A Methodology for Building IoT Solutions

Disclaimer: This slide deck is the amalgamation of various projects and concepts produced through developing smartliving.io, amongst many other initiatives.

Slides have been hacked together over the course of the last three weeks, thanks to a push from @robvank, and a recent flurry in calls for IoT Design tools.

Tom Collins
@snillocmot
tc@allthingstalk.com
The Goal

To allow everyone to experience the Internet of Things, by seeing and feeling the potentials of common use cases, through iterative prototyping and a ‘lean startup’ mentality.

Ultimately to enable individuals, communities and organizations to think, imagine and question ‘What’s next?’

This specifically concerns the services and apps created on top of these common use cases, in order to build a meaningful Internet of Things for Humans.

“We can build services for people, by people, of people, in the 21st century, if we make it so” - @timoreilly
Initiatives motivated solely by profit and politics hinder innovation and lack the *creativity*, *enthusiasm* and *courage* required to step into the unknown.

In the *spirit* of the *World Wide Web* and *Open Source* communities across the globe, a new *collaborative effort* must be taken to *make the Internet of Things a reality*.

The *IoT Methodology* aims to provide a loosely structured *ecosystem of mutual value* for all who participate, driven by *sharing, collaboration, community* and *learning*. An ecosystem made up of *tools, design patterns, architecture references* and *guidelines* to build IoT solutions.

It’s an *iterative methodology*, which is *developing iteratively*.

It’s *alive*, it *grows*, it *expands*, it *has no end date* or *budget restriction*. 
Steps

- **COCREATE**: Communicate with end users and stakeholders to identify pain problem areas, in a non-technical way.
- **IDEATE**: Simplify discussions to communicate requirements with designers, implementers and project managers.
- **Q&A**: Translate soft concepts into hard requirements, to analyze solutions and brainstorm options.
- **IOT OSI**: Requirements map to valid architecture, infrastructure and business frameworks.
- **PROTOTYPE**: Standardized toolkit assists building prototypes, which iterate towards minimum viable products.
- **DEPLOY**: Continuous Deployment assists closing the feedback loop, enhances knowledge sharing and collaboration opportunities.
CO-CREATE

Purpose

➔ Assist kick off session(s) to initiate projects and aid communication with end users and stakeholders
➔ User centric problem analysis
➔ Top down approach
➔ Removes the complexities and influences that technically minded individuals often bring into the equation
➔ Narrows the scope of a problem domain to the most practical and beneficial use cases

Current works & Influences

➔ cocreatetheiot.com @nstembert
➔ A manifesto for do-it-yourself internet-of-things creation @driesderoeck
➔ gov.uk/design-principles @benterrett

Next steps

➔ Build a repository of flavored techniques for specific domains and audiences
➔ Define concrete deliverables to feed the Ideate step
CO-CREATE: *In action*

@DunavNET - Novi Sad, Serbia 13th Apr 2014

A workshop to allow stakeholders from all levels and backgrounds to identify and conceptualize IoT solutions for Smart Cities.

**Summary**

⇒ **Discuss** the problem domain **using visual aids**
⇒ **Narrow** down the **biggest pain problems**
⇒ **Contextualize** problems with the **physical** environment
⇒ Consider **influences** and **outcomes** of these problems
⇒ **Identify** **knowledge areas** which contribute to solutions
⇒ **Triage** the most **pressing problem areas**
⇒ Create User Interface **mockups** to **allow users to visualize** and understand possible solutions

“In two and a half hours we developed a full IoT concept together with end-users, designers and developers.

Normally this takes us half a year and then we wouldn't even have involved people from the target group yet.”

Tools for the Co-Create IoT Workshop by Nathalie Stembert, [http://cocreatetheiot.com](http://cocreatetheiot.com)
IDEATE

Purpose

➔ Provides a common reference for brainstorming and discussing IoT projects
➔ Quick and easy to use
➔ Standardized terminology
➔ Allows for bottom-up and top-down approaches to find the most appropriate solution
➔ Designed with the IOT OSI model in mind

Current works & Influences

➔ The IoT Canvas @snillocmot
➔ Business Model/Lean Canvas @ericries @ashmaurya

Next steps

➔ Share the template to do it yourself
➔ Publish the guide inspired by Running Lean on how to apply this to IoT projects
➔ Analyze how best to extract requirements for validation which feeds into Q&A
➔ Build a web app to digitize the process
IDEATE: *In action*

@SmartLiving_io - Gent, Belgium 20th Nov 2014

The **IoT Canvas** is an adaptation of the **Business Model/Lean Canvas**, used in brainstorm sessions with various beta-users, it assists to validate and identify MVP requirements for projects.

