Building Connected Devices

With Thingsquare and Contiki

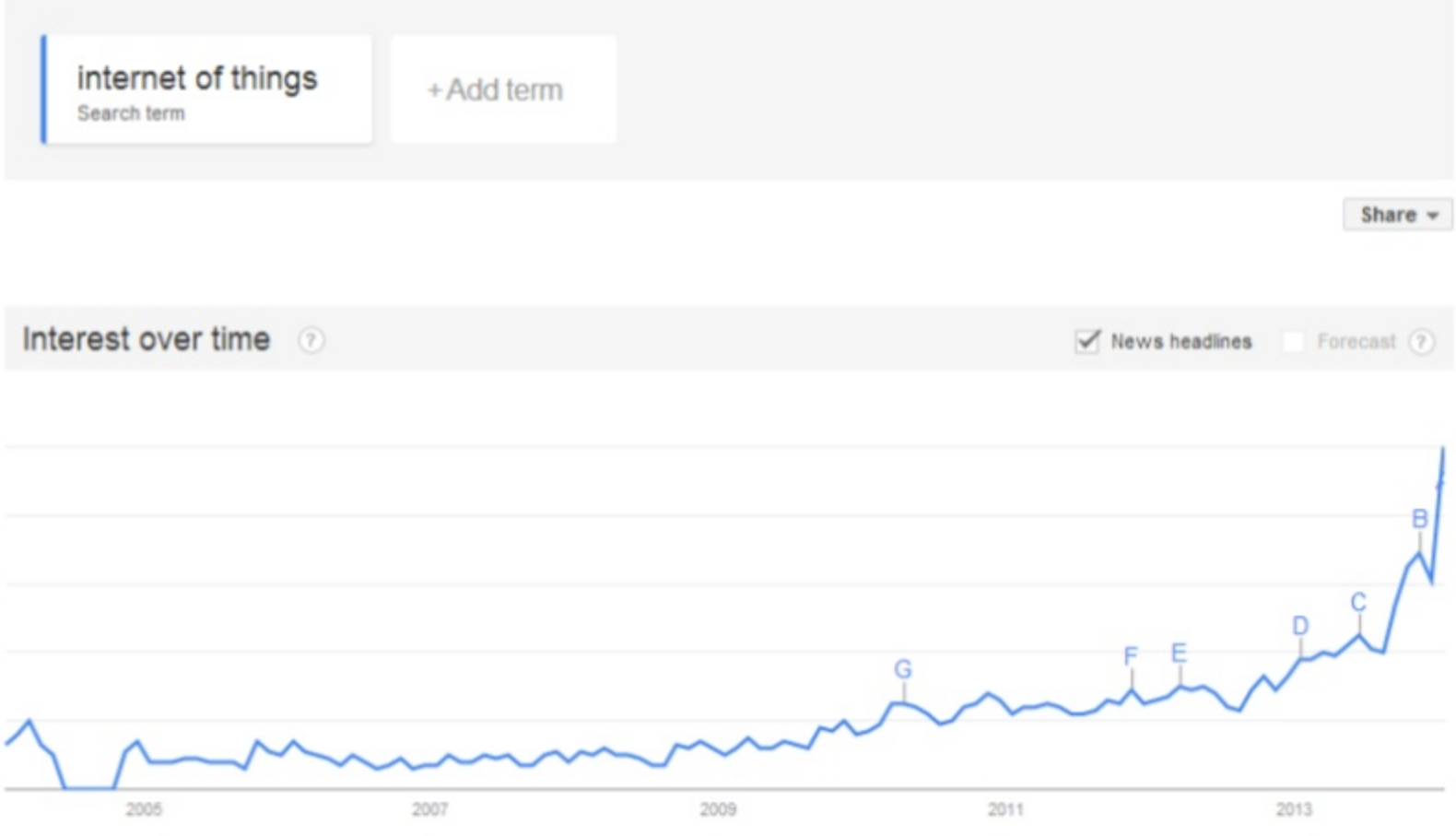
Overview

- Two hands-on labs:
  - The Big Red Internet Button
  - Build our own IoT cloud service
- Lots of background
- Lots of technology
- Lots of Contiki
- Lots of IoT/IP protocols

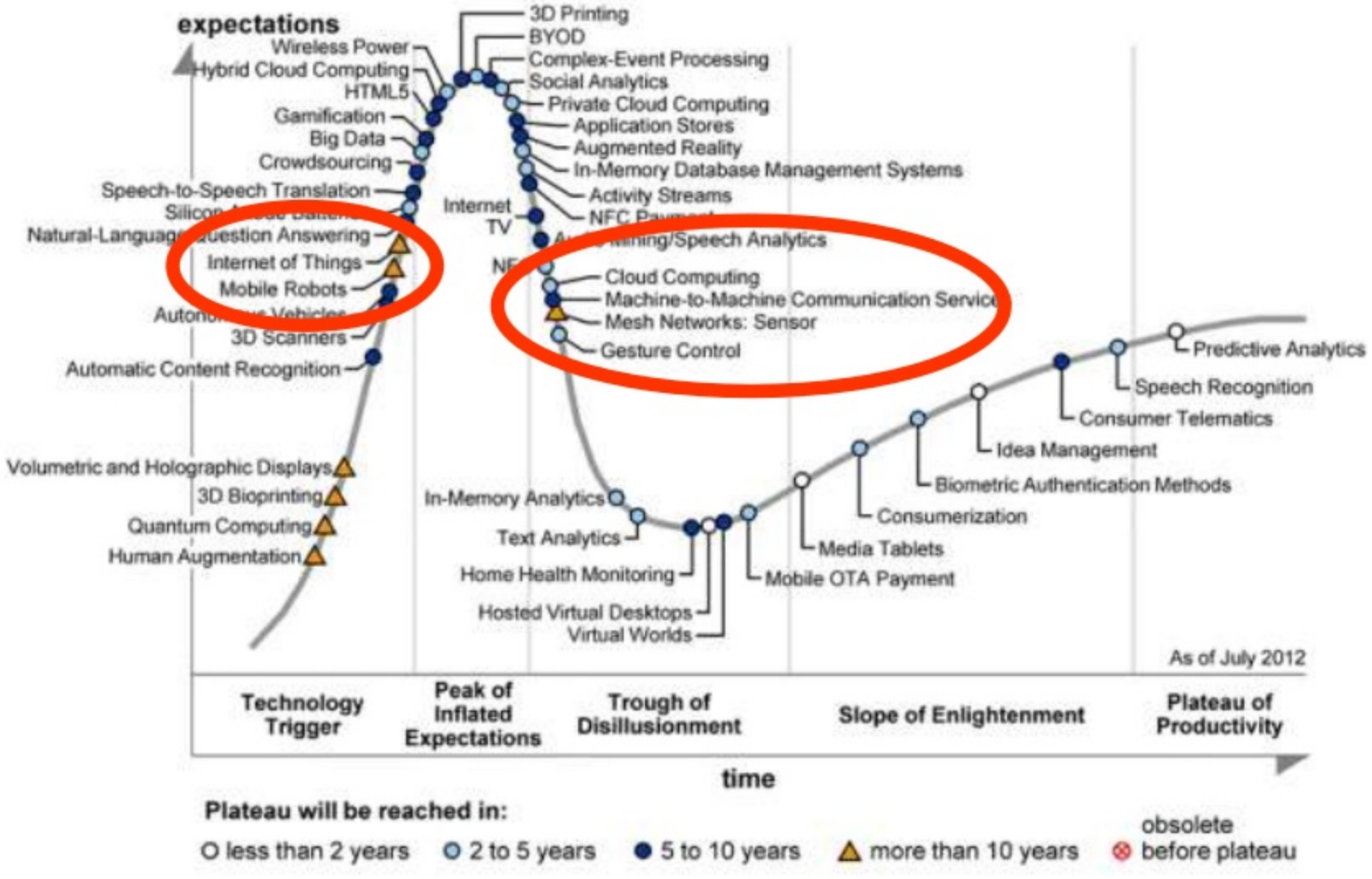
Thingsquare

- Build connected systems – leverage the Internet of Things
- Founded in 2012
- Creators of the open source Contiki OS
- Launching in 2014
  - Thingsquare cloud backend
  - Online development environment

