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Wayfindr

Accelerating the Adoption of Indoor Audio Navigation with a Standard User Interface

Global Initiative for Inclusive Information
and Communication Technologies

Wayfindr

Accelerating the Adoption of Indoor Audio Navigation with a Standard User Interface

A G3ict White Paper Innovation Series

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Acknowledgments

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G3ict White Paper Innovation Series

The G3ict White Paper Innovation Series documents innovative accessibility solutions and good practices with real-world case studies for users and organizations seeking to improve the accessibility of their information technology, applications and services.

About G3ict

G3ict, the Global Initiative for Inclusive Information and Communications Technologies was launched in December 2006, in cooperation with the Secretariat for the Convention on the Rights of Persons with Disabilities at UN DESA. Its mission is to facilitate and support the implementation of the dispositions of the Convention on the Rights of Persons with Disabilities in promoting e-accessibility and assistive technologies.

G3ict participants include industry, the public sector, academia and organizations representing persons with disabilities. G3ict relies on an international network of ICT accessibility experts to develop practical tools, evaluation methods and benchmarks for States Parties and Organizations of Persons with Disabilities. G3ict is the home of the International Association of Accessibility Professionals which counts more than 1,200 active members in 41 countries.

Since inception, G3ict has organized or contributed to more than 150 awareness-raising and capacity-building programs for policy makers in cooperation with international organizations such as the ITU, UNESCO, UNITAR and the World Bank. G3ict co-produces with ITU the “e-Accessibility Policy Toolkit for Persons with Disabilities” (www.e-accessibilitytolkit.org), which is widely used around the world by policy makers involved in the implementation of the Convention on the Rights of Persons with Disabilities. For additional information on G3ict, visit www.g3ict.org.

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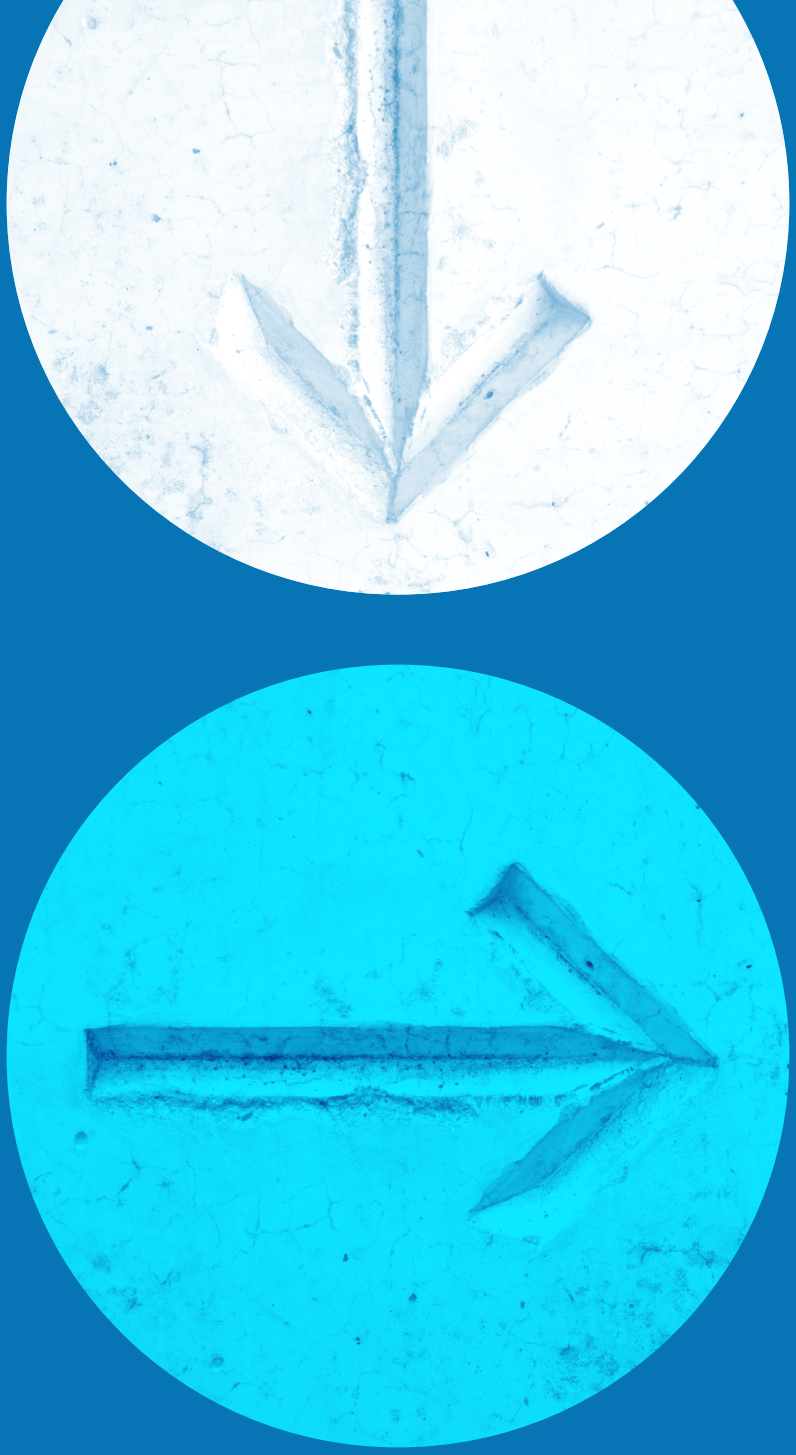


Executive Summary

For 285 million people who are blind or visually impaired around the world, audio indoor navigation which they could use across all environments with reliable, predictable guidance on their mobile devices would be a quantum leap for their independent living, well-being and safety. Wayfindr, a standardization initiative launched by the Royal Society for Blind Children, a leading U.K. based vision impairment charity and ustwo, a digital studio, and funded by a $1,000,000 grant from Google.org, was developed to specifically pursue this critical effort.

This report is designed to inform the community of executives overseeing complex facilities, public spaces, transportation hubs, campuses, shopping malls as well as accessibility experts, system integrators, advocates, local governments and policy makers about the considerable promises of audio indoor navigation for people who are blind or visually impaired. Furthermore, indoor audio navigation applications will also benefit millions of individuals with other disabilities, or who may have situational challenges such as those with print or intellectual disabilities or foreign visitors who need information in a different language.

The report examines the current state of technologies for indoor positioning and navigation and the importance of a technology neutral standardized approach to providing audio guidance to blind end-users. It describes how Wayfindr successfully enrolled the support of the International Telecommunication Union and worked with its accessibility experts to issue a standard in a record time in March 2017 as ITU-T Recommendation F.921. This accomplishment results in the Wayfindr Standard being now recognized as the global reference for indoor audio navigation by all ITU's 193 Member States and 800 private sector members.