**Summary**

- **Write a problem statement** summing up user’s pains
- **Identify Things** in the **physical world** relating to the problem
- **Consider sensors, actuators & controllers** which make up **Endpoints** to interact with Things
- **Produce data models** for the **Endpoints**
- **Choose Middleware** required for **Endpoints** to connect **IoT Services**
- **Summarize Third-party-web-services** that will be used
- **Sketch User Interface** elements for **Humans** to interact

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IoT Canvas for the 'Green Living' Makers project

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*“I’d like to make an automation project that “connects” the weather outside (rain, sun, radiation and darkness), takes into account the electricity produced by the solar panels and that from automates certain household appliances and the central heating. I would like to have such a system because I want our house to be smarter and less energy-consuming and thus more environmentally friendly.”*
Q&A

Purpose

➔ Closes the gap between idea and implementation
➔ **Validation** - What, where, when, why, how?
➔ **Feasibility** - For metrics, resources, skills, practicality, defined problem
➔ **Domain Analysis** - What else in the problem domain hasn’t been considered?
➔ **Solution & Topology Design** - What other requirements have stakeholders voiced which affect the selection of tools & technologies used in implementation?

Current works & Influences

➔ **IoT:DB** - Repository listing tools, technologies and solutions, that can be searched with IoT project requirements
➔ IoT Analysis Survey @AllThingsTalk

Next steps

➔ Analyze the path from ideation to architecture, to target specific verticals
➔ Create a web app survey to allow users to enter requirements
➔ Build **IoT:DB MVP** - facilitate adding new solutions and searching the repository
➔ Define a deliverable ‘report’ to feed the IOT OSI model & architecture design
Q&A: *In action*

**@AllThingsTalk - Conducted Online Apr-Aug 2014**

A series of surveys conducted with early user groups to discover the best way of conceptualizing a project and choosing the most appropriate solutions for each layer of the IOT OSI to lead project development tasks.

**Summary**

- Project outline - *Business value*
- Feasibility - *Validate scope*
- Practical Considerations - *Closing the scope*
- Problem Domain Analysis - *Solution summary*
- Solution & Topology Design - *Architecture*
- Infrastructure Considerations - *Infrastructure*
Slight detour...

Tim O'Reilly on Eric Ries' work on the Lean Startup.
Watch the next 60 seconds - http://youtu.be/nBNDfxiaQSQ?t=13m40s

"Lean Startup principles apply to every real-world service today"

"It's not just for web apps any more, every app, every real-world system
is subject to this development methodology"

"Continuous Deployment may seem hard for hardware, but you have to think about
everything you do in the context of data feedback loops"

Quoting @psemme - "Hardware is Hard"

One last quote from TOR
"We have to stop thinking that we're writing an app on a device,
and realizing that the internet is indeed the operating system."

Ok on with the methodology...
IOT OSI

Purpose

➔ Breaks down the components of the IoT into ‘Internet as an operating system’ paradigm
➔ Makes it easy to digest the scale of Internet of Things and all of it’s intricate components
➔ Define scope areas where specialists can focus efforts
➔ Simplifies communications with end users and stakeholders, if they need to know about technical aspects

Current works & Influences

➔ IoT:DB - Search for solutions based on architecture requirements
➔ The IoT-Architecture @IoT_A
➔ OSI Seven layer model

Next steps

➔ Map common solutions to the IOT OSI Model - Eclipse Open IoT Stack, IBM IoT solutions, etc
➔ Support the creation of new Architecture References for specific verticals
➔ Test and validate architecture using the Prototype step
# IOT OSI: Overview

## End Points

**aka Things**

Endpoints have a number of roles including producing data, receiving commands, providing services for management, discovery, persistence and local logic.

