A Methodology for Building the Internet of Things

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goal

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

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

Ultimately to enable **individuals**, **communities** and **organizations**
to **think**, **imagine** and **question** ***'What's next?'***
to inspire the next ***killer app.***

> *We can build services **for people**, **by people**, **of people**, in the 21st century, if we make it so*
> @timoreilly

motivation & ethos

Initiatives motivated solely by profit and politics hinder innovation and lack the **creativity**, **enthusiasm** and **courage** to step into the unknown

In the **spirit** of the **World Wide Web** and **Open Source** communities across the globe, a **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**.

perspective

What it isn't

An all encompassing master solution.

Nor does it favor any technology, protocol or preferences.

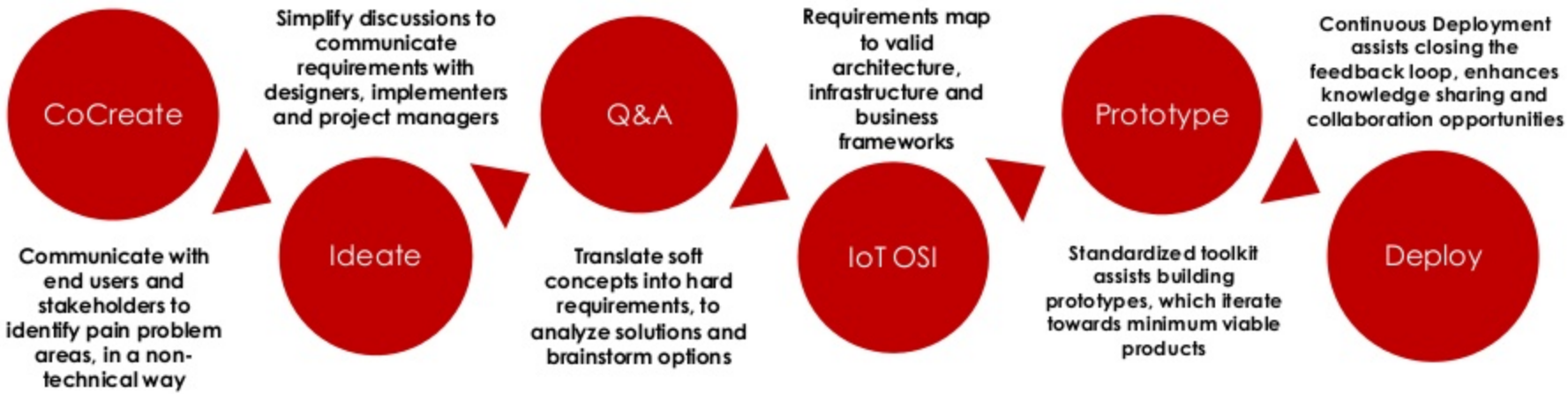
What it is

A curated repository of best practices, tried and tested tools, protocols and solutions, driven by a community who use them in real-world scenarios

The **catalyst** for the Internet of Things, are ***the do-ers, the explorers, the early adopters***, those ambitious enough to experiment, tinker and trial new technologies

The **'lowest common denominator'** to promote IoT from a bottom-up approach are **makers**, which will bring new technologies and disruptive innovation to industries and markets

iteration steps



co-create

Purpose

- **Assist** kickoff sessions to **initiate** projects and **aid communication** between end users, stakeholders and implementers
- **User centric** problem analysis
- **Conceptual designer approach**
- **Remove complexities** and influences that technically minded individuals bring to the equation
- **Narrow the scope** of a problem domain to the **most practical and impactful use cases**

Current works & influences

cocreatetheiot.com @nstembert

gov.uk/design-principles @benterrett

A manifesto for do-it-yourself internet-of-things creation @driesderoeck

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 April 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 props**
- **Narrow** down **biggest pain problems**
- **Contextualize** with the **physical** environment
- Consider **influences** and **outcomes** of these problems
- Identify **knowledge areas** contributing to solutions
- **Triage pressing problem** areas
- User Interface **mockup creation** to **allow users to visualize** and understand possible solutions

Tools for the CoCreate IoT Workshop by Nathalie Stembert

> *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.*

ideate

Purpose

- Provides a **common reference** for **brainstorming and discussing** IoT ideas, use cases and projects
- **Quick** and **easy** for the prospects and practioneers
- Standardized terminology
- **Designer or developer centric** approaches
- Opens discussions between varied stakeholders

