

*Internet of Things -
Towards New Frontiers of Knowledge Management*

IC3K 2012

Barcelona, October 4, 2012

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The Computer for the 21st Century

by Mark Weiser *September 1991*

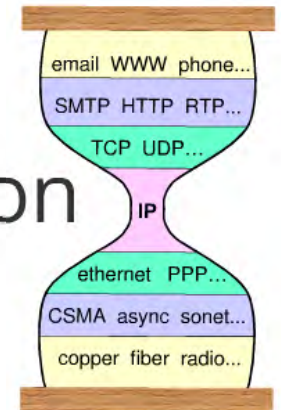


Internet of Things



Internet-oriented

established sphere of networked information

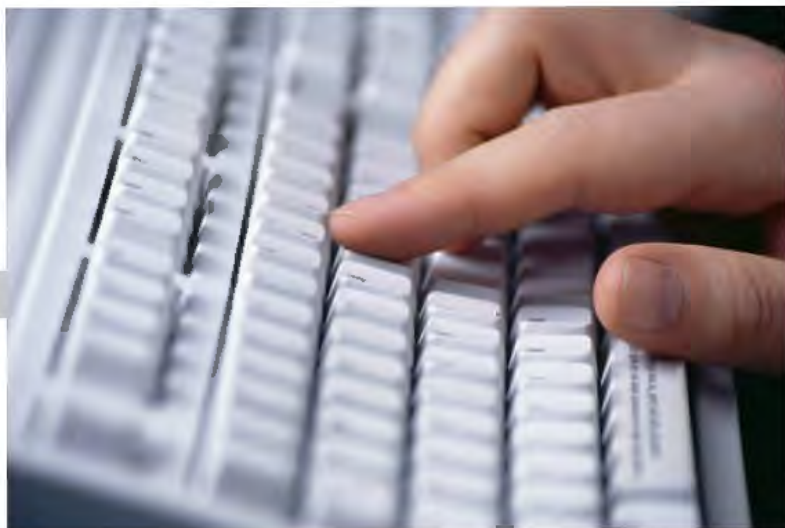


The logo for ipso Alliance, featuring a stylized network diagram with nodes and lines. Below the logo is the text 'ipso Alliance' and the website address 'www.ipso-alliance.org'.

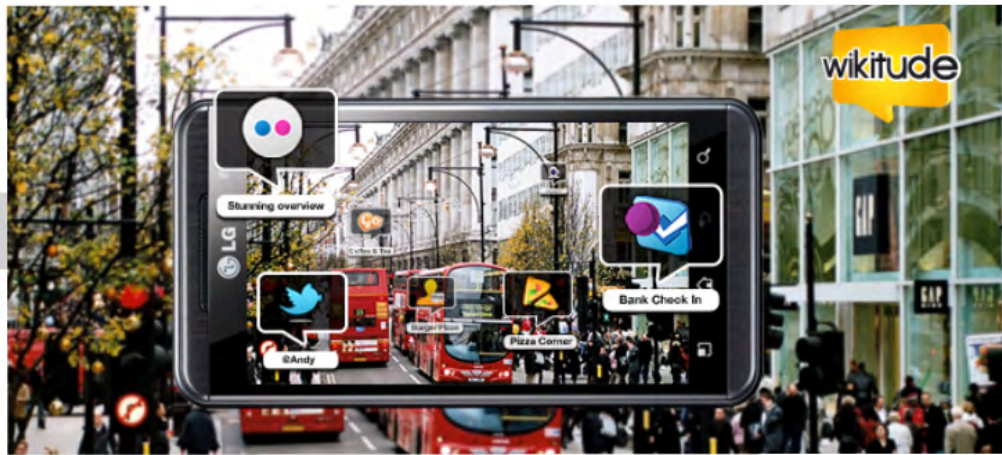
A diagram titled 'WEB of THINGS' in pink, slanted text. It shows a 'Web Cloud' containing a 'RESTful API', 'Web Server', and 'Smart Gateway'. The 'Smart Gateway' is connected to 'API1', 'API2', 'BT', and 'Zigbee'. Below these are icons for a computer, a PDA, and a mobile phone. The website address 'www.webofthings.com' is at the bottom.

thing-oriented

10

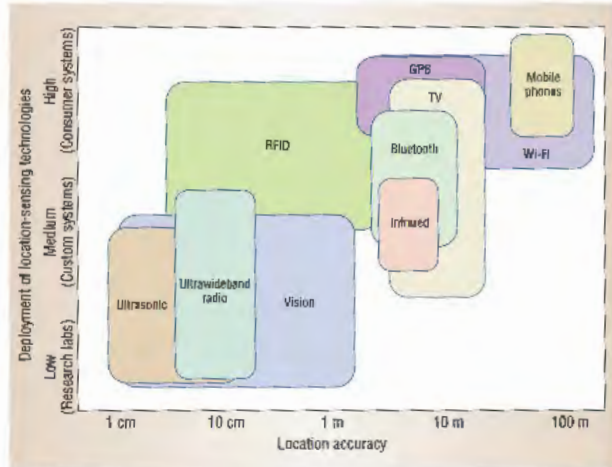


signa7



- antenna

Localization

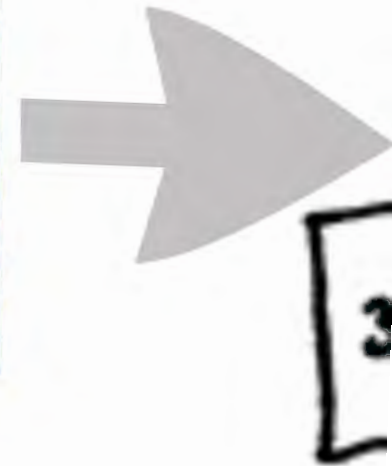


Quelle: Hezas et al. (2004)

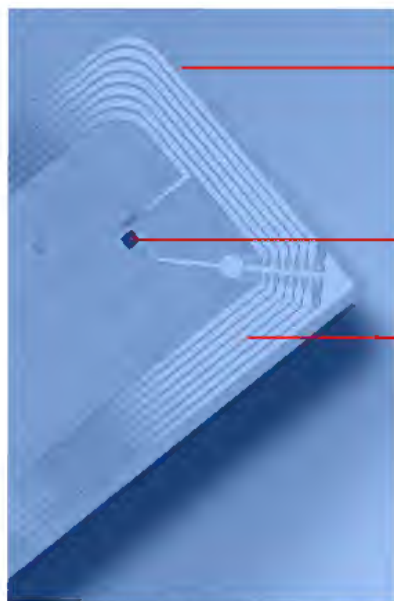
Sensors

Physical property	Sensor	Output
Temperature	Thermocouple	Voltage
	Silicon	Voltage/Current
	Resistance temperature detector (RTD)	Resistance
Force/Pressure	Thermistor	Resistance
	Strain Gauge	Resistance
Acceleration	Piezoelectric	Voltage
	Accelerometer	Capacitance
Flow	Transducer	Voltage
	Transmitter	Voltage/Current
Position	Linear Variable Differential Transformers (LVDT)	AC Voltage
Light Intensity	Photodiode	Current

Source: OECD based on Wilson, 2008.