The timing of this effort is excellent: the market for indoor navigation is exploding with multiple drivers and success factors supporting massive investments in new technologies and services across public transportation hubs, shopping malls, public buildings, advertising, and university campuses. The market for indoor positioning and navigation is expected to reach $8.96 billion in 2018 and $17.89 billion by 2021[1]. As facilities adopt audio navigation for business reasons, advocates in the United States, and elsewhere, will work to ensure that accessibility laws and regulations are applied to mandate the deployment of accessible audio navigation as an alternative to inaccessible signage in private businesses and public sector facilities, campuses or public transportation.

For the promises of audio indoor navigation to materialize for blind persons and better serve all users, advocacy organizations, leading IT vendors and policy makers should promote Wayfindr among developers, users and organizations managing commercial or public spaces. It is seldom and quite remarkable that an accessibility standard be ahead of the technology and market curves and be available at the early stage of the development of new systems. For this reason, G3ict, publisher of this White Paper and supporter of Wayfindr since its beginnings, calls on the broader community of advocates, accessibility experts, leading IT companies and policy makers to rally behind the Wayfindr Standard, participate in its evolution and take practical steps to foster its adoption in the United States and other major IT markets. In practice, this means:

- Regulators and policy makers are particularly encouraged to examine provisions of the Americans with Disabilities Act, Federally Funded Programs and Activities (Section 504) and Information and Communication Technology Accessibility (Section 508) and the use of audio wayfinding as a way to comply with this existing accessibility legislation.

- In particular, audio wayfinding can help entities comply with their effective communication obligations under the Americans with Disabilities Act.

- Chapter V discusses options under existing accessibility legislation and regulations, including examples of other efforts to take account of technological and standards developments to address ATM, e-book and web accessibility.

- Those covered by the law can take advantage of new and emerging technologies to comply with legislation most easily and deliver the greatest benefits to those with disabilities.

1. Source:Industry ARC report on Indoor Positioning and Navigation Market, 2016-2021, www.industryarc.com

Wayfindr and the Challenge of Indoor Navigation

The challenge of orientation to indoor environments and Indoor Navigation for individuals with disabilities

For people who are blind or visually impaired, obtaining and using information to support independent travel and finding directions to walk around public spaces and buildings is a critical requirement. The development of "turn-by-turn" GPS navigation has led to mainstream and specialized technologies to assist with independent travel wherever mapping data and satellite transmissions are available. However, satellite-based GPS solutions are not successful for independently navigating inside built environments where satellite signals cannot be used for GPS embedded in mobile devices. As a result, obtaining reliable cues, signage and other information to support independent navigation within large and complex interior spaces such as shopping centers, office buildings and transit facilities has proven difficult for individuals who are blind or visually impaired.

Advocacy organizations representing the interests of people who are blind or visually impaired have taken action to spur the development of technologies to support indoor navigation.

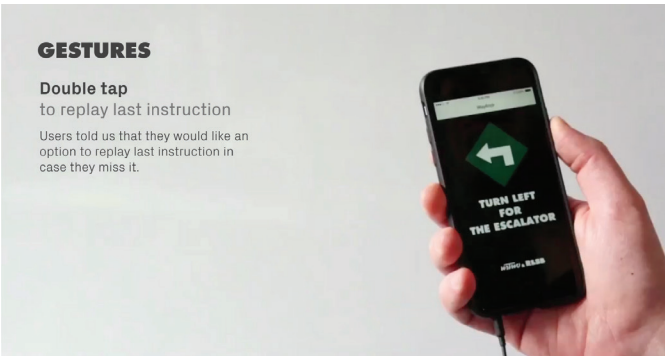


Photo: ustwo & RLSB / Wayfindr

For example, the National Federation of the Blind announced a research challenge in a March 2015 blog by Anil Lewis. He described the National Federation of the Blind Indoor Navigation Challenge as "a research partnership initiative to foster the development of devices or systems that the blind can use to obtain more useful information about the indoor environments in which we travel, such as schools, airports, hospitals, and shopping malls." He noted that the intent is to develop "an additional travel tool that enhances the travel experience of an independent traveler by providing access to environmental information which is currently unavailable non-visually."

The American Council of the Blind has also advocated for solutions to improve independent indoor navigation for individuals with vision loss. In July 2017, at its most recent convention, the Council approved Resolution 2017-22 which, among other actions, calls for the federal government to "allocate sufficient funds to support the deployment of indoor indicators that would enable people who are blind or have low vision to navigate public buildings independently."

Several key variables must be taken into consideration in the development of indoor navigation strategies, such as factors addressing the needs of the target population as well as technology and infrastructure alternatives. Finally, investment in deployment, maintenance and management and potential benefits for different categories of users need to be optimized for audio navigation systems to be sustainable.

Several technology developers, including Sendero, a company with a long track record in designing GPS navigation systems for people who are blind, have also taken up the challenge.Sendero received a grant from the United States National Institute on Disability and Independent Living Rehabilitation Research, under the Small Business Innovative Research program, to develop an indoor orientation information system to assist in navigating indoor public spaces and to create a seamless outdoor to indoor navigation strategy.

Other companies have launched technology-based systems to support indoor and outdoor orientation and navigation. Many of these organizations are members of the Wayfindr Community, a group of people and organizations who share a passion to change the lives of vision impaired people through enabling independent navigation[2].

The most promising approaches take advantage of smart phone technology and audio output, although support for Braille and large text will also be important in meeting the needs of people who are blind or who have low vision.

Indoor navigation systems utilizing new and emerging technologies therefore have huge potential to improve accessibility and increase independence for blind and visually impaired people.

Vision impairment in numbers [3]

285 million people around the world are blind or visually impaired.

Some studies estimate that this number could treble between now and 2050, primarily driven by the world's ageing population.

43% of vision impaired people in the UK would like to leave their home more often but face too many challenges to do so.

2. https://www.wayfindr.net/community
3. Source: RSBC statistics

The importance of standardized audio information

Standardizing the information will help address specific issues relevant to navigation systems for people who are blind or visually impaired and ensure end-user uptake by delivering a consistent user experience. Successful approaches must: maximize independent travel; incorporate various information access methods, including audio Braille and low vision techniques; provide timely feedback; and complement the user's mobility techniques, e.g., cane, dog guide or other aids. The technology involved will need to be affordable, readily available and usable by the user base and not draw undue attention to the user.

