

# Toward a Web of (more than just) Things

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## ABSTRACT

In this paper we encourage the W3C and the web community to embrace a re-framing of the idea of a “web of things” to encompass a broader mission around people, places and things as first-class citizens, personal data ownership, service composition and harmonious user experiences built on the principles of today’s successful web model.

## 1. INTRODUCTION

The “web of things” sounds like a fine idea on its face — applying the core principles and practices of the web to the rapidly proliferating, increasingly connected and computationally enabled population of physical objects in the world. It is a simple and catchy phrase that communicates the general idea easily. However we believe it is an overly narrow formulation that understates the dimensions of the transformation at hand. Even at this still-early stage of development of ubiquitous computing and communications, it is clear we are talking about much more than just networked physical things. While today’s web has obviously had a tremendous impact on all of our lives, it pales next to the implications of pervasive sensing, computation, communication and actuation becoming inseparable elements of the physical world that we inhabit. As one of us wrote several years back:

“What if every time you turn on a device, pick up an object, walk through a room, cyberspace is all around you? What if cyberspace is oozing through the walls that once held it back, seeping out of the very fabric of reality? What if cyberspace is ‘out there’ in the network, and cyberspace also suffuses the world all around us, immersing us simultaneously in the physical and the hyperreal?” [1]

In this short paper we wish to encourage a thoughtful re-framing of the Web of Things concept to encompass a broader set of concerns; for lack of a better term, we will call it the Web of Things++, or Web++ for short. We believe that the Web++ should be based on the following pillars:

- People, Places and Things as first-class entities
- Personal data ownership and control
- Service creation through SOA-style composition
- Building on the web model
- Harmonious User Experiences

## 2. PEOPLE, PLACES AND THINGS

In the Internet of Things community, the term “things” has been used as a broad proxy for elements of the physical world. However the word privileges physical objects over other equally significant entities in the world, such as people and places. This bias is also reflected in the kind of developments we see in the IoT space, where physical devices and connected objects dominate the industry conversation. In our view, people, places and things are all first-class citizens of the connected world, each with its own set of unique characteristics, relationships and behaviors to be expressed in network interactions. People are

independent actors, creators and consumers of content and services, owners and users of places and things, subject to social norms, legal and regulatory regimes and embedded in complex networks of social and political structures and relationships. Places are geographic and semantic, private and public, socially constructed, discrete, contiguous or sometimes overlapped, container and contained; places are the stage upon which Web++ interactions take place. In addition to the well-represented class of Things, we believe that People and Places should be explicitly considered as essential elements of any framework for Web++ standardization.

## 3. PERSONAL DATA

Pervasive sensing and contextual awareness are central aspects of the connected world platform of Web++, and data about our lives will flow continuously through services. We believe in a regime where “you own your data” and we see the need for a set of principles along the lines of Pentland’s “new deal on data” (2): you have the right to possess your data, you should have full control over the use of your data and you have the right to dispose of or distribute your data as you see fit, while also it should be possible to aggregate anonymous data to be applied for the common good of society. Furthermore, the consequences of sharing data need to be clear to individuals; this will impact both service and device architectures to enable a consistent and safe environment to share information and personal data.

At the service level, we should address how individuals and dynamic collections of people inform decisions on services and personal data. There must be a common standard to ensure safe discovery and access just like with SSL for web commerce and secure transactions. In a system where People, Places and Things are constantly interacting there will need to be a clear protocol for discovering, updating and accessing profile information. Consistent with the WWW architecture, profile information at any given time will be an aggregate from multiple sources.

## 4. BUILDING ON THE WEB MODEL

When we talk about the next wave of pervasive technologies, we are not simply connecting things to the Internet. We are transforming the world we live in into a platform for applications, for services, for new experiences. In our view, the entire world is becoming the platform. This is one of the reasons we believe the web community has a crucial role to play — the world is heterogeneous, fragmented, chaotic, and by far the most difficult problem will be getting broad agreement on standards and conventions for interoperability among devices, services and systems. The web is the only example of a distributed system that has achieved true global acceptance, and we believe that leveraging web standards and protocols is the best and perhaps only way to establish a similarly open, global Web++ platform for the connected world. At a minimum, the design principles underlying today’s web should be carried forward: simplicity, modularity, decentralization, tolerance; globally unique, human-readable identifiers, orthogonality of identification, interaction &

representation, extensibility and evolvability; seamless discovery, recruitment and control. These are all things that the web community understands, but they cannot be taken as givens; we need to actively champion these ideas in the development of Web++.

## 5. SERVICE COMPOSITION

If the world is the platform, then all entities in the world – people, places and things — become potential service providers. Some of these services may be similar to today’s web services, complete solutions to specific use cases. However, many more will be component level services which provide specific, narrow functionality such as data streams from sensors or control services for actuators. Creating higher level combinations and abstractions will require a common approach to service composition; one early example of this is IFTTT [3] which enables combinations of two distinct services using simple if-then logic. We believe that specification of an extensible approach to restful APIs and modular SOA-style service abstraction could be an appropriate task for the W3C community.

## 6. HARMONIOUS USER EXPERIENCE

Harmony with our mental capacity to absorb input and our physical surroundings must be at the core of any major building blocks for human interaction or information display. At the user experience level, we believe there is a need for new design principles that speak to how the connected world platform co-

exists with our daily physical lives. One early attempt to define such principles was made by Greenfield in the book *Everyware* [4]. Greenfield asserts that “everyware” must default to harmlessness, it must be self-disclosing, it must be conservative of face, it must be conservative of time and it must be deniable. While these principles are incomplete and perhaps infeasible in practice, this is a debate we need to have and the W3C community is a good place to have it.

## 7. REFERENCES

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