**Examples**
- Temperature sensor
- LED
- Weather service
- Email notifications
- RFID Reader, etc

## Connectivity

The wire(less) level communication protocols used to connect Endpoints to the Middleware.

Includes management of network sessions, reliability, security and routing protocols.

**Examples**
- TCP/IP
- MQTT
- IPv6
- CoAP
- REST
- XBEE
- ZigBee
- ZWave
- Serial
- custom radios
- IPoAC, etc

## Middleware

Standardized layer using connectivity drivers, to translate and connect disparate sources(or destinations).

Generally provides guaranteed delivery of messages and Auth* for IoT Services

**Examples**
- OpenHAB
- TheThingSystem
- ZIPR
- Dowse, Ponte
- WebSphere
- RabbitMQ
- Dweet

## IoT Services

Typically provides the ‘Smarts’ for the IoT and power where processing on endpoints or middleware is not sufficient.

All systems require a form of management for Endpoints, Middleware, Auth*, IDM, etc

**Examples**
- Persistence, (E.g TempoIQ)
- automation (E.g IFTTT)
- intelligence, third party integrators (ERP connectors)

## Apps

User facing front-end applications that facilitate using IoT services, in turn can be used to manage and automate endpoints, and generally orchestrate an Internet of Things

**Examples**
- WidgIoTs
- SmartLiving
- Web & Mobile Apps
- Freeboard

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**IOT OSI:** Overview

v0.1 - 28th November 2014 - by Tom Collins
IOT OSI: Architecture mapping

The OSI 7 Layer model

- Communication between each layer deals with: Authentication, Identification, Management, Telemetry
- It maps... however
- OSI adds unnecessary complexity
- We're not building protocols
- We're trying to build distributed applications which interact, and can be developed in a ‘lean’ fashion

Cloud Architecture Model

Distributed Computing Model
The ‘Green Living’ Project

A Maker project being built with SmartLiving, a consumer centric IoT solution.

The project concerned an energy conscious Maker who wanted to automate household appliances based on the amount of power collected by solar panels and the water available in a reservoir.

When resources are plentiful, appliances were operated just-in-time for greener, smarter living.

“I’d like to make an automation project that “senses” the weather outside (rain, sun radiation and darkness), takes into account the electricity produced by the solar panels and that than automatizes certain household appliances or the central heating.

I would like to have such a system because I want our house to be smarter and less energy-consuming and thus more environmentally friendly.”
IOT OSI: In Action - IoT Canvas mapping

**END POINTS**
- **SENSOR**
  - Solar Log
  - Water barrel
  - Weather Station
- **ACTUATOR**
  - Dryer
  - Dish Washer
  - Water/Power supply control
- **WEB SERVICES**
  - Weather Underground

**CONNECTIVITY**
- **Endpoint connections**
  - Weather station
  - Water level
  - Valve control
  - Weather Station

**MIDDLEWARE**
- **Local Home Gateway**
- **Raspberry Pi XBee Gateway**
- **Messaging Broker**
  - RabbitMQ

**IOT SERVICES**
- **Cloud based Command & Control**
  - Management
  - Telemetry DB
  - Rule engine

**APPS**
- **Mobile App Features**
  - Time series graph
  - Appliance status
  - Appliance control
  - Notifications

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## IOT OSI: *In Action - SmartLiving: IoT Toolbox*

### Solutions

- **Arduino**
- **Raspberry Pi**
- **ZWave Devices**
- **Android Makers App**
- **Web Services**
- **Custom microcontrollers**
- **Virtual actuator**
- **Virtual sensors**
- **Virtual actuator**
- **Virtual sensors**

### Connectors

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<tr>
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<td>IR??</td>
<td>PUBSUB Clients</td>
<td>Widget Lib</td>
<td>Go Lib</td>
</tr>
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</table>

### Dev Tools

- **C Lib**
- **Python Lib**
- **JS Lib**
- **Go Lib**
- **Node.js Lib**
- **Java Lib**

**Plenty of existing resources here**

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IOT OSI: *In Action*
Example #1 - Arduino Xbee to Gateway to Web App

- **END POINTS**
  - Arduino
    - Returns water level reading
  - Arduino Gateway
    - Wireless XBEE to TCP/IP
  - SmartLiving Web App for Makers
    - Real-time graph showing moisture