Wayfindr, a joint initiative between the charity Royal Society for Blind Children and digital product studio ustwo, has produced an internationally-recognized standard that supports the development of audio-based network navigation systems to ensure that indoor navigation systems meet the needs of persons with visual impairments. The standard is technology neutral in its approach so that it can work with various platforms. The standard defines terms and provides specific guidance on using audio prompts to assist individuals with vision loss in finding their way through an indoor facility. Such systems for audio based navigation may also benefit persons with other disabilities, age related disabilities, or anyone with specific needs. The Wayfindr standard can be applied to inclusive audio based network navigation systems in a variety of built environments including those in an urban or rural setting.

> Within the last few years, we have seen an exciting explosion of indoor wayfinding solutions on the market. However, without a standard way to share this information, people with visual impairments find themselves in a cumbersome situation where they have to access multiple information sources. For accessible indoor wayfinding solutions to become widespread, it is imperative that user needs are properly identified and addressed and that information standardization and sharing is achieved.
>
> *Kim Casey, CEO, Sendero Group*

The Technology Landscape for Indoor Mapping and Navigation

Challenges addressed by Indoor Audio Navigation

Interior spaces are often complex, highly flexible and ever-changing environments. Thus, people often find it difficult to pass through or find specific locations or objects within these environments. Static signage and maps are often inadequate for navigation. This is especially true for people with vision loss who face significant limitations obtaining information from traditional sources such as overhead signs, information screens and color-coded direction indicators.

Both commercial and public entities can benefit from deploying technology-based solutions to improve navigation and usage of indoor environments, particularly in complex interior spaces. Several technologies are already available and further development is underway. There are different approaches to mapping indoor venues - ranging from use of communications technologies like Wi-Fi and Bluetooth, (sometimes referred to as radio fingerprinting), to LED lighting and inertial sensor navigation (sometimes referred to as dead reckoning). Even magnetic field variations can be used. This paper is not intended to be an exhaustive investigation of such technologies, but seeks to examine leading technologies which can support access and navigation for people who are blind or visually impaired.

There are some challenges which hinder the usage of these technology-based solutions. First, individuals will need an access device such as a smart phone. Not everyone can afford these devices or afford the upgraded devices that may be needed to access the latest innovations. Smart phones, like any other technology, are subject to failures, and substitute or contingency strategies should be considered. Second, owners and operators of public and commercial facilities will also have to either invest in and maintain infrastructure or permit data mapping.

Finally, the identity of key interior points of interest will have to be labelled and updated. Actually, many building owners are already engaging in data mapping and infrastructure deployment for commercial reasons unconnected with increasing accessibility, which lowers the cost of deploying a technologically-enabled accessibility solution.

Data sources for audio navigation

Indoor navigation solutions, in order to be effective and reliable, need to rely on extremely accurate positioning systems, which, combined with various forms of indoor mapping, provide necessary data to generate accurate audio directions to the user. While very sensitive GPS devices can receive satellite signals indoors, those are not received with the precision of line of sight but through the propagation of radio waves through building openings that are difficult to model. This makes those signals difficult to use for accurate indoor positioning.

To compensate for this shortcoming, various technologies have been used to provide accurate positioning, including a combination of indoor markers that can be mapped and mathematical models that calculate position and path finding directions, and in some cases, combine information from various sources. While indoor navigation for human users is still an emerging type of application, it is widely used in factories and warehouses for automation and robotics solutions, and therefore benefits from considerable experience and technical innovation.

Several entities have used low energy Bluetooth beacons and mobile applications to develop indoor access and navigation solutions designed for individuals with visual impairments. The beacons can be programmed to provide specific audio instructions for navigation to a mobile device. They broadcast wayfinding information to smart phones about the location of entrances and exits, elevators or stairs, restrooms, and other points of interest.

However, Bluetooth signals are easily disrupted and the information is transmitted in multiple directions, making it difficult to use beacons to provide a pinpoint location. In addition, a significant number of beacons may be required to support indoor navigation, depending on the size of the venue. Investment and maintenance costs will likely be a deterrent, even though these investment and maintenance costs can be amortized across the various uses for a beacon network in a built environment.

The widespread availability of low-cost inertial sensors based on accelerators and gyroscopes, combined with data maps of interior spaces, can provide solutions for navigation within indoor environments or transition access from exterior into the indoor space. The system must address limitations such as errors from unexpected or irregular human movement. In addition, a detailed interior digital map is necessary to provide specific and relevant information to the user for navigation.

Paths to improving accuracy

To improve accuracy, indoor positioning may rely on various data sources including optical or acoustic and ultrasonic technologies, or the positions of emitters of radio signals to determine the in-door position of a user. Besides radio beacons using low energy Bluetooth technology mentioned above, alternative promising methods use signals of existing Wi-Fi access points such as those used by the app and service provider Anyplace. This is an appealing option since Wi-Fi networks can be found in most indoor environments. It is also possible that 5G small cell networks points of presence may be used for similar purposes. Finally, Radio Frequency Identification systems are also used for indoor navigation as passive beacons to confirm a location or presence of an object. These are however short range and need to be positioned along a narrow path to be effective.

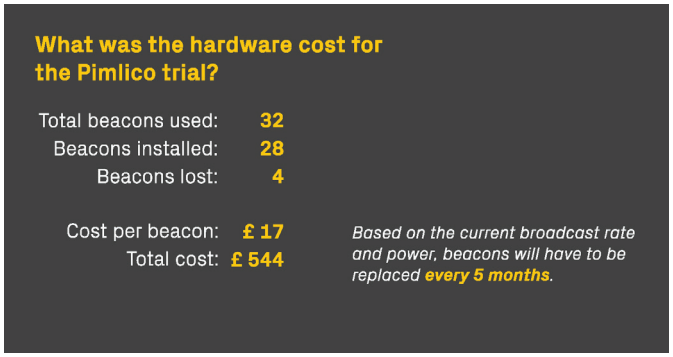


Photo: ustwo & RLSB / Wayfindr

Applications for indoor navigation use several methods to determine a user location with precision. Most use mathematical models based upon trilateration (distance from markers), triangulation (angle to markers) as well as dead reckoning (calculating one's current position by using a previous position and advancing that position based upon known or estimated speeds over elapsed time and course using a mobile device gyroscope and compass such as those embedded in most smart phones).

Proponents of each option emphasize different benefits such as: beacons have the advantage of simplicity and low cost for small scale implementations. For large scale projects, however, one must take into consideration issues of robustness and maintenance of beacons, as well as environmental risks to the beacon network. Dead reckoning, on the other hand necessitates less ad hoc infrastructure but requires precise mapping and smart markers. It is likely that the winning solutions will rely on a combination of technologies with different options for different scales of projects, including camera based object or site recognition coupled with 3D mapping.

Indoor Audio Navigation apps and services available in the market place

As of today, commercially available audio indoor navigation systems offer four different types of user support and guidance, sometimes combined:

- providing positioning information (where am I?)
- providing information on surroundings (what's around me?)
- providing point of interest information (details as to what's in front of me such as an exhibit or explanation of a building feature or function)
- providing point A to point B step by step navigation directions.