Current works & influences

Lillidots @DriesDeRoeck

The IoT Canvas @snillocmot

Business Model/Lean Canvas @ericries & @ashmaurya

Next steps

- Share the IoT Canvas template
- Publish **IoT Canvas & 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

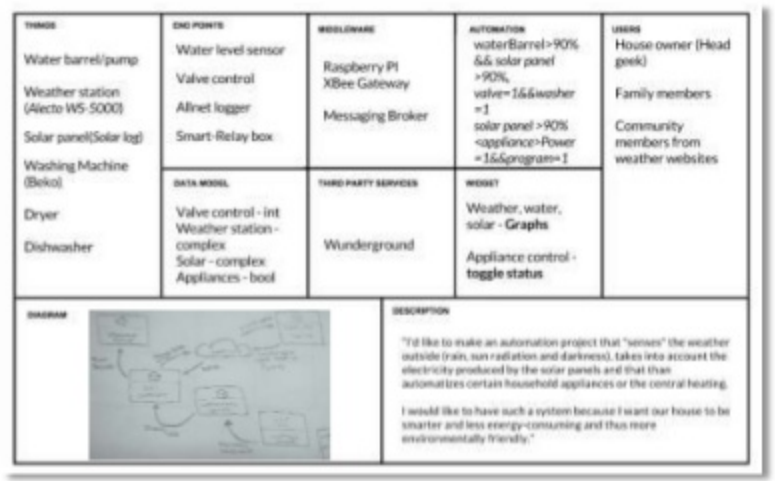
@smartliving_io

Gent, Belgium 20th November 2014

The **IoT Canvas** is an adaptation of the **Business Model/Lean Canvas**, used in brainstorm sessions with various user groups, it assists validation and identification of MVP requirements for projects.

Summary

- **Problem statement** summing up user's pains
- Identify **Things** in the **physical environment***(Context)*
- Consider **sensors***(inputs)*, **actuators***(outputs)* & **controllers** which make up **Endpoints** interacting with **Things**
- Define **Data models** for **Endpoints**
- Define **Middleware** requirements for **Endpoints** to connect **IoT Services**
- Summarize **Third-party-web-services** that will be integrated
- Sketch **User Interface** widgets
- **Define the key actors** *(Humans)* using the system



IoT Canvas for the 'Smart Greenhouse' Makers project

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

Current works & influences

IoT:DB - Repository listing tools, technologies and solutions, that
can be searched with project requirements

IoT Analysis Survey @allthingstalk

Next steps

- Guide for the **path from ideation to architecture**, to target specific verticals
- Define a deliverable 'report' to feed the **IOT OSI & IOT ARM**
- Web app survey to allow users to enter requirements
- IoT:DB MVP - facilitate adding new solutions and searching the repository

Q&A in action

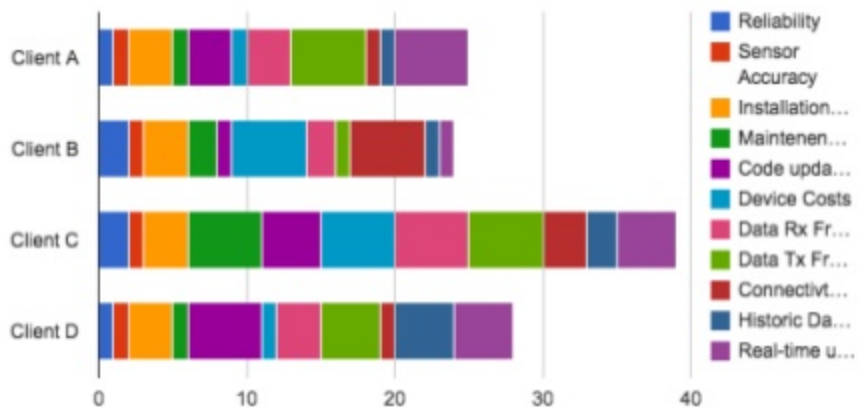
@allthingstalk

Conducted online – April to August 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 **IOT OSI** layers to assist project development.

