
“In the next century, planet earth will don an electronic skin.
It will use the Internet as a scaffold to support and transmit its sensations”

[Neil Gross 1999](#)

An Open Architecture Approach:

Towards Common Design Principles for an IoT Architecture

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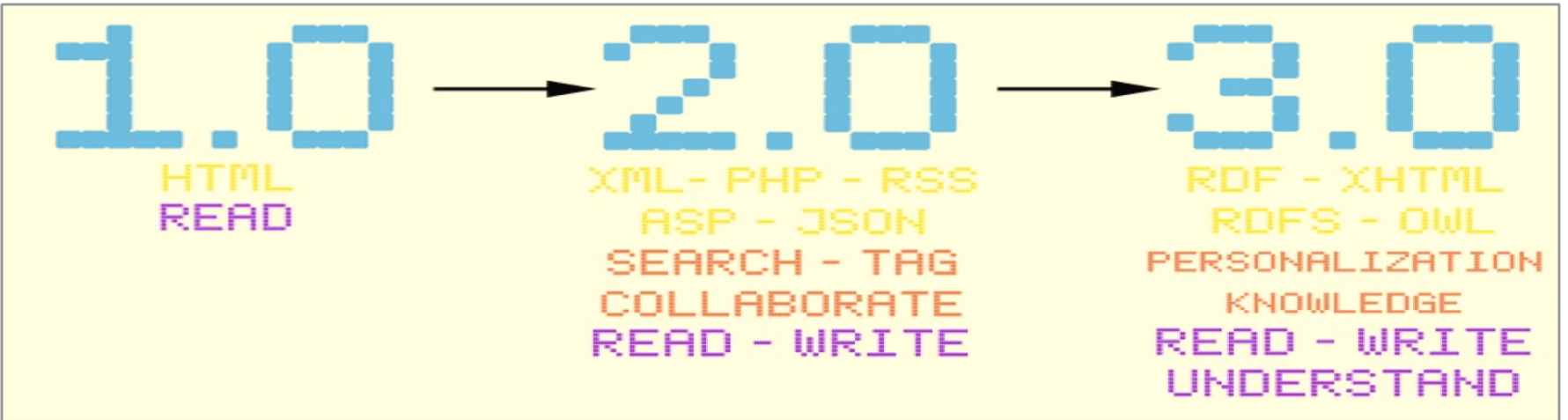
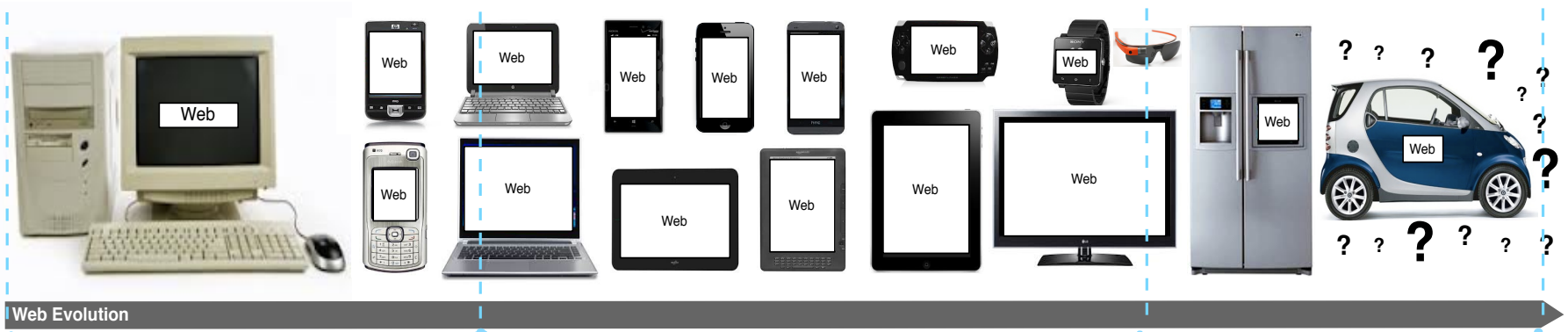


MALMÖ HÖGSKOLA

Miniaturization → diffusion

- Today there are more devices connected to the Internet than people living in the world
 - 1.8 d/p (2010), 3.5 d/p (2015), 6.6 d/p (2020)
- ➔ In the very near future, pretty much everything you can imagine will wake up and connect *people, processes, data* and *things* anywhere and anytime