While the fragmentation of available technologies and applications will likely consolidate along the most effective and economically viable solutions, today's market place is characterized by the co-existence of a multitude of audio navigation solutions. Added to this complexity, different types of mapping information are required to satisfy the need of applications providing indoor positioning, point of interest and navigation information. This is a field of intense competition with several companies offering solutions incorporating several underlying technologies and automated processes to create maps of buildings and public spaces.

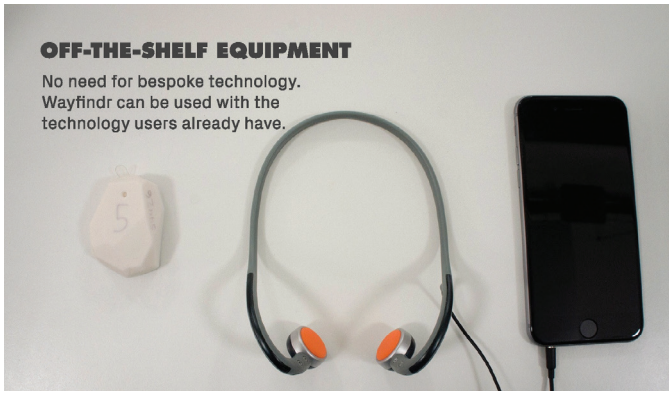


Photo: ustwo & RLSB / Wayfindr

Cambridge Consultants, Expert View:

"Advances in smartphone technology make it easier and easier to put audio navigation in the hands of people, thanks to the greater accuracy of location enabled by advanced algorithms and the amount of radio and motion sensors embedded within devices"

Tim Murdoch, Director, Cambridge Consultants

User perspective: How do individuals access the audio information?

Indoor audio navigation, while a promising concept, requires considerable attention to be effective, especially for wayfinding directions on the go. Blind or low vision users, in particular, will most often be receiving this information while walking independently. More so than for most digital interfaces, the degree to which users can rely on a standardized set of instructions across various applications and technical platforms will determine overall adoption and success. How audio information is spelled out to enable users to navigate or learn about their position and environment accurately, should therefore be similar across all indoor navigation technology platforms.

While the method and frequency of communicating this information to the user may influence data requirements and thus the configuration of existing deployments, ultimately, a standard for audio-navigation instructions will accelerate the adoption of all indoor audio navigation systems by unifying user experiences across all technologies.

Among the options that a standard must address are the user's preferred type of output, the way with which a direction is explained (clock or degrees for instance), the points at which directions are provided, the frequency of instructions while walking, the options available to explore surroundings and the way anticipated changes of directions are communicated. These are the critical elements of any audio indoor navigation system that the Wayfindr Standard helps unify based on detailed use cases and experimental evidence, boosting the potential for user adoption and the reliability of existing systems.

Connecthings

"At Connecthings we work every day, to provide mobile applications with the most accurate and contextual data about the moment and place where their users are, in real time. The pertinence of the location data combined with the Wayfindr Open Standard around IoT, will allow for the creation of a consistent, reliable and seamless navigation experience for the blind community."

Laetitia Gazel-Anthoine CEO, CONNECTHINGS

The Wayfindr Standard: Deployment and Research

Overview of the Wayfindr history and standard development

Wayfindr's origins lie in the RSBC's Youth Forum, an event bringing together young visually impaired (VI) people to discuss the challenges they face in life and potential solutions. In 2014, attendees raised an all-important question: what if vision impaired people were empowered to navigate independently using the smart phone they already have in their pocket?

For these blind young people, smart technology had already opened up many new opportunities and they wanted to push it further. They wanted the freedom, taken by their sighted peers for granted, to travel across their city independently, whenever and wherever they wanted to.

This was the challenge posed by RSBC's Youth Forum to ustwo, who used their Invent Time to investigate possible solutions. The aim was to find a way to help the Youth Forum members to navigate indoors, without any additional help (but not excluding the mobility aids, such as long canes or guide dogs, they already used).

From the assorted options considered, one solution stood out as the most promising. Audio wayfinding technology has the potential to open up much more of the world to VI people by enabling independent and spontaneous travel. It can be provided to users using smartphones and headphones, items already owned and used by most people, meaning there are few or no additional costs to users to take advantage of the solution.

In March 2015, Wayfindr secured a trial at Pimlico station in partnership with Transport for London (TfL). Bluetooth Low Energy (BLE) Beacons were installed across the station and a basic app developed which guided participants around the station. The prototype solution took advantage of smart phones, beacons and a corresponding app. This proved that such a solution could work for a public transport network.

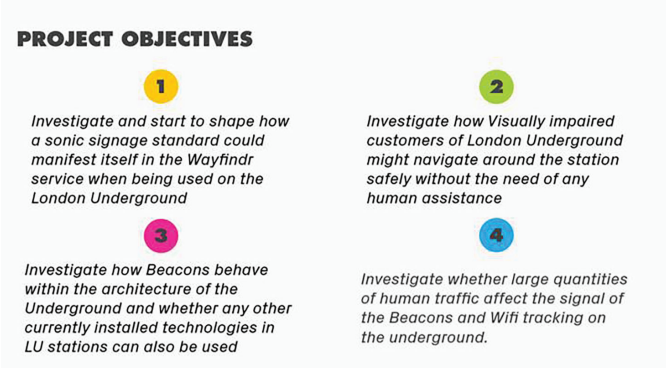


Photo: Wayfindr

It was at this stage that RSBC and ustwo concluded that the greatest impact they could make was to create a standardized set of instructions for venue owners and app developers to set up an inclusive and accessible audio-based navigation system. To build confidence in the technology, vision impaired people need a level of consistency across every navigation app that they use. Standardized instructions deliver this reliable, consistent and seamless experience. This led to the decision to create the Wayfindr Open Standard.

It was also clear that developing an Open Standard instead of a stand-alone app would maximize the reach of Wayfindr: new and existing navigation apps could build it into their offerings, and VI users could have a choice of navigation apps.

Working with the ITU

The ITU encourages the development of standards that take account of the widest range of characteristics and abilities of persons, including in particular those of older persons, children and persons with disabilities. The ITU additionally recognizes older persons and persons with disabilities as important user and consumer groups whose needs should be systematically addressed when standards are developed or revised. The ITU has also prioritized accessibility in various areas including several study groups that work on accessibility related issues and furthermore has a long history of developing open standards. Persons with Disabilities participate in the work of ITU Study Groups as experts or representatives of their own non-profit, academic or private sector ITU member organizations or through Member States or G3ict's Delegation at the ITU. This combination of factors along with the highly-respected expertise that constitutes the ITU membership, made the ITU the ideal setting for the development of the Wayfindr Open Standard into an internationally-recognized Open Standard.
"The ITU process was very precise, following our initial white paper submission there was a very clear pathway towards approval. We're delighted to have been at the forefront of the world's first accessible audio navigation standard with the ITU"

Tom Pey, Executive Chair, Wayfindr and CEO of RSBC.

