

National Institute of Standards and Technology

Preliminary report

A roadmap for future usability and accessibility guidance

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This roadmap was developed through a collaboration between NIST and the Center for Civic Design, under grant 70NANB14H280 from the U.S. Department of Commerce, National Institute of Standards and Technology. It is the result of discussions with stakeholders such as the Election Assistance Commission, state and local election officials, system vendors, researchers, and others about the needs for better guidance for usability and accessibility of future election systems.

Elections are changing. There are new technologies, new laws, and new elections procedures since the 2005 Voluntary Voting System Guidelines 1.0 were published. Recent years have brought changes to the state of the art and technology for voting systems, as well as public expectations about how voters will participate in elections.

Keeping up with these changes requires a new approach to usability and accessibility guidance for the next generation of election systems. To meet this challenge, this roadmap sets a direction for the research needed to develop future guidance on usability and accessibility to ensure that all voters can vote independently and privately.

A NIST roadmap is an outline for future work that identifies gaps to be filled, looking across technology, processes, standards and guidelines for objectives to meet, and recommends approaches for the work.

This is the first public draft of a roadmap for work on the usability and accessibility of future elections. The goals for the roadmap are to:

- Increase the level of knowledge for how to design, develop, deploy, and use of usable and accessible elections systems.
- Promote consistent levels of usability and accessibility across technology in all parts of the elections process.
- Make systems more usable for everyone in the elections process, including voters, poll workers, elections staff, and third-parties such as election interest and advocacy groups or technology developers.
- Shift from single focus on standards and certification to identifying the appropriate guidance, including guidelines for best practices, procedural support, training.

A roadmap is not a detailed work plan, but an outline of the areas of work and a high level view of the steps needed to address them. This roadmap identifies 6 priority areas and 21 objectives for work on accessibility and usability. It also suggests a framework for how useful guidance and standards can be organized around principles and core requirements.

A roadmap is also not list of tasks for one organization, especially in a work as complex as elections. With the roadmap as a guiding outline, many groups and projects can contribute to a larger outcome.

We hope that this roadmap can serve the entire election community: the Election Assistance Commission (EAC), NIST, academic researchers, as well as those who design, develop and test voting systems and other election systems.

We welcome comments on this draft, especially:

- Identifying gaps in the objectives or additions to the roadmap
- Identifying the most important objectives so tasks can be prioritized
- Begin to identify resources to work on the objectives

We hope to release a final draft of the roadmap in May-June 2015.

Please send your comments and questions to
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Background – Elections Systems and Standards

This roadmap is not created in a vacuum, but is part of the continuing work to improve elections. The first step is to examine the current voting system standards and how well the current voting systems meet the needs of voters.

One of the challenges for the current voting systems is that the standards currently in place are focused on voting in polling places. The technical approach to developing those standards assumed a kiosk-style voting machine in a polling place. Further, the requirement for one accessible voting machine per polling place led to a standard that distinguished an accessible machine from one that is not accessible resulting in voters with disabilities using a separate system from those used by other voters.

Voting System Standards

Since the standards were written both elections and technology have changed.

- Voters are now offered a wider range of options for how to vote, with a rise in the use of absentee (or vote-by-mail) ballots marked and cast outside of a polling place.

Help America Vote Act
http://www.eac.gov/about_the_eac/help_america_vote_act.aspx

Election Assistance Commission
<http://www.eac.gov>

Voluntary Voting System Guidelines
http://www.eac.gov/testing_and_certification/voluntary_voting_system_guidelines.aspx

- Everyday life has seen the rapid adoption of mobile technologies—smartphone and tablets, and apps for everything from banking to traffic direction, and a greater use of technology for other civic interactions.

The current election standards are based on mandates in the Help America Vote Act of 2002 (HAVA). HAVA created the Election Assistance Commission (EAC) and directed it to create guidelines for voting systems used by states and local governments conducting Federal elections.

HAVA contains usability and accessibility requirements (in Section 301 of HAVA), including permitting the voter to verify their vote before it is cast, make corrections, and be

warned if they have selected more than one candidate for a single office, in a private and independent manner.

It also requires that the voting system be “accessible for individuals with disabilities, including nonvisual accessibility for the blind and visually impaired, in a manner that provides the same opportunity for access and participation (including privacy and independence) as for other voters” and that there be at least one accessible voting system at each polling place.

The EAC’s Technical Guidelines Development Committee (TGDC), with technical support from NIST researchers as directed by HAVA, wrote requirements for voting systems that included requirements for human factors (usability, accessibility, and privacy), software, hardware, and security which became known as the Voluntary Voting System Guidelines (VMSG).