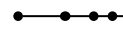
Web evolution: Technologies everywhere



Sharing

Contributing

Contextualizing



The power of Web



At Stake: IoT Platforms



- There are more than 300 IoT platforms in the market today and the number is continuing to grow.
- **Not every IoT Platform is an IoT Platform**

At Stake: IoT Platforms (cont'd)

- There are 4 types of platforms that are often referred to as “IoT Platform”:
 - **Connectivity / M2M platforms.** These platforms focus mainly on the connectivity of connected IoT devices via telecommunication networks
 - **IaaS backends.** Infrastructure-as-a-service backends provide hosting space and processing power
 - **Hardware-specific software platforms.** Some companies that sell connected devices have built their own proprietary software backend.
 - **Consumer/Enterprise software extensions.** Existing enterprise software packages and operating systems such as Microsoft Windows 10 are increasingly allowing the integration of IoT devices



Apples vs Oranges – Not all IoT Platforms are the same

- **The different types of IoT Platforms and the complex IoT Platform offerings create confusion**

At Stake: Mobile platforms (cont'd)

- Lots of smartphones



Android



iOS



Windows



Blackberry

- Lots of operating systems

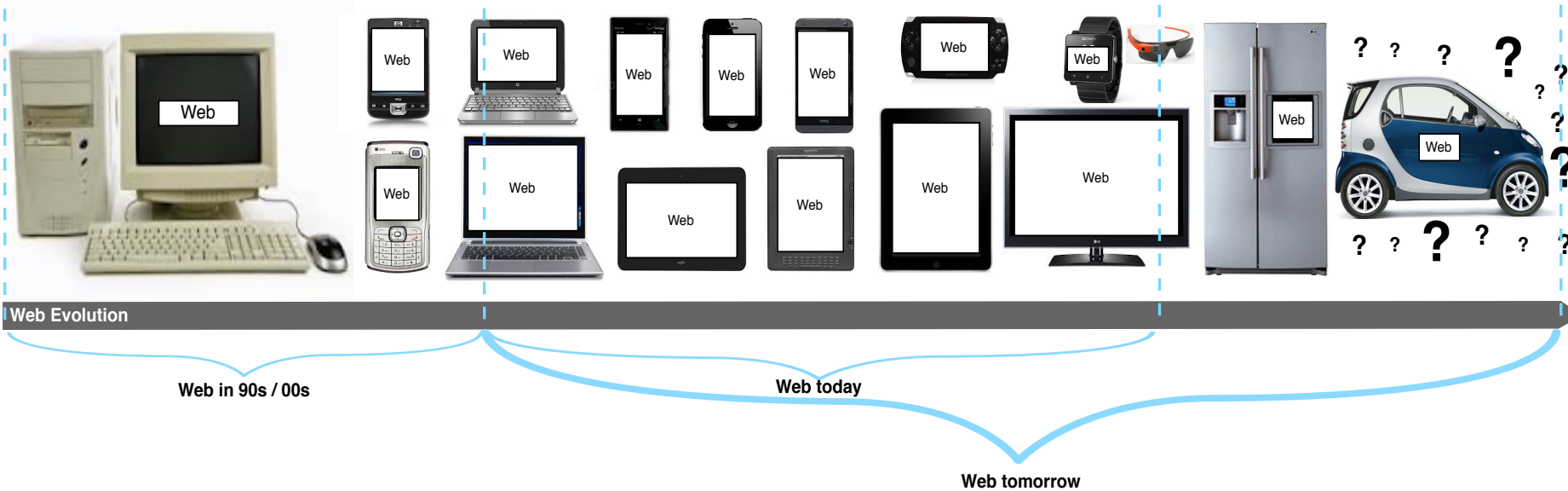
- Platform Fragmentation



- From OS fragmentations we are moving to Browsers fragmentation

At Stake (cont'd)

- These platforms are almost always based on different standards
- The challenge is more than just mo