Google trend



Gartner Hype Curve, Emerging Technologies, 2012



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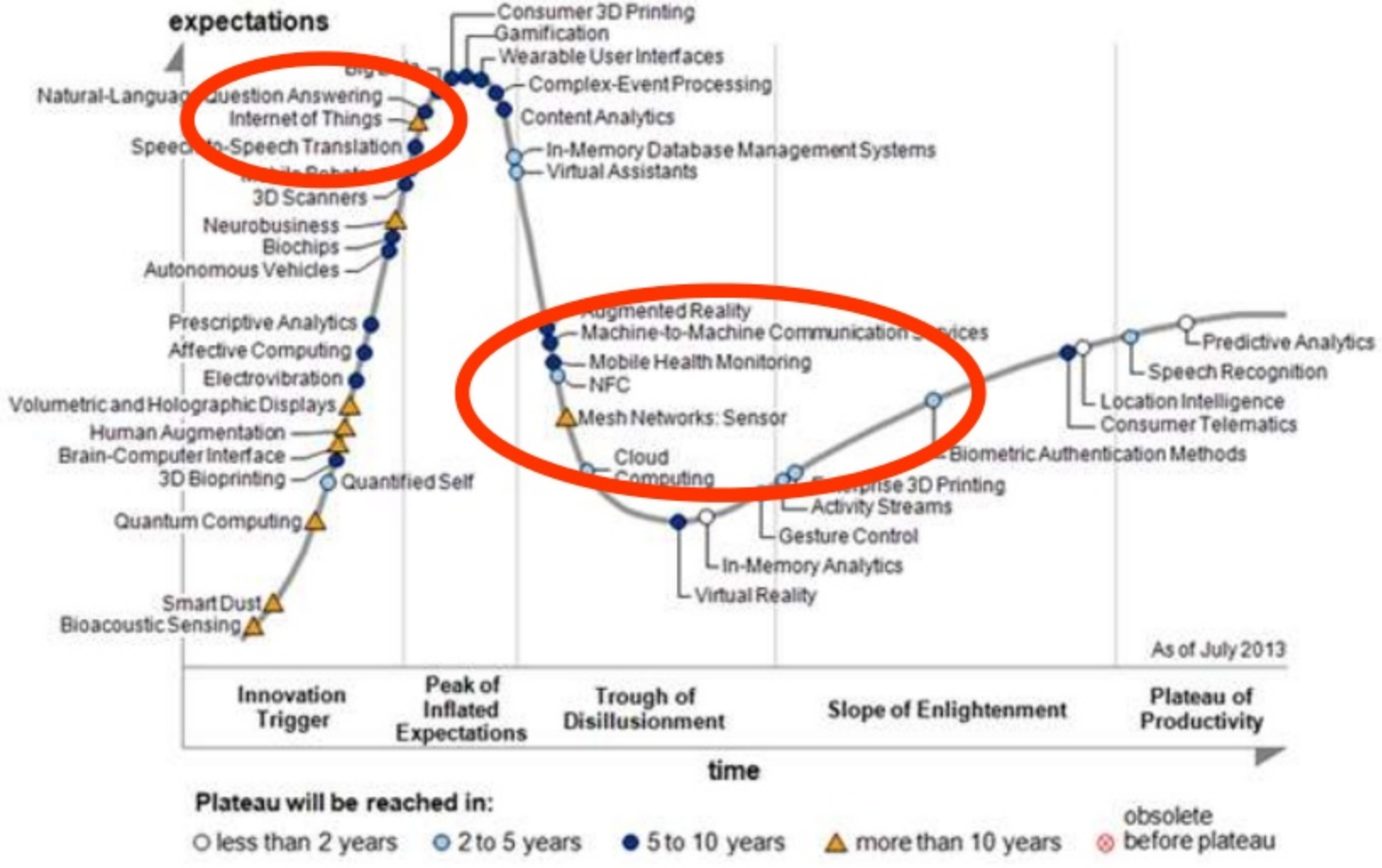
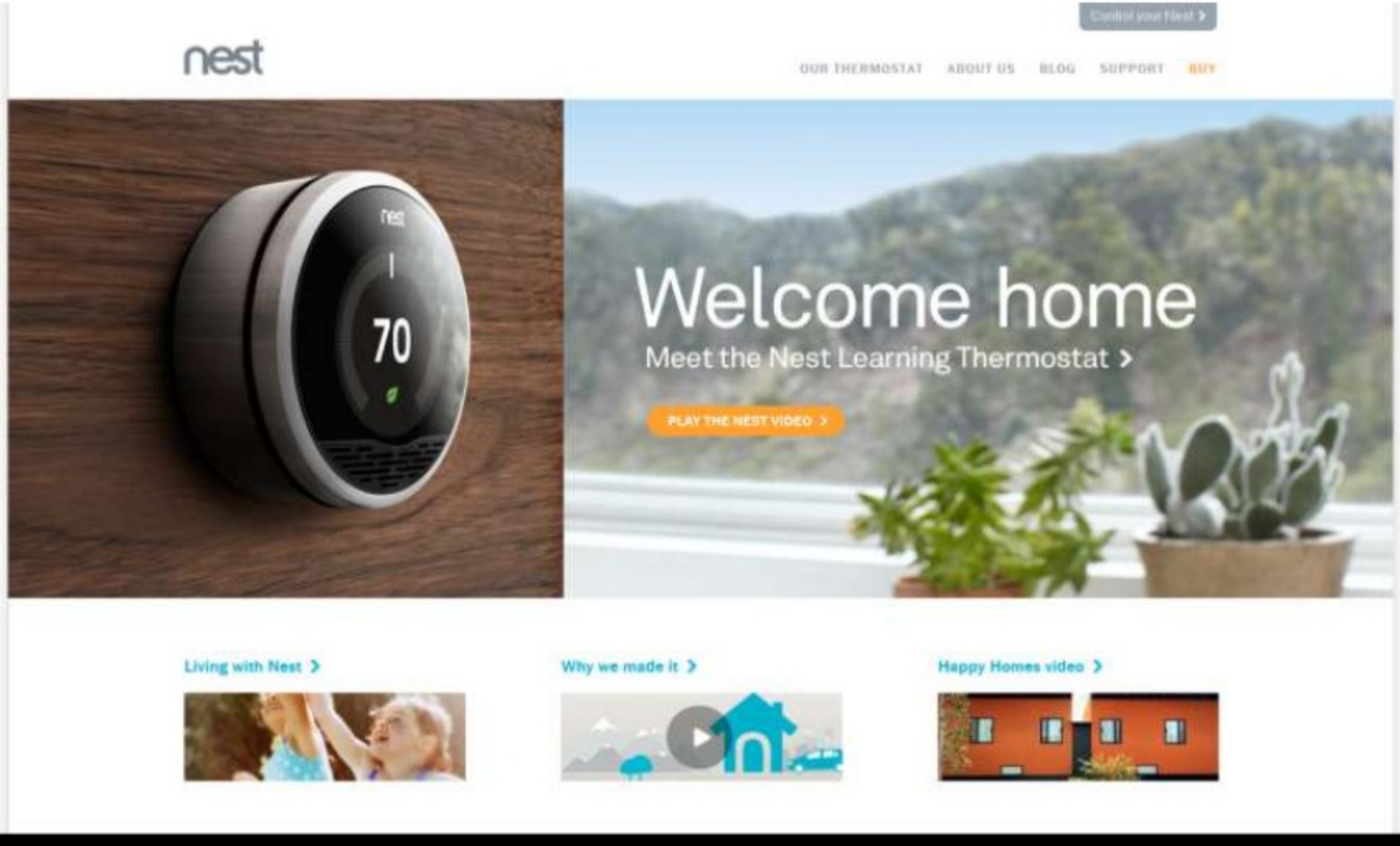


What is the IoT?

- New technology
  - Wireless, communication, low-power, large-scale, big data, Internet-connectivity
- New concepts
  - New ways of interaction, new ways of thinking
- New business opportunities
- Emerging products and systems

The Connected Home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SUPPORT
BUY
70
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COOL
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Honeywell
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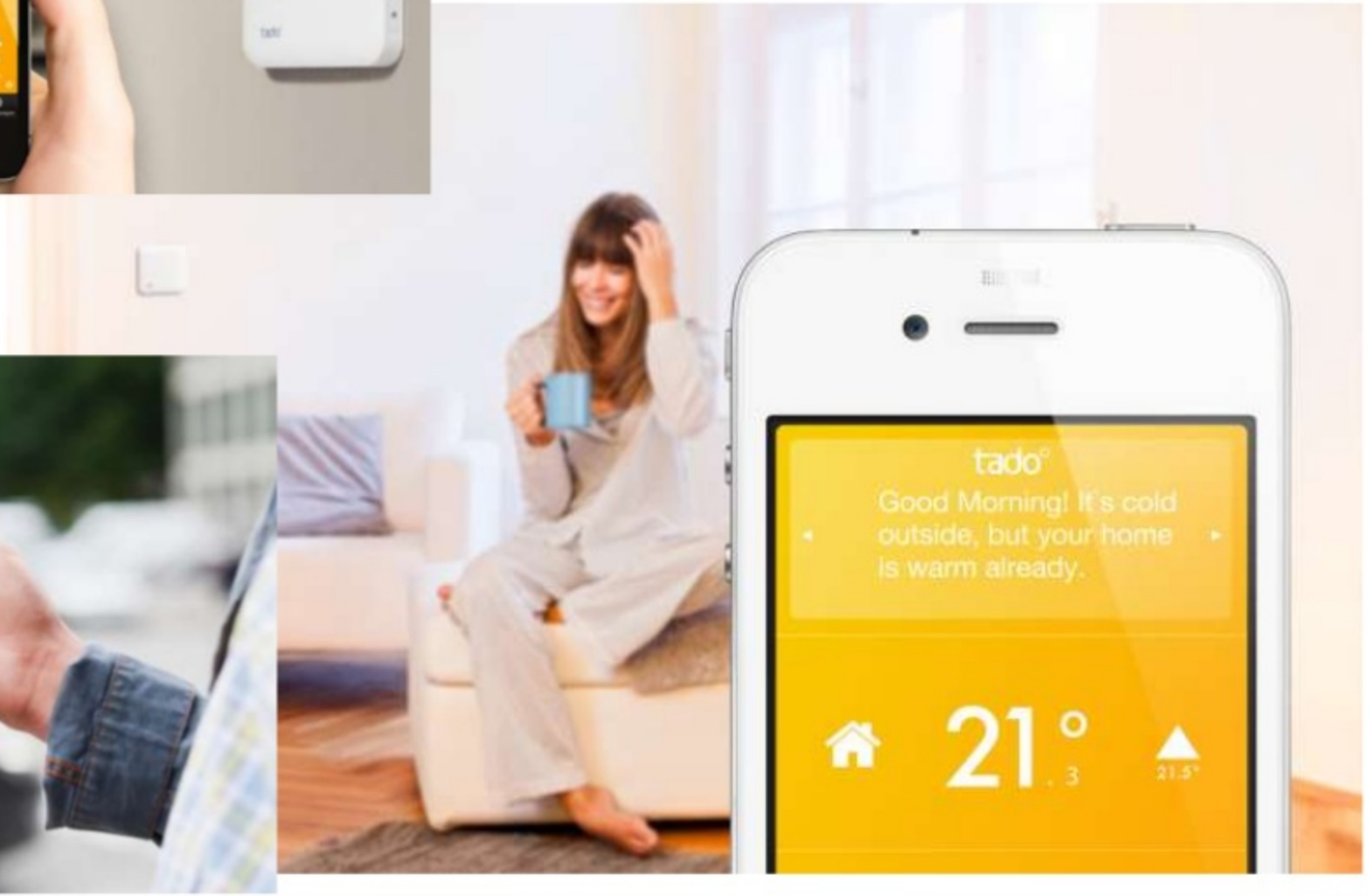
nest
72


