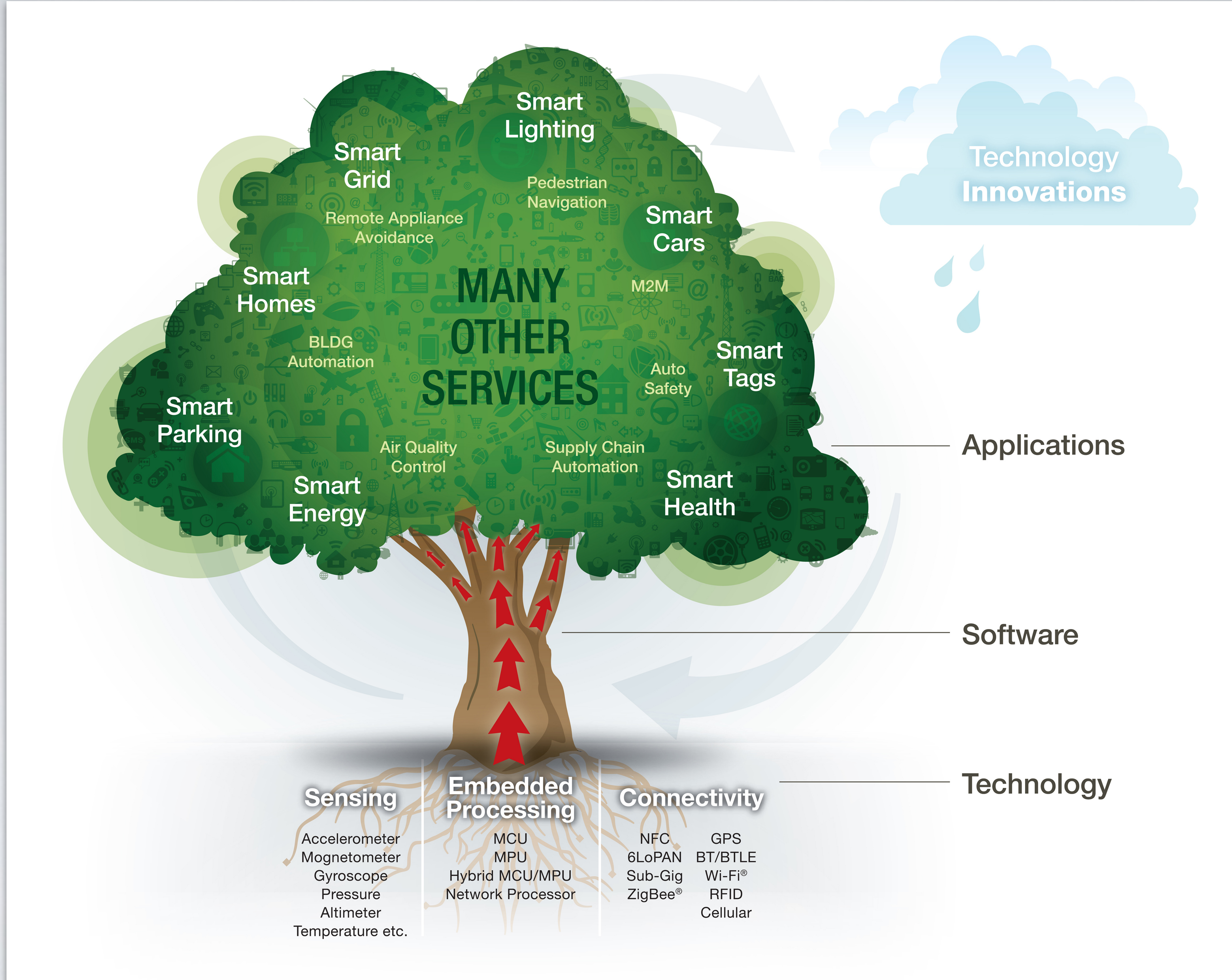
Internet-of-Things

Einleitung

Matthias König



[Quelle: Ian Chen (Freescale), *Sensors Are a Primary Source for Big Data*, Zugriff: 13.11.2015, http://eecatalog.com/IoT/2014/05/16/sensors-are-a-primary-source-for-big-data/,]

Internet-of-Things

- Generelle Bezeichnung für:
  - Netzwerk (*Internet*) von miteinander kommunizierenden eingebetteten Systemen mit Sensoren/Aktoren (*Things*)
- Oft Anbindung des *Things* an Cloud-basierte Anwendungen
- Beispiele: intelligentes Gartengerät, Fitnesstrecker, Lichtsysteme
- "Nachfolger" von M2M

Internet-of-Things (IoT): a definition

“IoT is about connecting the unconnected, enabling smart objects to communicate with other objects, systems, and people. The end result is an intelligent network that allows more control of the physical world and the enablement of advanced applications.”

Source Barton, Salguiro, Hanes “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, 2017

Internet-of-Things (IoT): another definition

"The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure."

Source: Wikipedia, https://en.wikipedia.org/wiki/Internet_of_things

IoT: eine weitere Definition

- Definition des European Research Cluster on the Internet of Things:

  “*Internet of Things (IOT) is an integrated part of Future Internet and could be defined as a* ***dynamic global network infrastructure*** *with* ***self configuring capabilities*** *based on standard and interoperable* ***communication protocols*** *where* ***physical*** *and* ***virtual "things"*** *have* ***identities, physical attributes, virtual personalities*** *and use* ***intelligent interfaces****, and are seamlessly integrated into the information network.*“

  [Quelle: http://cordis.europa.eu/fp7/ict/enet/rfid-iot_en.html, Zugriff: 13.11.2015]

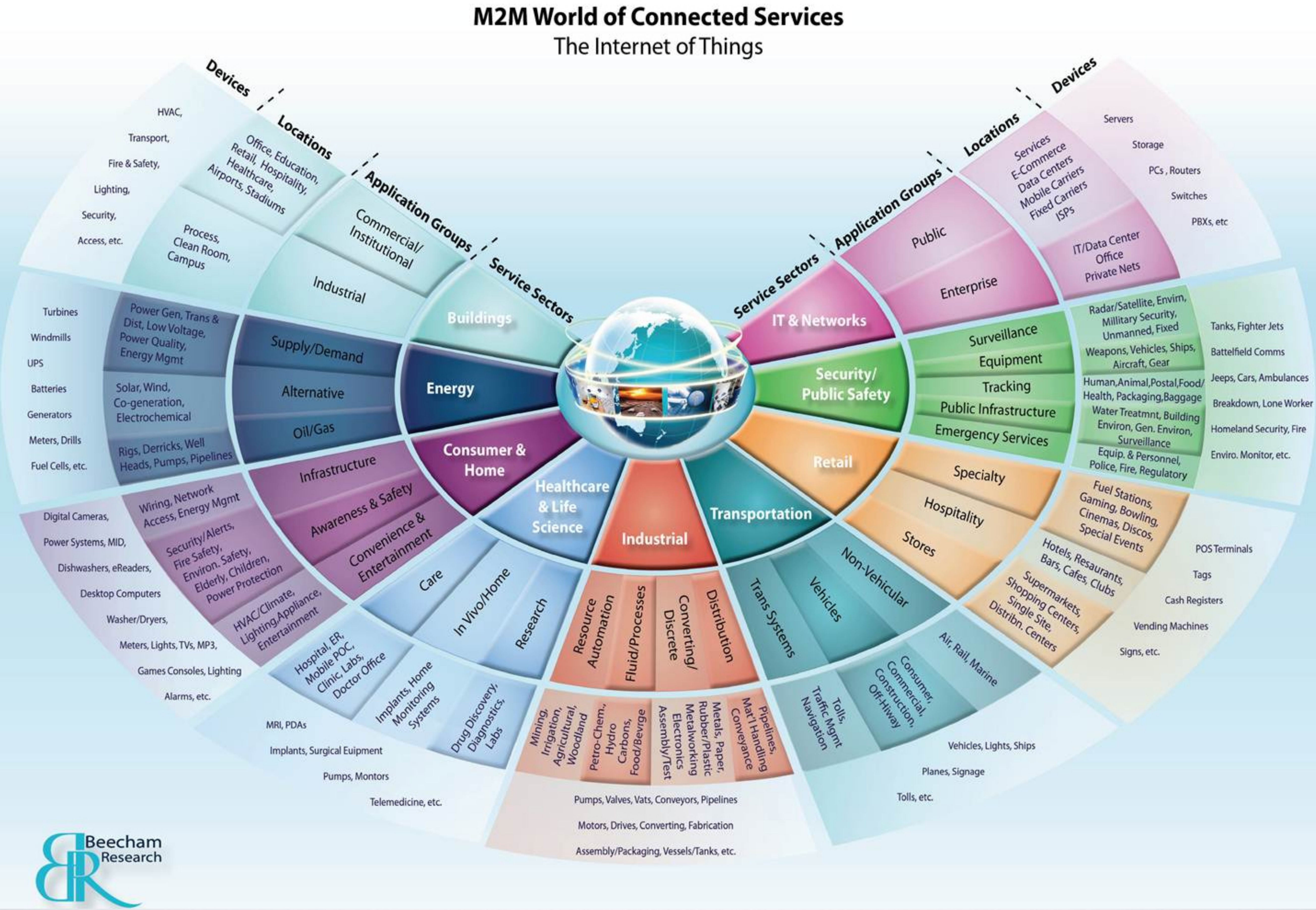
Cyber-physisches System (CPS)

- Begriff oft synonym zu IoT verwendet
- in US bevorzugte Bezeichnung
- *Mögliche* Abgrenzung CPS von IoT durch stärkeren Fokus auf:
  - eigenständiges Zusammenspiel der Komponenten
  - Zusammenspiel mit "Cyber-" (Software-)Komponenten
  - Echtzeitanforderung
  - IoT besteht aus vielen CPS.

