# Creating a Global Public Inclusive Infrastructure

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**Abstract.** As we move more to a digital economy and integrate technology every more completely in all aspects of life there is a looming crisis for a growing number of increasingly marginalized individuals. The accessibility technologies we have are meeting the needs of only some, at high cost – and will not work with many new technologies. In addition, the pace and path of technological change predestines these approaches to fail in the very near future. At the same time, the incidence of disabilities is increasing as our population ages. The same technical advances however hold the key for a radical paradigm shift in our approach to accessibility that can harness the pace of innovation and have it work for us rather than against us. Proposed is the development of a Global Public Inclusive Infrastructure (GPII) that can tap the unprecedented ability to pool resources and match demand with supply enabled by the Cloud to deliver accessibility to every individual where they need it, when they need it and in a way that matches their unique requirements; automatically so that they do not need to negotiate, explain, qualify or justify.

**Keywords:** digital divide, universal design, cloud computing, personalization.

## 1 Introduction

### 1.1 The Need and the Background

There is a pressing need for a paradigm shift in access to ICT by people with accessibility problems due to disabilities, literacy and aging. Our current model works well for some but is not able to reach many others.

- We are not reaching but a fraction of those who need access technologies – yet access is rapidly becoming mandatory for participation in education, employment, commerce, civics, health and safety.
- We do not have good solutions for many types, degrees & combinations of disability, or functional limitation disabilities including, particularly combinations

C. Stephanidis (Ed.): Universal Access in HCI, Part I, HCII 2011, LNCS 6765, pp. 517–526, 2011.

and cognitive, language, and learning disabilities and the combinations that come with aging.
- Many individuals are excluded from special services because they do not fit the current definitions of disability and yet they face significant barriers to accessing ICT.
- In addition, access solutions are hard to find & find out about; many who need access solutions do not know that any solutions exist – so it doesn't occur to them to even search for one.
- As new equipment and devices are developed at a rapid rate, choosing the AT and ICT that best matches the needs of an individual can be intimidating or impossible for many.
- We do not have access technologies that are affordable (not only for users but even for public access points and governments) and yet will work with the latest technologies on the web. The cost of assistive technologies is increasing, while the functionality, reliability and availability are decreasing. The opposite is true for mainstream ICT.
- The technology world is changing such that many of our current approaches for delivering accessibility will soon not be effective (Cloud computing, Web 2.0, 1 million authors of next generation applications).
- Even what we have is so complex that parents, users, teachers, librarians but also public access points, companies, and even governments that must deal with it, set it up, maintain it, etc. are just not able to do so effectively or at all.

These problems are not because there are no companies in this field that are interested in lower cost products or expanding their sales deeper into the market. There are, but they are unable to address the problems above using the model we currently have, no matter how much effort is expended. The model works well for about 15%-20% market penetration with a stable technology landscape. But companies using this model can't provide access to all or even the super-majority (as is now needed) or survive the multi-platform technology environment that is rapidly emerging [1].

Yet it is not possible to solve the problem without industry. The problem is simply too big to be addressed purely with government and philanthropic efforts. The cost would be enormous – beyond the will of societies. It is therefore necessary to find a way to facilitate the private commercial sector efforts; help them reduce costs and grow their markets to cover as much as possible, while ensuring that those they cannot reach also will have access. The commercial sector, mainstream and AT, must be enabled to cover as much as possible. And methods must be found to reach the rest without jeopardizing the commercial market.

A new approach is needed that can address the underlying problems of:

- limited market penetration,
- high cost for marketing, distributing and supporting assistive technologies,
- high cost for development of new approaches,
- high cost of just keeping existing technologies working with ever-changing ICT and web technologies,
- difficulties faced by new innovators in developing alternate and innovative solutions and getting them to market, etc.