DO NOT PAINT

Works with your Nest Thermostat.


21°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21°
3
21.5°


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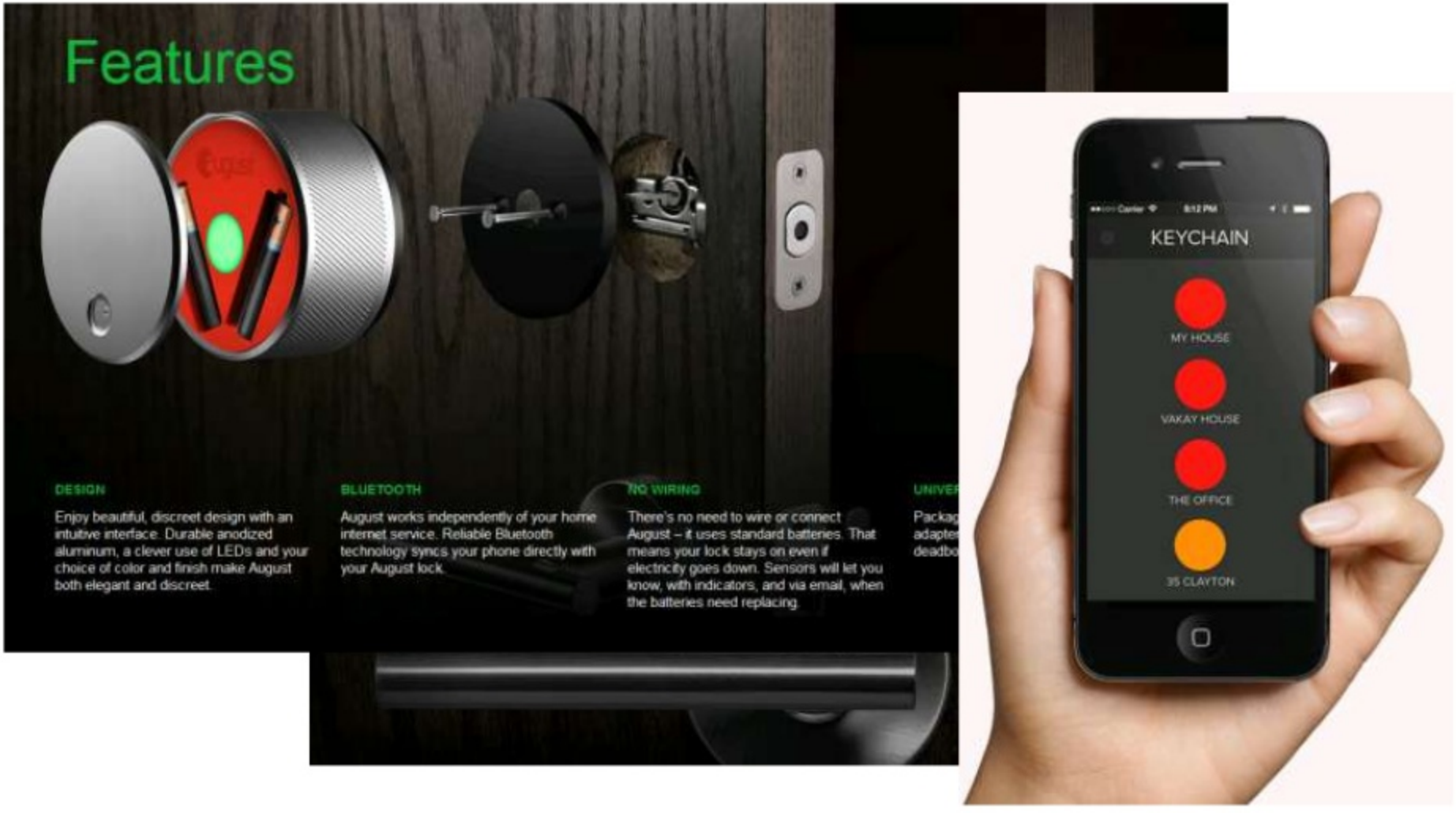

Features
DESIGN
Enjoy beautiful, discreet design with an intuitive interface. Durable anodized aluminum, a clever use of LEDs and your choice of color and finish make August both elegant and discreet.
BLUETOOTH
August works independently of your home internet service. Reliable Bluetooth technology syncs your phone directly with your August lock.
NO WIRING
There's no need to wire or connect August – it uses standard batteries. That means your lock stays on even if electricity goes down. Sensors will let you know, with indicators, and via email, when the batteries need replacing.
KEYCHAIN
MY HOUSE
VAKAY HOUSE
THE OFFICE
35 CLAYTON

24 hour snooze lets you delay watering. After 24hrs Lono will pick up watering right where it left off.

Too dry? Quickly adjust the watering level for each zone right here.

Turn zones on and off with the touch of a button.

The Cities

streetlinenetworks.com

zolertia.com

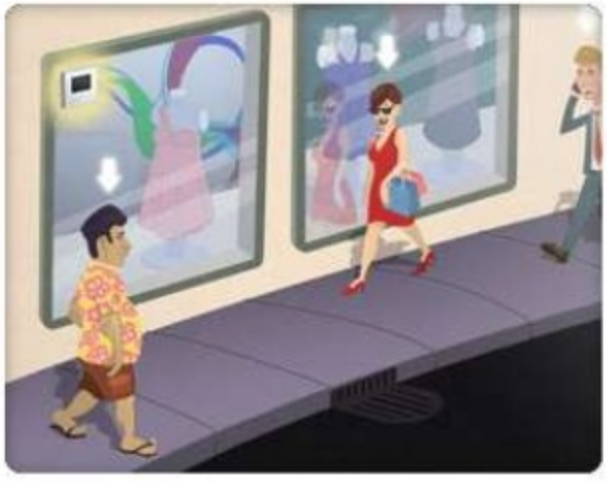
www.motionloft.com

Motionloft

Property Owners Brokers Retailers Prici

Property Owners Solutions for developers and property owners

Retailers are quickly making Motionloft data a requirement before considering expanding to new locations.



Measure the true value for your property

The Kickstarters

thingsquare

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RadioBlock: Simple Radio for Arduino or any Embedded Syst

by Eric C

Home Updates 4 Backers 234 Comments 31

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Teensy 3.0 - 32 bit ARM Cortex-M4, usable in Arduino and C

by Paul Stoffregen

Home Updates 18 Backers 1,572 Comments 332 Sherwood, OR Technology

Funded! This project successfully raised its funding goal on September 16.

1,572
backers

$70,874
pledged of $5,000 goal

0
seconds to go

Project by
Paul Stoffregen
Sherwood, OR
Contact me

$55,421
pledged of $25,000 goal

0
seconds to go

Project by
Amperic
Boston, MA
Contact me

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Ninja Blocks: Connect your world with the web.

by Ninja Blocks

Home Updates Backers Comments San Francisco, CA Open Hardware

Funded! This project successfully raised its funding goal on March 10.

578
backers
$102,935
pledged of $24,000 goal
0
seconds to go

KICKSTARTER Discover Start BLOG HELP SIGN UP LOG IN

Twine : Listen to your world, talk to the Internet

by Supermechanical

Home Updates Backers Comments Cambridge, MA Technology

Funded! This project successfully raised its funding goal on January 3, 2012.