Industrie 4.0

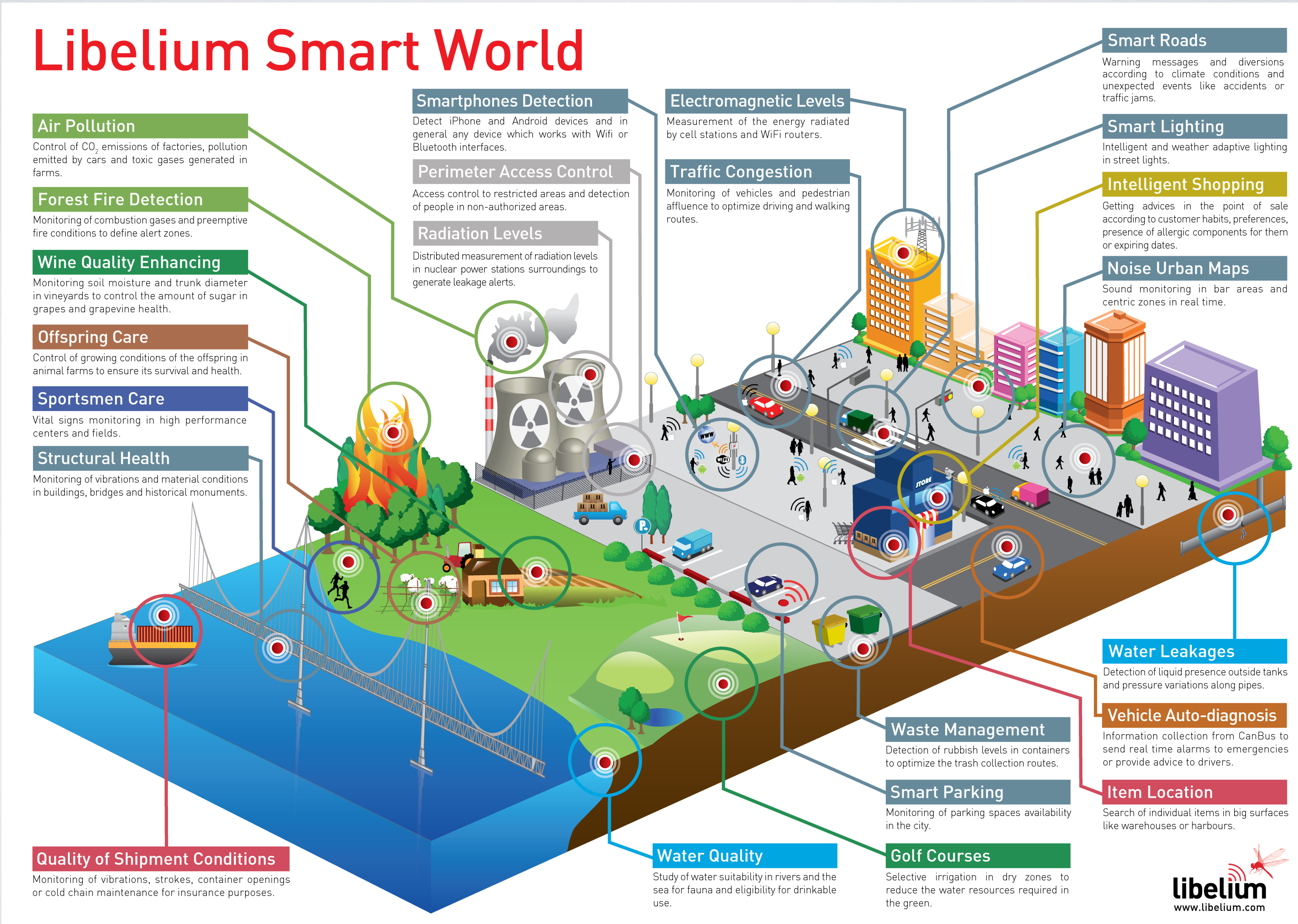
- Schwerpunkt auf miteinander arbeitende Maschinen
- Politisch motivierter Begriff bzw. Förderung mit Ziel des Voranbringen der Digitalisierung bei KMUs im Maschinenbau
- im Englischen besser bekanntes Konzept “industrial internet”

IOT-APPLICATIONS



Source: http://www.beechamresearch.com/article.aspx?id=4 [accessed 13.04.2018]

Sensor application examples



Source: http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/#show_infographic [accessed 13.04.2018]

One of the many smart x examples

Figure 3.17 Smart building implementation [22].

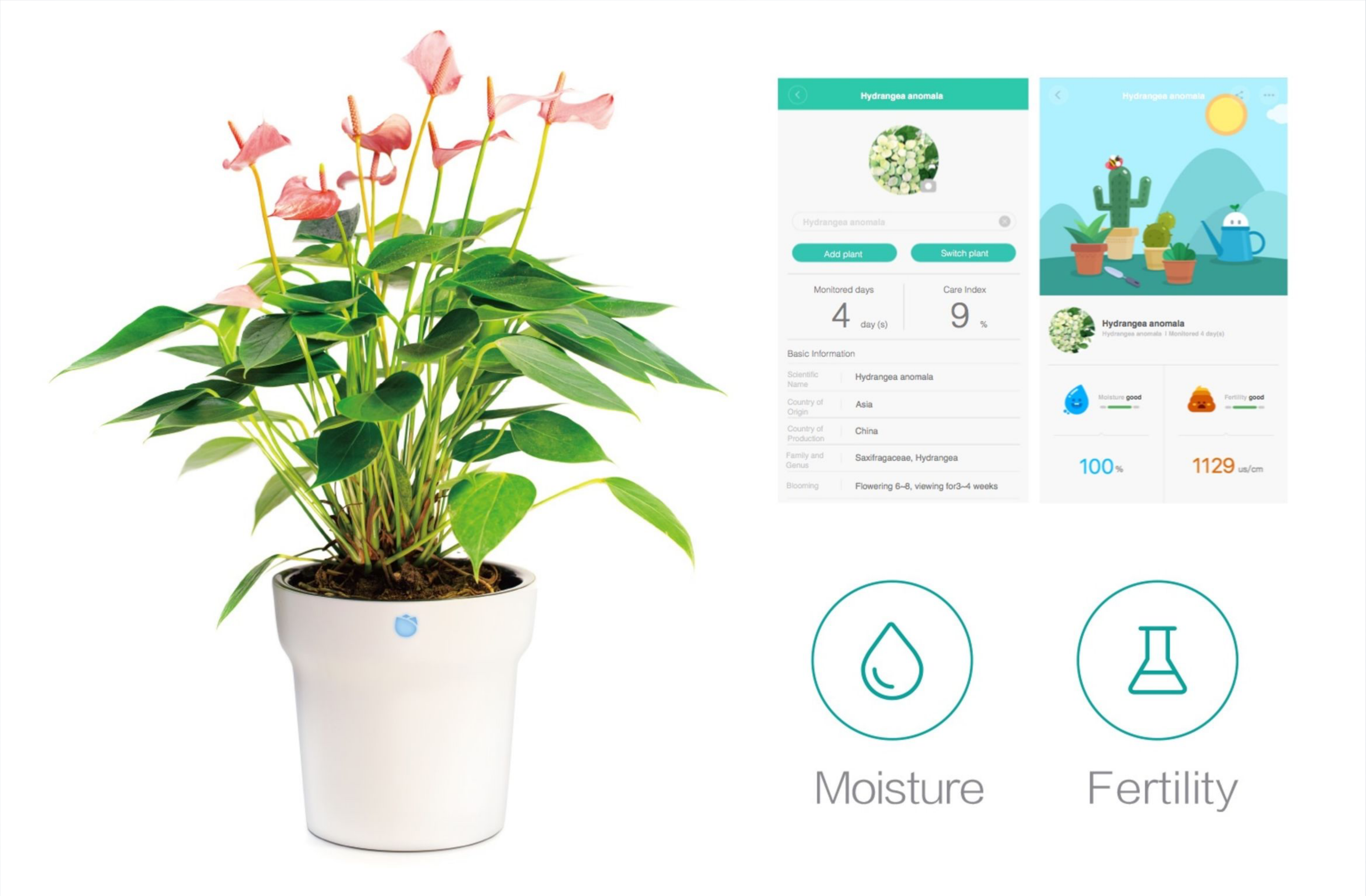
Source: Vermesan and Bacquet, "Cognitive Hyperconnected Digital Transformation Internet of Things Intelligence Evolution", River Publisher, 2017

One of the many smart x examples

Figure 3.10 Smart wristbands and watches – connected IoT devices.

Source: Vermesan and Friess, "Building the Hyperconnected Society ", River Publisher, 2015

One of the many smart x examples



Source: https://ifworlddesignguide.com/entry/208134-ropot [13.04.18]

IOT: WHAT'S BEHIND?

Another view on IoT

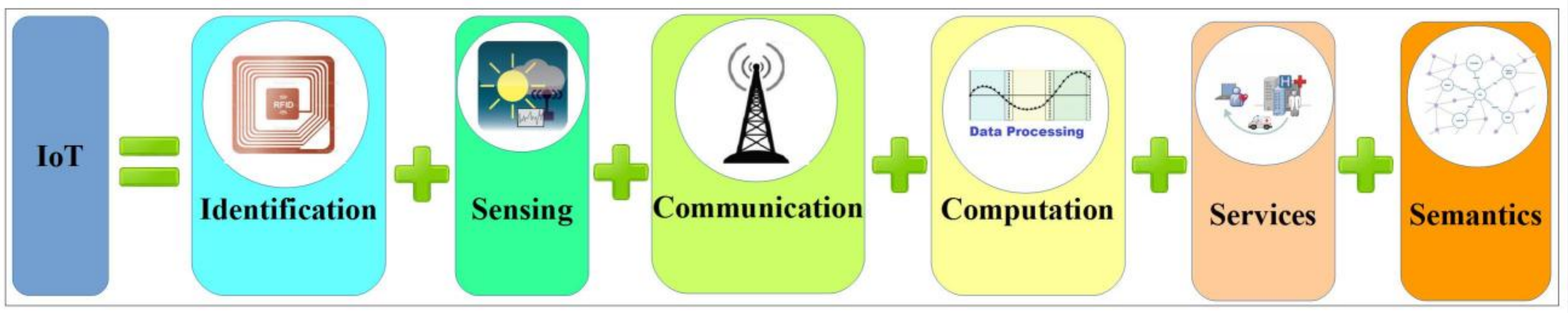


Fig. 4. The IoT elements.

Source: Al-Fuqaha et al. "Internet of Things: A Survey on Enabling Technologies, Protocols and Applications", IEEE Communications Surveys & Tutorials, Vol 17, 2015