"Audio navigation has huge potential for those with disabilities, especially vision impairment. We hope that this will be the first of many standards using audio navigation to make the world more accessible to those with disabilities"

Masahito Kawamori, Rapporteur, Question 28, Study Group 16, ITU – T.

Development process

Development of the Wayfindr Open Standard began in September 2015. The approach was based on the principles of user-centered design, i.e.:

- Real users
- Real settings
- Real time iterations

In practical terms, this meant involving VI people in the design process from the beginning, focusing initially on public transport settings, and running iterative trials that allow for incremental testing of hypotheses. The first working draft of the Wayfindr Standard was published in May 2016 and was followed by a five-month period of open consultation involving feedback, support, and input from VI organizations and technology partners. This led to the publication of a Candidate Recommendation in December 2016.

The ITU Recommendation

Following a successful white paper submission to the International Telecommunication Union (ITU-T), the ITU accessibility standardization experts group invited Wayfindr to submit the open standard to become an ITU Recommendation. Through ITU-T Study Group 16, the Recommendation was approved in March 2017. It was published in March 2017 as ITU-T Recommendation F.921: Audio-based network navigation system for persons with vision impairment. This is one of the fastest approvals for an ITU Recommendation in their history, a testament to the quality of the submission and process of creating the standard. By virtue of its approval, the Recommendation is recognized across the 193 countries and almost 800 private sector entities and academic institutions which are members of the ITU.

The Recommendation explains how audio-based network navigation systems (ABNNS) can be designed to ensure that they are inclusive and meet the needs of persons with visual impairments. The Recommendation adopts a technology-neutral approach by defining and explaining the functional characteristics of the system. The aim is to give designers of ABNNS the information that they need at the initial stages of development, to anticipate and overcome any restrictions and barriers that prevent users with visual impairments from making full and independent use of the built environment. This Recommendation explains how to accommodate users' experience of ABNNS and ensure the interoperability of those systems.

The ITU Standard

Recommendation ITU-T F.921 explains how audio-based network navigation systems can be designed to ensure that they are inclusive and meet the needs of persons with visual impairments. The Recommendation contains sections on both design and validation principles for an audio navigation system. The main portion of the Recommendation focuses on the audio instructions delivered to end users, including the format an instruction should take. Based on extensive research, the Recommendation also includes guidance on how instructions should be provided when a user engages with various elements of the built environment, such as ticket barriers, escalators, and elevators. This can include telling the user which escalator to use or where the controls of the elevator are located. The Recommendation also contains a section on mobile application features. This section is intended to provide a list of baseline features, allowing application developers to add more functionality and customization as they see fit and in response to user demand.

This Recommendation provides specifications for the design of inclusive audio-based network navigation systems (IABNNS) to accommodate users with vision impairment as well as users with a wide range of characteristics and capabilities. It also aims to help design professionals to achieve an inclusive environment through an IABNNS that augments the physical environment by the provision of an audio version of that environment for users.

In addition, while this Recommendation recognizes the necessity of providing audio-based network navigation outputs in languages determined by the user, it is beyond the scope of the present Recommendation to provide a specific solution. Current work aims at exploring the use of meta-coding for providing a flexible user-centric translation system. This audio-based Recommendation does not consider the specialized requirements of people who are deaf or hard of hearing.

Wayfindr is also investigating the possibility of working with the Consumer Technology Association (CTA) to have the ITU Recommendation recognized under the CTA Technology and Standards Program.

Pilot tests and deployments

To date, Wayfindr has conducted a number of successful trials in the United Kingdom and Australia, with more planned in Europe and the United States. So far, trial locations have included:

- Pimlico station – London, UK
- Euston (Underground) station – London, UK
- Town Hall station – Sydney, Australia
- The Pedestrian Accessibility Movement Environment Laboratory (PAMELA), UCL London UK
- University College of Applied Sciences, Oslo, Norway

Pimlico

The first Wayfindr trial took place in Pimlico in February 2015. The trial consisted of three testing iterations over four weeks. There were twelve participants with a range of different user profiles, including age, different levels of vision impairment and different levels of familiarity with the station area. This trial provided much of the research base for the audio instructions element of the ITU Recommendation, such as the level of detail needed for an audio instruction as well as recommendations for app functionalities.

Photo: Sophie Mutevelian

Another small-scale trial also took place at Pimlico with the cooperation of the UK Department for Transport. This was the first multi-modal Wayfindr trial, guiding users between bus stops and a station entrance.

Euston

The next Wayfindr trial took place in the London Underground station at Euston in London. This station was chosen due to its complicated infrastructure such as multiple junctions, curved corridors, escalators, steps and lifts, the fact that it is an interchange station, and due to its popularity with VI users. This trial took place from November 2015 to January 2016, allowing for iterative testing and incremental hypotheses testing. There were twenty-four trial participants, again with a range of user profiles.

The trial provided further user insights on audio instructions which informed the development of the standard, in particular concerning instructions relating to specific features, landmarks, and objects such as escalators, and the necessity of providing instructions at every decision point.

The ITU Process

The technical work of ITU-T is managed by the issue-area study groups (SGs) that develop Recommendations and other publications. The people involved in these SGs are experts in telecommunications from all over the world. Study groups may have a number of working parties addressing specific issues.

ITU-T study projects are defined by questions, which are approved either by the World Telecommunication Standardization Assembly or the study group itself. Each of the study questions is assigned a rapporteur who may be assisted by associate rapporteur(s). The responsibility of the rapporteur is to ensure that experts make progress on the work assigned to the question. Editors may also be appointed to manage the development and drafting of the text of a Recommendation once discussions have evolved sufficiently.

Recommendations are drafted based on study questions. Once the draft is sufficiently evolved, the draft Recommendation is put forward for approval.

All new or revised Recommendations require formal approval by the study group. ITU-T uses two different processes for such approvals, known as the Traditional Approval Process and Alternative Approval Process designed to follow the pace of innovation. More information on these processes is available on the ITU website.

Sydney Town Hall

The Town Hall trial featured sixteen participants and took place over three weeks with five days of testing. As well as further refining audio instructions, including acceptable ways to provide orthogonal information, this trial provided user insights for the mobile application features section of the Standard. It was also established that further research was required on the repetition of guidance required to reassure users that they were on the right course when walking longer distances between decision points.