3,966
backers
$556,542
pledged of $36,000 goal
0
seconds to go

Project by Supermechanical
Cambridge, MA
Contact me

First created · 6 backed
Has not connected Facebook
Website: http://supermechanical...

marter

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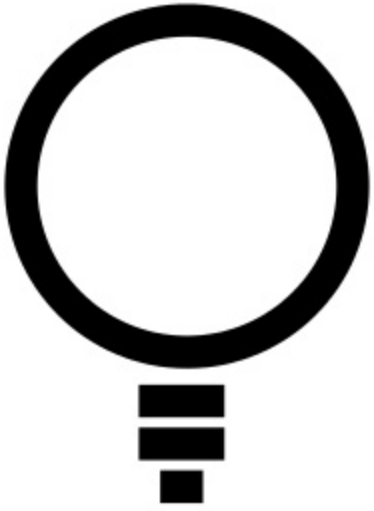
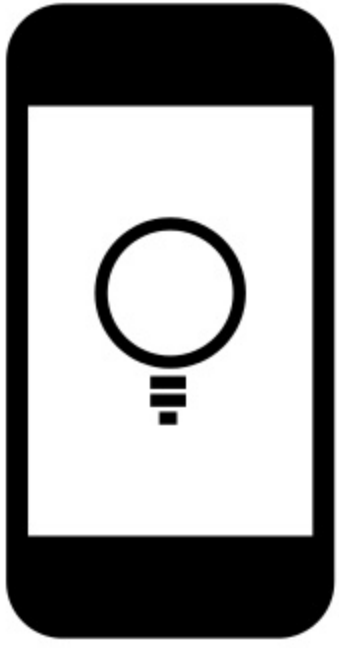
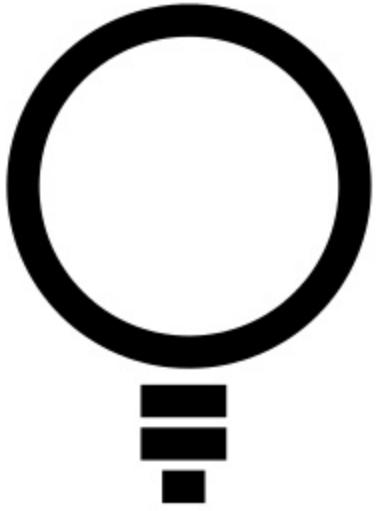
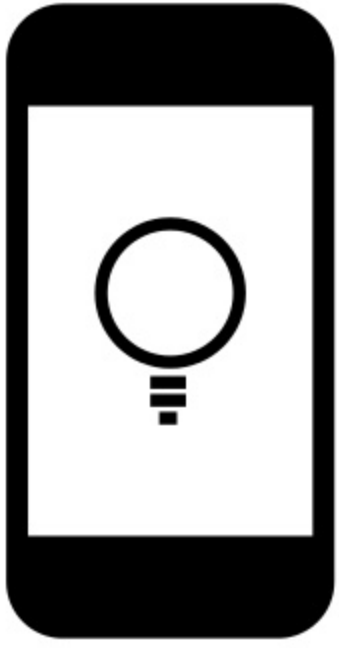
What is the common denominator?









IoT System Architecture

- Specialized protocols?
- Smart hubs?
- Direct or indirect connectivity?
- Via the cloud?


revolv


smartthings
SmartThings

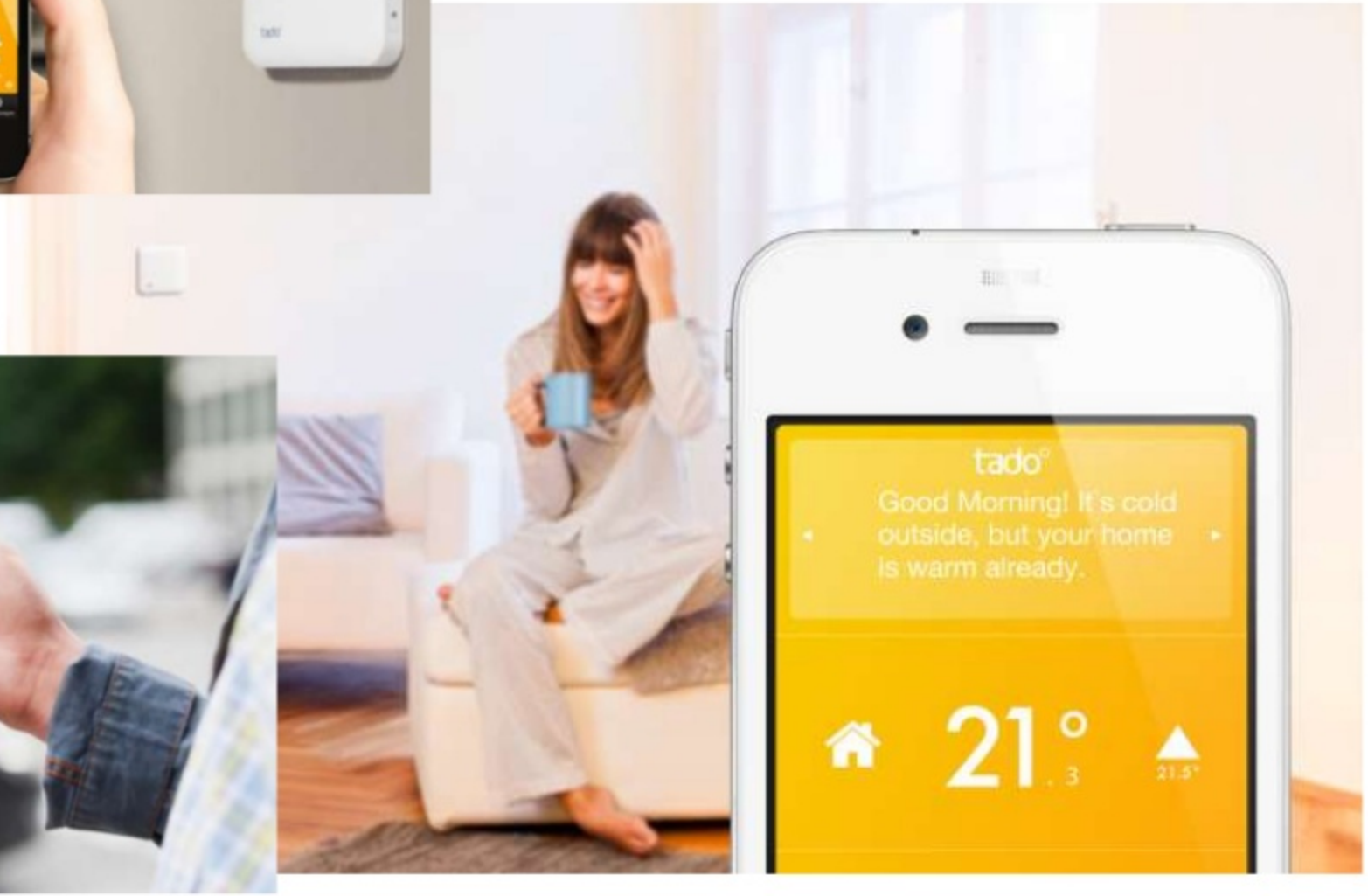
Direct connectivity

- WiFi
- 6lowpan

thingsquare

Ayla Networks


21°


tado°
Good Morning! It's cold outside, but your home is warm already.
21°
3
21.5°

thingsquare


Success!

Indirect connectivity

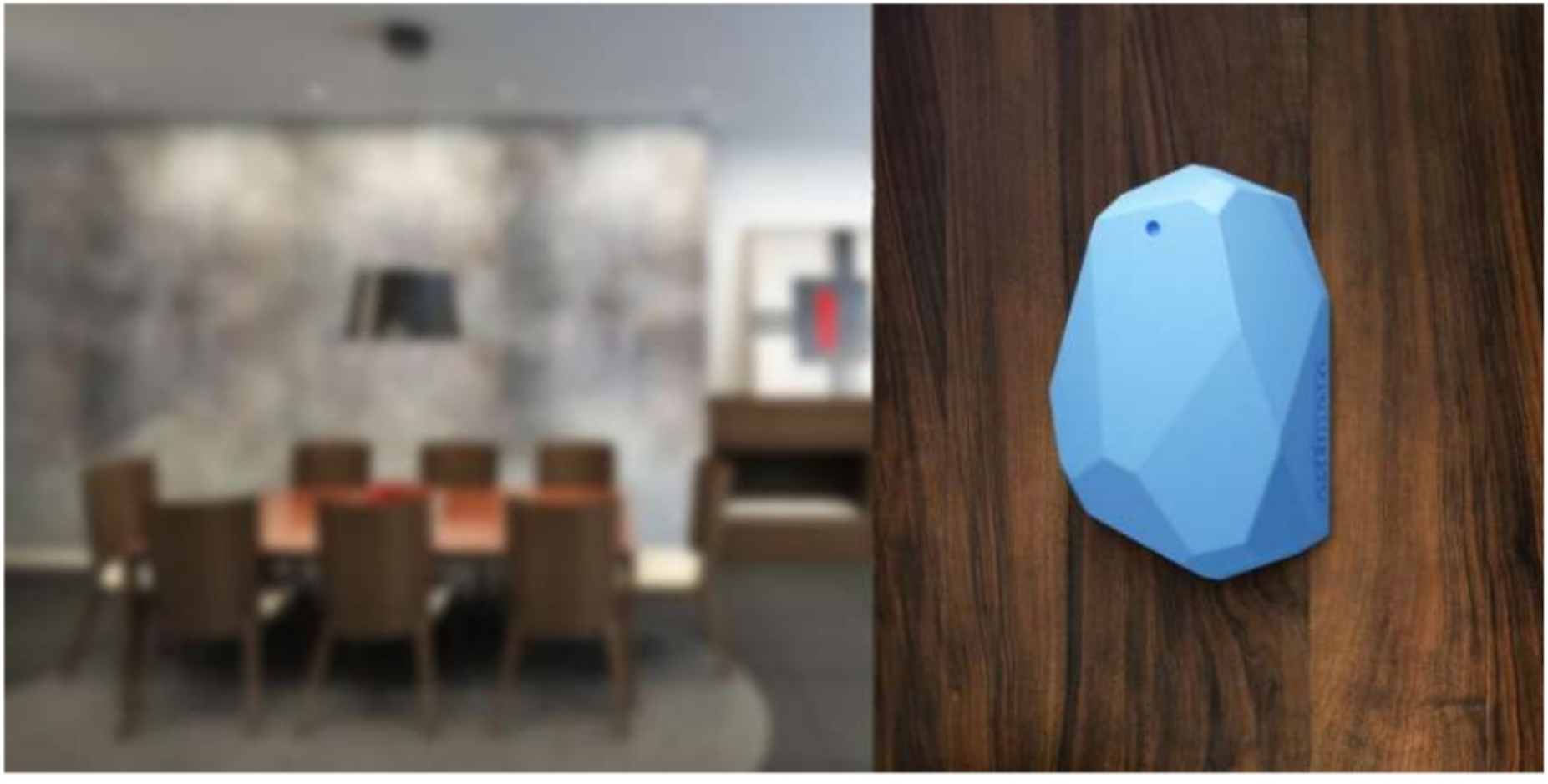
- Plenty of standards for different niches
  - ZigBee, Z-Wave, Dash7, Enocean, ANT+, WirelessHART, ...
- Enocean: energy harvesting
- WirelessHART: industrial automation
- ANT+: fitness equipment
- Smart hub required