- It concerns heterogeneity

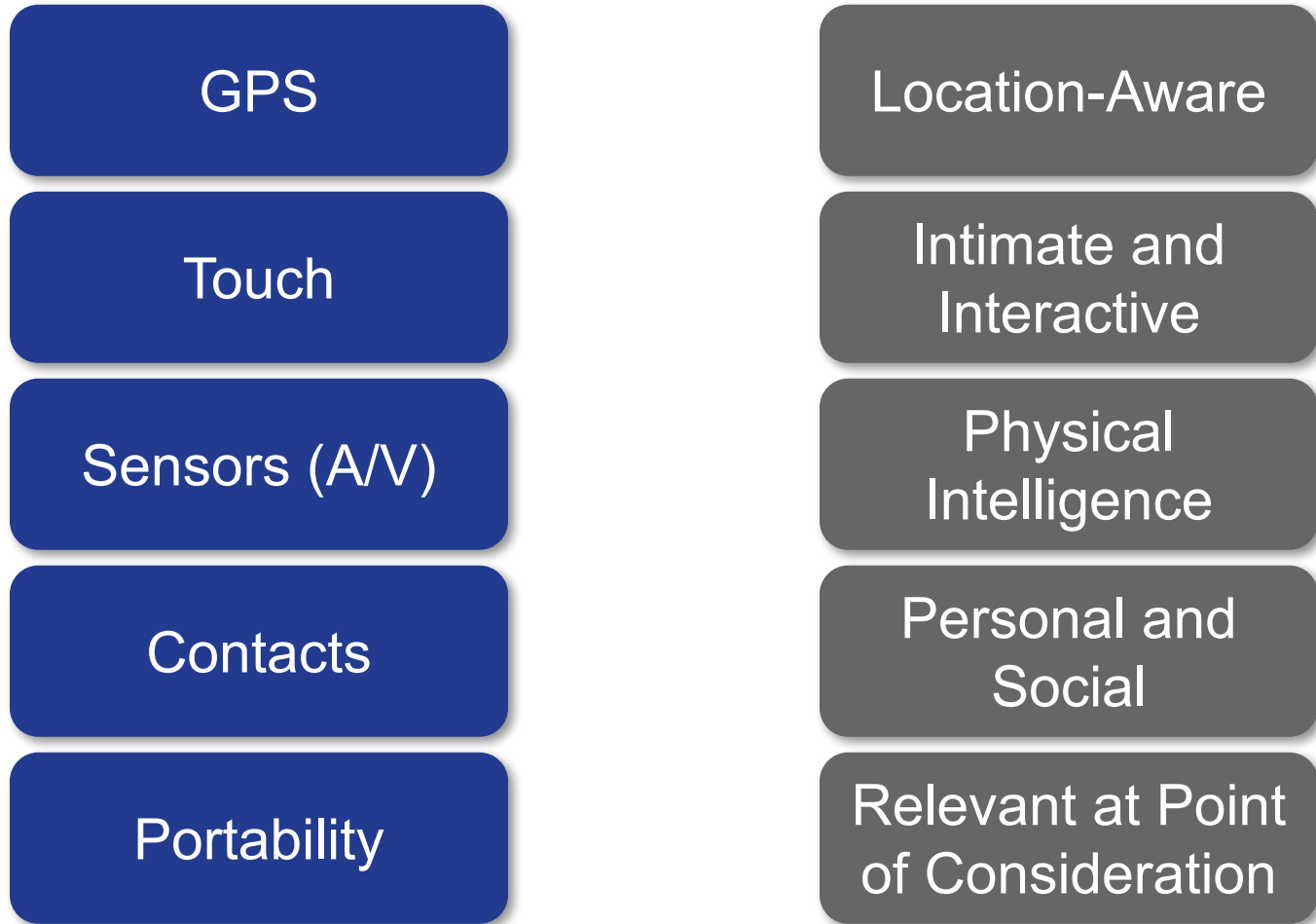
Diversity is not a bug..it's an opportunity 😊



Source: <http://stephanierieger.com/diversity-is-not-a-bug/>

Source: <http://bradfrostweb.com/blog/mobile/beyond-media-queries-anatomy-of-an-adaptive-web-design/>