IoT value cycle

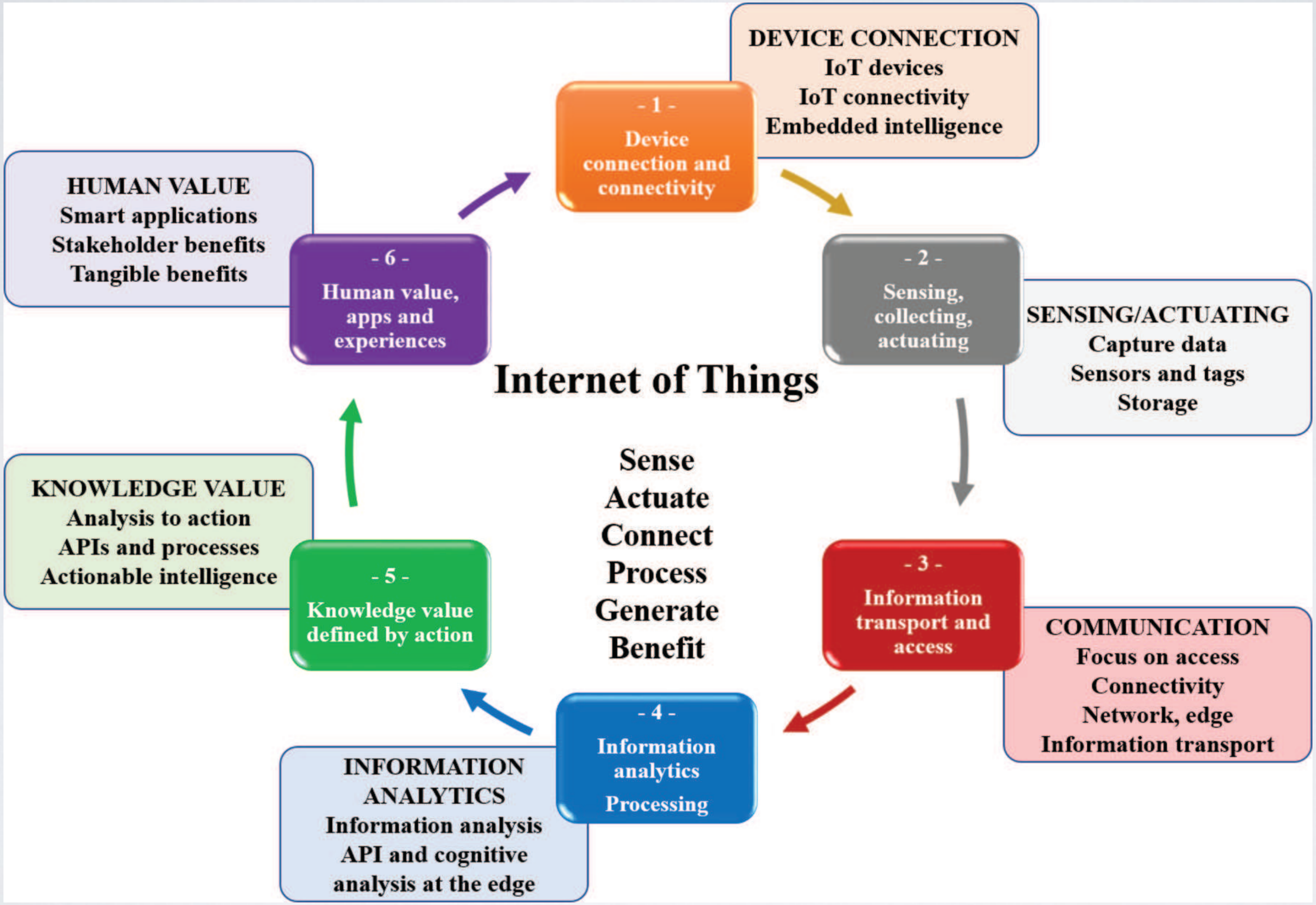


Figure 3.8 IoT value and benefit paradigm.

Source: Vermesan and Bacquet, "Cognitive Hyperconnected Digital Transformation Internet of Things Intelligence Evolution", River Publisher, 2017

IoT-Device

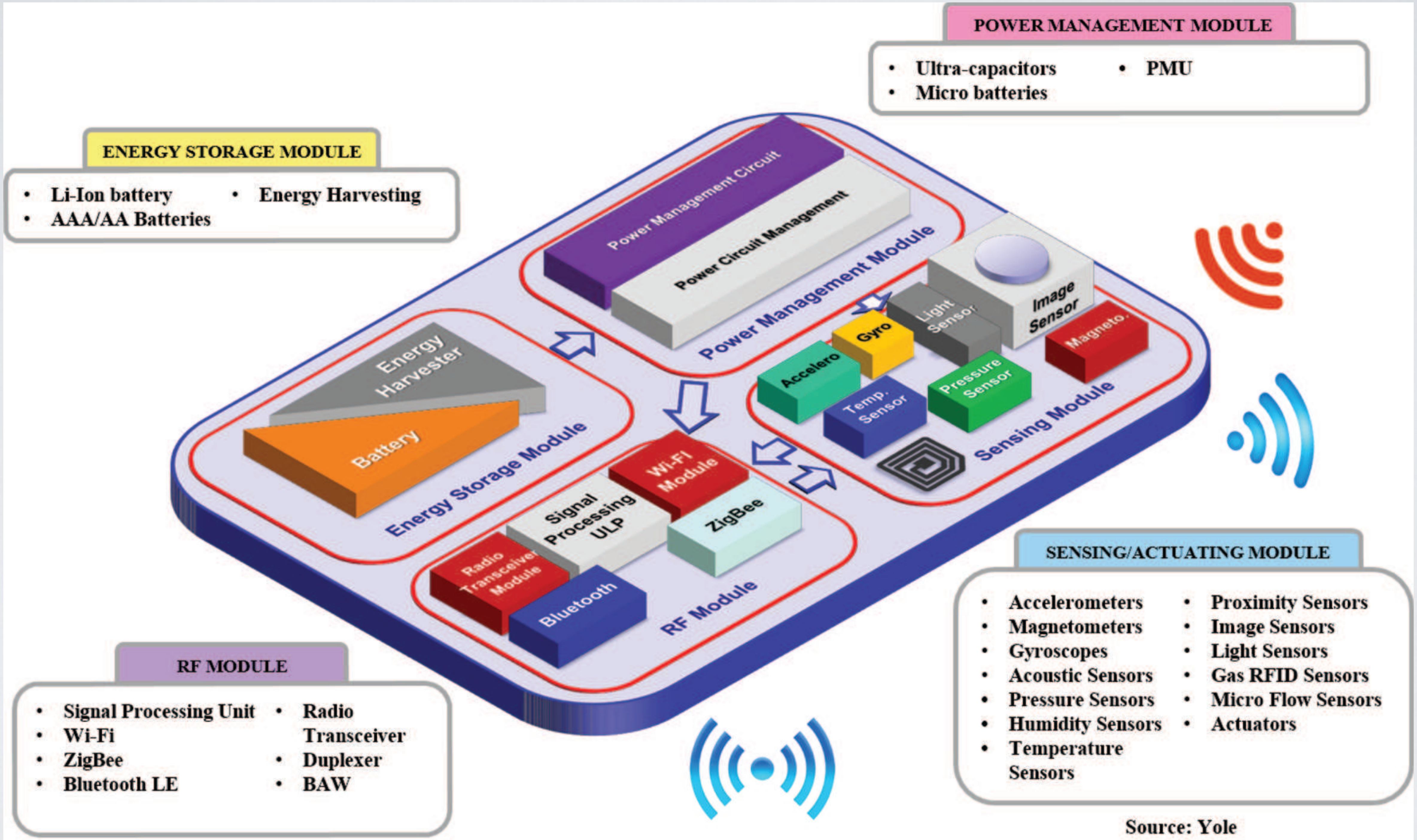


Figure 3.9 IoT sensors/actuators map [12].

Source: Vermesan and Bacquet, "Cognitive Hyperconnected Digital Transformation Internet of Things Intelligence Evolution", River Publisher, 2017

Data analytics in IoT

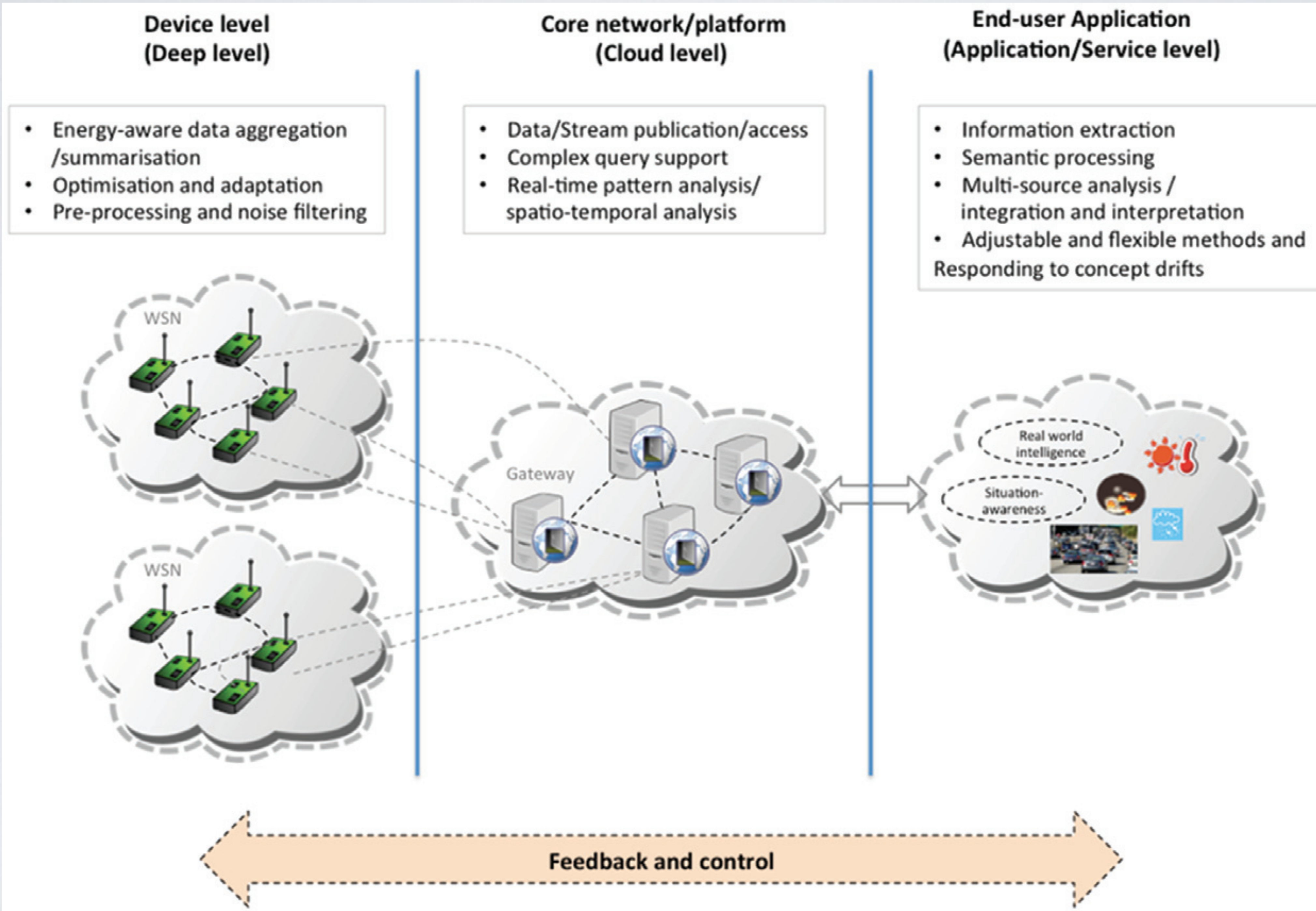
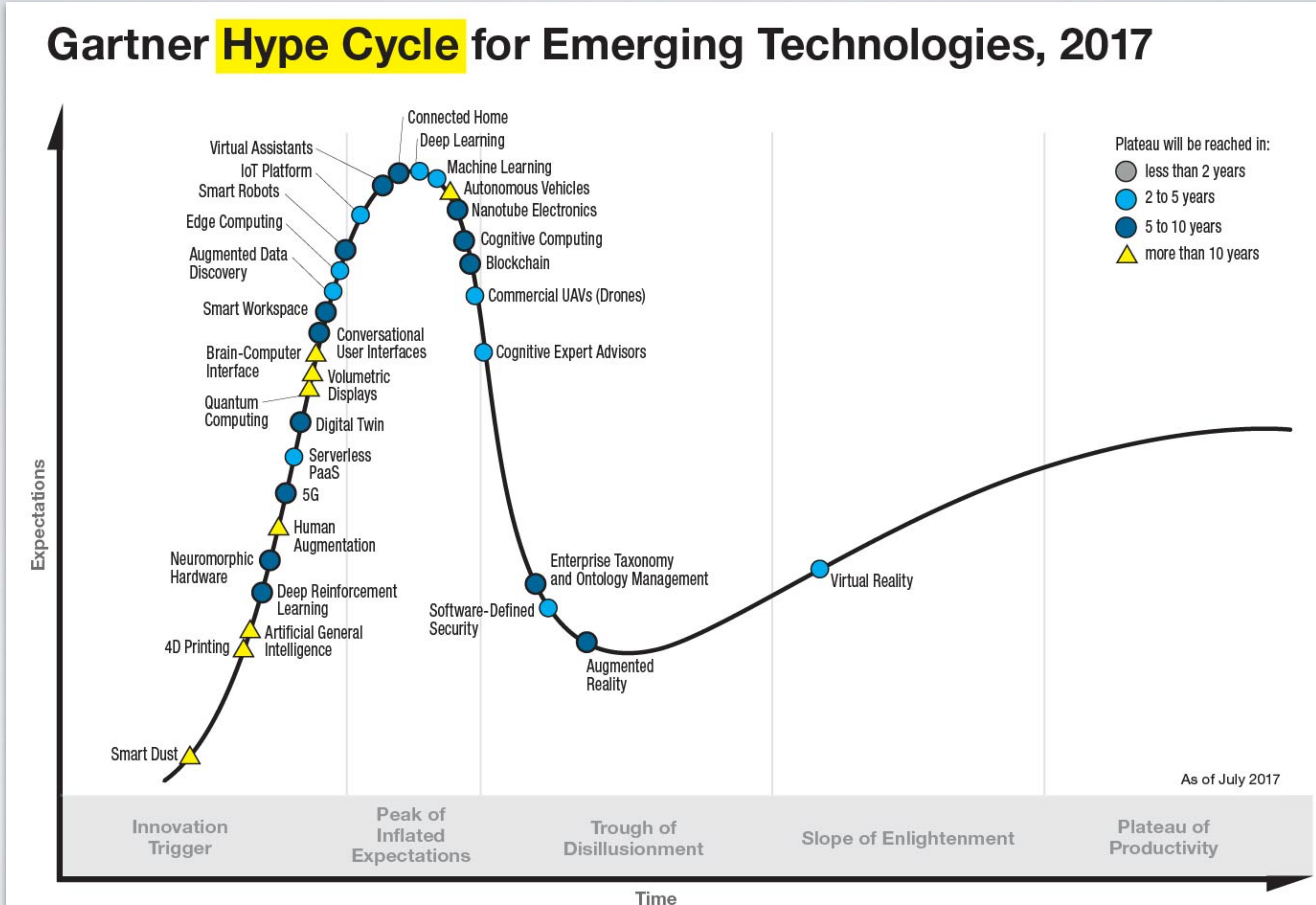