Bluetooth

- Bluetooth Smart
- Bluetooth beacons, Apple iBeacon
- Low power consumption
  - ~50-100 mW
- Low cost
  - ~$2 USD


1753
fitbit
12680
fitbit

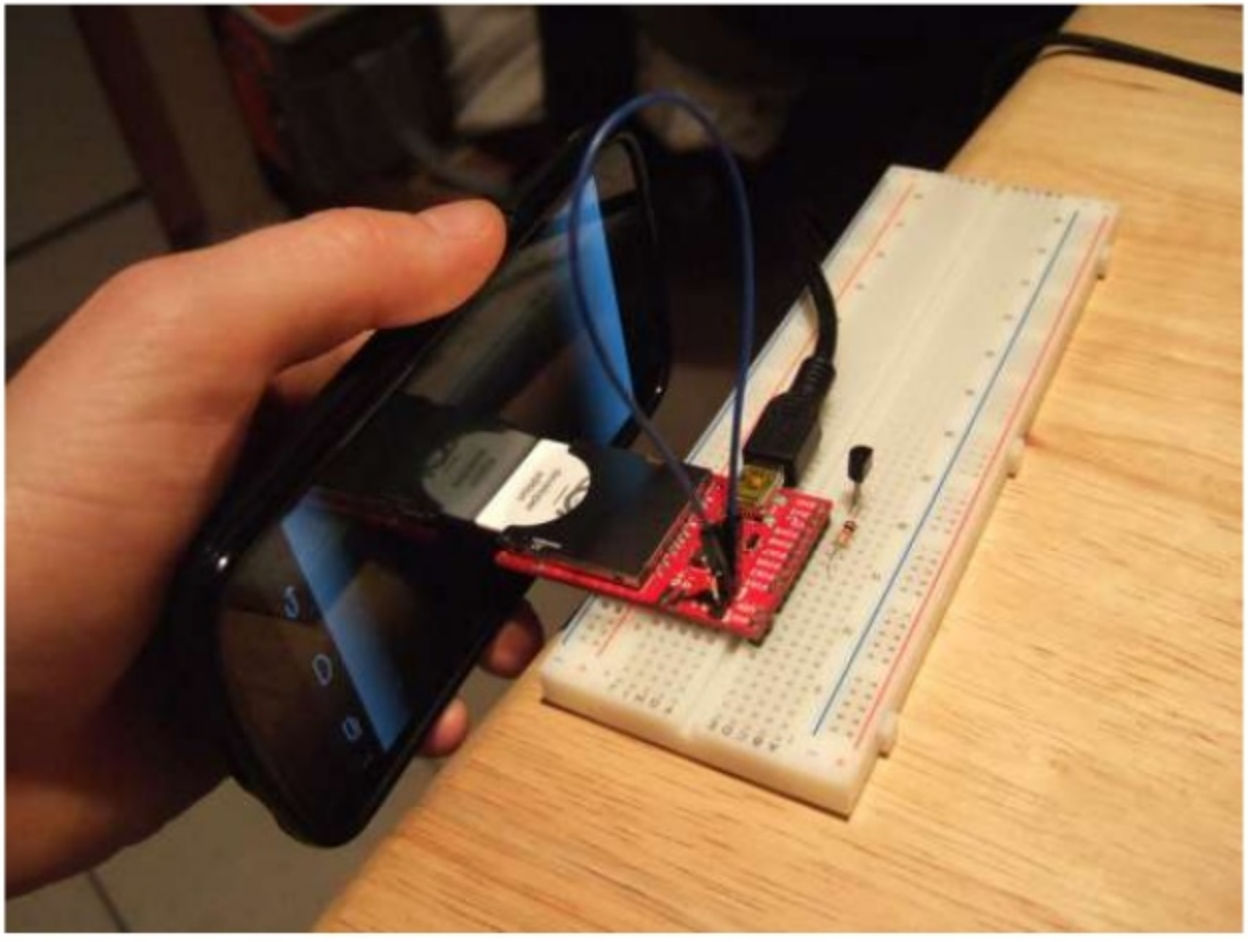

28:56
4.08mi
PACE
7:05
min/mi
twelve
thirty
five



WiFi

- Everyone has WiFi
  - Great for consumer products
- Fast: 11 Mbit/s
- Drawbacks
  - 2.4 GHz
  - Power consumption: ~500-1000 mW
  - Cost: $10 USD per chip
  - Range
  - Passwords

WiFi passwords: Electric Imp



https://github.com/lifegraph/graphbutton-imp

IPv6 / 6lowpan

- Runs on IEEE 802.15.4
- Lower power consumption than WiFi
  - ~30-60 mW
- Lower cost
  - $1-$4 USD
- Automatic meshing
- Very long range
  - Sub-GHz communication
- Drawbacks
  - Lack of infrastructure in homes

IPv6 / 6lowpan contd.

- IPv6 addresses are large
  - 6lowpan compresses headers
- Automatic meshing: RPL
  - Automatically form large (1000+) node networks
  - Self-suppression of control trafic

NFC, QR codes

- NFC: Near-Field Communication
  - A way to convey information in 4-5 cm
  - Useful for identification
  - Not for communication
- QR codes
  - A few to identify things using the smartphone camera

IoT killer applications

Beyond the app

System health

- Monitor vital stats, mitigate problems when they happen
- Or better, identifying trends and tendencies to stop problems before they happen
- Finding bugs is turned into great customer service!

A/B testing – for real

- How can I optimize metric X?
  - Click rate, spending, page views, ...
- Used extensively on the web