Despite its name, the VMSG is a standard: a voting system must meet all the requirements to obtain Federal certification, conducted by accredited voting system test laboratories (VSTL) and certified by the EAC. It is “voluntary” because the States do not have to adopt it for their voting system purchases. However, many states do require Federal certification, or use EAC-certified voting systems. Many also have state certification requirements.

There are several versions of the VMSG:

- In 2005, the EAC approved VMSG 1.0, which included the first set of comprehensive usability and accessibility requirements for voting systems.
- In 2007, the TGDC completed a draft comprehensive update to VMSG 1.0, called the “TGDC Recommended Guidelines”, “VMSG 2007”, or “VMSG 2.0”. The EAC requested public comments in 2007. It has never been finalized.
- In 2009, the TGDC completed a draft update to VMSG 1.0 with minor modifications called the draft VMSG 1.1. The EAC requested public comments in 2009 and 2012.
- As of this report in February 2014, the final VMSG 1.1 draft is waiting for the commissioners’ final vote of approval. (See the [EAC web site](#) for current status.)

To support the process of developing the usability and accessibility requirements, NIST conducted research to fill gaps in knowledge and support work on both requirements in the VMSG and best practices.

This work includes:

- An initial report on how to improve the usability and accessibility of voting systems and products

- Best practices for ballot instructions and error messages
- Test methods for usability of system documentation for poll workers
- Work on a performance-based test for voting systems
- Use of color in voting systems
- Usability and accessibility for voters with cognitive disabilities and low literacy
- Accessible ballot design for mobile devices
- (more to be added in the final draft)

The NIST research reports and other papers are online at vote.nist.gov.

What's New in Elections

Change is occurring on each step on the voter journey, affecting not only how Americans vote, but when and where they do so. Improvements to voting technologies are reducing barriers and providing voters with greater access and flexibility during the entire voting process. Additionally, the widespread use of convenience voting has shifted the emphasis from polling place voting to vote-by-mail and other early voting systems.

All of these changes also affect the human factors of elections, as each new technology brings with it new usability challenges and the possibility of accessibility barriers.

Use of web and mobile technology has changed the needs and expectations of voters

At its core, the goal of usability and accessibility is to align system functionality with the needs and expectations of current and future users. While the introduction of the mandates in HAVA was a major step toward improving the user experience of voting systems, many of the systems currently in use lag behind modern expectations.

The way Americans use and interact with technology continues to evolve as the number of individuals with Internet access increases. The Pew Research Internet Project reported in 2014 that 87% of American adults are accessing the Internet, leading to widespread changes in how individuals gather information, communicate with others, and purchase goods and services. The proliferation of Internet access has increased the acceptance of online transactions such as those that exist on ecommerce or banking sites. Even government organizations have taken to moving many of their services online.

Not only is the way Americans use the web changing, but also how they access it. Recent studies have shown a dramatic increase in mobile

connectivity, with 68% of American adults accessing the internet from a mobile device, 34% of whom use their mobile device as their primary source for internet access.

Adoption of mobile devices has grown faster in some populations than others, with Hispanic adults showing the highest rate of smartphone ownership. Accessibility options that are standard to devices such as iPhones and iPads have also reduced some of the barriers to Internet access for individuals with disabilities, leading many people with disabilities to prefer mobile apps to less-accessible web sites.

A digital divide still remains. Only 14% of American adults do not use the internet at all. Although 90% have a cell phone, only 58% have a smart phone. Some still rely on simple mobile phones and text messages. Even within those who use computers or mobile devices, there is also a wide range of proficiency with them or comfort using them for critical tasks.

Despite the widespread use of web enabled devices, many voting systems have yet to evolve to accommodate this growing trend. Long service periods have resulted in older voting systems, with many jurisdictions using machines that are nearing the end of their life. Systems created before the advent of the smartphone may no longer be able to meet the needs and expectations of the current voting population.

Convenience voting reduces barriers to voting

Convenience voting has its roots in the absentee voting process. While all states allow for absentee voting, it is only in recent years that the liberalization of election laws has allowed for more voters to take advantage of it.

The introduction of absentee voting in the United States largely occurred so that military voters could cast their ballots while stationed away from their local precincts. Laws such as the Uniformed and Overseas Citizens Absentee Voting Act (UOCAVA) were created to ensure that members of the military, their families, and citizens living overseas were able to vote in US elections. UOCAVA was later amended by the Military and Overseas Voter Empowerment Act (MOVE) to require states to send absentee ballots to all military and overseas voters no later than 45 days before a federal election.