Figure 7.3 A view of data analytics levels in an IoT framework.

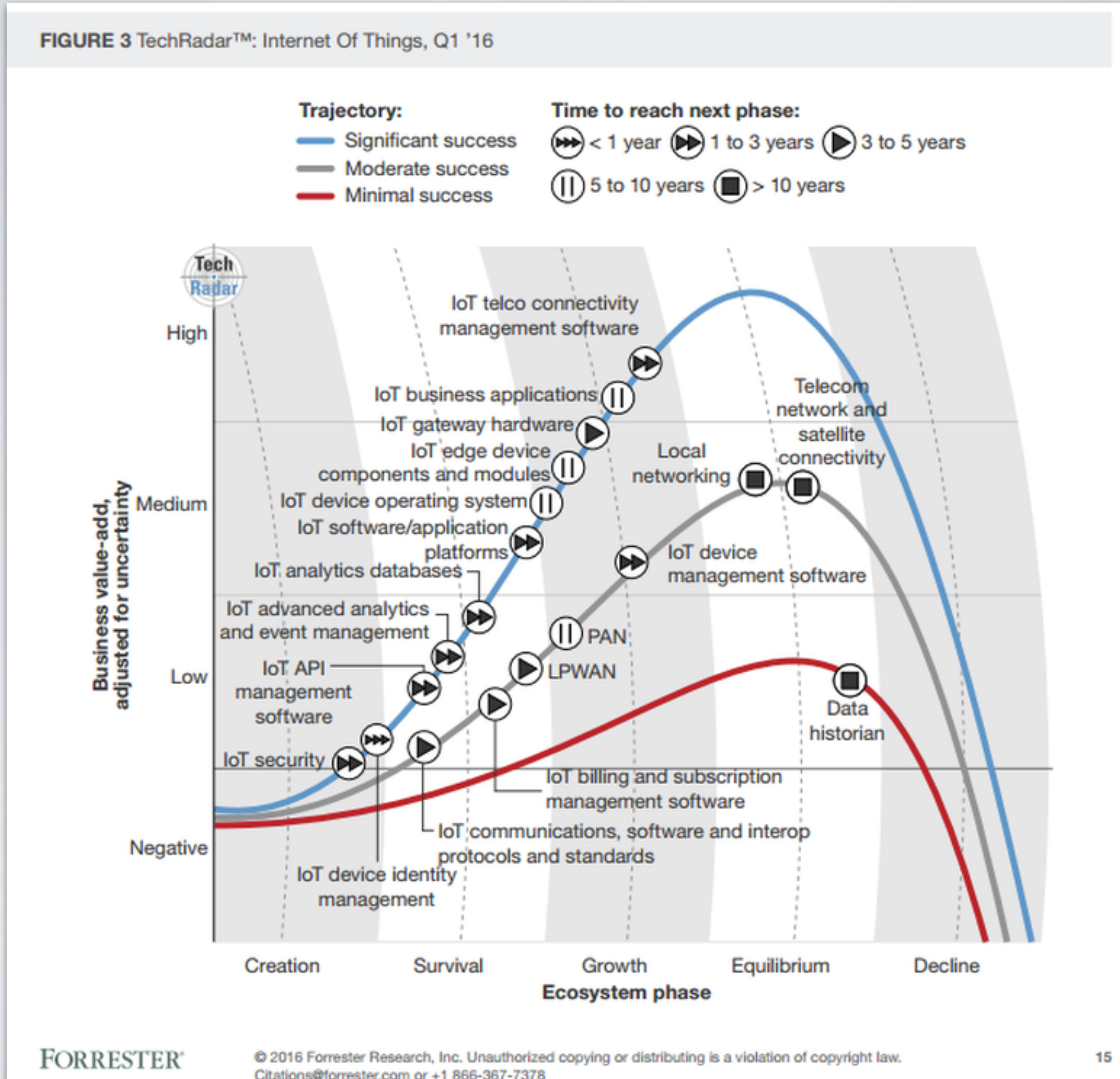
Source: Vermesan and Friess, "Building the Hyperconnected Society ", River Publisher, 2015

IOT-HYPE

IoT is hyped



Source: Gartner, https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/ [accessed 13.04.18]



Source: https://www.zdnet.com/article/internet-of-things-security-years-away-from-being-fully-baked-says-forrester/ [accessed 13.04.2018]

Prediction of IoT-markets

EXHIBIT 1 | Services and IoT Applications and Analytics Will Capture Some 60% of IoT Spending

TECHNOLOGY LAYER	DESCRIPTION	MARKET SIZE (€billions) 2015	MARKET SIZE (€billions) 2020	CAGR, 2015–2020 (%)	VALUE
Services	Allows companies to integrate and customize data so that it's readily accessible and actionable	10	60	~40%	IoT users need customization
IoT applications	Allows companies to make sense of data and generate meaningful insights	10	60	~40%	Application and software development precedes hardware rollout
IoT analytics		3	20	~40%	Analytics support applications and drive insights
Identity and security	Restricts access to the IoT system and safeguards connected devices	3	20	~40%	Financial and technical challenges will limit initial spending
IoT backbone (cloud and platform)	Captures and stores data from connected devices	3	15	~30%	Platforms will initially be given away and will lag behind point solutions
Communications	Allows sensors attached to or embedded in connected things to communicate with the internet	10	25	~20%	Commoditization and scale effects will lead to price erosion; existing network infrastructure will likely be reused
Connected things	Allows sensors, processors, and microcontrollers to monitor, for example, homes, packages, inventory, and machinery	20	50	~20%	Commoditization and scale effects will lead to price erosion in sensors

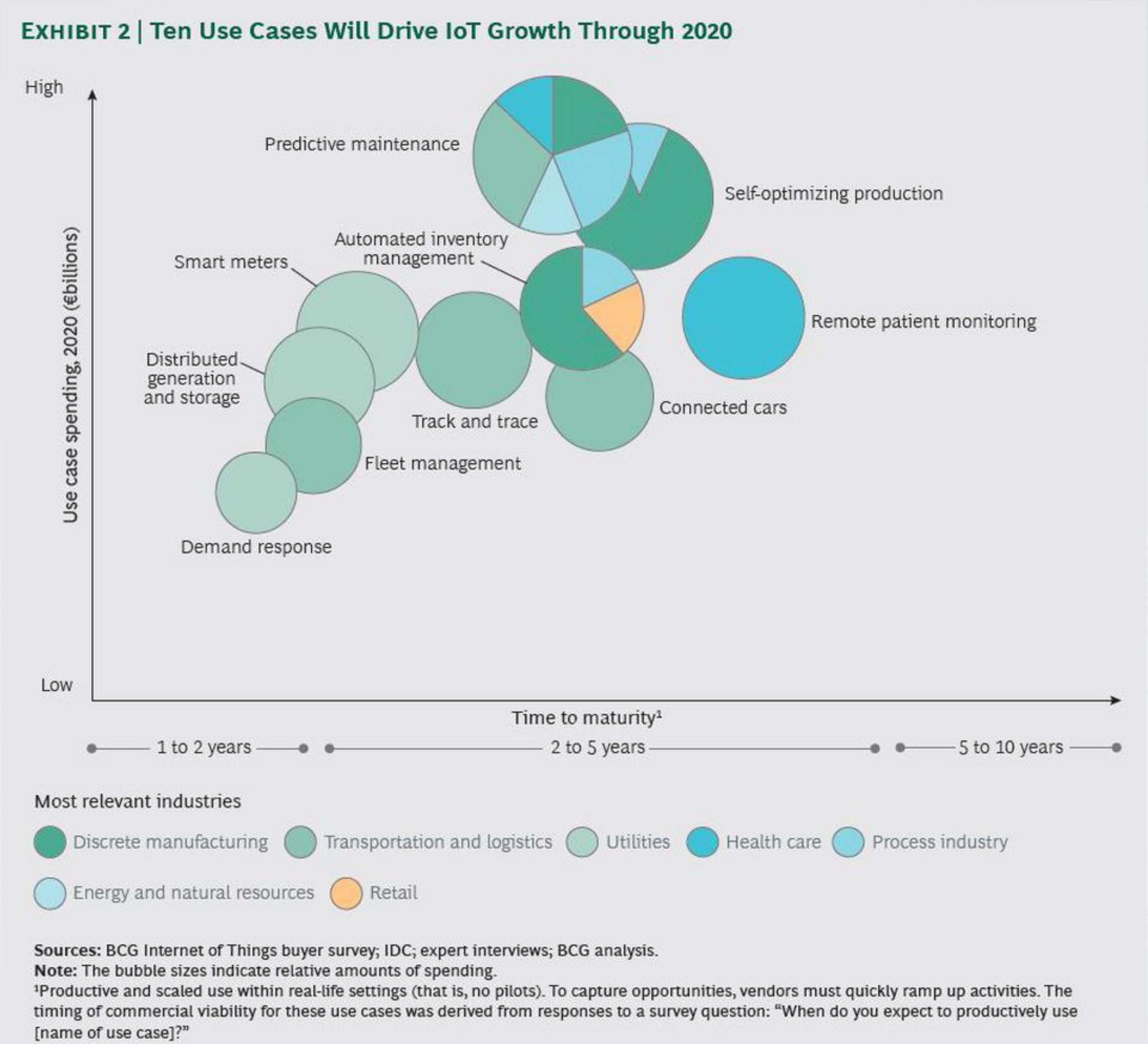
0 20 40 60

2015 2020 CAGR, 2015–2020 = ~40% CAGR, 2015–2020 = ~30% CAGR, 2015–2020 = ~20%

Sources: IDC; Gartner; ABI Research; BCG Internet of Things buyer survey; expert interviews; BCG analysis.