A/B testing

A

B

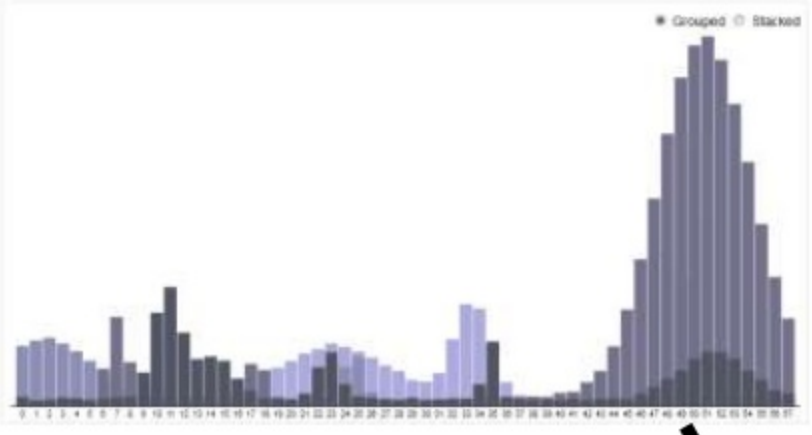
Analytics

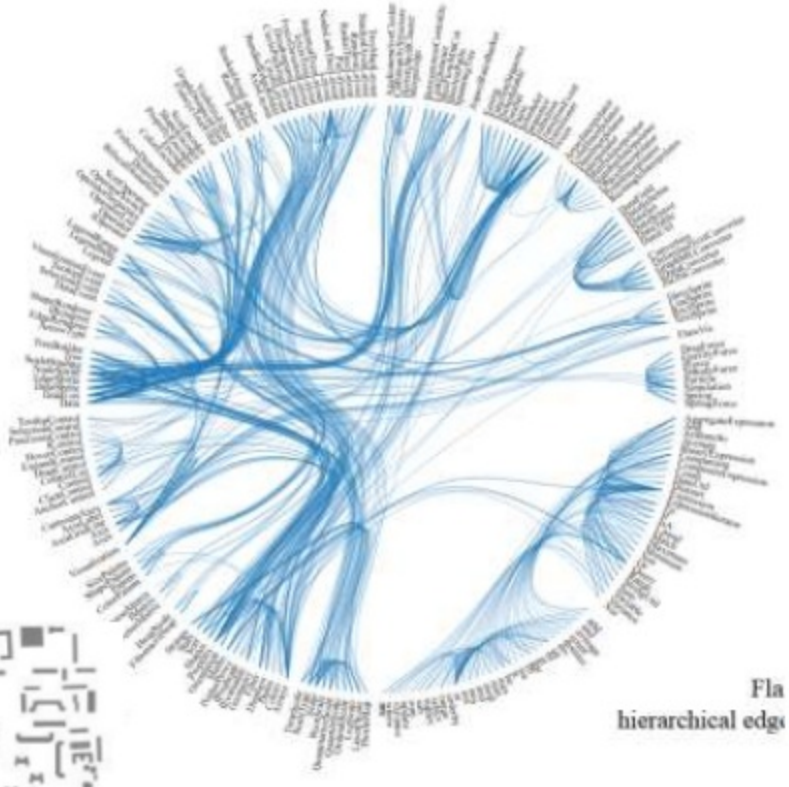
- On the web many metrics used for evaluating and optimizing
  - Click-rate, page-views, unique/returning, time on page, bounce rate, location, browser, etc
- On embedded products, typically hard
  - How do we get access?

Analytics

- When, and for how long, is the fridge open?
- What power level on the microwave oven is used and when?
- What are the ambient sound and light levels in the office?
- Etc, etc.

Analytics





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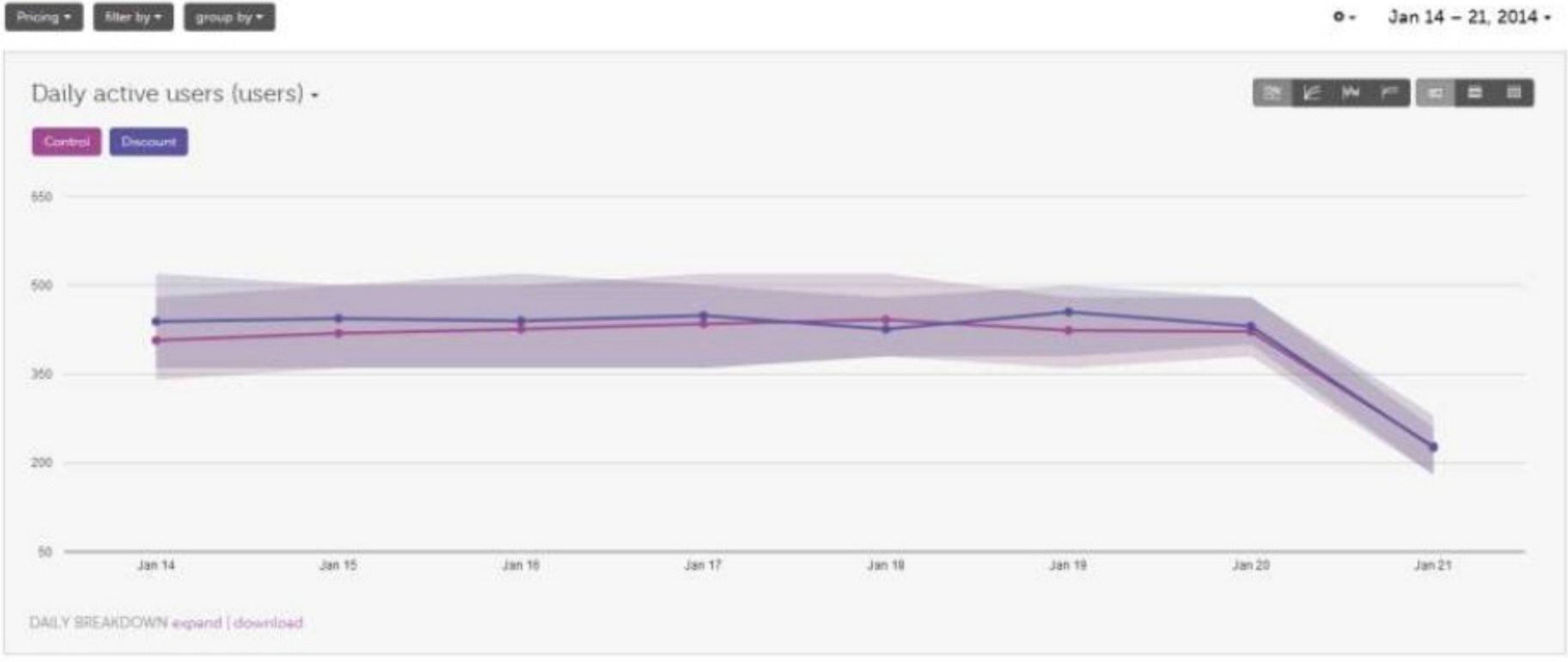
Analytics



https://www.leanplum.com/

IoT hardware

IoT hardware

- Sensors and actuators
  - Connects to the physical world
- Microprocessor
  - To be able to do something with the sensors/actuators
- Communication device
  - To communicate with the world
- Power source

Example: Arduino Yun

Example: STM32L+Spirit1

Example: CC2538

Cloud Technology

A cloud server

- Physical servers in a rack
- Virtual servers
  - Amazon AWS
  - Rackspace
- Dedicated service
  - Electric Imp
  - Ayla Networks
  - Thingsquare

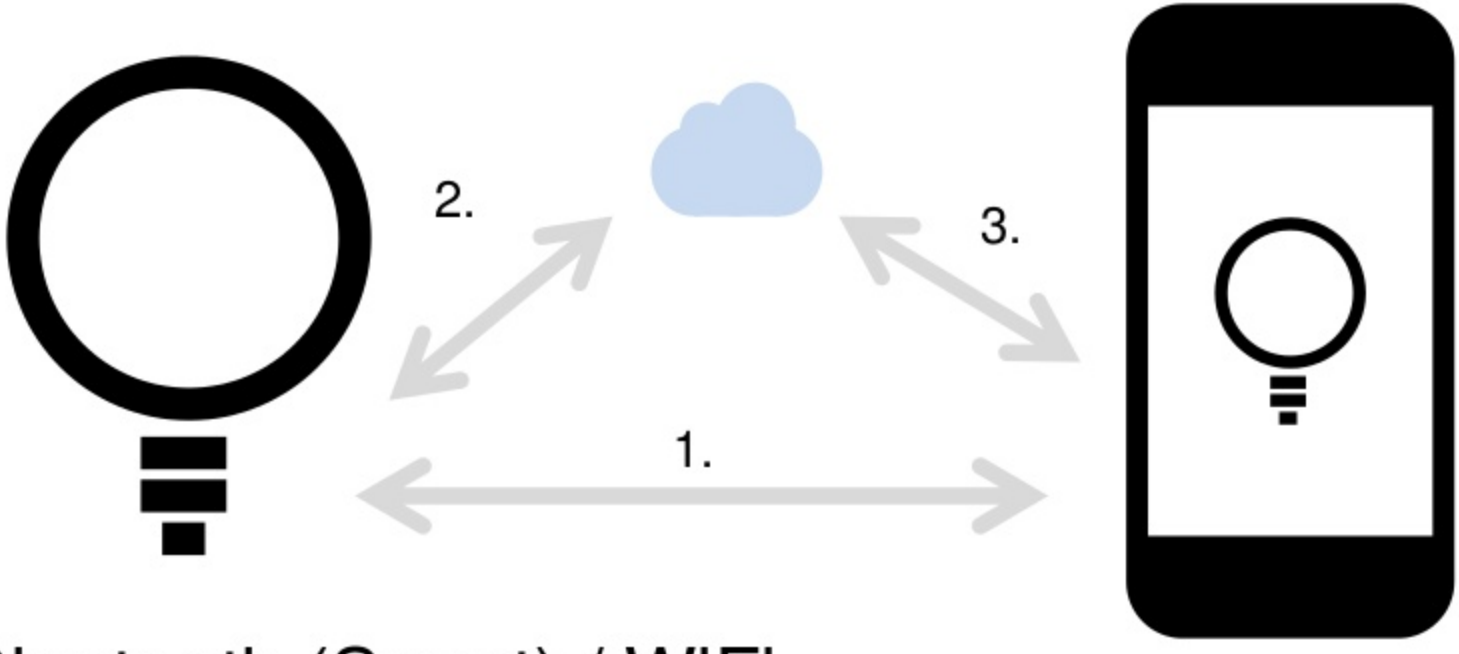
A cloud service

- Ruby on Rails
- Java
- Node.js
- MySQL, memcache, redis
- Protocols, user management, data base management

Cloud APIs

- RESTful APIs
  - Access over HTTP/HTTPS
  - GET data
  - POST data
- Websocket connections
- Less widely used: MQTT, CoAP, …
- Javascript & JSON

Putting it together



1. Bluetooth (Smart) / WiFi
2. WiFi / 6lowpan or through a smart hub
3. RESTful API

A History of the IoT

A brief history of the IoT

- 1985: unlicenced ISM bands
- 1988: ubiquitous computing
- 1991: Pre-IEEE 802.11 (Wi-Fi)
- 1999: wireless sensor networks
- 2003: IEEE 802.15.4 and ZigBee, Contiki
- 2005-2010: IETF 6lowpan, roll, core
- 2012: first WiFi light bulbs, Kickstarter projects

