Accessibility and the Web of Things

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Abstract

This position paper outlines accessibility implications in the Web of Things from two perspectives:

- Users who are persons with disabilities that affect how they interact with web technologies;
- Public and private organizations which provide products and services to persons with disabilities.

It offers important considerations for the web standards community to incorporate accessibility consistently throughout the stack of web technologies and applications built using these technologies.

Introduction

The Web has the potential to provide unprecedented opportunities for people with disabilities to have equal access to information, as recognized by the UN Convention on the Rights of Persons with Disabilities (CRPD). This includes people with auditory, cognitive, neurological, physical, speech, and visual disabilities. The Web facilitates equal participation in society, including access to education, employment, civic participation, entertainment, social interaction, and much more.

The Web of Things elevates these potential opportunities to yet new levels. Mobile devices are increasingly being used to access the Web, including by people with disabilities. These allow access to services on the go and allow customization to specific individual needs and preferences. Internet-enabled sensors and actuators are also increasingly being deployed in the physical world. This opens new possibilities to further blend data from, and control interaction with the physical world via the Web. While for most people a web of things is but another option for interacting with the physical world, for many persons with disabilities an accessible web of things can provide interaction and control opportunities that would otherwise simply not be possible

However, it is not yet clear whether the Web of Things will prove to be of service and allow people with disabilities to function more effectively at home, work and at play, or whether it will erect yet another series of barriers to participation in society. While the outcome may be unclear today, the danger is already evident because the default situation, device by device, and technology by technology, is not

inclusive.

Thus, making the Web of Things accessible to people with disabilities will require both a vigilant application of existing, well recognized standards (especially ISO/IEC40500, developed by, and better known as W3C/WAI Web Content Accessibility Guidelines (WCAG) 2.0), as well as the development of new solutions, including technological, regulatory, security, and privacy solutions. In particular, it requires consistent functional support for accessibility throughout the Open Web Platform.

Use cases

1. Accessible device discovery

Scenario: A blind home owner is shopping for an accessible, Internet connected thermostat and has found several options, including one from her electrical utility that offers to reduce her monthly electrical service charges. But, which option is accessible today? And which one can she trust to stay accessible through software updates on the device and on the cloud service tomorrow?

Generally speaking, there's no way to know whether any particular device today will be accessible off the shelf. Neither the box the device comes in, nor the web marketing announcements, nor technology industry news reviews inform today's person with a disability whether, or not any particular device interface is accessible, despite the fact that this characteristic is quantifiable and knowable. The user is left to gamble on a purchase or do without. If the device UI proves to be accessible today, there's no guarantee it will remain so following the next software update. It's called cloud service, but is actually an ongoing commercial relationship the user must also gamble on. The vendor controls the UI and generally makes no representations on whether it is accessible. And, if it is accessible today, there's no guarantee it will be accessible following the next web site update.

Use case: Well-defined accessibility principles help manufacturers to make devices accessible. This applies to the hardware itself and to the user interface, particularly when exposed as web content. These principles also help third parties to efficiently evaluate and rate devices, enabling informed purchasing decisions by users.

The advantage to the blind home owner, should the interface prove to be accessible, is clear. The traditional, on the wall, stand-alone thermostat has never been accessible, except that occasional specialty models are sometimes produced. The builtin UI is unlikely to be accessible, but there is ample reason to expect that a web-based UI could be accessible. This direct access to data and controls through a standard browser would provide accessibility where none existed heretofore, both on premises and on the go.

2. Alternate controllers

Scenario: The user above has been fairly lucky this time. She has discovered that, while the thermostat she bought does not provide an accessible interface on the unit itself, or even an accessible browser interface to the device, it is supported by an accessible app available for her mobile phone.

Use case: Devices that participate in the Web of Things are increasingly able to communicate with one another, generally via APIs. While this enables the energy savings described in the scenario, it also permits the use of alternate controllers. In order to control the thermostat, the user installs an accessible desktop or smartphone application. This eliminates the accessibility gap and allows them to take full advantage of the device.

In principle, this application could be provided by either the device manufacturer or by a third party, even the user herself. This requires open protocols and data formats allowing the alternate controller to connect to, control, and receive information from the device. While that ability is part of the definition of the Web of Things, the formats need to provide enough detail to allow meaningful data interchange. This may be by universal formats, device-type formats, or well-documented manufacturer-specific formats.

3. Universal controllers

Scenario: While the user has found an accessible application to control the thermostat, that's all this app does. Other apps are needed to support the home security and electrical system. Therefore the user is unable to take advantage of some of the energy-reduction savings possible by controling the thermostat in tandem with her other home control devices. Moreover, she undergoes the same accessibility concerns with each separate device.

Use case: The vision of universal controllers has existed for a long time. A single controller able to interface with multiple devices allows users to reduce the number of controllers they manage, and requires them only to learn the user interface for one. In fact a fully elaborated, transport independent specification for such a controller is already available as ISO/IEC24752.