- **CONNECTIVITY**
  - XBEE
  - Arduino Lib
  - Arduino Gateway Lib

- **MIDDLEWARE**
  - MQTT Plugin
  - AMQP

- **IOT SERVICES**
  - Management, automation rules, persistence

- **APPS**
  - Front end user facing App (beta.smartliving.io)
Example #2 - Web app to Android endpoint

**IOT OSI: In Action**

*Actuator Widget*

Receive voice commands from browser (HTML5 device API)

*Android Makers App*

Trigger Text-to-Speech actuator
IOT OSI: *In Action*

Example #3 - Green Living  ‘Let me know when I can turn on the washer’ scenario

- **Water barrel**: Measures water level
- **Rules Engine**: Automation to trigger notifications
- **Android Makers App**: Text-to-speech alert
- **Email service**: Email with monthly report on usage
PROTOTYPE

Purpose

➔ Defines an ethos with ‘Lean startup’ mentality, prototype for POC, test, measure, iterate
➔ Uses standard building blocks to build IoT products fast
➔ Allows developers and practitioners to focus on what they’re good at, and using the ‘IoT Toolbox’ for all other layers
➔ Use technologies and tools conducive for Rapid Prototyping (web > native, script > bare metal code)
➔ No major concern for auth*, scalability or UX in early iterations (Exploit SaaS or specialists when you’re ready to scale, deal with this after you learn enough from users)

Current works & Influences

➔ @SmartLiving_io - Open consumer (Makers, developers, enthusiasts) centric IoT solutions
➔ The Lean IoT - An open source effort to iterate IoT solutions, features voted for via community and contributions from guest tech’ companies

Next steps

➔ Validate prototyping techniques via SmartLiving & @iMinds IoT Maker Hackathons and Meetups
➔ Start sharing apps and services via github for people to collaborate and extend
➔ Standardize project structure for Deploy
PROTOTYPE: Coming Soon

Opportunities

➔ Startup Weekend Demo of IoT Prototyping, Gent Belgium - 5 Dec 14
➔ SmartLiving IoT Hackathon #1, Gent, Belgium - 13 Dec 14
➔ SmartLiving IoT Hackathon #2, Brussels, Belgium - Feb 15
➔ SmartLiving IoT Hackathon #3, Netherlands - Mar 15

Got a hackathon you want to add a spark of IoT to? Get in touch
tc@allthingstalk.com
DEPLOY

Purpose

➔ Package up IoT projects to share with the world, defining a **standard IoT project structure**

➔ **Cuts deployment time**

➔ Integrates **IoT Unit Testing**

➔ Collates code for a whole project with all layers of the IOT OSI, along with all configurations

➔ Makes it easy to share, collaborate and build on top of existing solutions

➔ Incentivized

➔ Enhances knowledge sharing

Current works & Influences

➔ Inspiration from every PaaS platform that’s supporting web developers to build what they want, fast. Without dedicated DevOps.

➔ Xively

➔ IBM Bluemix

Next steps

➔ Find a ‘dream team’ to start implementing the architecture and developing a pre-processing scripting language to support projects which feed directly to IoT PaaS, current solutions are still maturing and are driven by commercial needs
**DEPLOY: Coming Soon**

**Houston - Mission Control for the IoT**

**Concept requirements**

Strict version control structure for pushing entire IoT ‘project’ to a CI platform

➔ Platform facilitates continuous integration

➔ Pre-processor (*Looks for .iot files*), when user wants to deploy a project it allows them to dynamically add their own resource ID’s at build time

➔ For widgets/dashboards/scenarios all fully automated and hosted on the web as with PaaS as we know it

➔ Automation and cloud scripts are deployed as Micro-services

➔ Microcontroller code/dependencies/startup scripts are auto-generated leaving you to upload to your controller (*The dream is OTA updates, anyone for an Electric Imp demo?*)

**Next steps**

- Analyze **Gilliam** and **Flynn** as possible solutions
- Analyze flexibility of IBM **Bluemix**, it does a lot, practical use cases seem to be lacking however
- Analyze flexibility of **Xively**, it claims to be PaaS, but practical use cases also lack and it’s not all encompassing (*Frontend, Automation, intelligence?). They’ve also shut the doors for new users ;-)
Who needs an IoT Methodology?