If we can substantially improve accessibility over the next ten years, we will open up access to, and improve the use of, ICT products and services in general (whether eCommerce, eGovernment, eHealth, eCulture, or Internet banking) and make opportunities available for the elderly and for people with disabilities (i.e. to make online job applications, use job-matching platforms or eLearning applications). If we don't, the lack of accessibility or even maintenance of the status quo will further compound social exclusion, its improvement can contribute to greater social inclusion (better access to health and public services, improved employability and productivity, increased embeddedness for individuals in social relations and networks, and more).

The new approach also needs to make it much easier for users to:

- discover there are solutions to their problems,
- determine what types of access features or technologies would address their particular problems,
- locate specific solutions, and
- get these solutions delivered and set up on their computer(s), phone(s) and other devices.

Moreover, it needs to allow them to access and use these solutions not just on a single computer or two, but on all of the different computers and ICT that they encounter and must use (in different classrooms and laboratories, at home, at work, and the community, when traveling, etc.).

## 2 The Global Public Inclusive Infrastructure (GPII) Initiative

To address these issues, an international coalition of organizations and individuals is coming together and proposing the development of a global public inclusive infrastructure (GPII). The GPII would consist of enhancements to platform and network technologies to create an infrastructure that would simplify the development, delivery and support of access technologies and provide users with a way to instantly apply the access techniques and technologies they need, automatically, on any computers or other ICT they encounter. (A video short introducing the concept is available at http://GPII.net)

In specific, the proposed GPII aims to:

1. **Simplify accessibility** for users, schools, public access points, organizations, companies, governments, etc.
2. **Increase built-in accessibility** in those places where it is practical and effective, to provide ubiquitous access that is natural, doesn't have a stigma, and doesn't 'tax' individuals with disabilities by causing them to pay more to access the same ICT as their peers.
3. **Grow the market for assistive technologies and services**, in order to serve more people, lower costs, and increase motivation to innovate and invest in accessibility.

4. **Facilitate international, public-private, private-private and cross sector collaboration** in order to lower costs, to reduce duplication and to accelerate innovation.
5. **Increase the number of new ideas and products that make it to market** – and make it easier and much less expensive to market them internationally.

### 2.1 The GPII Concept

The functionality of the GPII is based upon the creation of an explicit and implicit user profile (kept either locally or in the cloud; depending upon user preference), that automatically matches mainstream products and services with necessary access features and configures them according to users preferences and context of use, anywhere (any device the person encounter in any location) on any device (PC, mobile, smart phone, iTV,…), seamlessly and holistically (configuring both content and user interface) including augmenting the accessibility of the product if needed (through special web applications, cloud based AT, cloud based desktops, run without AT installation or with download and AT installation).

The situation before and after GPII is graphically depicted in example form in figures 1 and 2.

**Before GPII**


**Fig. 1.** One example is kiosks and fare machines. Here an individual cannot read the text on the screen due to font size and contrast.

**With GPII**

**With GPII**


**Fig. 2.** With GPII the interface will adapt to the user automatically based on the user needs profile on a card or in the cloud, in this case providing a larger, higher contrast display.


**Fig. 3.** Major components of the GPII concept. (long description).

### 2.2 GPII Components

The major components of the GPII Concept as it is currently conceived are shown below. [2]

The GPII concept is based on three pillar functions (or legs):

1. Providing a way for people to easily learn about, and determine what solutions/features would help them and then to store that information in a common, portable, private, and secure manner.
2. Providing a way to use their stored preferences (and permissions) to invoke and configure the accessibility features, assistive technologies, and/or services that they need - anywhere, anytime, on any device they need to use.
3. Providing the tools and infrastructure needed to allow diverse developers and vendors to create new solutions for these different platforms and easily and cost effectively move them to market and to users internationally.

Each of these 'pillars' is in turn composed of 5 components as detailed in figure 3.