Near Field versus Far Field

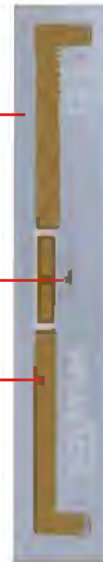


Near-field HF tag with loop antenna

Substrate

Tag IC

Antenna



Far-field UHF tag with dipole antenna





atomic components
to link the world

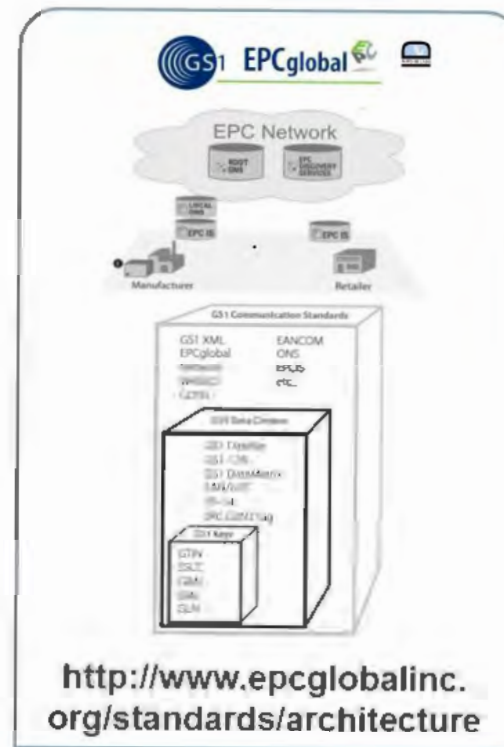


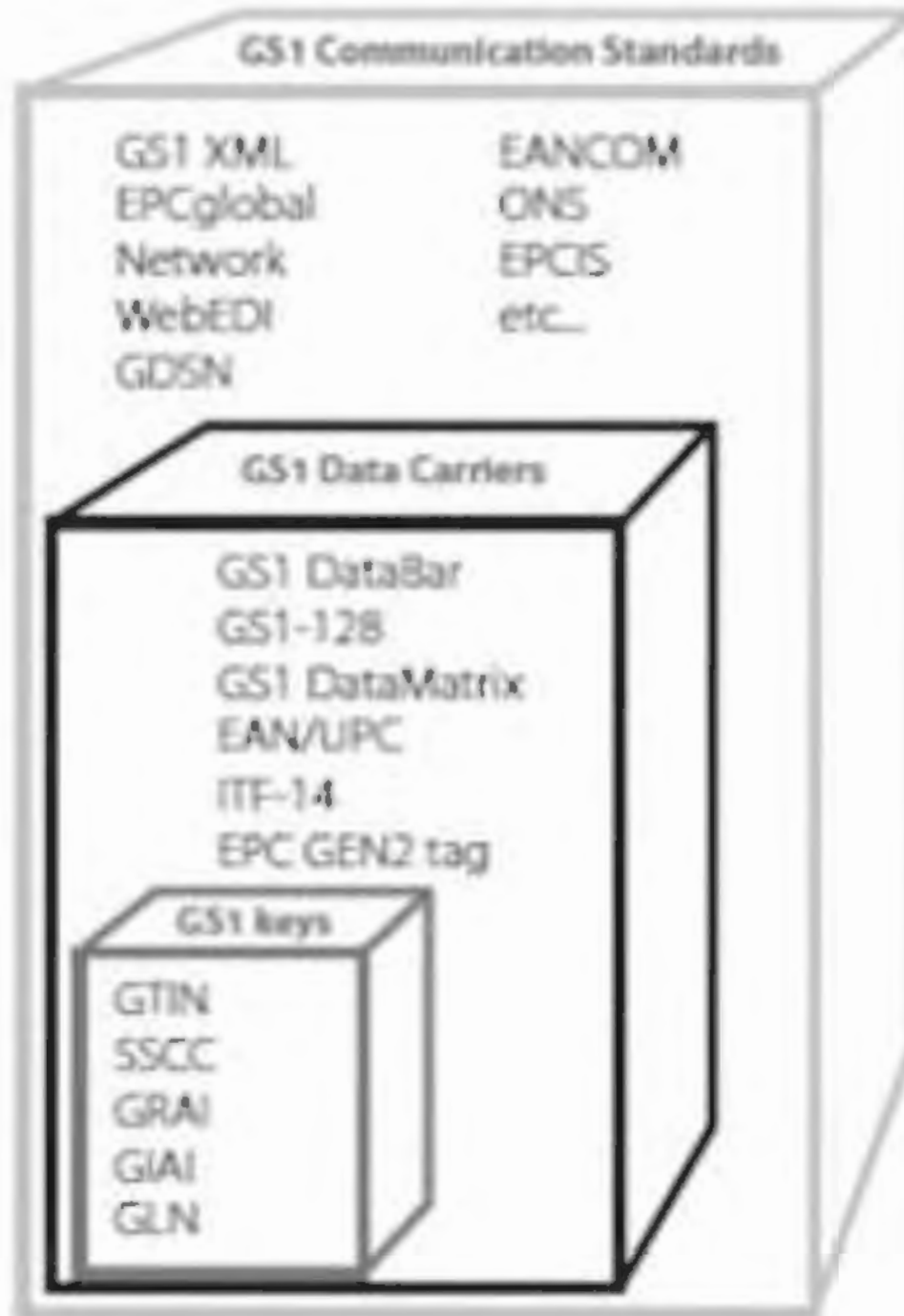
RFID

UID

NFC

WSN





Standard	Objective	Status	Comm. range (m)	Data rate (kbps)	Unitary cost (\$)
<i>Standardization activities discussed in this section</i>					
EPCglobal	Integration of RFID technology into the electronic product code (EPC) framework, which allows for sharing of information related to products	Advanced	~1	~10 ²	~0.01
GRIFS	European Coordinated Action aimed at defining RFID standards supporting the transition from localized RFID applications to the <i>Internet of Things</i>	Ongoing	~1	~10 ²	~0.01
M2M	Definition of cost-effective solutions for machine-to-machine (M2M) communications, which should allow the related market to take off	Ongoing	N.S.	N.S.	N.S.
6LoWPAN	Integration of low-power IEEE 802.15.4 devices into IPv6 networks	Ongoing	10–100	~10 ²	~1
ROLL	Definition of routing protocols for heterogeneous low-power and lossy networks	Ongoing	N.S.	N.S.	N.S.
<i>Other relevant standardization activities</i>					
NFC	Definition of a set of protocols for low range and bidirectional communications	Advanced	~10 ⁻²	Up to 424	~0.1
Wireless Hart	Definition of protocols for self-organizing, self-healing and mesh architectures over IEEE 802.15.4 devices	Advanced	10–100	~10 ²	~1
ZigBee	Enabling reliable, cost-effective, low-power, wirelessly networked, monitoring and control products	Advanced	10–100	~10 ²	~1

Luigi Atzori, Antonio Iera, Giacomo Morabito. The Internet of Things: A survey, Computer Networks 54 (2010) 2787,805.