Medium and Context

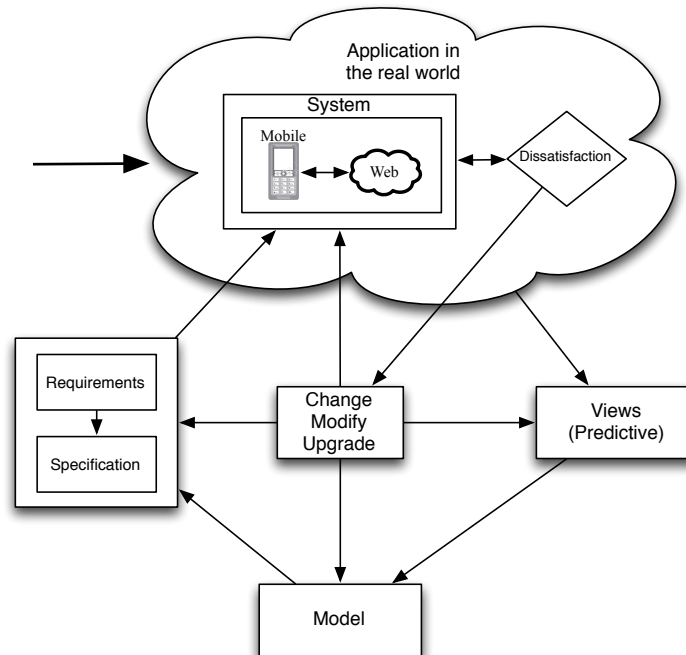


A worldwide computing environment

New Landscape



Dynamic Requirements and Uncertainties

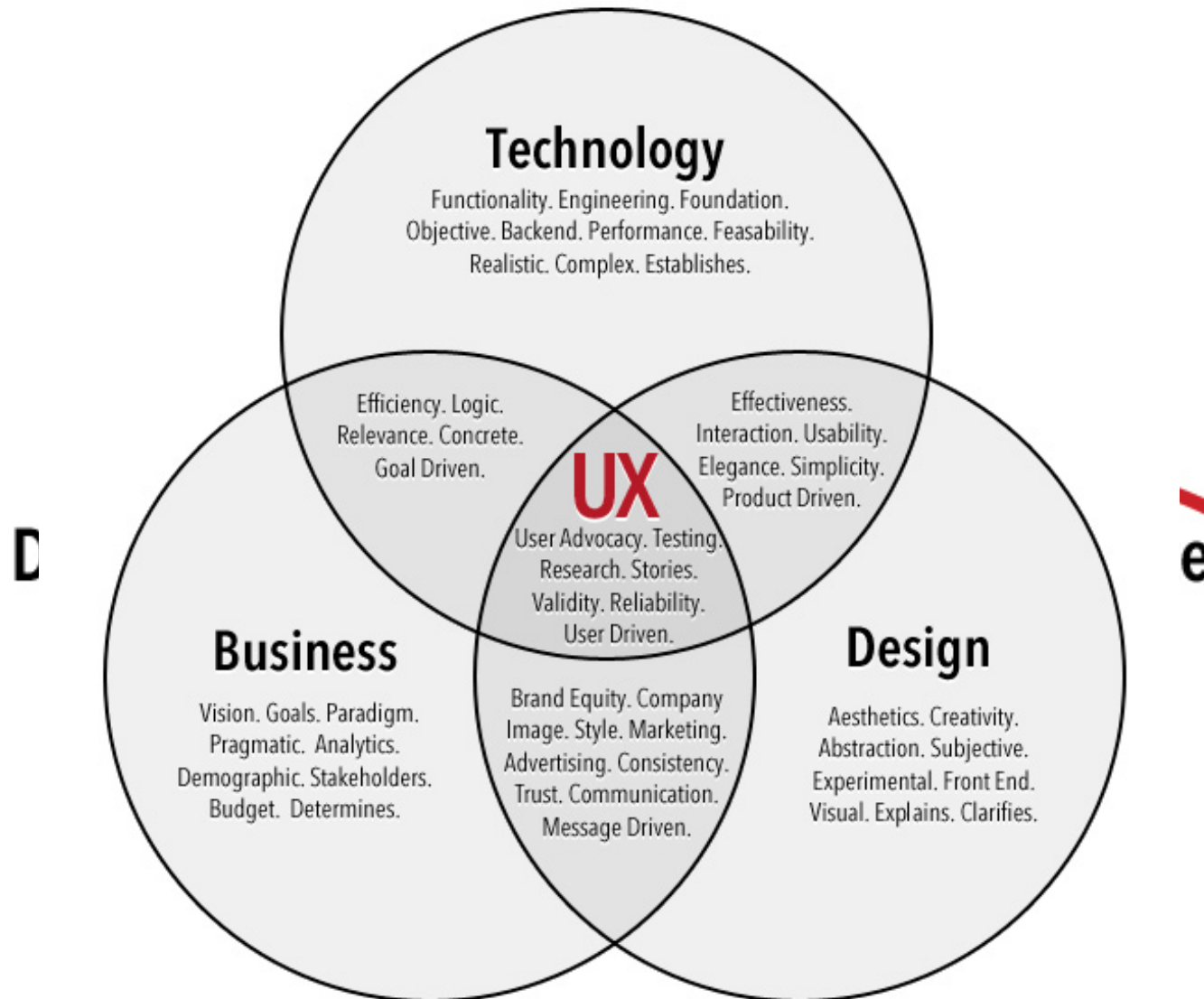


- Constant changes, modification and upgrade, users needs and the rapid evolution of technologies (Vogel, 2013)
- Uncertainty usually can lead to incomplete, unreliable, false results and may harm the longevity of the IoT system (Weyns et al, 2015)
- Uncertainty affects many dimensions, such as context, goals, models, functional and quality properties (Weyns et al, 2015)