PAMELA

The Pedestrian Accessibility Movement Environment Laboratory (PAMELA) is a multisensory laboratory for the assessment of pedestrian movement. The Lab is part of University College London's Transport Institute and allows for full-scale pedestrian infrastructure to be built and tested. The study involved using the laboratory to create a replica of a London Underground station adjusted to provide four different routes that included right and left turns and movement up and down stairs.

The purpose of this study was to gather evidence regarding the utility of Wayfindr to vision impaired participants when they were invited to navigate along each of the 4 routes laid out in PAMELA.

The participant sample consisted of 36 vision impaired participants. The age of the participants ranged from 21 to 77 years, with an average age of 41 years. Fifteen individuals reported being blind since birth while 6 had been blind for less than 10 years. The main finding from this study is that participants provided positive feedback regarding the usability of Wayfindr, and that the majority of participants felt confident about using the technology even before trying it.

M-Enabling Summit 2017

The first deployment of a Wayfindr-compliant application in the United States took place at the 2017 M-Enabling Summit in Washington D.C. Right-Hear, an advanced accessibility solution provider and Wayfindr Community Member, made their mobile app available to conference attendees in the conference venue. The app provided navigation information for both the exhibition space and the conference venue, including description of the layout of the exhibition and names of exhibitors and their location) and of the various meeting rooms.

Future Plans

At the time of writing, further trials are planned in the UK, Europe, and North America. Wayfindr is also working in partnership with other organizations on audio wayfinding projects across the UK and supporting venues in assessing and designing accessibility solutions with an audio wayfinding component.

The user-centered, iterative approach taken during the design and trial phases of Wayfindr pilots to date has provided a significant amount of data which has informed trials and the development of the ITU recommendation, as well as providing areas for further investigation. It is clear that people who are blind or visually impaired perceive Wayfindr-based solutions as usable and effective. It is equally clear that there are areas where the standard can be further developed, for example in relation to the timing and frequency of the audio instructions.

Future work will factor in these learning points and determine at what stage of the design and deployment process they need to be accounted for, in which case there are sufficient grounds to standardize at a mandatory or optional level, and which elements should be provided as guidance for venues and technology developers.

Success Factors

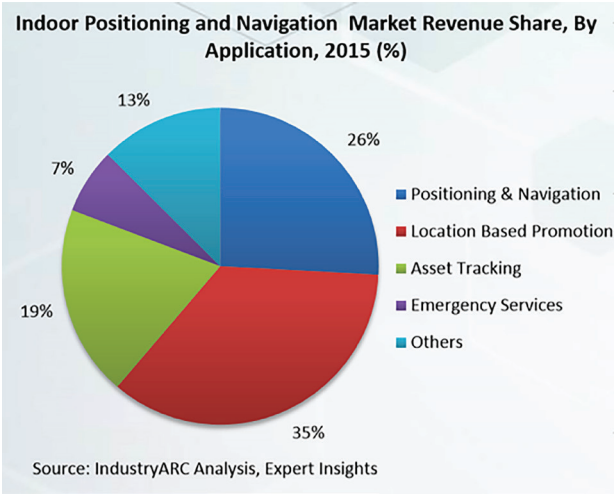
Interaction between mainstream developments and accessibility

Building design elements and information technologies developed to provide access for people with disabilities often prove to be popular and useful for the general public. Wheelchair ramps and closed captions are two examples of this phenomenon. Ramps are very beneficial for individuals accessing facilities with baby strollers or rolling luggage, and closed captions are highly popular in health clubs, bars, airports or other loud places where individuals are attempting to watch television. Similarly, access for persons with disabilities is often facilitated by the development of technologies such as the voice user interface. The development of strategies to provide indoor navigation through technologies that support audio-based access for people with vision loss is likely to benefit the general public, and be driven by mainstream developments in indoor mapping and data transmission.

Successful development and deployment of the technologies that will enable indoor navigation, as with other emerging technologies, will require achieving scale and developing a supporting ecosystem including app development, mapping services, infrastructure deployment and maintenance. The following section will examine key market drivers and emerging applications that will likely accelerate the deployment of audio indoor navigation. While solutions designed specifically for individuals who are blind have begun to be deployed, we expect that large-scale development will occur only when applications serving the general public become widely available. As mainstream development proceeds, it is critical that the access needs of individuals with vision loss and other disabilities are incorporated from the outset of design and deployment of these solutions. The availability of a standard interface for persons with disabilities is therefore critical at this early stage.

Market drivers

As noted earlier, there are many factors that are already driving the development of technologies to support indoor navigation. According to Industry ARC, the market for those technologies is growing at a significant pace. In addition to the application of mapping and navigation, location information is also being used for social networking and other types of entertainment. Industry ARC estimates revenues in 2018 to be $8,954.9 million and the market to reach $17.89 billion by 2021 growing at a CAGR of 27.9% during the forecast period[4].



Graph: Indoor Positioning and Navigation Market Revenue Share

4. www.industryarc.com

Transportation hubs and complex indoor environments

The complexity of indoor environments such as airports, transit stations, convention and exhibition venues, malls and large office buildings, creates confusion for individuals with and without disabilities as they attempt to navigate through and find specific directions and locations within these facilities. Passenger traffic at large cities underground rail stations or airports for instance, can amount up to several hundred thousand persons per day. Such heavy traffic requires live assistance and the availability of significant support staff. Decreasing the amount of requests for support and help for orientation creates a clear business incentive to deploy highly functional and easy to use navigation solutions.

In addition to decreased demand for assistance from support personnel who are then hindered in performing their duties, quantifiable benefits justifying investments in indoor navigation systems in complex indoor environments may include more efficient alteration of signage and direction elements, better overall movement of customers through a facility, improved customer satisfaction and improved safety and emergency evacuation capacity. Systems are being implemented in the transportation sector and among commercial public spaces to meet these benefits. Development of an audio-based system would have the added value of support for multiple languages to assist international visitors. Those opportunities will likely be factored in Smart Cities strategies driven by local governments around the world and accelerate the adoption of indoor audio navigation for public transportation hubs and public spaces.

Photo: Wayfindr

"Our partners, cities and transit companies, are in strong need of reinforcing the accessibility of their public spaces and infrastructures for their citizens with visual disabilities. Relying on international experience-proof standards is key to us to provide the most reliable and flexible solution to them."

Louis-Alban Batard-Dupré, Executive Vice President, Connecthings

Advertising

Advertising represents an important revenue source driving potential adoption of indoor information and navigation systems. Local advertising represents today more than half of the total web advertising market place. Ever more sophisticated processes target consumers "here and now" which benefits local advertising linked to outdoor mapping and navigation helping to develop a business case for indoor navigation. There are 47,000 shopping malls in the United States, of which 1,100 are categorized as enclosed indoor malls. Most of those operate in conjunction with national retailers and department stores and serve regional areas. As brick and mortar retail stores are losing market share to on-line stores, malls can enhance customers' shopping experience by offering audio navigation supporting near field promotions or continuous outdoor-indoor proximity advertising for local services.