McKinsey Quarterly 2010 Number 2

Tracking behavior

Monitoring the behavior of persons, things, or data through space and time.

1

Example: Customer-based advertising and payments based on location of consumers

Industry and supply chain tracking with handheld

Enhanced situational awareness

Achieving real-time awareness of physical environment.

2

Example: Sniper detection using direction of sound to locate shooters

Sensor-driven decision analytics

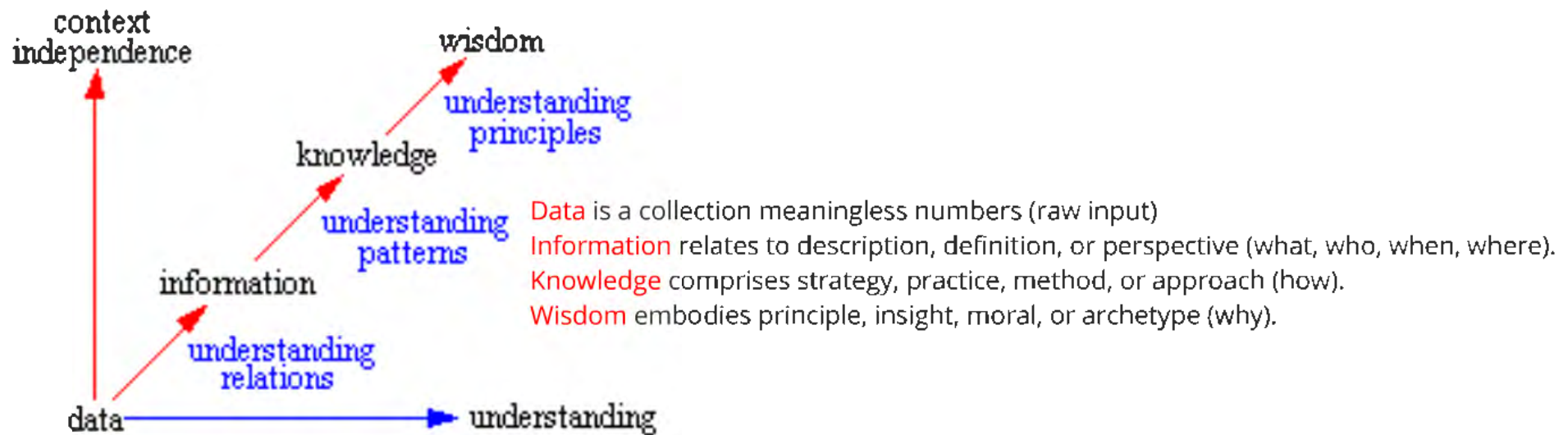
Assisting human decision making through deep analysis and data visualization

3

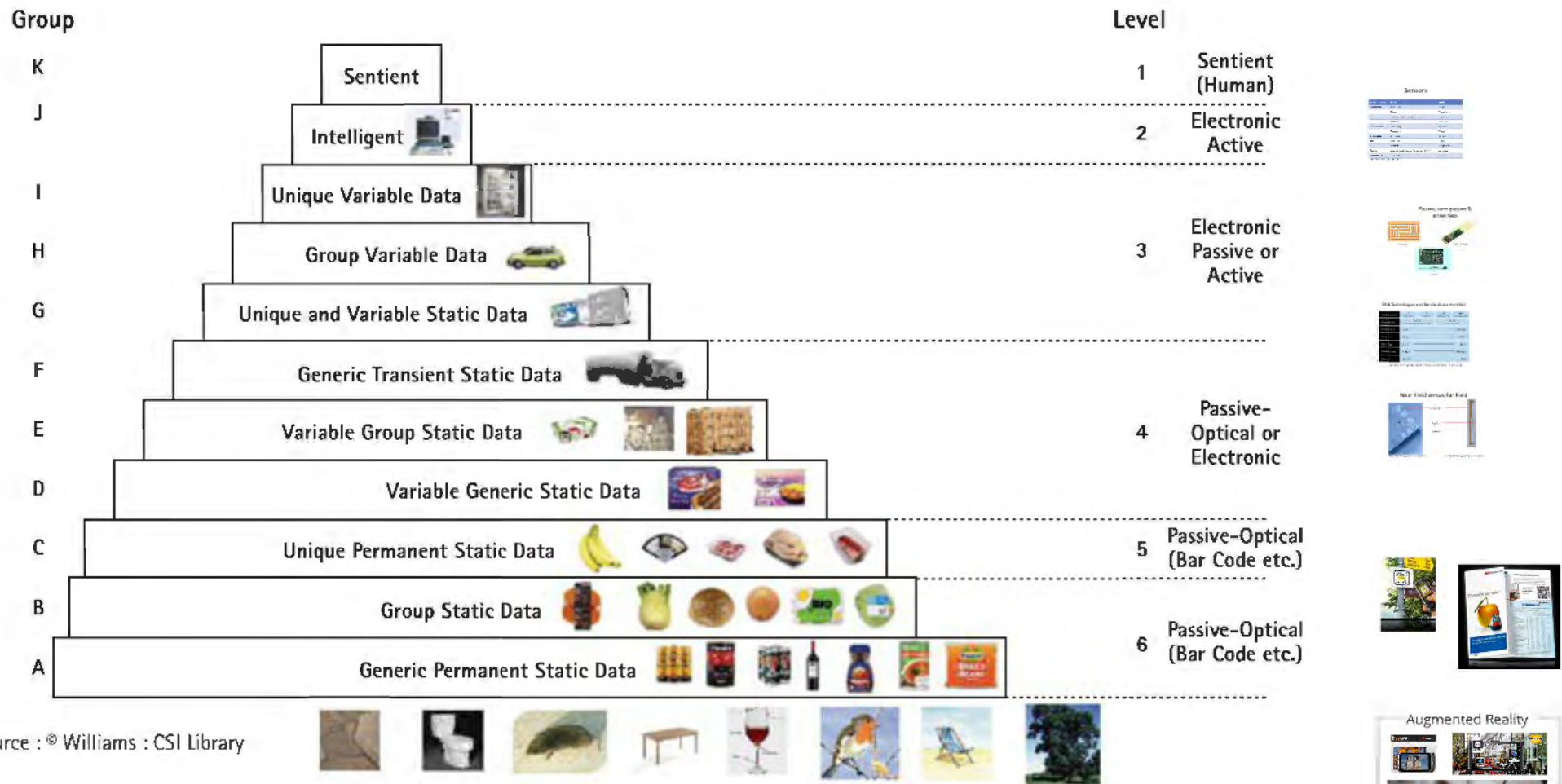
Example: Oil field rate planning with 3D visualization and simulation