1980s: Ubiquitous Computing

- Mark Weiser (1952-1999)

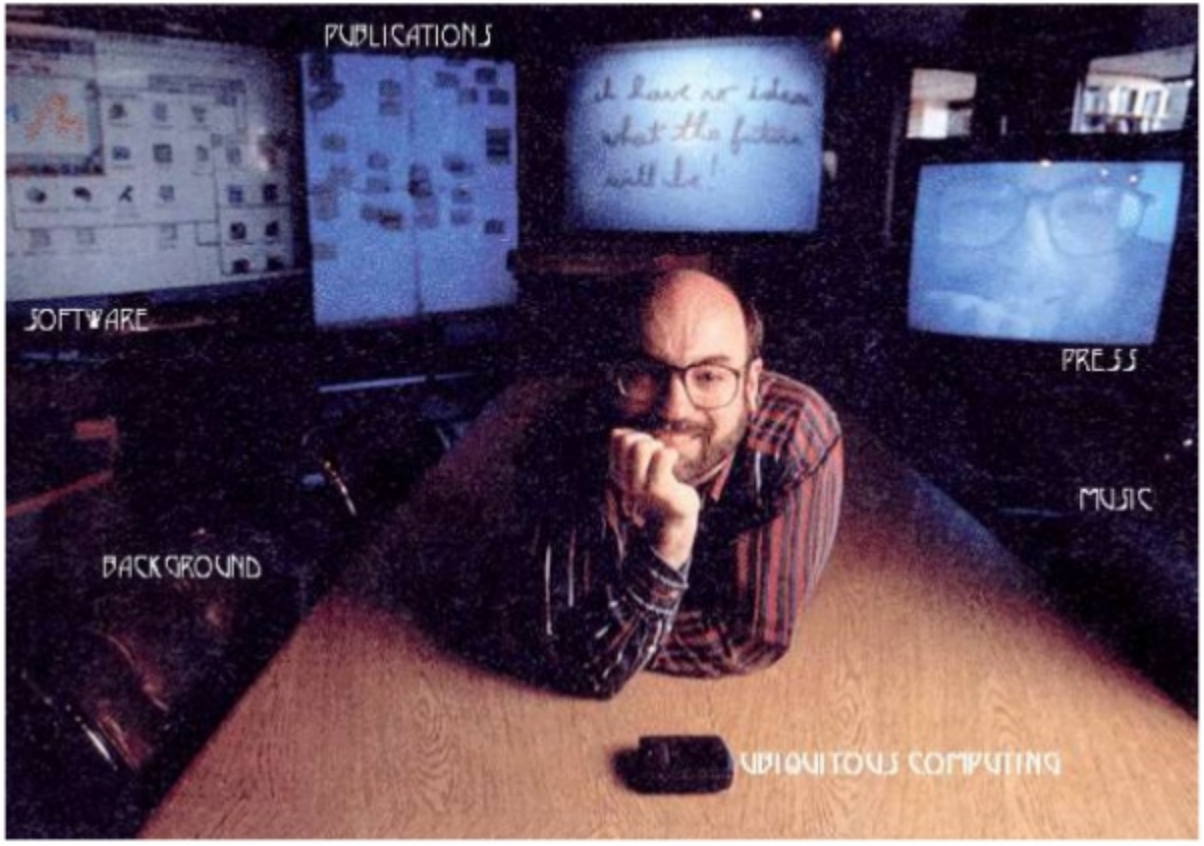


Photo: Mark's old web page

1990s: WaveLAN

- Before IEEE 802.11

Photo: wikipedia

2000s: Smart dust

- Kris Pister

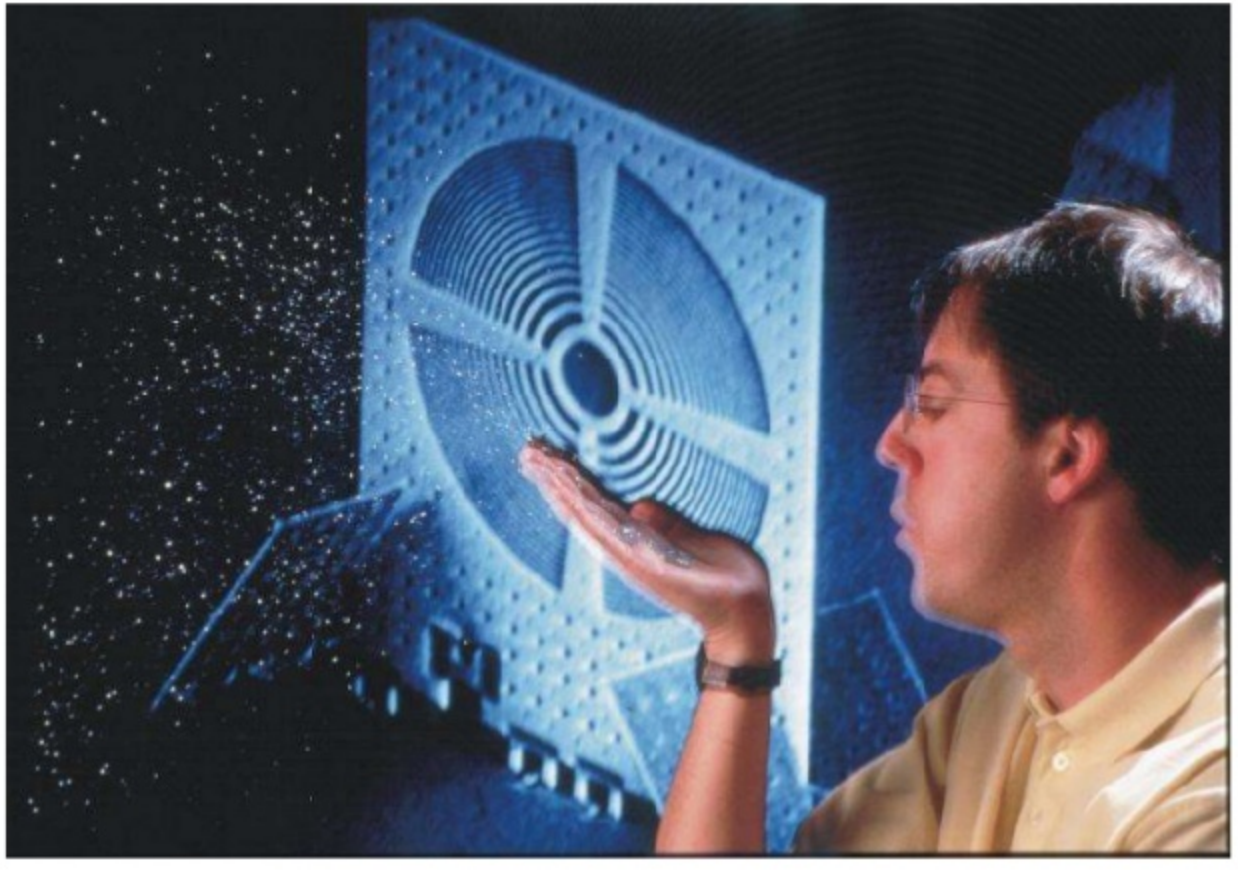
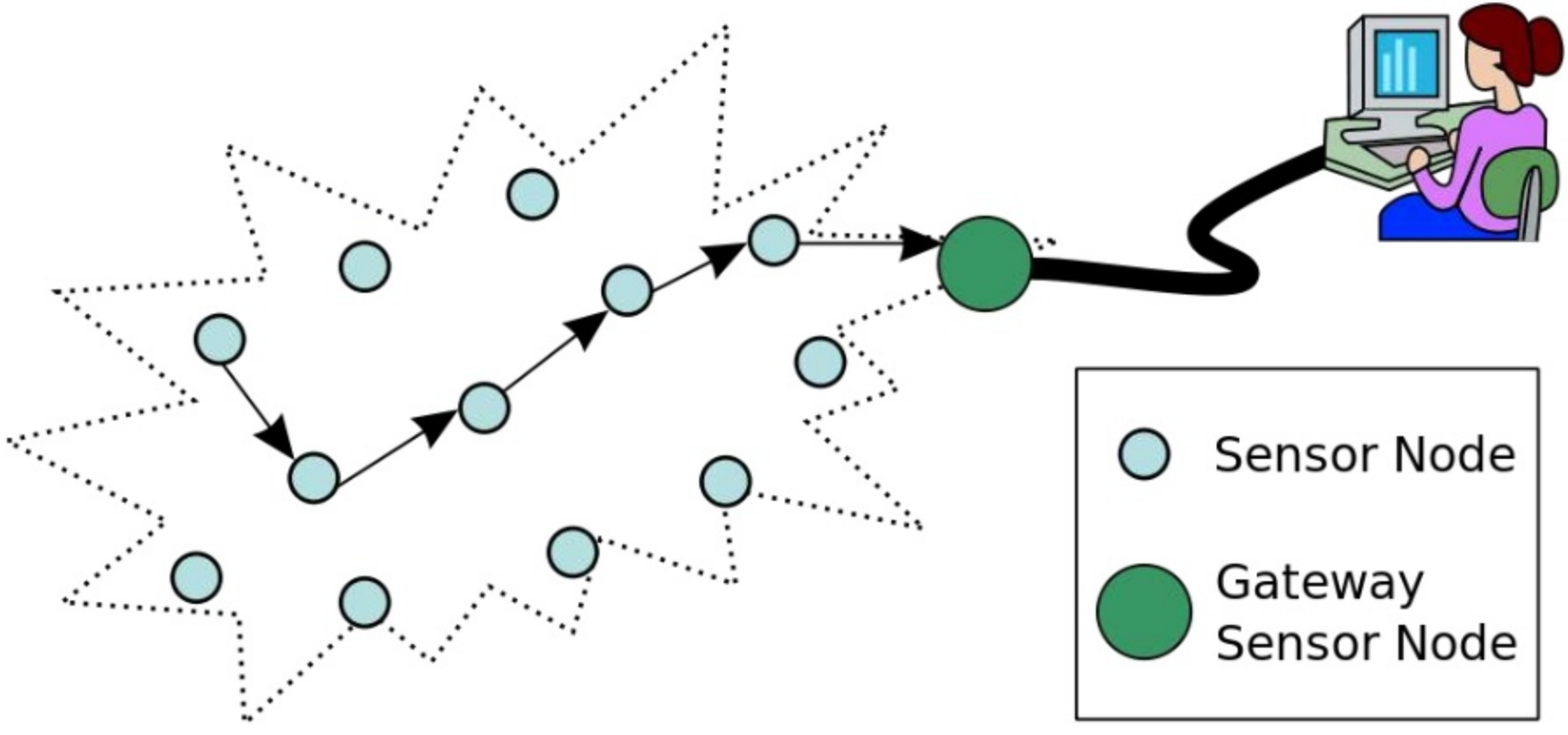
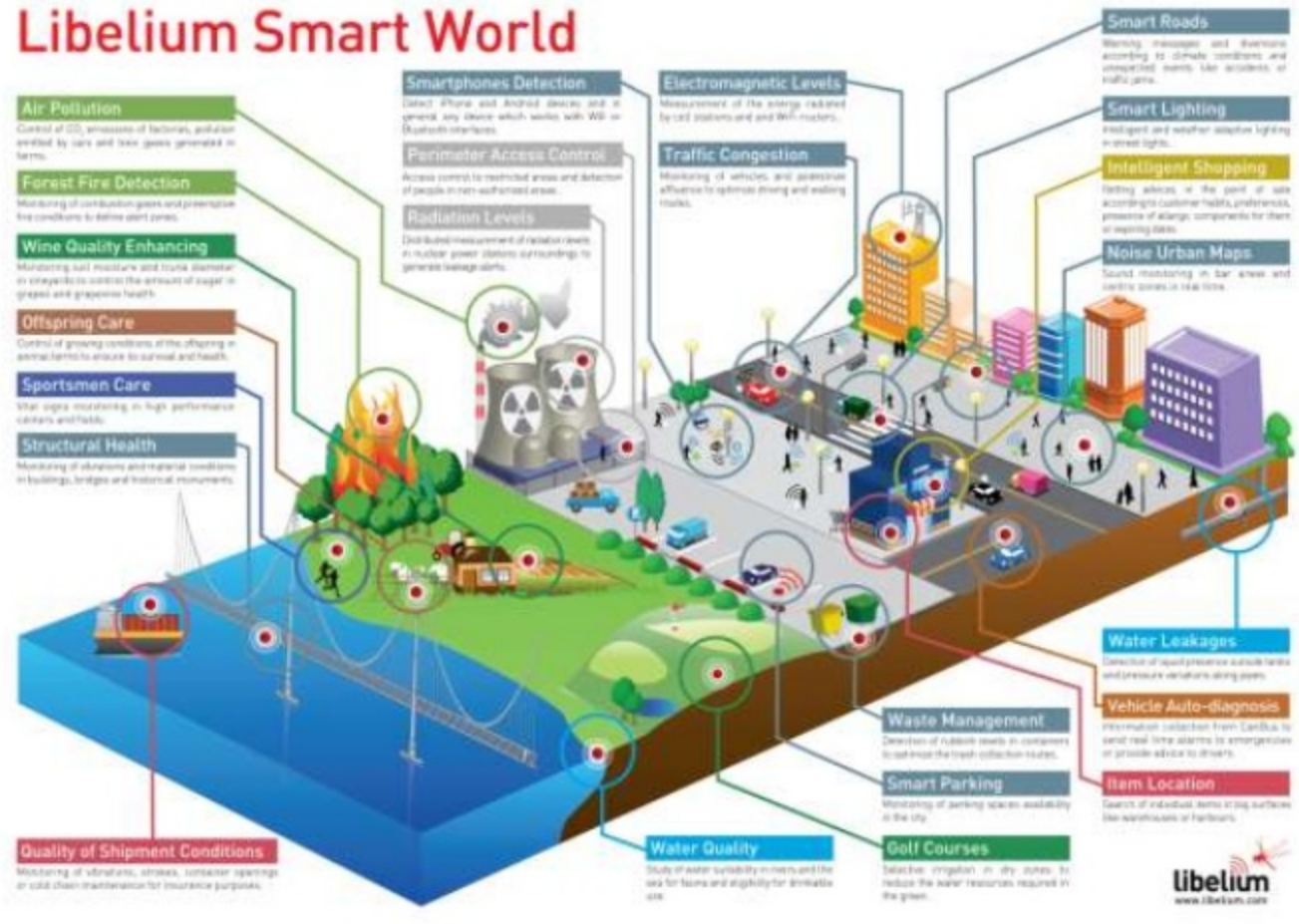


Photo: Peter Menzel

2000s: wireless sensor networks



2014: Internet of Things



2000s

2010s

Cloud services

- File storage
  - Dropbox
  - Box.net
- Text messages
  - Twillo
  - Nexmo
- Email
  - Mailgun