Source: https://www.forbes.com/sites/louiscolumbus/2017/01/29/internet-of-things-market-to-reach-267b-by-2020 [accessed 13.04.2018]

Prediction of IoT-markets



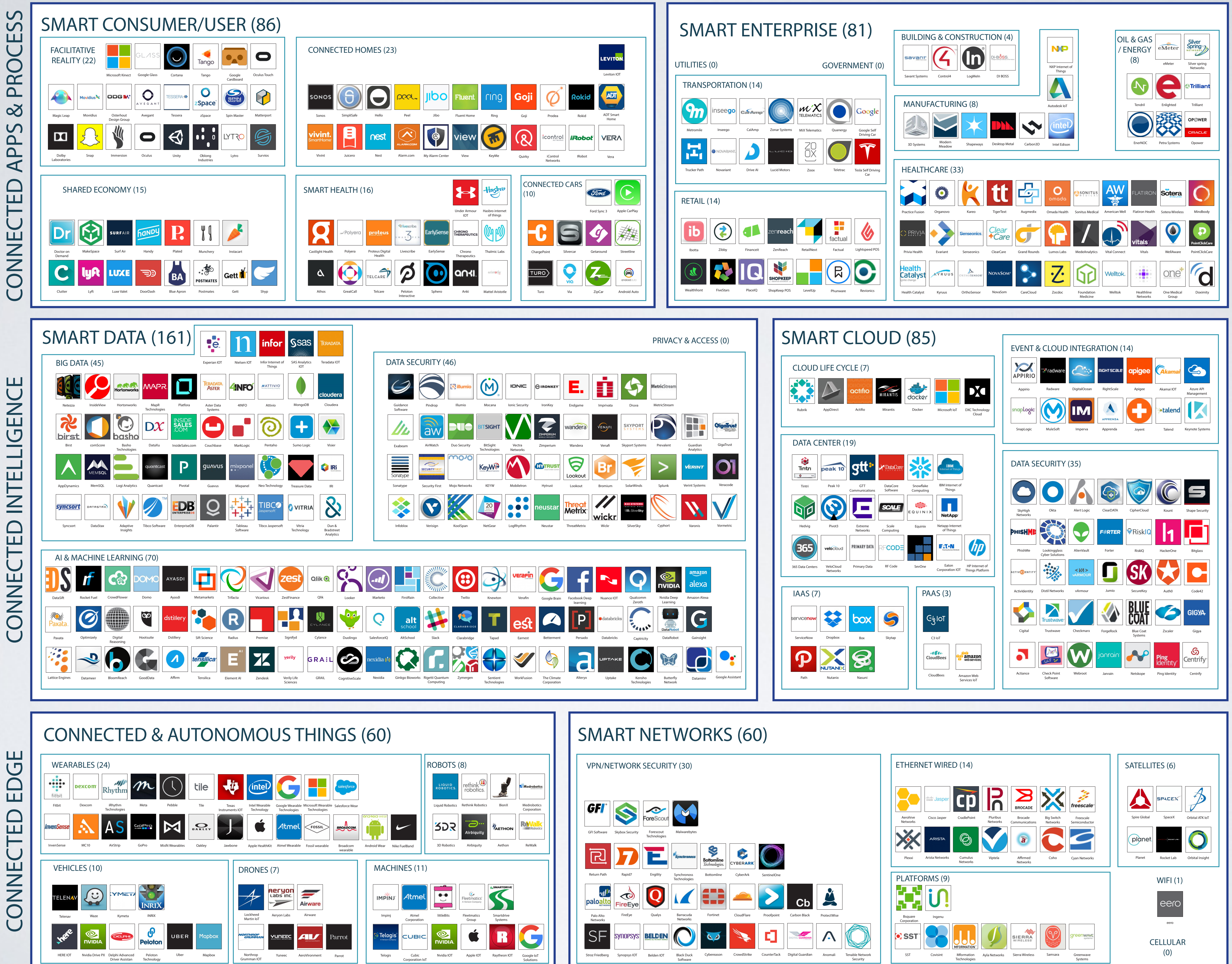
Source: https://www.forbes.com/sites/louiscolumbus/2017/01/29/internet-of-things-market-to-reach-267b-by-2020 [accessed 13.04.2018]

DESIGNED BY readwrite

IOT Revolution Landscape 1.0

July 2017 / $50M+ Raised

POWERED BY spoke Intelligence



Source: http://iotrevolutionlandscape.pagedemo.co [13.04.18]

A few selected platforms

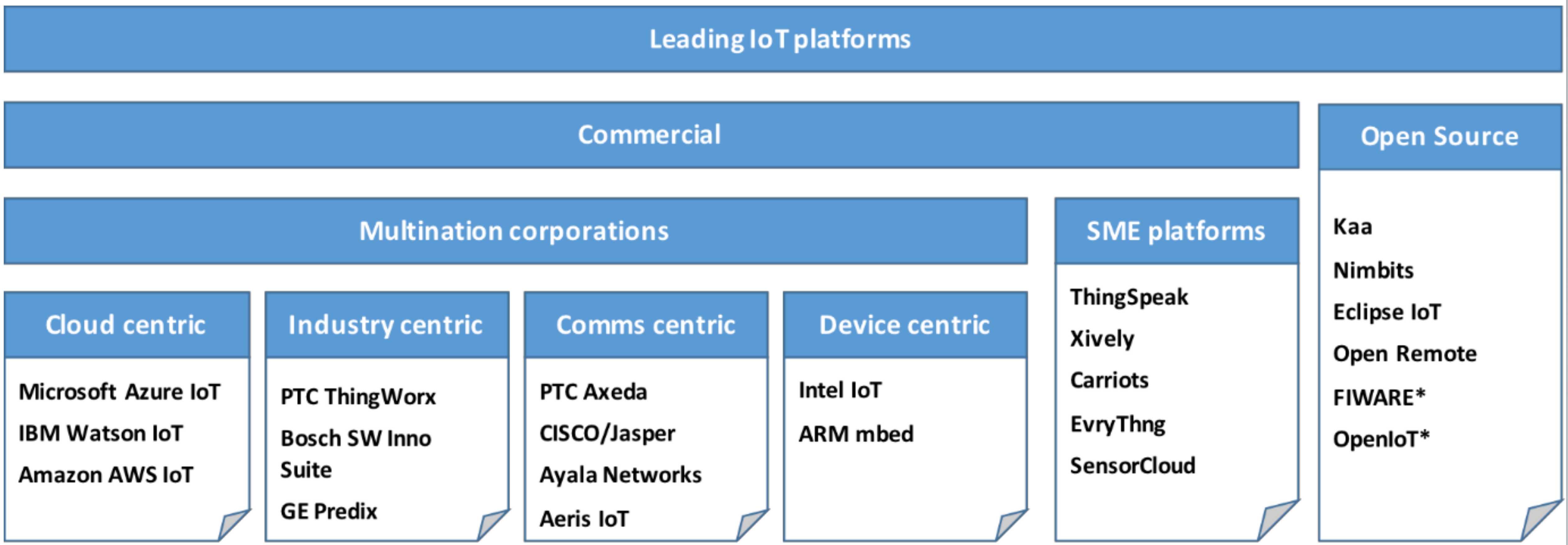


Figure 19: Selection of 23 leading IoT platforms for a more in-depth analysis.

of more than 360 covered in the report.

Source: Report on IoT platform activities, H2020 Unify-IoT-Project, 2016

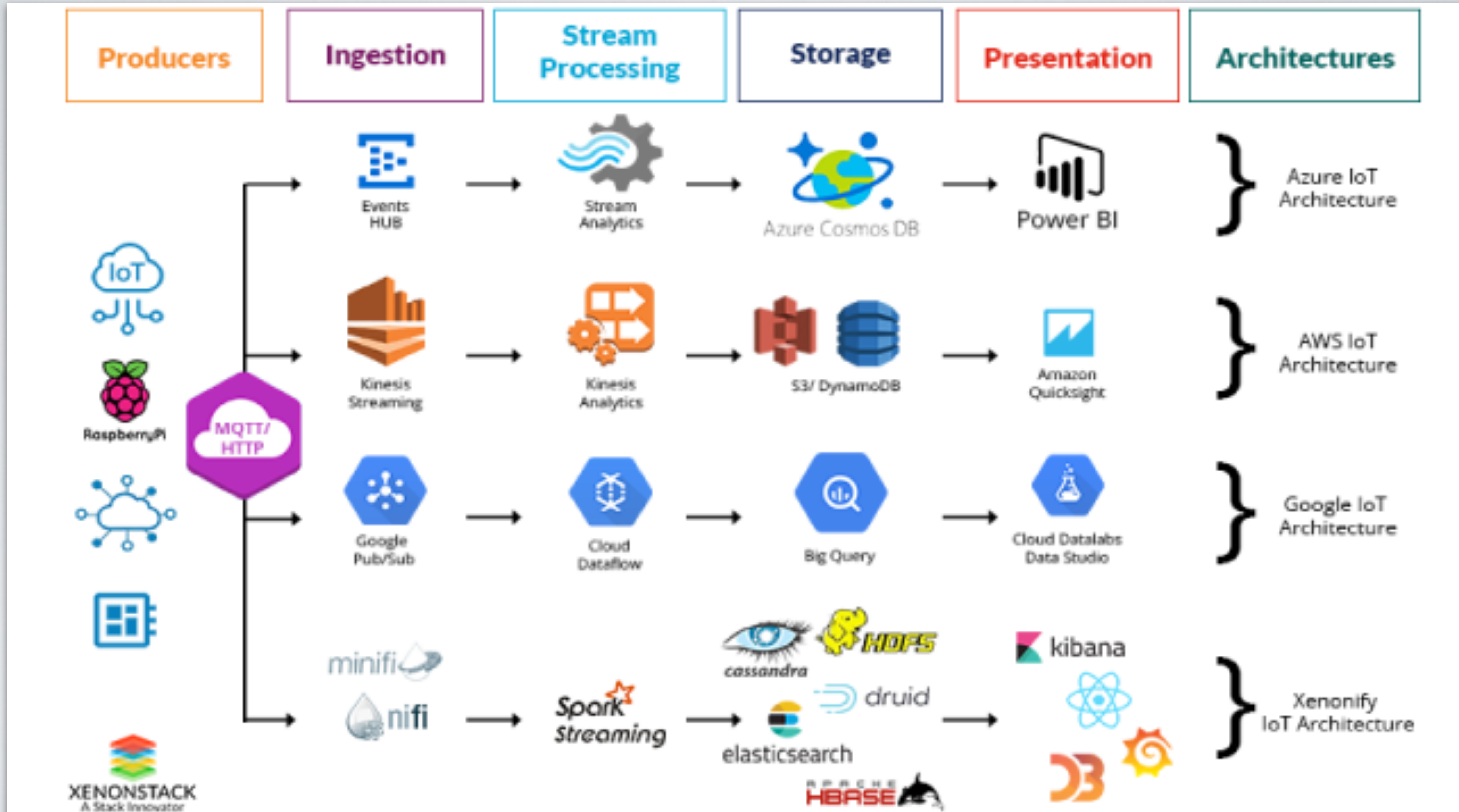
Mapping IoT-Platforms to 8 layer architecture