Continuous monitoring of chronic diseases to help doctors determine best treatments

Knowledge Mgmt: wisdom from **people-data**
Internet of Things: wisdom from **thing-data**



[<http://www.systems-thinking.org/kmgmt/kmgmt.htm>]



Source : © Williams : CSI Library

Items without connectivity to the 'Internet of Things'

[source: Bob Williams, What is the Real Business Case for the Internet of Things?, Synthesis Journal, ITSC, 2008]



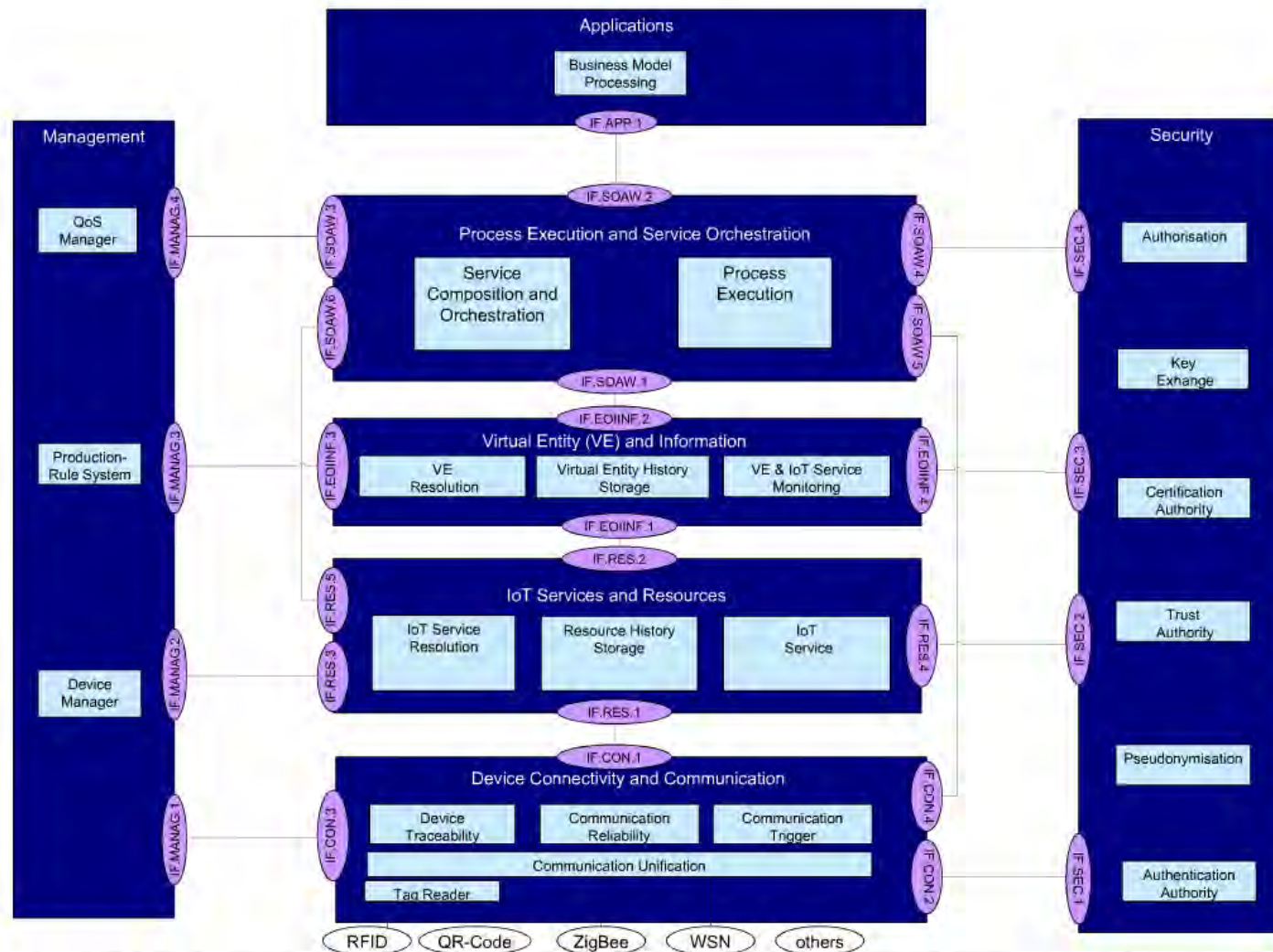


Figure 19: Diagram depicting the functional view of the IoT reference architecture. Each major box represents a functionality group, while the smaller boxes represent functional components. The lines between functionality groups –terminating in ellipses- represent interfaces.

Embedded Innovators

- product-centric service offerings
- preemptive predictions
- investigate lifecycle (e.g. maintenance, replenishment)



Solutionist

were :

- focus on associated activities
- model new processes
- high-value activities

multiple-vendor integration

multiple-vendor integration

Source:
 Four Strategies for the Age of Smart Services

Aggregator

- focus on multi-vendor data integration
- vertical integration instead of product lifecycle
- managing relationships
- data processing, analytics, warehousing
- revenue, selling information services

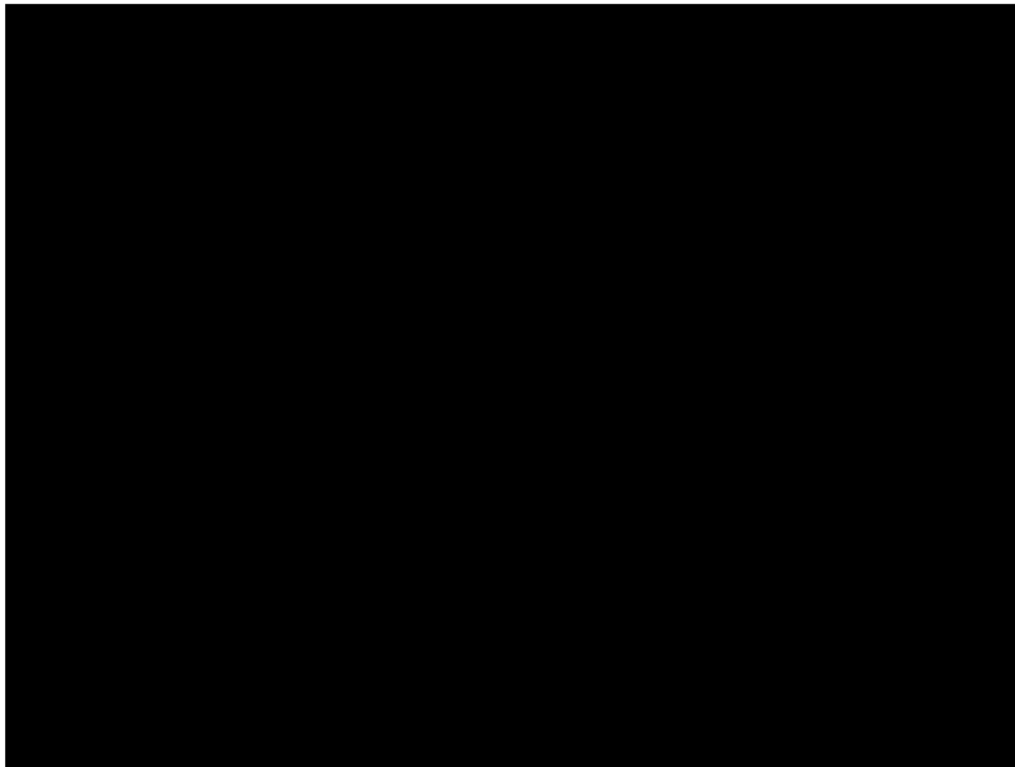


Synergist

- provision of data-palms
- products providing data
- focus on community building