Summary

- Project outline - **Business value**
- Feasibility - **Validate** scope
- Practical Considerations - **Close** scope
- Problem Domain Analysis - **Solution** summary
- Solution & Topology Design - **Architecture**
- Infrastructure Considerations - **Infrastructure**



Results from architecture design preferences for end point devices

IOT OSI

Purpose

- **Breaks down and the simplifies** the components of the IoT into an ***'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** for domain **specialists** to focus efforts
- **Simplifies communications** with end users, stakeholders and development teams

Current works & influences

IoT:DB - Search for solutions based on architecture requirements

The IoT-Architecture Reference Model @IoT_A

OSI Seven layer model

Next steps

- **Map common solutions** to the IOT OSI – Intel IoT Solutions, Eclipse Open IoT Stack, etc
- **Support** the creation of **new architecture references** for specific verticals
- **Test and validate** architectures 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, ..

MIDDLEWARE

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

Guarantees delivery, QoS, Privacy and Auth* for IoT Services

Examples

Dowse, OpenHAB, TheThingSystem, ZIPR, 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)

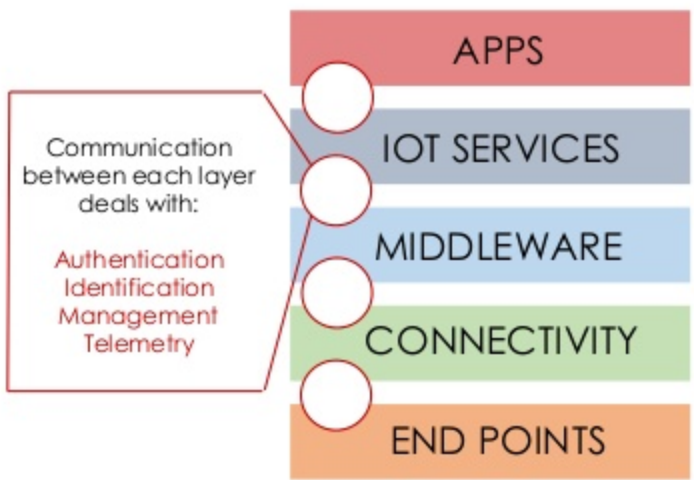
APPS

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

IOT OSI architecture models

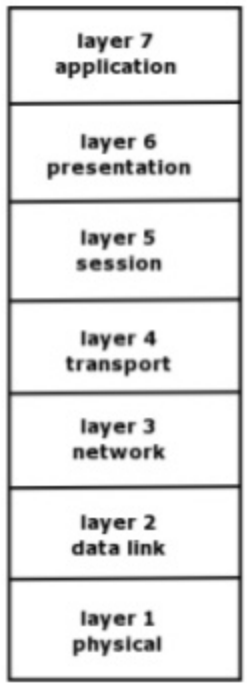


The OSI 7 Layer model

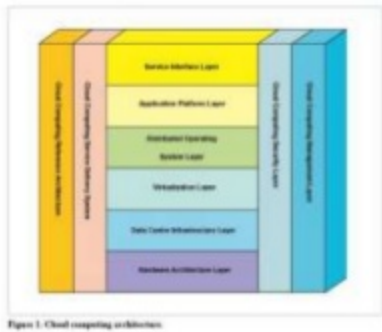
It maps, however.. OSI adds unnecessary complexity

We're not building protocols

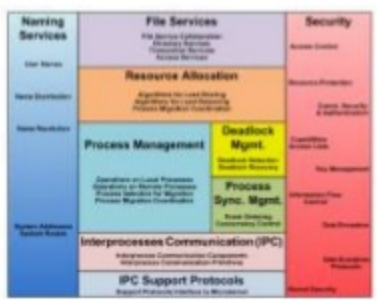
We're trying to build distributed applications which interact, and can be developed in a 'lean' fashion



Cloud Architecture model



Distributed Computing model



IOT OSI in action – IoT canvas mapping

The Smart Greenhouse Project

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

The project aims to use IoT to make growing vegetables more efficiently in a sustainable and automated way.

THINGS	END POINTS	MIDDLEWARE	AUTOMATION	USERS
Plants Window vents Door Glass panes Water catcher Sprinkler Watering can	Galileo Plant sensor xbee node	Message Broker Xbee Gateway	W: moisture < 80 T: sprinkler =1 E:sprinler=0 W: temp > x T: servo=50	Gardener Fellow gardeners Smart city initiatives Open source urban green housing
	DATA MODEL	**THIRD PARTY SERVICES**	**WIDGET**	
	Temp – int Lux – int Moisture – int AQ – int Humidity int Sprinkler - bool	Wunderground Growing Green cities	*See mockups*	