Layer	Compo-nents	Definitions	Microsoft	amazon	IBM	KAA	Nimbits	eclipse smarthome
Collaboration	Business System Integration	Enables integration with existing enterprise and other external systems	V	V	V			
Application	Visualization	Presents device data in rich visuals and/or interactive dashboards	V	V	V			V
	Development Environment	Provide integrated development environment to simplify developerment of apps	V		V			
Service	Service orchestration	Supports mashup of different data streams, analytcs and service components	V		V			
	Advanced analytics	Allows insights from data to be extracted and more complex data processing to be performed	V	V	V			
Abstraction	Event & action management	Simple rules engine to allow mapping of low level sensor events to high level events and actions	V	V	V	V	V	V
	Basic analytics	Provides basic data normalization, reformatting, cleansing and simple statistics	V	V	V	V	V	V
Stor-age	Storage/ Database	Cloud based storage and database capabilities (not including on premise solutions)	V	V	V	V	V	V
Processing	Device management	Enables remote maintenance, interaction & management capabilities of devices at the edge	V	V	V	V		V
	Edge Analytics	Capabilities to perform processing of IoT data at devices at edge as opposed to cloud.	V	V	V	V		V
Network	Connectivity Network/ Modules	Offers connectivity networks/HW modules enabling air interface connectivity						
	Edge Gateway (HW based)	Offers IoT gateway devices to bridge connectivity from IoT nodes into the cloud based platform						
Physical Layer	Operating system	Offers low-level system SW managing HW, SW & runs applications	V	V				
	Modules & Drivers	Offers adaptable modules, drivers, source libraries that reduce development & testing time	V	V	V	V		V
	MPU / MCU	Offers multi-purpose programmable electronic devices at microprocessor/microcontroller level						

. . .

Source: Report on IoT platform activities, H2020 Unify-IoT-Project, 2016

Four IoT-frameworks compared



Source: https://www.xenonstack.com/blog/data-engineering/real-time-iot-analytics-platform-using-mqtt-xenonify-with-azure-google-cloud-aws, [13.04.18]

IoT-Architecture: Microsoft's view

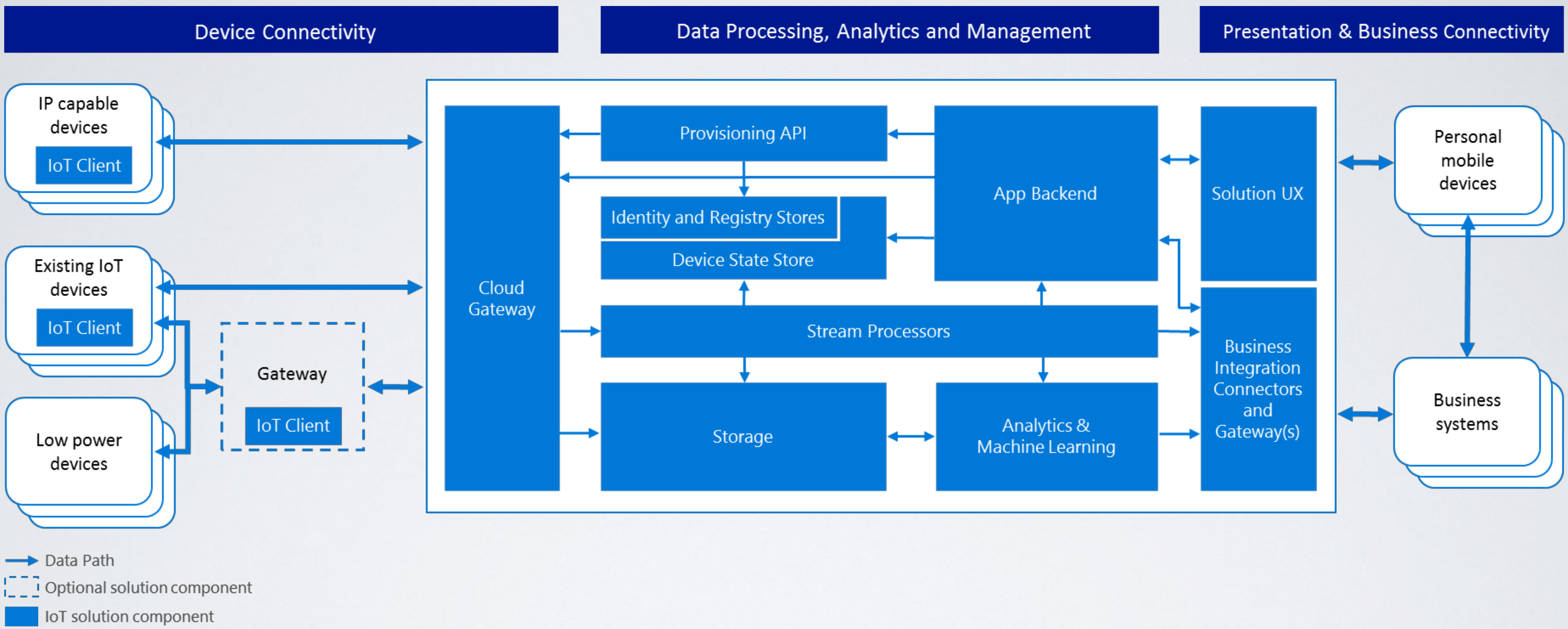
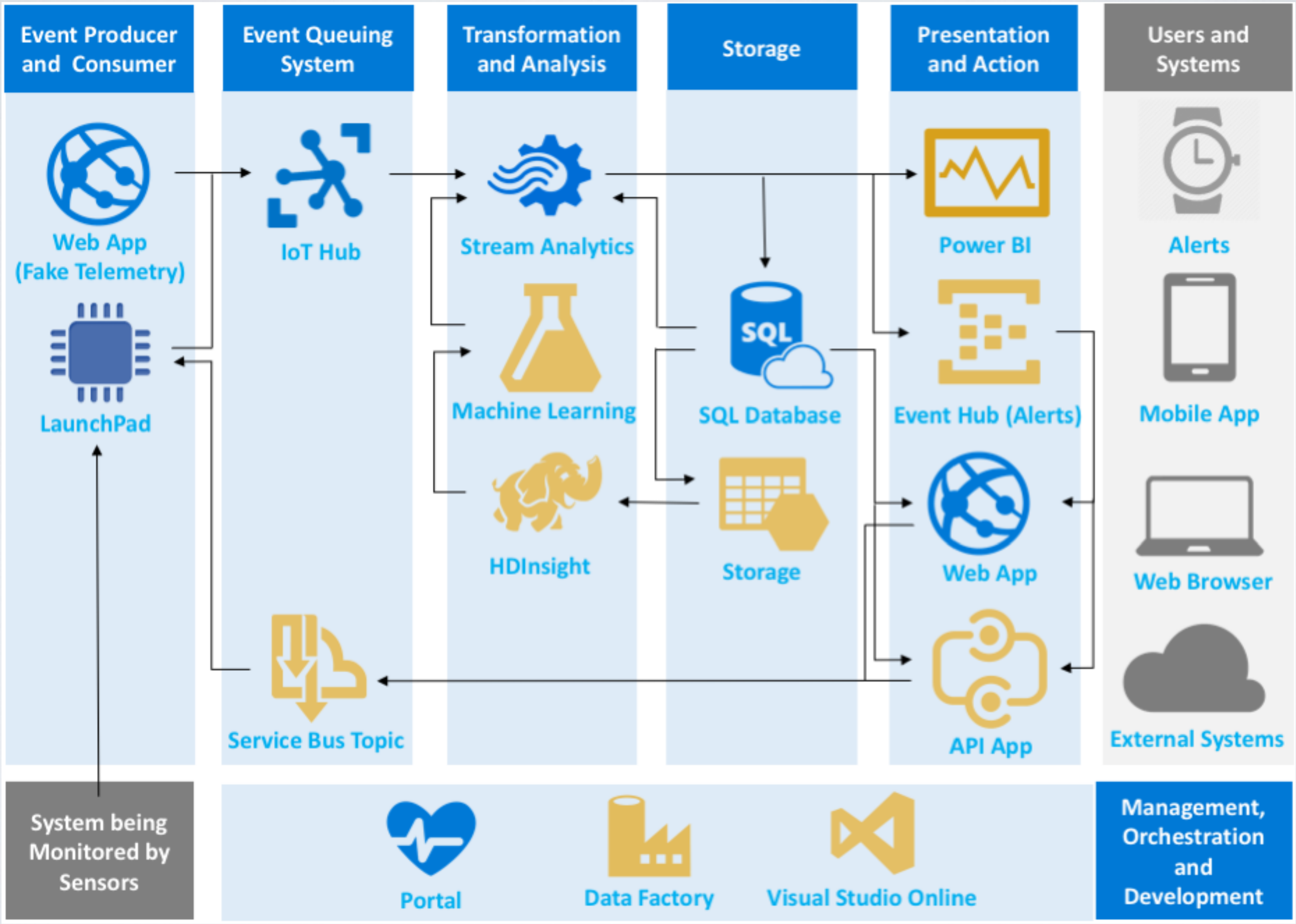