Embedded Innovators

- product-centric service offerings
- preemptive predictions
- investigate lifecycle (e.g. maintenance, replenishment)



service integration



Solutionist

feedback on transportation behavior

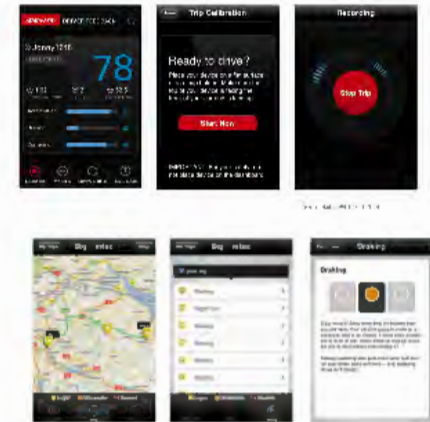


[source: Consolvo, McDonald, Landay: Theory Driven Design Strategies for Technologies that Support Behavior Change in Everyday Life. CHI 2009.]

- tracking of behavior
- garden metaphor for visualization



[Source: Consolvo, McDonald, Landay: Theory Driven Design Strategies for Technologies that Support Behavior Change in Everyday Life. CHI 2009.]



- focus on associated activities
- model new processes
- high-value activities



requirements, financing, installing, testing, maintaining, replenishing, training, scanning, interpreting, updating...



Source: GE

multiple-vendor integration



Aggregator

- focus on multi-vendor data integration
- vertical integration instead of product lifecycle
- managing relationships
- data processing, analytics, warehousing
- revenue: selling information services

Ford + Bug Labs Press Release

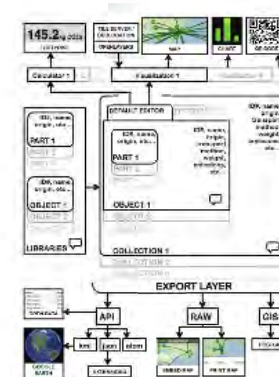
Ford and Bug Labs explore open innovation and crowd sourced, community-driven development

Ford and Bug Labs Develop Open-Source R&D Platform for Socially-Networked In-Car Connectivity Innovation

- Ford and Bug Labs, an open-source hardware and software provider, announce a joint development project to research, develop and distribute open-source developer tools to advance in-car connectivity innovation.
- Known as OpenXC, the research platform is based on Bug Labs' open-source Bug System and will enable the developer community to quickly prototype ideas and test out affordable new connectivity concepts that could enhance Ford's future products.
- At the TechCrunch Design Summit conference, the two companies will demonstrate an in-car solution based on OpenXC, including a socially-networked in-car fuel economy monitor connected to the Internet, via Bug Labs' cloud-based service, [BUGswarm](#).

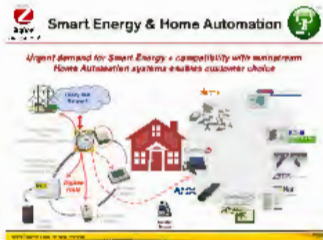


as in: [source: Forrest Matthews, Heidebrecht David, Wang, Chen, Chakraborty, and Hershkoltz, 2010. Small business application of sourcemap: a web tool for sustainable design and supply chain transparency. In Proceedings of the 28th international conference on Human factors in computing systems \(CHI'10\). ACM, New York, NY, USA, 947-948.](#)



source: www.arduino.cc

Synergist



- provision of data-points
- products providing data
- focus on community building