- … and almost anything we'd like

Combinational cloud services

- IFTTT

IFTTT

500px

App.net


bitly


blink(1)


Blogger

Box

Boxcar

Boxoh Package Tracking


Buffer

BuzzFeed


Campfire


Craigslist


Date & Time


Delicious

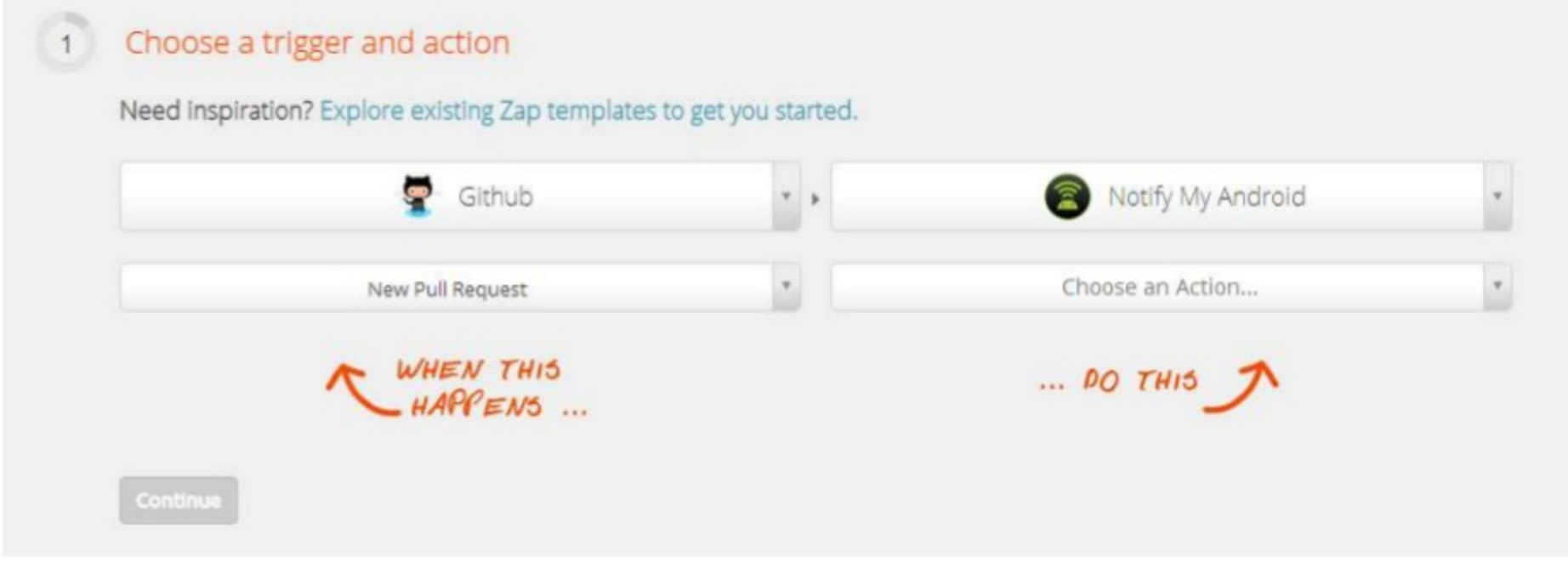

Diigo


Dropbox


Email

ESPN

Zapier


1
Choose a trigger and action
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Github
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Choose an Action...
WHEN THIS HAPPENS ...
... DO THIS
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