## 3 Profile-Based Interface Design

Designing user interfaces for specific user profiles is not a new concept. Human-centered-design and user-centered-design are founded on this premise. However historically the user profile has been a profile that reflects a class of user or a representative persona (the user who is blind, the typical housewife). This presents a problem for individuals who do not fit into these profiles or whose unique needs are not expressed in the profile. Only a few disjointed efforts, primarily in the education domain, have increased the granularity of the profile to the individual user, making it possible to achieve one-size-fits-one.

Most of the state of the art has laid the groundwork for this area but is based on ***disability user groups (as a whole)*** or provide profiles only for ***a specific application***

***domain*** and do not provide the individual personalization schema and tools (that can be applied across domains) that are needed for this work.

Specific examples include:

1. Personas as a design tool were initially introduced by Alan Cooper in 1999 [3] to humanize the design process, to build consensus in the design team and to measure the design's effectiveness.
2. The BBC MyDisplay [4] uses pre-set themes that address common disability groups as groups.
3. A number of EU projects have provided disability specific personas and ontologies such as the EU FP6 ASK-IT project [5] and the FP7 running projects AEGIS [6] and ACCESSIBLE [7] but again are mostly disability group oriented.
4. Four European FP7 research projects (GUIDE, MyUI, VERITAS, VICON) have teamed up to form the VUMS cluster [8], to develop a common methodology for user profiling, including a user profile standard. These again are focused on user-profiling using disability groups - that provide information useful to this effort but do not provide the individual oriented profiling needed by this effort.
5. FP7 OASIS project (Open architecture for accessible services integration and standardization), has implemented appropriate ontologies describing common disability user groups and their needs in Ambient Assisted Living (AAL) environments,
6. AccessOnTo [9] and Van Heijst [10] propose and use ontologies in the accessibility requirements specification process,
7. The Inclusive Learning Exchange, TransformAble and the AccessForAll Infrastructure projects led by the IDRC provide one-size-fits-one design and delivery in the education domain [11].
8. The Floe project is developing personalized learning infrastructure for Open Education Resource delivery globally and will contribute to Cloud4All [11].

What does not exist is a means of creating profiles for design and delivery that acknowledges that everyone is unique and can be applied in all contexts.

### 3.1 Personalization of Product User Interfaces

Personalization of the user interfaces of specific products or functions is also not new. Most applications and devices include preferences, user options or settings. There are also several utilities that specifically address personal accessibility requirements for a given product or platform. Most applications also offer user preferences that persist from session to session. However, there are no applications or initiatives that enable preference portability across applications, platforms, devices and contexts (e.g., automatic configuration of user interfaces of workstations in libraries, online booking systems, kiosks, ticket machines, and computerized appliances).

Specific examples of device or platform specific personalization include:

- the Multireader for delivery of accessible ebooks [12],
- most browsers and Web applications (which retain user preferences from session to session,)
- Web search utilities that use metrics of the current user and past users to customize content delivery (e.g., Google search),

- Web4All in Canada provided portable preferences profiles on a USB stick or smartcard that would enable the automatic personal configuration of a multi-user workstation including the operating system, browser, installed assistive technology and peripheral settings [http://web4all.ca]. This only worked on a closed set of specially outfitted computers and only with a small set of pre-installed AT.

What does not exist is a general infrastructure that enables personalization that can be applied to any user interface a user may encounter.

### 3.2 Standards and Specifications for Personalization

There are several standards and specifications efforts that have attempted to capture the interoperability issues that must be addressed to achieve the type of personalization proposed. These are currently either limited to a specific application domain (i.e., education), tackle the problem from different but not harmonized perspectives, prescribe implementation that is outdated or not applicable, or leave large gaps and uncertainties in the areas that must be interoperable.

Currently there is also no clear means of managing the relationship between the context of use (e.g., at home, while parenting, with slow computer and attending to children, vs. while travelling in a foreign country and using a mobile device, vs. in the office with a high powered network and fully loaded workstation but noisy colleagues) and the variations of personal preferences. To deliver this solution anywhere, anytime and on any device requires harmonization of these multiple disjointed efforts.