Drivers

Hybrid Shopping



Future Kiosk



Product Twitter



Crowdsourcing

A playful approach of crowdsourcing barcode master-data

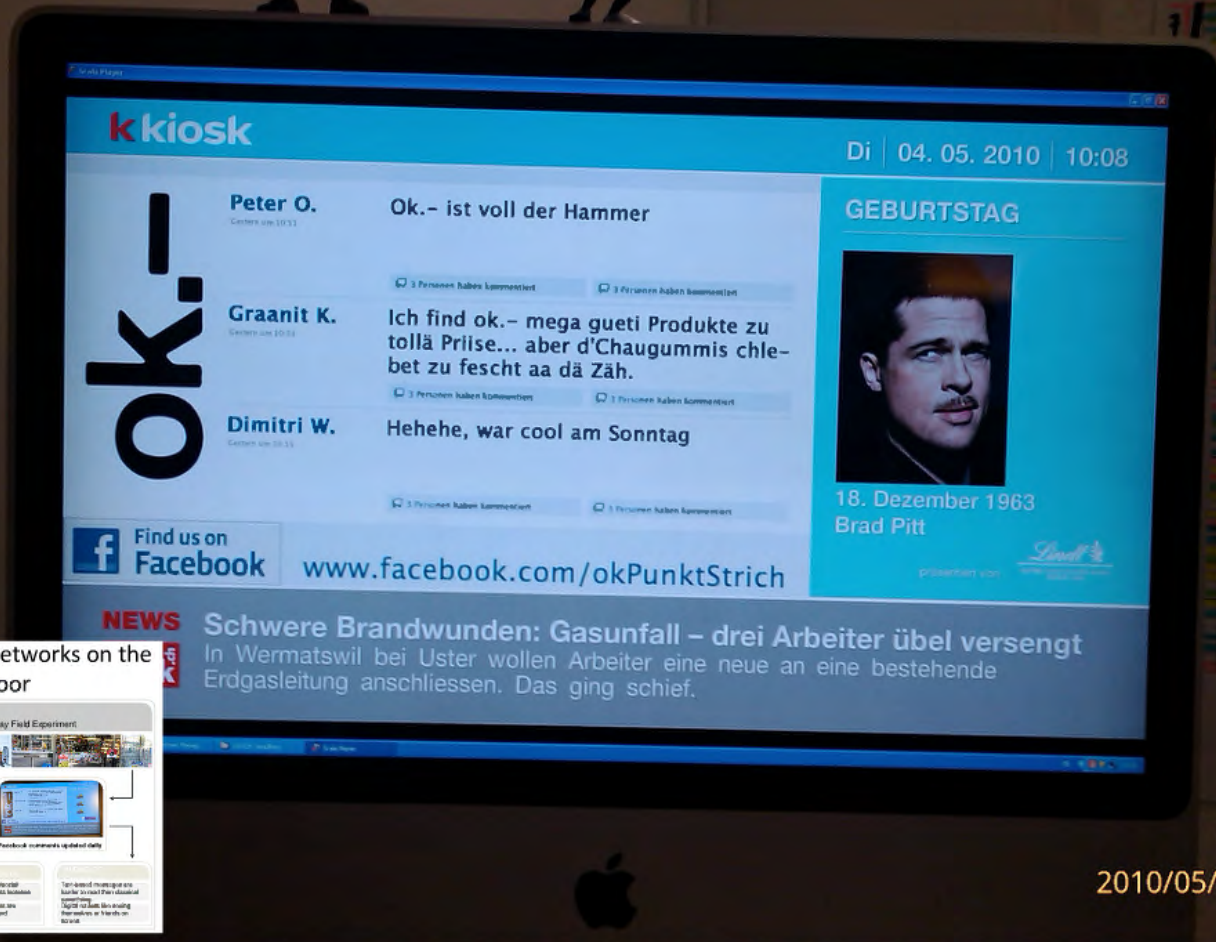


Evaluation
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Wolfgang W. Maier, Produkt-Fabrik, "Product-Fabrik: Smarte Produkte mit Smarten Kunden", 1. Aufl., 2010, 160 Seiten, ISBN 978-3-7089-1721-9, 2010

Future Kiosk





Embedding Social Networks on the Sales Floor

Social Media
Facebook Product Fan Page

Line graph showing fan growth from 10/04/2009 to 01/04/2010. The y-axis ranges from 0 to 5000.

Public Display Field Experiment

Facebook comments updated daily

Quick response to real customer comments increases sales. Product companies are stronger than brand companies.

Top-level managers are better suited than frontline staff to be using their networks in hands-on work.

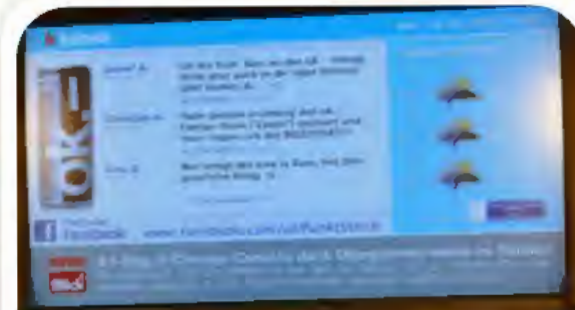
2010/05/04 10:05

Embedding Social Networks on the Sales Floor

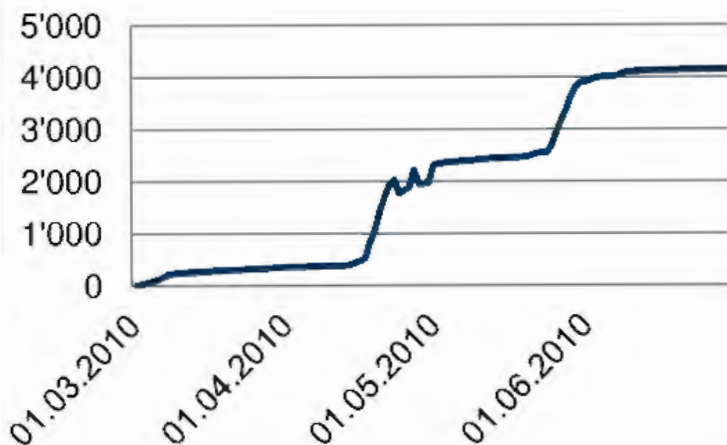
Social Media: Facebook Product Fan Page



Public Display Field Experiment



Facebook comments updated daily



Impact on Sales

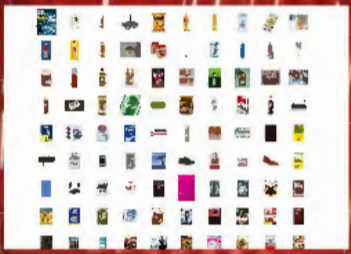
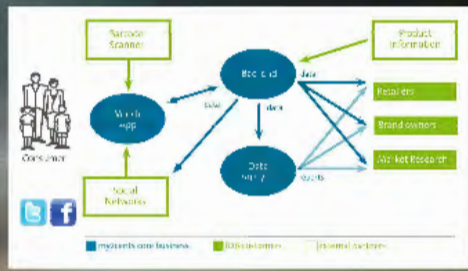
Digital signage w/social network comments increase sales.
Product comments are stronger than brand comments.

Impact on

Text-based messages are harder to read than classical advertising.
Digital natives like seeing themselves or friends on screen.

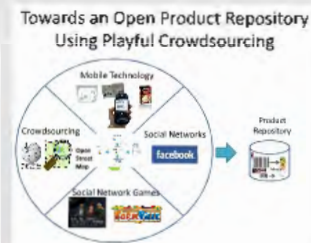
Product Twitter





Crowdsourcing

A playful approach of crowdsourcing barcode master-data



Budde, A., Michahelles, F.: Product Empire - Serious playing with barcodes : Internet of Things 2010 Conference (IoT2010), Tokyo, 2010

Insurance as a feature

Shoppingversicherung



Weltweit einkaufen, Shopping unbeschwert geniessen!

→ Mehr

Skiwetter Versicherung



Entspannt in die Skiferien. Jetzt gegen schlechtes Wetter absichern!

→ Mehr

MOBI24 BIKE ASSISTANCE

Zusammen mit der Mobiliar Versicherungsgesellschaft bieten wir diese interessante Velo Assistance an. Nachfolgend sind die wichtigsten Leistungen aufgeführt. Für Detailangaben vergleiche die Allgemeinen Bedingungen im Ausweis, die allein massgebend sind.

GELTUNGSBEREICH
Europa

DAUER
2 Jahre

LEISTUNGEN FÜR DAS FAHRRAD INKL. STROMER
Ausfall des Fahrrades infolge einer Panne, eines Unfalls, eines Diebstahls* oder einer Beschädigung.