B. Vogel. 2013. Towards Open Architecture System. In Proceedings of the 20139th Joint Meeting on Foundations of Software Engineering (ESEC/FSE 2013). ACM, New York, NY, USA, 731–734.

Danny Weyns, Mauro Caporuscio, Bahtijar Vogel, and Arianit Kurti. Design for Sustainability = Runtime Adaptation U Evolution. ECSAW '15, 62 (2015), 7 pages.

Iterative Process: User Experience design



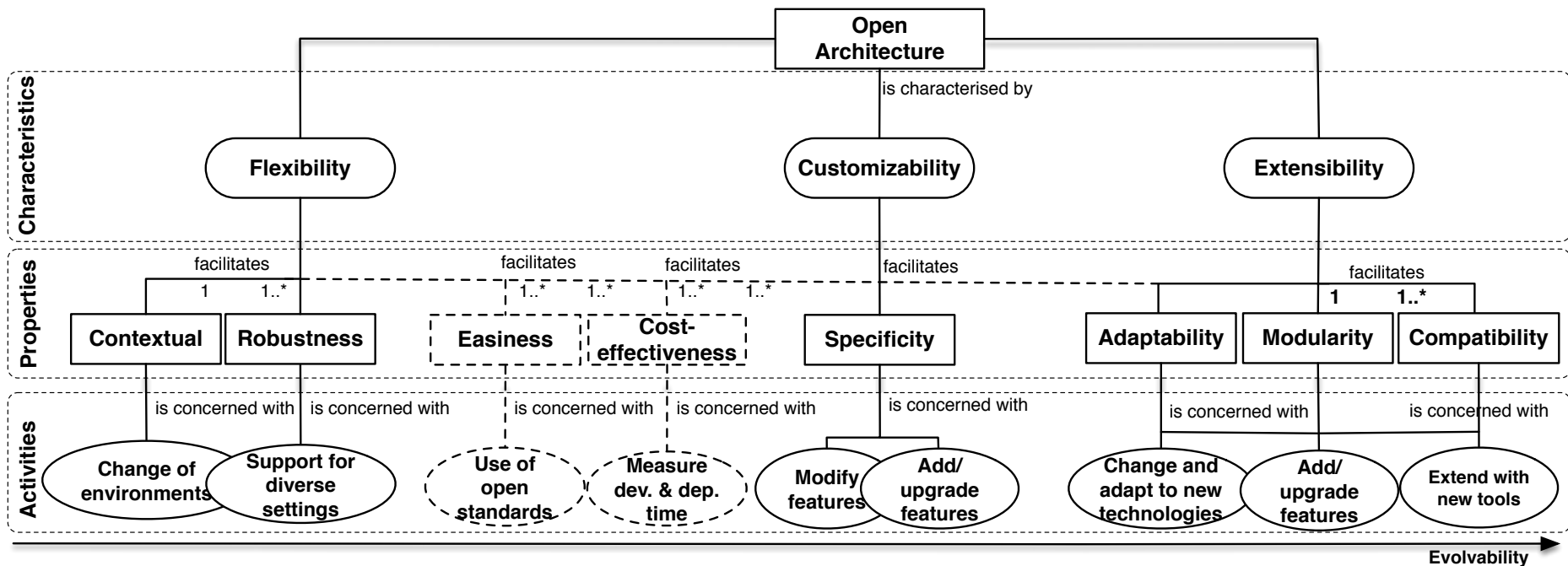
Towards openness: the open architecture approach

- Open architecture is characterized:



- system integration and data interoperability
- *grow and evolve over time* in terms of the new services, devices and subsystems attached to it.
- *service-oriented approaches* and modularity with *open source components* and *open standard data formats*
- that allow different platforms to easily address *dynamic requirements* by reducing development and deployment time.

Open Architecture design principles conceptualized



- The model is derived from the systematic literature review (Vogel et al., 2014)
- Further research is necessary in order to test and verify an open architecture approach in IoT by applying the abstract design principles to a practical realization.

