober 2016

	Sprint ID	Label	Description	Relax	Start Date		Duration	End Date	
1)	***#01 - Overture***	Overture	Planning & Initial Setup Sprint		2016-10-24	*Montag, 24. Oktober 2016*	8.0 Days	2016-11-04	*Freitag, 4. November 2016*
2)	***#02 - Introduzione***	Introduzione	Proof of Concept		2016-11-07	*Montag, 7. November 2016*	5.0 Days	2016-11-11	*Freitag, 11. November 2016*
3)	***#03 - Allegretto***	Allegretto	Functionality		2016-11-14	*Montag, 14. November 2016*	5.0 Days	2016-11-18	*Freitag, 18. November 2016*
4)	***#04 - Funèbre***	Funèbre	Doom day approaching		2016-11-21	*Montag, 21. November 2016*	5.0 Days	2016-11-25	*Freitag, 25. November 2016*
5)	***#05 - Scherzo***	Scherzo	Just some better stuff	3 Days	2016-12-01	*Donnerstag, 1. Dezember 2016*	7.0 Days	2016-12-09	*Freitag, 9. Dezember 2016*
6)	***#06 - Alla Marcia***	Alla Marcia	Now it goes forward		2016-12-12	*Montag, 12. Dezember 2016*	5.0 Days	2016-12-16	*Freitag, 16. Dezember 2016*
7)	***#07 - Finale***	Finale	Additional Stuff, not to be tracked		2016-12-19	*Montag, 19. Dezember 2016*	5.0 Days	2016-12-23	*Freitag, 23. Dezember 2016*

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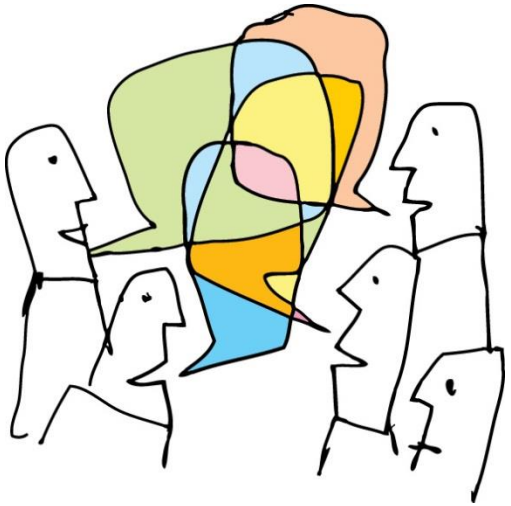
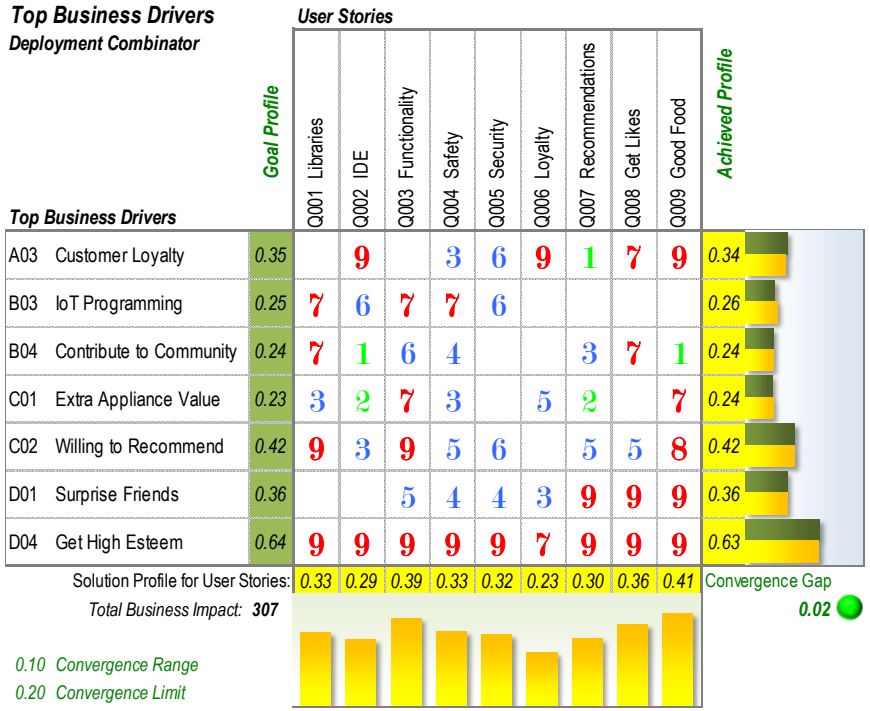
Average Sprint Duration: 5.7 Days



- 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 the 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



Questions?


Goals
Decision
Needs
Realization
Tests
Enablers
Features
Tests
Qualities
Managing Complexity
Uncover Mysteries by Six Sigma Transfer Functions
Thomas M. Fehlmann, Eberhard Kranich
Logos Publishing
Berlin 2016