Universities

University campuses, often complex to navigate, are another excellent candidate to drive adoption of indoor navigation to complement their existing outdoor navigation tools. With a population of mobile and technology savvy users, institutions of higher education are in a good position to enjoy large user adoption of both outdoor and indoor navigation apps. Since higher education institutions in the United States have an obligation to provide equal access to their built environment, digital contents and academic services to students with disabilities, it is likely that accessible indoor audio navigation will become a widespread feature on campuses for students with disabilities.

Shopping Centers social media

Historic data shows that Shopping Centers were quick to adopt Social Media at an early stage of the development of social media. As of September 30, 2011, 63.2% of U.S. shopping centers already had a Facebook page (up from 29.2% in Q1 2010) and 53.9% were using Twitter to reach their shoppers (up from 27.4% in Q1 2010)

Source: Alexander Babbage, Inc., based on U.S. shopping centers 300,000 square feet or larger.

Campuses in the United States

There are more than 4,724 institutions of higher education in the United States. And among 3,039 four-year colleges and universities, enrolment demographics show that approximately 40% have more than 2,500 students.

SOURCE: U.S. Department of Education, National Center for Education Statistics. (2016). Digest of Education Statistics, 2015 (NCES 2016-014), Chapter 2.

Public buildings

Advocates for people with disabilities argue that as indoor navigation systems are deployed within government facilities to assist the public they should be made accessible to persons with disabilities, similar to university campuses that operate in a regulated environment with accessibility requirements. As indoor navigation technology becomes widely available, advocates will certainly argue that inaccessible visual signage and directories in government facilities discriminates against individuals who are blind or visually impaired. Advocates would likely argue that accessible indoor audio navigation is fundamental to requirements for accessible routes and effective communication.

Policy and regulatory impact on indoor navigation accessibility

As noted earlier, technology-based indoor navigation is an emerging area and therefore no law or regulation currently addresses the accessibility of these systems. However, accessible audio navigation can help entities meet existing accessibility obligations, in particular, those contained in broad-based civil rights law such as the Americans with Disabilities Act and Section 508 of the Rehabilitation Act.

Below is an overview of current accessibility-related legislation and obligations that are relevant to the discussion of accessible indoor navigation. The Wayfindr standard is a key tool to maximise the benefits of audio navigation as an accessibility compliance solution.

Americans with Disabilities Act

The Americans with Disabilities Act, widely known as ADA, a far-reaching civil rights law, was enacted in 1990 to prohibit discrimination on the basis of disability. ADA protects the rights of individuals with disabilities in: employment; access to services programs and activities of state and local government agencies; access to transportation; and full and equal enjoyment of goods, services, facilities, privileges, accommodations or advantages offered by places of public accommodation.

ADA requires newly designed and constructed or altered state and local government facilities, public accommodations, and commercial facilities to be readily accessible to and usable by individuals with disabilities. The scope of ADA is broad, applying accessibility requirements on most government facilities, services and activities and similarly covering most private businesses. Although the law and its accompanying regulations did not specifically mention indoor navigation technologies, ADA's access requirements have been updated and interpreted to cover other emerging areas such as the Internet.

The United States Department of Justice enforces the provisions of ADA that affect governments and private entities and has issued regulations providing detailed guidance and requirements for these sections of the law. The United States Architectural and Transportation Barriers Compliance Board (commonly known as the Access Board) establishes accessibility guidelines that set scoping and technical requirements for accessibility to sites, facilities, buildings, and elements by individuals with disabilities under the ADA.

Recommendation: Several specific requirements established by the Department of Justice and further defined by the Access Board may be relevant in the analysis of ADA's potential impact on the accessibility of indoor navigation. In particular, the analysis should focus on requirements for accessible signage and path of travel and effective communication.

Accessible Signage. The ADA regulations and guidance devote significant attention to accessible signage with specific details describing the design of Braille and raised characters and the need for contrast. However, the requirements are focused on static signs such as room numbers and restroom designations. In fact, signage such as building directories and company names are specifically exempted from the ADA accessibility requirements. Although directional and certain information signs must comply with character size and contrast requirements, generally, there is no requirement for accessibility of indoor navigation signs.

Accessible Path of Travel. The ADA regulations and guidance regarding an accessible path of travel set forth requirements focused on physical access, including ramps and other means to move from the exterior, through an accessible entrance and includes references to clear floor paths through lobbies, corridors, rooms, and associated restrooms, telephones and drinking fountains. The regulation does note that if wheelchair access is not possible, the facility must provide access for other people with disabilities.

Effective Communication. According to the U.S. Department of Justice, "The ADA requires that title II entities (State and local governments) and title III entities (businesses and non-profit organizations that serve the public) communicate effectively with people who have communication disabilities. The goal is to ensure that communication with people with these disabilities is equally effective as communication with people without disabilities.[5]" Often, an auxiliary aid or service may be needed to communicate effectively with people who have communication disabilities. The effective communication requirement is generally interpreted to apply to communication between a government or private entity directly with an individual with a disability. For example, this provision requires that information be provided in alternate formats (e.g. Braille, large print, electronic) for individuals who are blind or visually impaired.

However, the Department of Justice also notes that auxiliary aids may also include communications technologies such as assistive listening systems, closed caption decoders, and video description devices. Covered entities are required to provide aids and services unless doing so would result in an "undue burden," which is defined as significant difficulty or expense. If a particular aid or service would result in an undue burden, the entity must provide another effective aid or service, if possible, that would not result in an undue burden.

Recommendation: The advent of an Audio Indoor Navigation standard, along with the development of supporting technologies, provides the impetus to encourage a broad reading of ADA provisions regarding accessible signage, accessible path of travel and effective communication to require accessibility for indoor information for people with vision loss. An additional advantage of the audio Wayfindr Standard is that it can further meet the effective communication requirement because it permits users to preview route guidance, allowing them to plan their journey.

Section 504, federally funded programs and activities

Section 504 of the Rehabilitation Act of 1973 was enacted to require federal government funded programs and activities to be accessible to people with disabilities. It states:

> "No qualified individual with a disability in the United States shall be excluded from, denied the benefits of, or be subjected to discrimination under any program or activity that receives Federal financial assistance."

Section 504 applies wherever federal funds are provided, generally including state and local government programs and education and health institutions. While there is no specific requirement for indoor navigation, the language of Section 504 is broad and the deployment of indoor navigation technologies in facilities that receive federal funds would certainly be accompanied by demands for such systems to be accessible to and usable by people with disabilities. Transportation, healthcare and education facilities are likely to deploy indoor navigation systems in order to maximise the efficient movement of individuals in these complex buildings.