Properties of Open Architecture Characteristics

	Flexibility	Evolvability	Customizability	Extensibility
Contextual	X			
Robustness	X			
Easiness	X	X	X	X
Adaptability		X		X
Cost-effective	X	X	X	X
Specificity			X	
Modularity		X		X
Compatibility				X



CHALLENGES

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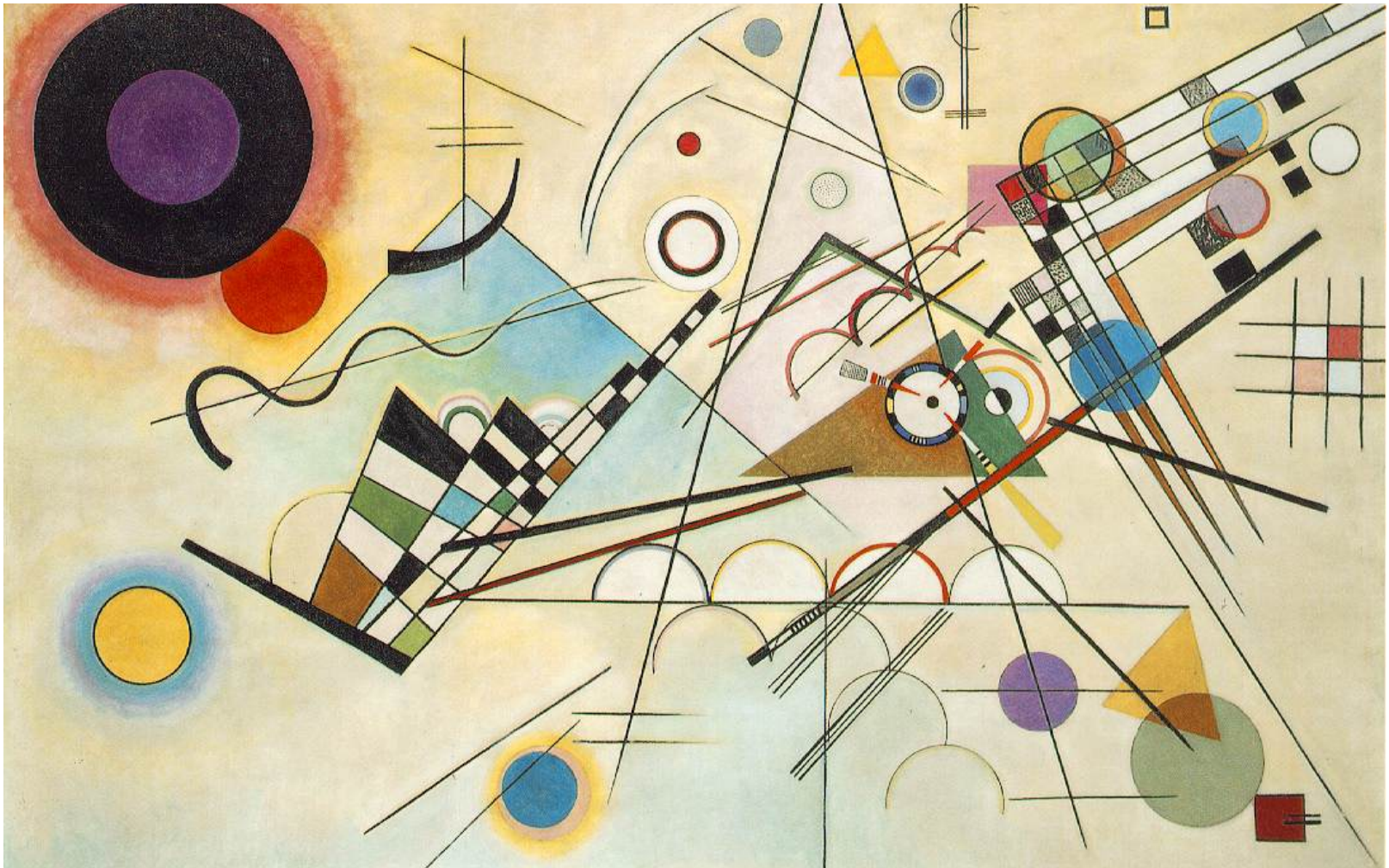
Standards



Big data



~~Engineering~~ - Composition



Kandinsky painting - Composition VIII (1923)



Don't think about how to build an **App or a Solution**
but
think about how to build a great **Service**