Figure 1 IoT solution architecture

Source: Microsoft Azure IoT Reference Architecture, Microsoft, 2015

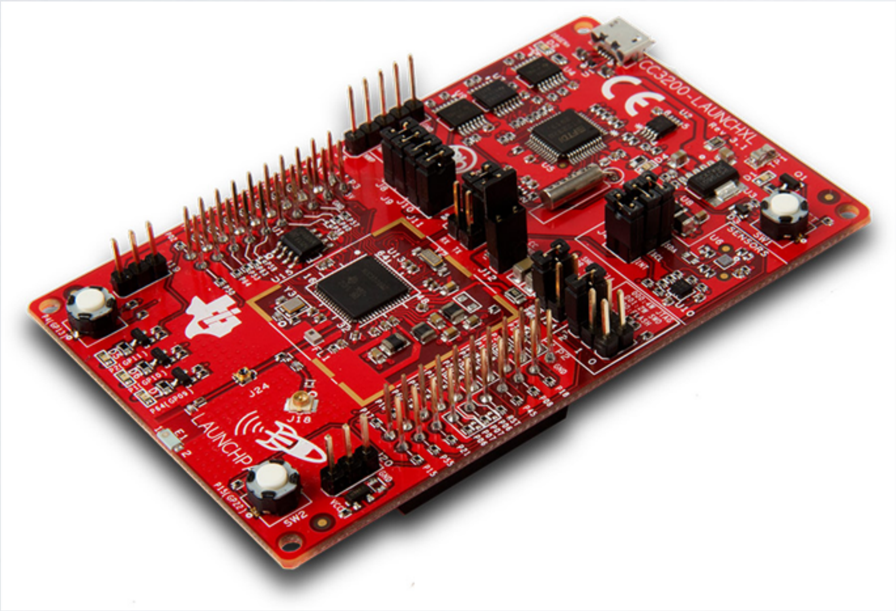
IoT-Platform: Microsoft + TI



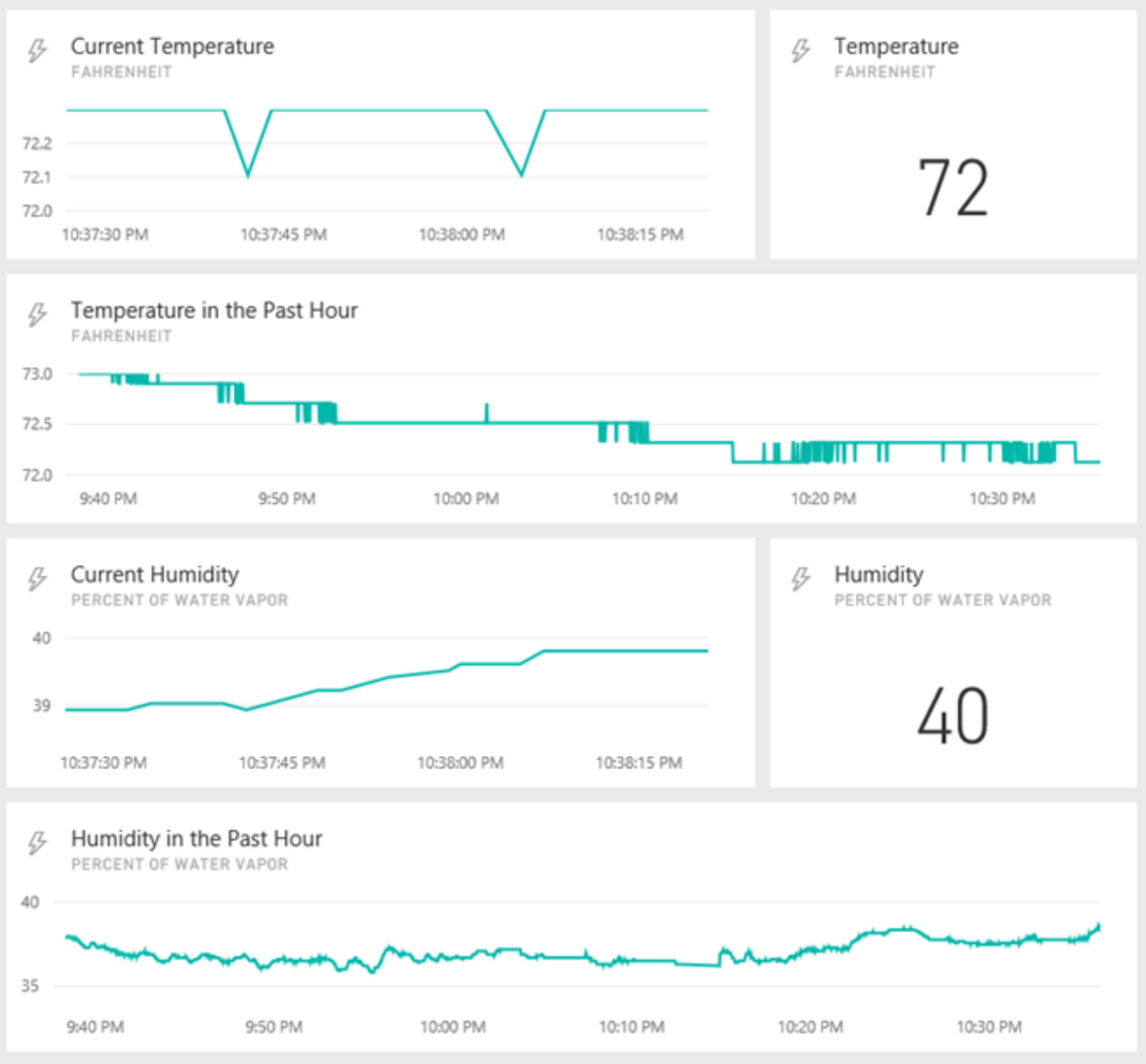
Source: http://ssmlwf.azurewebsites.net [13.04.18]

Example for a IoT-Platform: Microsoft + TI

Launchpad



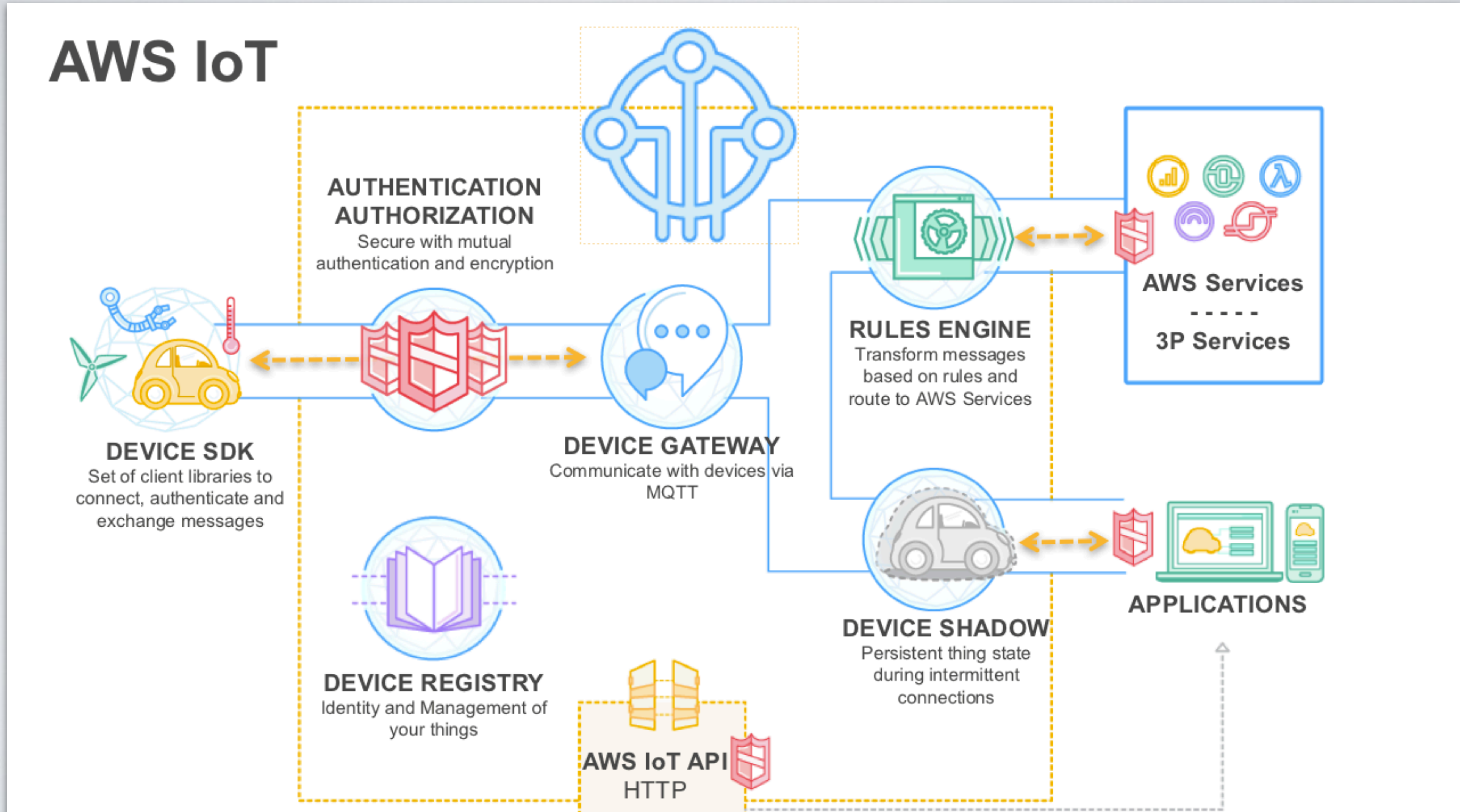
Power BI



Source: http://www.ti.com/ww/en/internet_of_things/Microsoft-Azure-IoT-Suite-for-SimpleLink-Wi-Fi-LaunchPad.html [13.04.18]

Source: https://blogs.technet.microsoft.com/cloudready/2017/08/03/iot-project-for-anyone-designing-iot-microsoft-power-bi-dashboard/ [13.04.18]

IoT-Platform: Amazon's view



Source: https://developer.amazon.com/blogs/alexa/post/Tx3828JHC7O9GZ9/using-alexa-skills-kit-and-aws-iot-to-voice-control-connected-devices [13.04.18]

ORGANISATORISCHES

Lernergebnisse (learning outcomes)/ Kompetenzen

Die Studierenden erlernen das Entwickeln von smarten Systemen. Dazu werden **Technologien** des **Internet-of-Things** (bzw. Industrie 4.0, Cyberphysische Systeme) vermittelt und analysiert. Das Ziel ist die Förderung der Selbstständigkeit und praktischen Problemlösungskompetenz sowie der Fähigkeit zum selbstständigen **wissenschaftlichen Arbeiten**. Das vom Dozenten gestellte **Projekt** dient der Wissensvertiefung im Bereich der Programmierung von Internet-of-Things bzw. Smart Systems und als praktische Erfahrung in der Projektplanung und –realisierung eines Forschungsprototyps.

Inhalte

Der Seminaristische Unterricht behandelt Verfahren und Technologien zur Umsetzung von Internet-of-Things-Anwendungen, welche auf den Projektinhalt abgestimmt sind. Eine Analyse der Verfahren und deren Umsetzungen im Projektkontext führen die Studierenden durch.

Beispiele von behandelten Themen im Gebiet des Internet-of-Things:

- Protokolle
- Architekturen
- Algorithmen
- Frameworks und APIs
- Zusammenspiel mit mobilen Anwendungen und Cloud-Computing
- Anwendungen
  - Smart Home, Smart Cities, Smart Health, Smart Energy...
  - Condition Monitoring, Predictive Maintenance…

Ablauf der Projekte:

Weitgehend s**elbstständige Bearbeitung einer komplexeren Aufgabenstellung** im Rahmen eines Forschungs- und Entwicklungsprojekts. Der Dozent definiert die Zielsetzung und führt einen regelmäßigen Diskurs über den Fortgang des Projekts. Er vereinbart außerdem mit den Studierenden **Meilensteine** und **Form der Projektabgabe**.