Recommendation: Federal agencies such as the Departments of Education Health and Human Services and Transportation should take note of the development of indoor navigation systems to foster the deployment of these technologies with accessibility at the initial design phase.

5. See https://www.ada.gov/effective-comm.htm

Section 508, Information and Communication Technology accessibility

Section 508 of the Rehabilitation Act of 1973, as Amended in 1998, requires increased access to government information and services for members of the public who have disabilities and Federal workers with disabilities. The law requires that information and communication technology that is developed, procured, maintained, or used by federal agencies be accessible unless doing so would impose an undue burden. The Access Board has established the accessibility guidelines implementing Section 508. Each federal agency is responsible for enforcing Section 508 requirements related to the work of that agency. Section 508 has fostered development of accessible technology. The regulations implementing the law were recently revised in 2017 to address new technological developments. The regulations and guidance implementing Section 508 are focused on the accessibility of government agency websites, software for internal communications and productivity, and documents.

Recommendation: The Access Board should review and develop guidelines for accessible indoor navigation technologies so that when the federal government adopts and deploys these technologies, they are designed and develop to meet Section 508 requirements.

Focus of advocacy in support of Indoor Audio Navigation

As indoor navigation is developed and deployed to provide assistance to the general public, advocacy organizations representing the interests of people with vision loss and other disabilities will doubtless work to ensure that it is required to be accessible. This action will likely follow the same trajectory that advocates deployed to address accessibility of Automatic Teller Machines, the Internet and ebooks. ADA and Section 504 would provide the legal lever and Section 508 would provide the technology access protocols. Accessibility is most achievable and best accomplished at the outset of technological development. At that stage, developers of indoor navigation technologies can incorporate accessibility and follow an accessibility standard without incurring undue economic burden.

Recommendation: In the absence of deployed indoor navigation systems, advocacy efforts should focus primarily on recognising accessible audio navigation as a means to comply with effective communication guidelines. Follow-on efforts could also focus on the inaccessibility of visual directional and information signage within complex indoor spaces.

"The American council of the Blind (ACB) has long supported innovation that results in smarter cities intended to not just remove barriers of access, but to expand new opportunities for greater independence in the community. To that end, further work needs to be done to harmonize technology intended to assist in navigating various environments through wayfinding technology."

Anthony Stephens, Director of Advocacy & Governmental Affairs

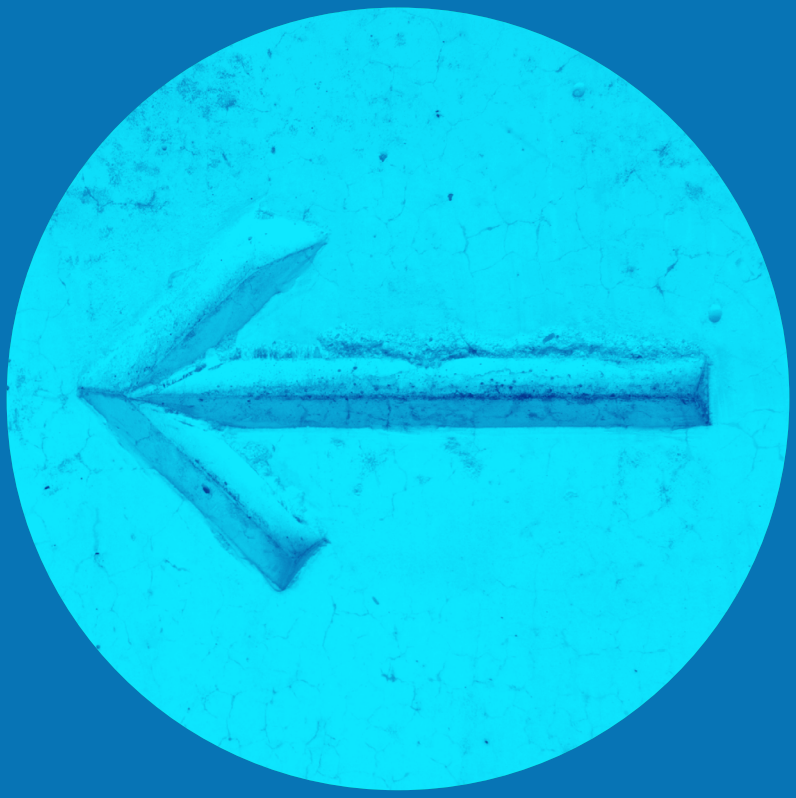
Conclusion

To achieve the promise of accessible indoor navigation for persons with vision loss or other disabilities, and better serve all users, advocates, accessibility experts, leading IT companies and policy makers must promote the Wayfindr Standard, participate in its evolution and take practical steps to foster its adoption in the United States and around the world. Technology-based systems are being developed and launched to support indoor orientation and navigation in commercial and public facilities. Wayfindr and other organizations have developed the technical and practical knowledge to enable accessibility of these systems. Developers of indoor navigation apps can incorporate accessibility at little or no cost by following the Wayfindr standard.

An estimated 23.7 million adult Americans (or 10% of all adult Americans) reported they either "have trouble" seeing, even when wearing glasses or contact lenses, or that they are blind or unable to see at all. (www.afb.org/stats, findings from the 2015 National Health Interview Survey (NHIS), accessed 09/23/17) Recognizing that the Wayfindr standard was initiated to address the access needs of people who are blind or visually impaired, advocates should take steps to work with government agencies such as the Access Board, along with the Departments of Education Health and Human Services, Justice and Transportation, to ensure that laws such as the Americans with Disabilities Act are interpreted to cover this critical emerging area. Both the American Council of the Blind (ACB) and the National Federation of the Blind (NFB) have expressed support and taken action. For example, NFB established the Indoor Navigation Challenge www.nfb.org/indoornav.

Public and private entities should take note that a sizeable segment of the population is affected by the lack of accessible indoor navigation. In addition to people with vision loss, many other disability groups find it difficult to obtain the information they need to move efficiently through complex interior spaces. As accessibility laws and regulations are broadened to address indoor navigation, those covered by the law can take advantage of new and emerging technologies to comply most easily and deliver the greatest benefits to people with disabilities.

With the development of the Wayfindr standard, the path is now clear for an efficient and effective means to enable all people to move about interior spaces more safely and independently. It allows people to more easily find the information and directions they need to find meeting rooms, restrooms, stores and restaurants, travel gates, cultural attractions even emergency exits. The next frontier of accessibility is at hand, let us ensure that it is fully accessible to all people.



Global Initiative for Inclusive Information and Communication Technologies

www.g3ict.org