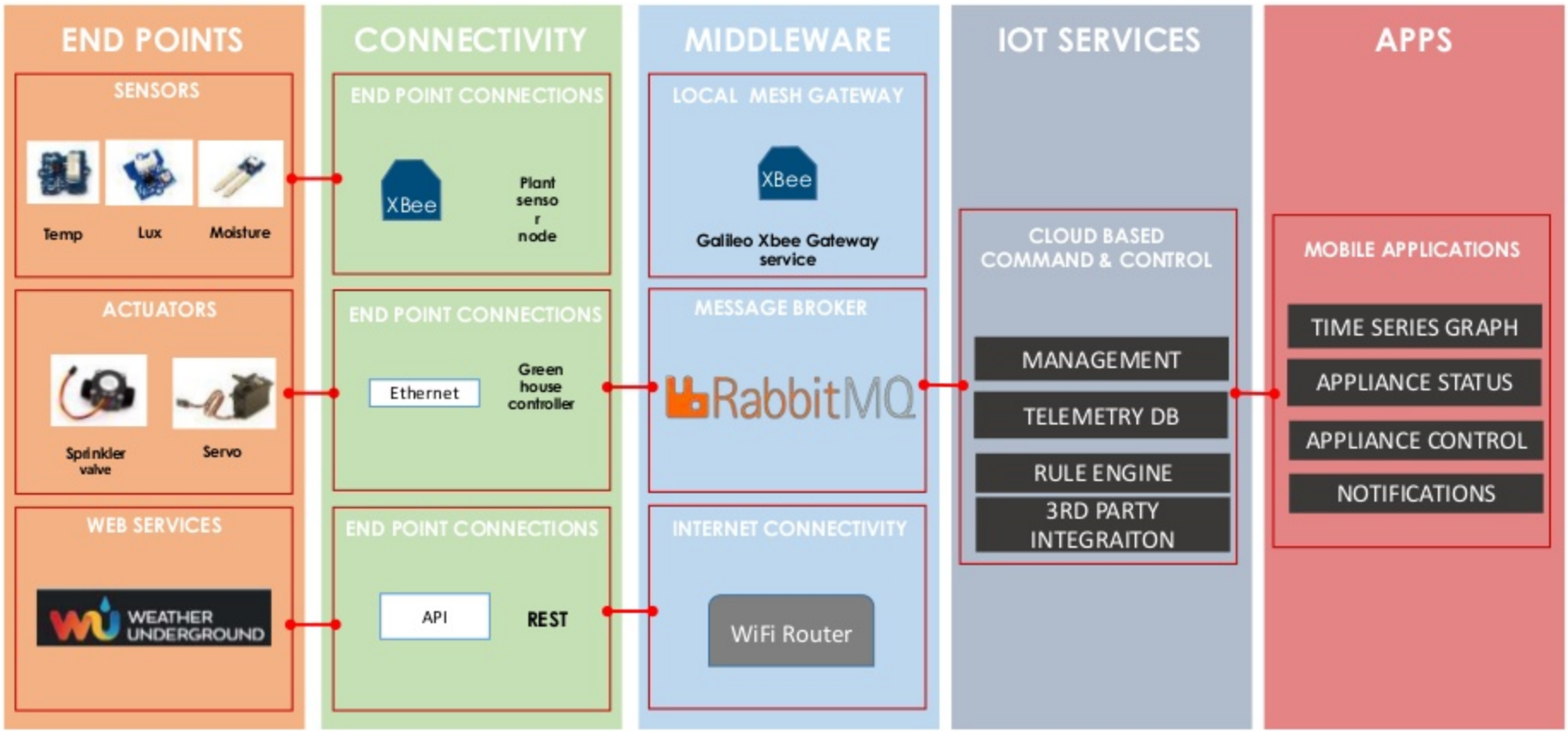
DIAGRAM

DESCRIPTION

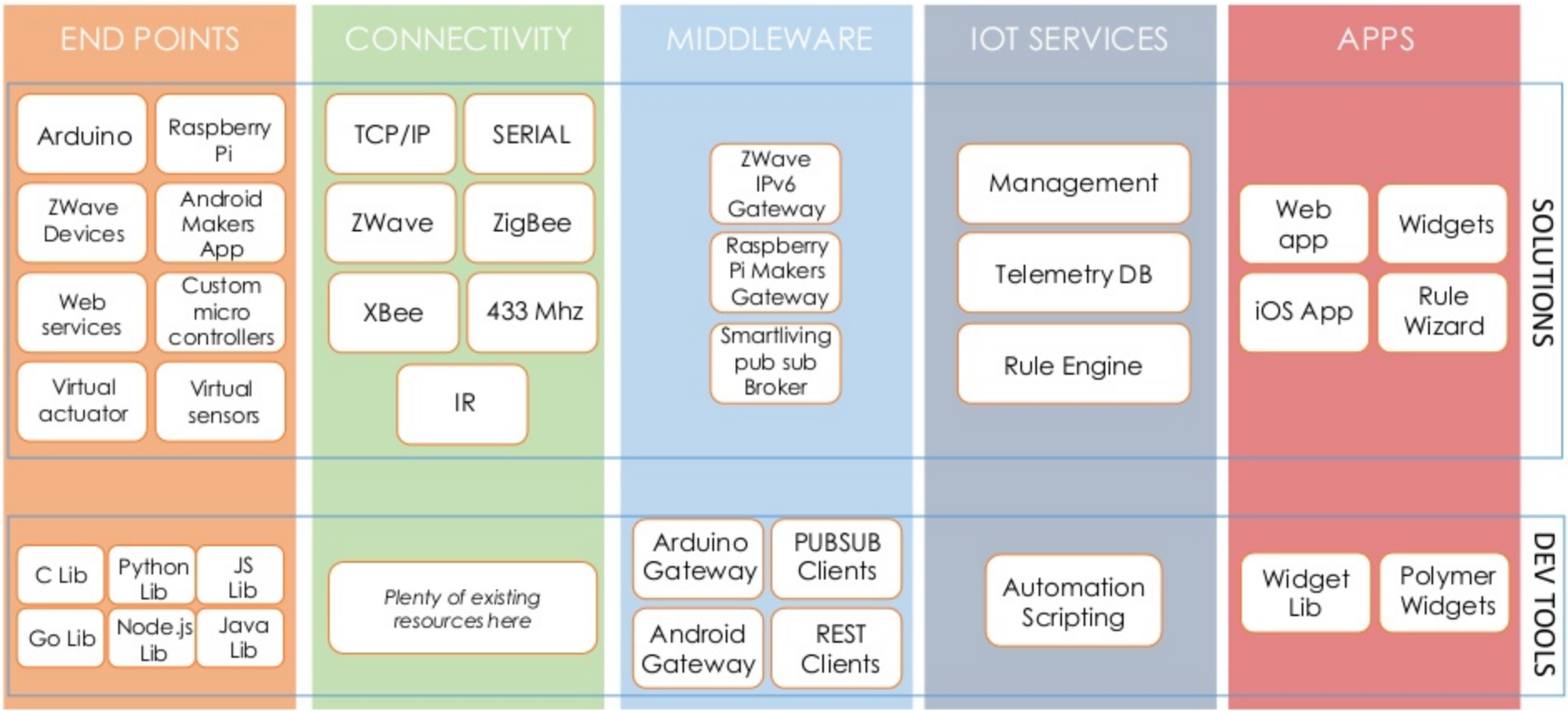
"I'd like to make an automation project that "senses" the weather outside (rain, sun radiation and darkness), takes into account the electricity produced by the solar panels and that than automatizes certain household appliances or the central heating.