Some of the notable efforts in this area include:

- ISO EN 1332 which attempts to standardize user profiling, but in broad categories;
- ETSI ES 202 746 (Feb. 2010) lists a broad vocabulary for user profile data, and covers a wide range of user and device capabilities;
- ISO/IEC 24756:2009 introduces a model for describing a user's needs in relation to a system's affordances, by the notion of "channels" and "filters";
- ISO/IEC 24751:2008 parts 1, 2, 3 defines a framework and XML-based vocabulary for personal user profile data, has been implemented in projects such as Web4All, TILE, TransformAble, Fluid, AccessForAll Ontario and Scholar's Portal and is currently being revised to reflect future developments, including the global GPII effort. [13]

Former standardization work on context profiles includes W3C CC/PP (Jan. 2004), the Delivery Context Ontology draft (June 2009), and CEA-2014 (September 2010).

What is needed is harmonization of disparate standards and resolution of gaps, including standards to cover context and new application domains.

## 4 GPII Architecture

In this section we briefly outline the basic architectural components that will be explored and developed in GPII.

The different components of the **Basic Cloud4All operation** is shown in the following figure and are as follows:

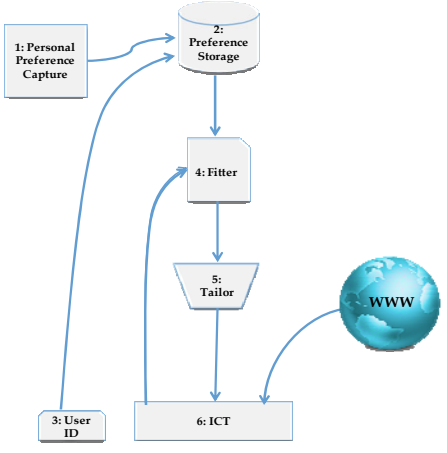


**Fig. 4.** Basic GPII operation

1. Personal Capture Mechanisms (different types)
2. Preference Storage Mechanisms (cloud, USB, other)
3. Mechanisms for person to ID themselves to the server (but not necessarily to the device)
4. Fitter that determines the settings for the ICT (based on settings and other factors)
5. Tailor that configures ICT (or content) to fit the user's needs (often part of the ICT itself)
6. The adapted ICT (including built-in features and built-in AT

The procedure followed is decomposed to the following steps:

1. User preferences are gathered;
2. Then stored for later use;
3. The person ID's themselves to the server (but not necessarily to the device);
4. The preferences go to a Fitter that determines the settings for the ICT;
5. The Tailor configures ICT to fit the user's needs as instructed by Fitter;
6. The adapted ICT accesses the Web or whatever its function.

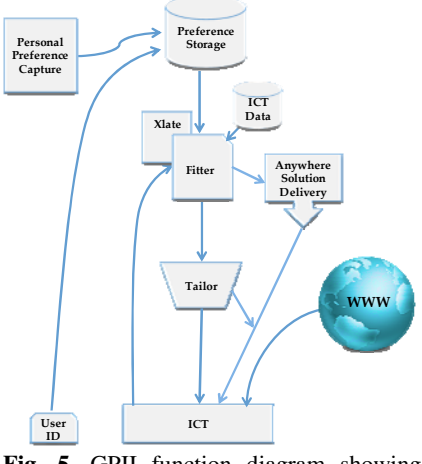


**Fig. 5.** GPII function diagram showing advanced components

**(Alternate step 5& 6): The tailor alters the content on the web or causes alternate form to be served to the ICT.*

The full GPII system however involves more than just statically adjusting features that already exist on the ICT. In addition the final GPII system will use contextual information, and information about the target device to adjust the interface and materials to better meet the users needs on that device, carrying out that task, in that environment. The ability to translate preferences from one platform to address another will also be provided to allow users to access new devices (computers, operating systems) or different resolution screens than they have encountered before. The GPII will also have the ability to call up additional accessibility functions from the cloud and bring them to bear on the problem. Figure 5 provides a diagram with these functions in place.