**Ignition Partners** - 25 Nov 14 *(Date of publish via sys-con)*
Searching for the missing link: DevOps and the Internet of Things

**Tim O'Reilly** - 20 Nov 14 *(Original article Apr 14)*
The Internet of Things & Humans
https://www.youtube.com/watch?v=nBNDfxiaQSQ

**Bosch** - 17 Nov 14
5 Lessons Startups have for the old economy
http://blog.bosch-si.com/categories/internetofthings/2014/11/5-lessons-start-ups-have-for-the-old-economy-iot-entrepreneur

**Aeris Communications** - 16 Nov 14
Call for Internet of Things practitioners *(via LinkedIn)*
https://evernote.com/shard/s134/sh/b10a2869-5852-4efc-9b5c-b6cfc9ad8680/c1c484b0369eb23547d83d8eea97ce62

**This guy...** - 16 Nov 14
Platform-as-a-Service and Micro-services for the Internet of Things
http://cloudbestpractices.net/blog/paas-microservices

**Forbes** - 13 Nov 14
The Internet of Things has an Enthusiasm Gap

**Gigaom** - 5 Nov 14
The Internet of Things needs developers, so what do developers need?

**Gartner** - 13 Oct 14
Start-Ups - Not 'Enterprise Elephants' Lead the Internet of Things
Advocates of the IoT Methodology

Rob van Kranenburg - @robvank
Rob van Kranenburg wrote The Internet of Things. A critique of ambient technology and the all-seeing network of RFID, Network Notebooks 02, Institute of Network Cultures. He is co-founder of bricolabs and the founder of Council. Together with Christian Nold he published Situated Technologies Pamphlets 8: The Internet of People for a Post-Oil World. He currently works as Community Manager at the EU Project Sociotal. He is consultant to IoT China, Shanghai 2014. He Chairs AC8 - Societal Impact and Responsibility in the Context of IoT Applications of the IERC, The European Research Cluster on the Internet of Things.

Lorna Goulden - @lornagoulden
Lorna Goulden is the founder and director of Creative Innovation Works, a networked innovation consultancy specialised in guiding multi-stakeholder innovation developments with an emphasis on end-user value creation within the often-disruptive context of the Internet of Things. Clients and partners are supported through means of an advanced toolkit that guides them through the translation of technological, business and socio-cultural trends into relevant user experience flows. The most promising value propositions are then extracted and coupled with strategically focused business models for implementation.

Dries De Roeck - @driesderoeck
Dries works as a designer and researcher at Studio Dott, specializing in the confluence of digital and physical systems, with a focus on human involvement during the design, creation and modification of meaningful connected products for everyday life.
Advocates of the IoT Methodology

Alessandro Bassi - @bassiconsulting
Alessandro Bassi graduated in Computer Science from the University in Milan in 1994. He joined Amadeus in January 1997, and he moved to the University of Tennessee in 2000, where he was involved in the seminal work of the Internet Backplane Protocol. From 2002 he then held a Research Visitor position at the Ecole Normale Superieure in Lyon, France. After working one year for RIPE NCC, in November 2004 he joined Hitachi Europe. Since September 2010 an Independent Consultant, working on topics related to Big Data, Internet of Things and Smart Cities technologies.

Tom Collins - @snillocmot
After being awarded first place for his Graduate Exhibition, and gaining a First with Honors for his work on ‘The Convergence of Cloud Computing, Smart Devices & the Internet of Things’, Tom went on to co-found SmartLiving, assuming a jack-of-all-trades role spanning architecture, DevOps, full stack and mobile development. He’s now set on making the Internet of Things a reality for everyone.
Call to action

Join the editorial team
info@iotmethodology.com

We need a diverse community of IoT enthusiasts
to spark the fuse
and make the Internet of Things a reality

You’ll be exposed to the whole IoT Methodology, and get hands on developing and implementing the techniques for use in your own practices. Your own works will also contribute the foundation of the IoT Methodology

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Let us know your involvement with IoT, what areas you’re interested in and what you can bring to the table
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