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

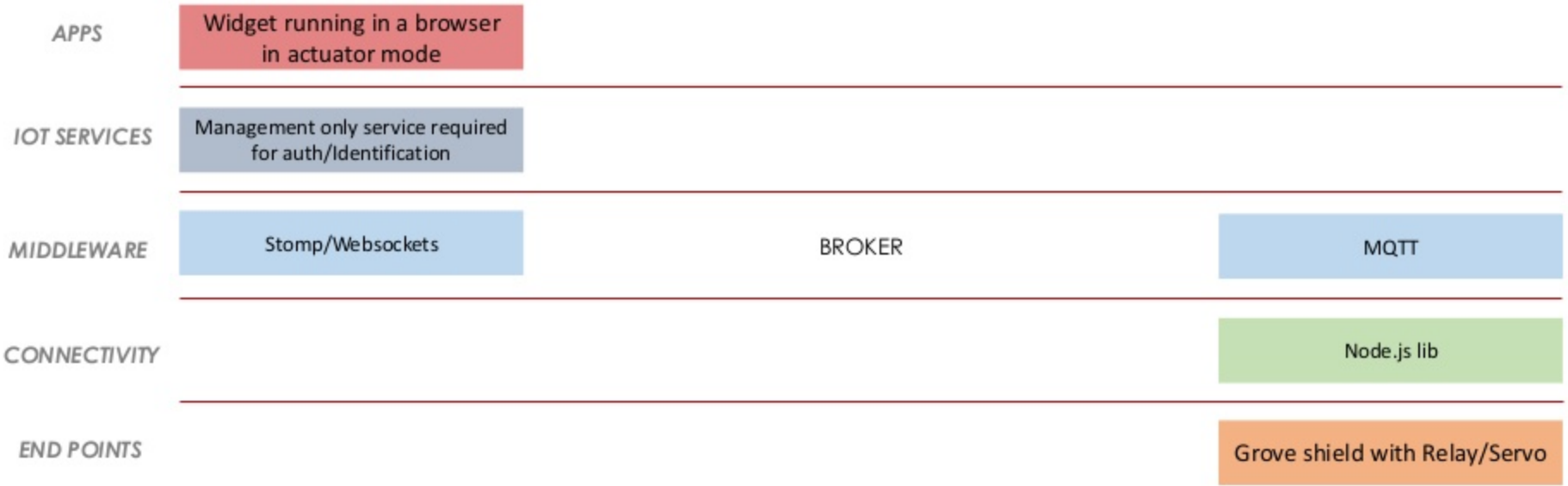


IOT OSI in action – SmartLiving.io implementers Toolbox



IOT OSI in action

Usecase One – Greenhouse controller



Actuator control Widget

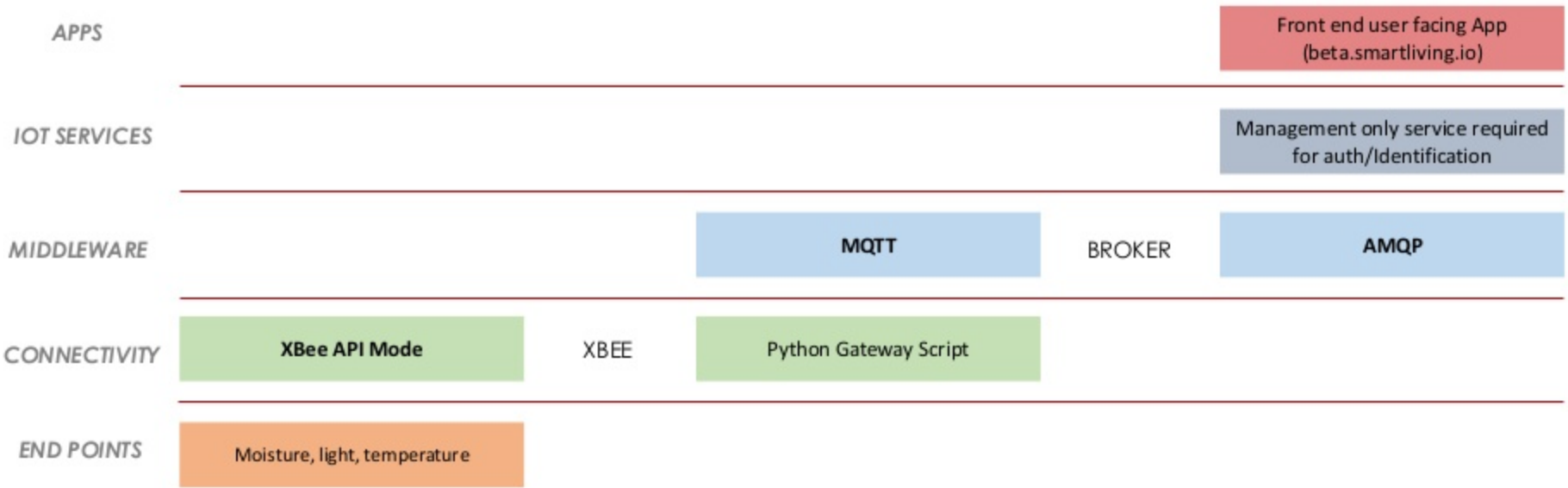
UI interaction commands from a browser (HTML5 device API)

Galileo – Arduino interface

Sprinkler and ventilation controller

IOT OSI in action

Usecase Two – Smart Plant Node



Smart Plant node

Provides readings for Moisture, temperature and light lux

Galileo Gateway Service

Wireless XBee to TCP/IP via serial

HTML5 Web socket Graph widget

Real-time data showing sensor values

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 End-2-end IoT solution for Makers, developers, enthusiasts

Every hackerspace, maker community, hackthon, and lean startup out there

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**