It is important to note that the "components" shown above are functions and not separate devices or even necessarily separate services. All of the functions in figure 5 may be embodied in a single device or mixed and matched in almost any configuration. Almost all could be housed in a mainstream device itself. All of them, or parts of them, could reside in the cloud, the ICT or in a USB device. A particular instance may rely heavily on the cloud or not involve use of the cloud at all. Figure 6 shows some different cases illustrating ways the functions may be housed and implemented.

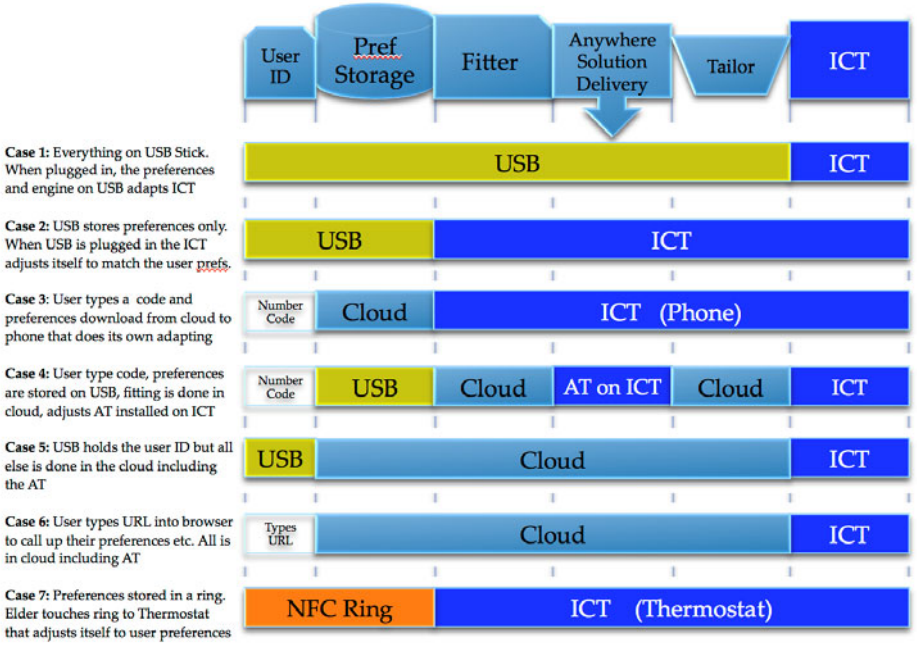


**Fig. 6.** Different embodiments of the 5 core components of GPII showing that the components could reside in many different places including the cloud, the ICT or in a USB device

## 5 Conclusion

The GPII is both a synthesis of existing ideas and approaches for interface and material personalization, and a paradigm shift in how we address access issues and provide universal access to ICT for people who face disability, literacy or aging related barriers. It is still in its conceptualization, development and testing phase. It has however generated much interest and participation due to its potential for providing access across the full range of disabilities and delivering access to those who have limited resources. This includes both those in developing countries and those with limited resources and program connections in developed countries as well. The coalition that is exploring and building the GPII is looking for existing projects,

programs and individuals interested in collaborating on the development and/or testing of the concepts involved. For more – see http://RaisingTheFloor.org and http://GPII.net.

**Acknowledgments.** This paper is based on sections of the CLOUD4All proposal. We thank the following for their contributions (in alphabetical order), Evangelos Bekiaris, Maria Gemou, José Ángel Martínez, Roberto Toreno, and Kostas Votis.

The contents of this paper were developed with funding in part from the National Institute on Disability and Rehabilitation Research, U.S. Department of Education, grant number H133E080022 (RERC on Universal Interface and IT Access), The Andrew W. Mellon and William and Flora Hewlett Foundations. However, the contents do not necessarily represent the policy of the funding agencies, and you should not assume endorsement by the Federal Government.

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