Organisatorisches

- Dozent: Matthias König
- Tutor: Aljoscha Pörtner
- Seminaristischer Unterricht:
  - Donnerstags, 09:45-11:15, D327
- Praktikum:
  - Donnerstags, 11:30-14:30, D327

Zum Seminar (35%)

- Jeder hält einen Seminarvortrag (und ggf. Vorführung)
- Bewertung des Seminarvortrags
  - Inhalt
  - Präsentation
  - Vortragsweise und Verständlichkeit
  - Einhalten der Zeitvorgabe
  - 40 Minuten Vortrag und 5 Minuten Fragen

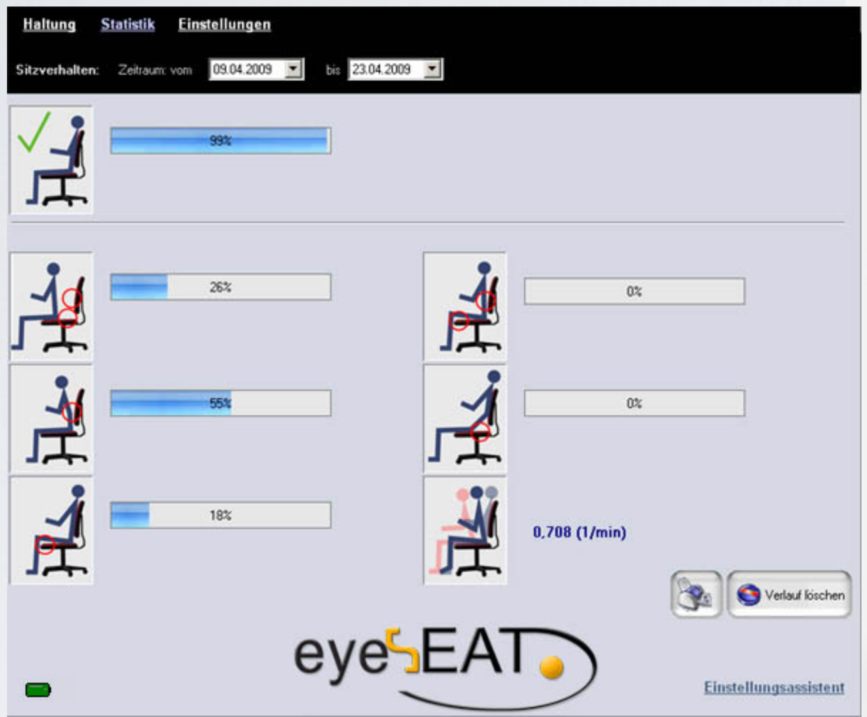
Themenauswahl Seminar

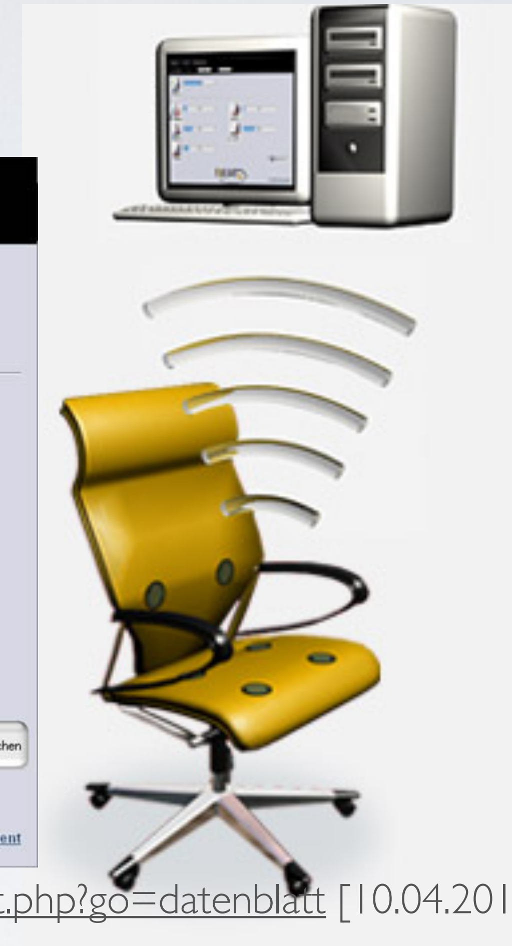
- Thema aus einem der Bereiche:
  - IoT-Architekturen
  - IoT-Protokolle und Standards
  - IoT-Workflow
  - IoT-Plattformen und hinterliegende Technologien
- und zwingend basierend auf wissenschaftlichen Veröffentlichungen bzw. Standards.

Projektarbeit (65%)

- Entwicklung einer Anwendung bis zum Prototypen
- Einzeln oder 2er-Teams mit klarer Aufgabenteilung und jeweils einer eigenen Ausarbeitung
- Wissens. Ausarbeitung über Projekt/-ergebnis (s. nächste Slide)
- Source-code zwingend hochzuladen in vorgegebenes GIT
- Gegenseitige kurze Vorführung der Projekte in letzter Lehrveranstaltung

Projekte: Thema Smart Chair





Source: http://www.eyeseat.de/start.php?go=datenblatt [10.04.2019]

Source: https://www.bma-ergonomics.com/de/axia-produkte/axia-smart-chair/intelligenter-burostuhl/ [10.04.2019]

Projekte

- “Aufmöbeln” eines bzw. mehrerer Bürostühle zu Smart Chairs
- Eigene Ideen für Smart Chair Use Case möglich
- Plattform:
  - Device: ESP32-DevkitC und für Sensoren für Use Case
  - AWS-Frameworks: FreeRTOS, IoTCore & Greengrass, Analytics, Quicksight oder ElasticSearch/Kibana
- Ziel: Alle Stühle jeder Gruppe sind gleich umgebaut und liefern für jeden Use Case Daten.

Wissenschaftliche Ausarbeitung

- Wissenschaftliche Arbeit (Paper in englischer Sprache)
- Aufarbeitung des Stands der Technik mit Literaturrecherche und –analyse
- Abgrenzung und Begründung des eigenen Ansatzes
- Darstellung und Technik des eigenen Ansatzes
- Eigenkritische Bewertung und Evaluierung
- Umfang: ca. 6 Seiten mit Layout-Vorlage (s. Springer-Style)
- Darstellung <u>Zwischenstand nach 2 Monaten</u> zur Ermöglichung einer Hilfestellung

Springer-Style ist Pflicht für Ausarbeitung


Machine Vision and Applications
DOI 10.1007/s00138-007-0086-y

ORIGINAL PAPER

Automated insect identification through concatenated histograms of local appearance features: feature vector generation and region detection for deformable objects

Natalia Larios · Hongli Deng · Wei Zhang · Matt Sarpola · Jenny Yuen · Robert Paasch · Andrew Moldenke · David A. Lytle · Salvador Ruiz Correa · Eric N. Mortensen · Linda G. Shapiro · Thomas G. Dietterich

Received: 17 October 2006 / Accepted: 17 March 2007
© Springer-Verlag 2007

Abstract This paper describes a computer vision approach to automated rapid-throughput taxonomic identification of stonefly larvae. The long-term objective of this research is to develop a cost-effective method for environmental monitoring based on automated identification of indicator species. Recognition of stonefly larvae is challenging because they are highly articulated, they exhibit a high degree of intraspecies variation in size and color, and some species are difficult to distinguish visually, despite prominent dorsal patterning. The stoneflies are imaged via an apparatus that manipulates the specimens into the field of view of a microscope so that images are obtained under highly repeatable conditions. The images are then classified through a process that involves (a) identification of regions of interest, (b) representation of those regions as SIFT vectors (Lowe, in Int J Comput Vis 60(2):91–110, 2004) (c) classification of the SIFT vectors into learned "features" to form a histogram of detected features, and (d) classification of the feature histogram via state-of-the-art ensemble classification algorithms. The steps (a) to (c) compose the concatenated feature histogram (CFH) method. We apply three region detectors for part (a) above, including a newly developed principal curvature-based region (PCBR) detector. This detector finds stable regions of high curvature via a watershed segmentation algorithm. We compute a separate dictionary of learned features for each region detector, and then concatenate the

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Fig. 1 Regions defined by principal curvature. a The original, b principal curvature, and c cleaned binary images. The resulting d boundaries and e regions that result by applying the watershed transform to c. f The final detected regions created by fitting an ellipse to each region

an image as an intensity surface, the curvilinear structure detector looks for ridges and valleys of this surface. These correspond to white lines on black backgrounds or black lines on white backgrounds. The width of the detected line is determined by the Gaussian scale used to smooth the image (see Eq. 1 below). Ridges and valleys have large curvature in one direction, edges have high curvature in one direction and low curvature in the orthogonal direction, and corners (or highly curved ridges and valleys) have high curvature in two directions. The shape characteristics of the surface can be described by the Hessian matrix, which is given by

$$\mathbf{H}(\mathbf{x},\sigma_D) = \begin{bmatrix} I_{xx}(\mathbf{x},\sigma_D) & I_{xy}(\mathbf{x},\sigma_D) \\ I_{xy}(\mathbf{x},\sigma_D) & I_{yy}(\mathbf{x},\sigma_D) \end{bmatrix} \quad (1)$$

where I_{xx}, I_{xy} and I_{yy} are the second-order partial derivatives of the image and σ_D is the Gaussian scale at which the second partial derivatives of the image are computed. The interest point detectors mentioned previously [16,29,30] apply the Harris measure (or a similar metric [25]) to determine a point's saliency. The Harris measure is given by

$$\det(\mathbf{A}) - k \cdot \mathrm{tr}^2(\mathbf{A}) > \text{threshold} \quad (2)$$

where det is the determinant, tr is the trace, and the matrix A is either the Hessian matrix, H, (for the Hessian-affine detector) or the second moment matrix,

$$\mathbf{M} = \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}. \quad (3)$$

for the Harris or Harris-affine detectors. The constant k is typically between 0.03 and 0.06 with 0.04 being very common. The Harris measure penalizes (i.e., produces low values for) "long" structures for which the first or second derivative in one particular orientation is very small. One advantage of the Harris metric is that it does not require explicit computation of the eigenvalue or eigenvectors. However, computing the eigenvalues and eigenvectors for a 2 × 2 matrix requires only a single Jacobi rotation to eliminate the off-diagonal term, I_{xy}, as noted by Steger [39].

Our PCBR detector complements the previous interest point detectors. We abandon the Harris measure and exploit those very long structures as detection cues. The principal curvature image is given by either

$$P(\mathbf{x}) = \max(\lambda_1(\mathbf{x}), 0) \quad (4)$$

or

$$P(\mathbf{x}) = \min(\lambda_2(\mathbf{x}), 0) \quad (5)$$

where $\lambda_1(\mathbf{x})$ and $\lambda_2(\mathbf{x})$ are the maximum and minimum eigenvalues, respectively, of H at $\mathbf{x}$. Equation 4 provides a high response only for dark lines on a light background (or on the dark side of edges) while Eq. 5 is used to detect light lines against a darker background. We do not take the largest absolute eigenvalue since that would produce two responses for each edge. For our stonefly project, we have found that the patterning on the stonefly dorsal side is better characterized by the dark lines and as such we apply Eq. 4. Figure 1b shows an eigenvalue image that results from applying Eq. 4 to the grayscale image derived from Fig. 1a. We utilize the principle curvature image to find the stable regions via watershed segmentation [44].

3.3 Watershed segmentation

Our detector depends on a robust watershed segmentation. A main problem with segmentation via the watershed transform is its sensitivity to noise and image variations. Figure 2a shows the result of applying the watershed algorithm directly

Fig. 2 a Watershed segmentation of original eigenvalue image (Fig. 1b). b Detection results using the "clean" principal curvature image (Fig. 1c)

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IDEEN? FRAGEN? SONSTIGES?