In the Web of Things context, a universal controller need not be merely one controller for multiple devices, but is logically positioned to manage interaction among those devices. Therefore the full benefit of communication between thermostat, lighting system, and security system can be realized, allowing the user to set parameters for each device based on the state of other devices.

In tandem with the alternate controller model above, users can select a universal controller that is optimized for their accessibility needs. A set of different devices participating in the Web of Things and supporting custom accessible universal control opens a new dimension of environmental control and independence for people with disabilities.

4. Health monitoring

Scenario: A person with a metabolic disorder, such as diabetes or mitochondrial disorder, uses monitoring devices to determine when medication is needed. The amount of medication varies with activity level, food consumption, and other variables in the individual's daily life. Occasionally he receives too little medication and undergoes metabolic shock requiring emergency medical treatment.

Use case: A metabolic status monitor participating in the Web of Things can factor additional available data into its alarm algorithm. The time and nature of food eaten may be available from a smart refrigerator; activity level may be available from

exercise trackers or environmental sensors. Together with direct measurement, this allows more accurate judgement on timing and amount of medication suggested. In emergency situations, the monitor can use location data to contact the nearest emergency service and provide information to support quick and appropriate treatment.

5. Safety monitoring

Scenario: An individual with age-related cognitive impairment, brain injury, or developmental disability is unable to make some decisions that are important to personal safety. He may forget where he is and wander off, walk into traffic, or be excessively trusting of strangers. This person lives in an assisted living facility or with family, but desires more independence.

Use case: Networks of personal and environmental monitors participating in the Web of Things provide automated detection of unusual or dangerous behavior. Some of these monitors may be dedicated to providing independence to the individual, such as location-tracking ID bracelets. Others may simply be available services of other devices used primarly for other purposes, such as a door passage indicator in a security system, or a coffee maker that knows its usage pattern. Working together, these devices can detect if a user has left the premises and could be in danger as well as provide the ability to locate them; or they can detect if a pattern has changed such as not making the morning coffee, suggesting the need for a check-in. These forms of monitors are less intrusive than devices like cameras, and can provide independence from assistive living facilities or dependency on family.

6. Increased accessibility in public spaces

Scenario: Some users need particular accessibility services to be available in public spaces. For instance, people with mobility impairments need to find and operate the accessible entrance to a building. A blind person needs a talking bank machine. A deaf person needs a caption / description display when watching a movie in a theater with friends. These accessibility features increasingly exist, but can be hard to discover, and are not always optimized for an individual's particular needs.

Use case: Personal tokens that can distribute (with appropriate permission) accessibility requirements to the environment is a long-standing vision in the field of accessibility. The Web of Things enables a general-purpose version of this model to emerge. An individual carries a device (presently, likely a smartphone) that is able to communicate relevant requirements to other devices in the environment. Other devices can adapt their interaction appropriately. A user in a wheelchair following a map to a building is automatically directed to the accessible entrance, and the door automatically opens as they approach, and remains open if they require extra time to pass through. A blind person approaching a bank machine automatically accesses the talking interface without searching for it. A deaf person attending a movie can access the movie's synchronized description on their tablet computer. The ability for devices to communicate with each other opens vast new possibilities in environmental customization.

Conclusion

Throughout the world a host of private and public agencies exist to assist persons with disabilities in various ways. These include schools for children with disabilities, rehabilitation centers for adults with newly acquired disabilities, and senior centers devoted to enhancing quality of life for aging populations--people who often resist self-identifying with disability, even though they encounter the same challenges.

The web of things will revolutionize much of the work of these organizations in ways we can only glimpse today. Living spaces equipped with numerous sensors provide one likely example. Setting automated monitoring services to constantly look for anomalous behavior in clients resident in these spaces, and flagging anomalies for followup by agency case workers will help agencies (and families) respond when aging parents might need assistance.

The web of things holds promise for persons with disabilities. By merely making UIs accessible it can provide accessible functionality where none was available before.

- It will be necessary to explore customized UIs which will be more appropriate not only to overcoming the functional limitations imposed by particular disabilities, but which are situation aware and which can adapt to provide information adapted to user needs, e.g. the person using a wheel chair will likely be uninterested in discount coupons to restaurants nearby that can only be entered by climbing stairs.
- Regulatory requirements for accessible UIs on various classes of web of things devices and services will need to be developed, because there's no evidence that industry will simply do the right thing on its own.
- As a web of cloud services, the web of things is also emerging as a web of ongoing business relationships. This needs to be acknowledged and appropriately regulated.

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Making the Web, including the Web of Things, universal and available to all people, "*whatever their hardware, software, language, culture, location, or physical or mental ability*", is a dedicated goal of the W3C. The W3C Web Accessibility Initiative (WAI) develops, in coordination with other parts of W3C, strategies, guidelines, resources to make the Web accessible to people with disabilities. This paper is provided with support from the European Commission funded WAI-ACT Project, a project of W3C/WAI.