HILFELEISTUNG
Call Service Center «Mobi24» in Bern

WIEDERHERSTELLUNG DER FAHRBE-REITSCHAFT AM SCHADENORT BEI KLEINEN PANNEN
unbegrenzt

REPARATURKOSTEN ALS FOLGE EINES UNFALLS OD. STURZES
Neuwert bis max. Fr. 8'000.- im 1. Jahr. (Selbstbehalt 10% mind. 100.-)

MEHRKOSTEN FÜR DIREKTE HEIMREISE SOWIE HEIMSCHAFFUNG DES FAHRRADES
max. Fr. 1'000.- je Schadenfall für öffentliche Verkehrsmittel

MIETKOSTEN FÜR ERSATZRAD
max. Fr. 500.-

FAHRZEUGREPARATUREN IM AUSLAND
Kostenvorschuss bis max. 500.-

LEISTUNGEN FÜR DEN LENKER IM AUSLAND
Personenverletzungen als Folge eines Unfalles mit dem versicherten Fahrrad

ÄRZTLICHE BEHANDLUNG IM AUSLAND
Kostenvorschuss bis max. Fr. 5'000.-

TRANSPORTKOSTEN INS SPITAL
bis Fr. 20'000.- je Schadenfall

RECHTSSCHUTZVERSICHERUNG IM AUSLAND
Leistungen bei einem Unfall mit dem versicherten Fahrrad

KOSTENÜBERNAHME FÜR ANWALT & GERICHT ZUR WAHRUNG IHRER RECHTE
bis Fr. 50'000.- je Schadenfall

2-JAHRESPRÄMIE
Fr. 180.-

* Bei Diebstahl sind nur Assistance-Leistungen versichert.


24h-NOTFALLNUMMER
0844 84 84 84

Mobi 24 Die Mobiliar
Versicherungen & Vorsorge



Zurich → to go! @kkiosk


Hochzeitsversicherung



Bester Schutz für den schönsten Tag. Jetzt entspannt heiraten!

→ Mehr


Umzugsversicherung



Zeit für Tapetenwechsel. Jetzt sorglos umziehen!

→ Mehr

Partyschutz



Ein Grund zum Feiern. Entspannt bis zum Morgengrauen tanzen!

→ Mehr

Bike Versicherung




Rundumschutz für ein entspanntes Bike-Vergnügen für nur CHF 65.- pro Jahr!

→ Mehr



Zurich → to go!

Skiwetter Versicherung



Überblick

Damit schief geht.

Ob Regen oder werden Ihre Desaster.

Die Zurich - finanziellen A Wetter.

Haben Sie Sk vielleicht auc

Dann kaufen unkompliziert

Preis: CHF 49.- inkl. 5% Stempelsteuer

Zurich → to go!

Mobility/Free

Partyschutz

Überblick Details Kaufen

So können Sie entspannt bis zum 1 Das Catering ist bestellt - der DJ geb schnell eine kostspielige Angelegenheit Tag vor der Party krank werden: kein Der Zurich - to go! Partyschutz über bis zu CHF 10'000.-.

Einfach online kaufen, bereits ab mor sein. Für eine entspannte Partyvorbe

Preis: CHF 49.- inkl. 5% Stempelsteuer



Virtual value chain

- accurate,
- complete,
- detailed,
- and rapid.



manage real time demand



Here we see the world's largest and most powerful jet engine, the GE90-115B, which is used on the Airbus A380-800. The engine is designed to meet the demand for increased passenger capacity while using less fuel and producing less noise. It is a true engineering marvel, and it's only one of the many innovations that GE Aviation has to offer.

Collaborative Business Model



- openly sharing: -> open source
- tap into specialist knowledge from contributors and participants
- creating communities of collaborating devices
 - allows problems to be solved quickly and accurately.
 - diagnostic approaches are captured and readily available for reuse

<p>Open System</p>	<p>Qualified Group of Innovators</p> <p>A community where a focused player proposes a solution system and invites participants to add value (e.g. The Apple iPhone App Store)</p>	<p>“Come One - Come All” Group of Innovators</p> <p>A community where any and all participants can propose and design solution systems (e.g. open source software projects)</p>
<p>Closed System</p>	<p>Select Group of Focused Innovators</p> <p>A community where a focused player designs a solution system and chooses a group of select players with distinct skills to participate (e.g. select automotive systems design partnerships)</p>	<p>Select Group of Focused Innovators</p> <p>A closed or private community of developer/designers of system solutions (e.g. focused partnerships utilized to design large scale products such as the Joint Strike Fighter Jet)</p>
<p>Command & Control</p>		<p>Federated Participation</p>

blur between producers and consumers



- allow clients to play a more active role as agents of production
- enable businesses to develop by sharing existing resources.
- efficient distribution thanks to permanent and ubiquitous connectivity
- enabling collaboration and interaction between the different agents across the network

Drivers

Hybrid Shopping



Future Kiosk



Product Twitter



Crowdsourcing



Insurance as a feature



Virtual value chain

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Challenges

Open issue	Brief description of the cause
Standards	There are several standardization efforts but they are not integrated in a comprehensive framework
Mobility support	There are several proposals for object addressing but none for mobility support in the IoT scenario, where scalability and adaptability to heterogeneous technologies represent crucial problems
Naming	Object Name Servers (ONS) are needed to map a reference to a description of a specific object and the related identifier, and vice versa
Transport protocol	Existing transport protocols fail in the IoT scenarios since their connection setup and congestion control mechanisms may be useless; furthermore, they require excessive buffering to be implemented in objects
Traffic characterization and QoS support	The IoT will generate data traffic with patterns that are expected to be significantly different from those observed in the current Internet. Accordingly, it will also be necessary to define new QoS requirements and support schemes
Authentication	Authentication is difficult in the IoT as it requires appropriate authentication infrastructures that will not be available in IoT scenarios. Furthermore, things have scarce resources when compared to current communication and computing devices. Also man-in-the-middle attack is a serious problem
Data integrity	This is usually ensured by protecting data with passwords. However, the password lengths supported by IoT technologies are in most cases too short to provide strong levels of protection
Privacy	A lot of private information about a person can be collected without the person being aware. Control on the diffusion of all such information is impossible with current techniques
Digital forgetting	All the information collected about a person by the IoT may be retained indefinitely as the cost of storage decreases. Also data mining techniques can be used to easily retrieve any information even after several years

Luigi Atzori, Antonio Iera, Giacomo Morabito. The Internet of Things: A survey, Computer Networks 54 (2010) 2787,805.

- identification
- communication
- sensing/localization
- processing
- user - interface



Research Questions

- Which data to capture?
- What sensors to measure?
- How to correlate sensor readings across multiple devices?
- How to interpret data with regards to context of use?
- How to represent thing knowledge?
- Whate business incentives to share knowledge?



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Research Questions

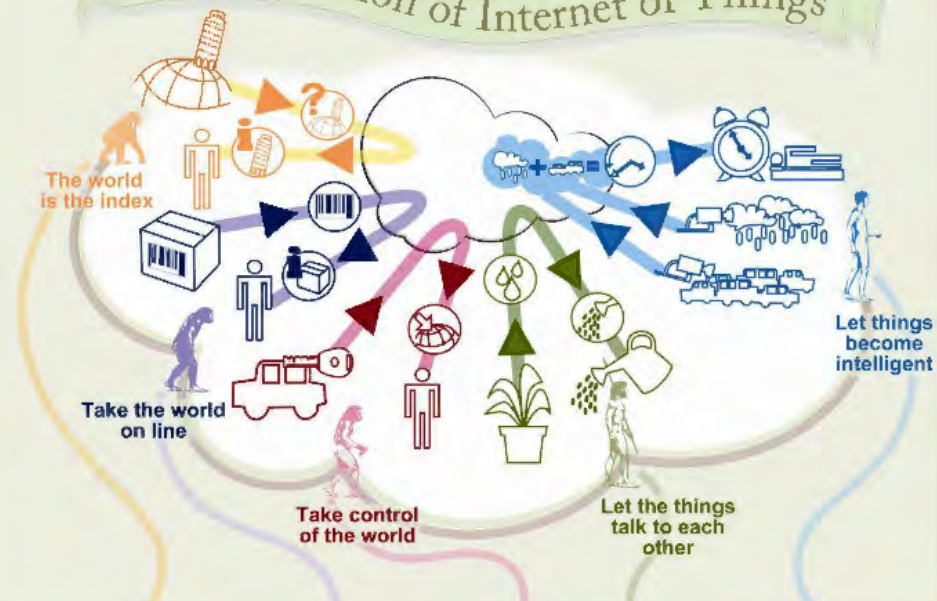
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CASALEGGIO ASSOCIATI
STRATEGIE DI RETE

The Evolution of Internet of Things



The example	How it works	Technologies	On the market
All the monuments of the world are described in detail on the Net.	Objects are identified by their position in the World. They have an information shadow on line, but there is no direct interaction with the object.	Augmented Reality Geotagging GPS	Audio on monuments Wikitude Google Earth
The packages that we send are tracked on the Web and we know where they are.	Moving objects are uniquely identified by a code. They have an information shadow on line, but there is no direct interaction with the object.	RFID NearFieldCommunication Barcode Visual Recognition	Championchip Collari RFID Stickybits, Mirrrow It's alive inside Traced cows Catchthebusapp Nokia 6212, iCarte Google Shopper SoundHound Shazam Picasa
Lost or stolen objects (eg keys or car) can tell us where they are.	The objects are connected to the Internet and interact with people: they communicate, take orders and state information about themselves (e.g. their position if they are lost).	Remote control	iTunes Remote Homecamera Withings Botannicalls
Plants can water themselves when they are thirsty.	Objects communicate with each other and action each other to the occurrence of certain conditions.	Machine2Machine	Goodnightlamp iPhone+Nike (Nike+) Poken Pachube
The alarm can ring earlier in case of traffic or bad weather.	Objects communicate with the Net to which they provide information that can be elaborated and used as new knowledge.	Object Generated Content (OGC) Device to grid	WineM Nike Human Race GlowCap Intelligent meters

Source: Casaleggio Associati, 2011 - www.casaleggio.it/internet_of_things

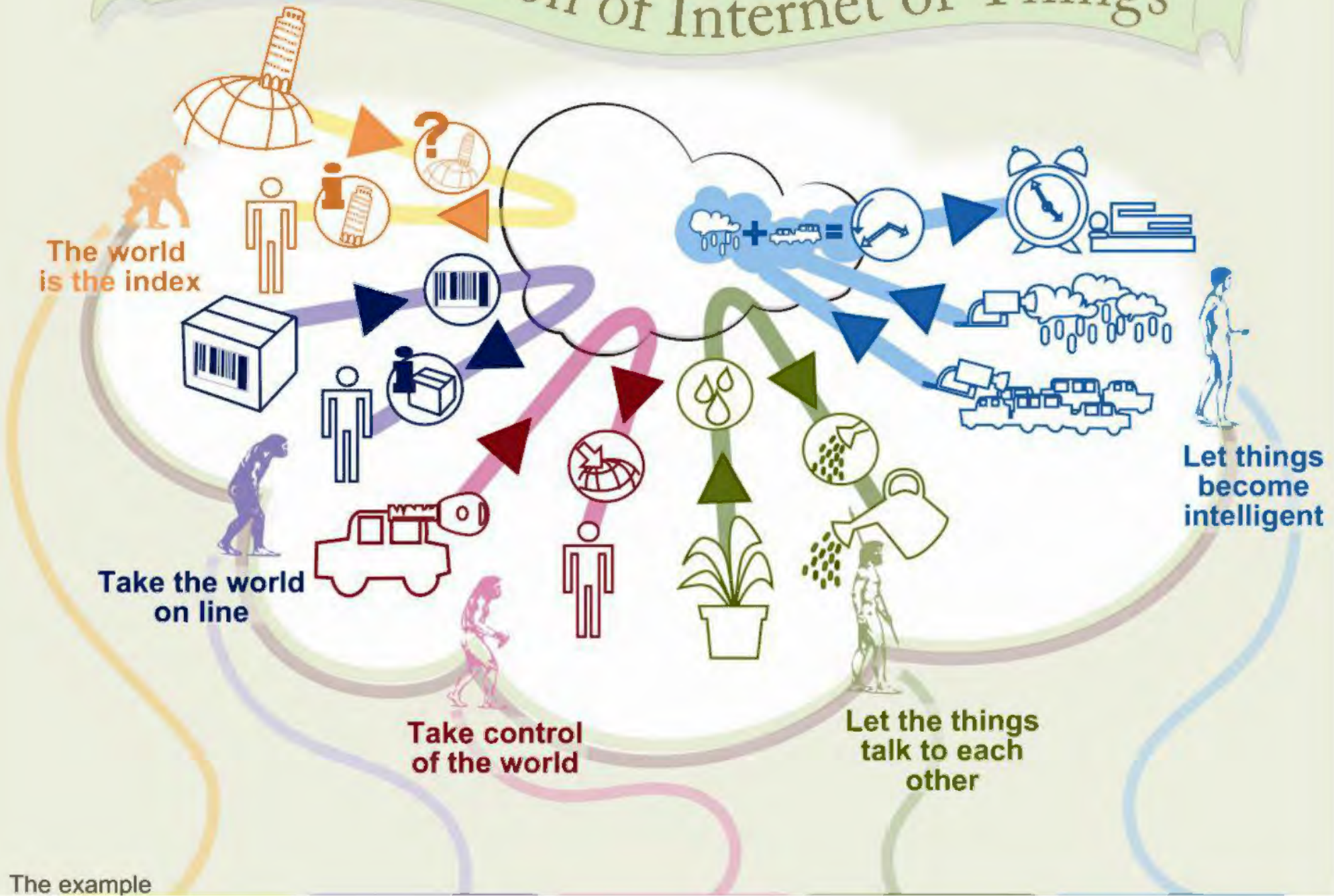


http://casaleggio.it/internet_of_things/



ENTELEGGIO ASSOCIATI
STRATEGIE DI RETE

The Evolution of Internet of Things



Thank you very much!



*Internet of Things –
Towards New Frontiers of Knowledge Management*

IC3K 2012

Barcelona, October 4, 2012

Florian Michahelles, Auto-ID Labs/ETH Zurich
fmichahelles@ethz.ch
autoidlabs.ch florian-michahelles.blogspot.com