While all states currently allow any registered voter to request an absentee ballot if they will be out of the state and (in many cases)

**Pew Research Center
Internet Project**

<http://pewinternet.org>

**Mobile Technology Fact
Sheet**

<http://www.pewinternet.org/fact-sheets/mobile-technology-fact-sheet/>

because of a disability, there has been a trend toward loosening requirements. No-excuse absentee voting has reduced many of the barriers to voting by allowing individuals to mark and cast ballots from the convenience of their home, regardless of their situation.

The National Conference of State Legislatures (NCSL), which tracks state election laws, reports that 20 states require a valid excuse in order to be granted the ballot, while 27 states and the District of Columbia offer no-excuse absentee voting. Out of the 28 jurisdictions that offer no-excuse absentee voting, eight of them have the additional option to become a permanent absentee voter.

The availability of the permanent absentee status marks a distinct shift in the way elections are being held, and gives insight into how they are likely to be conducted in the future. Oregon, Washington, and Colorado have already moved away from polling place voting to vote-by-mail (VBM) election systems. In California, as many as 69% of votes were cast by mail in the June 2014 primary.

Even vote-by-mail (VBM) states offer a limited number of vote centers to accommodate voters with disabilities and those who do not wish to vote by mail for other reasons, every registered voter is sent a ballot in the mail prior to the election. The number of states holding VBM elections may be likely to increase in upcoming years as this type of election benefits both the state and the voter. States with VBM elections provide the same benefits as no-excuse absentee voting but require fewer polling places, decreasing the number of resources needed to run an election.

Early voting is another method of convenience voting that is offered in 33 states, either in place of or in conjunction with no-excuse absentee voting. While early voting still requires individuals to vote in-person, it removes many of the other barriers that make single day voting difficult. For one, early voting makes use of voting centers instead of individual polling places. Often times, voters are able to vote at any early voting center in their county, oppose to having to vote at a designated polling place. Though voting centers are less numerous than standard polling places, the option to vote at any voting center provides some degree of flexibility as to which location works best for the voter. Voting centers also reduce the chance of error on the part of the voter, as they can vote at any center, not just at their designated polling place.

MOVE Act

<http://www.justice.gov/opa/pr/fact-sheet-move-act>

The Uniformed and Overseas Citizens Absentee Voting Act

<http://www.fvap.gov/info/laws/uocava>

NCSL: Absentee and Early Voting

<http://www.ncsl.org/research/elections-and-campaigns/absentee-and-early-voting.aspx>

Same-day registration may be viewed as another convenience method, with ten states (plus the District of Columbia) currently allowing residents to register and vote on Election Day. While not all states allow same-day registration on Election Day, some states do allow individuals to register and vote on the same day during early voting periods. The EAC's National Voter Registration Act (NVRA) studies show that in 2010, 2.4 million registration applications were filed on days in which it was possible to both register and vote, while in 2012 this number dropped to 1.4 million.

Though the effect of convenience voting on voter turnout is unclear, the fact remains that convenience voting expands the number of ways to vote. Alongside the rise of convenience voting, there has been an increase in voter participation by individuals with disabilities. Since 1992, there has been a general narrowing of the voter participation gap between those with and without disabilities.

The interconnectivity of voting technologies is steadily growing

In recent years, there has been a dramatic growth in the number of technologies used during different stages of the voting process. While online ballot casting is unlikely to come into widespread use at any time in the near future, the implementation of other online voting technologies has been shown to benefit both the voter and the states that deploy them.

These systems are also increasingly connected, either networked directly, or through data interchanges. Work to create common data formats for election equipment aims to create technical formats to enable interoperability, allowing all parts of an election system to work together. The IEEE/VSSC 1622 committee includes standards working groups covering the entire elections process from voter registration to election results reporting.

Most of these systems are outside of the scope of the VVSG, but could benefit from its general guidance to improve their usability and accessibility.

Online voter registration. Processes such as voter registration, can now be completed electronically in many states. By shifting voter registration online, states are able to reduce their overall costs, increase the accuracy of their voter lists, and provide voters with a quick and convenient way to register or update their information. According to the PEW Charitable Trusts report "Understanding Online Voter

EAC Voter Registration Data
<http://www.eac.gov/registrati-on-data/>

IEEE Voting Systems Standards Committee
<http://grouper.ieee.org/groups/1622/>

Registration” and the NCSL’s election research, Arizona was the first state to provide this option back in 2002. Since then, 21 states have started using online voter registration, with three more in the process of creating an online registration option.

Voter registration databases are increasingly connected. Integration with state motor vehicle data makes it easier for voters to register online by connecting their signature from their driver’s license to their voter registration entry. States are also working with non-governmental services, such as Rock The Vote, to allow them to submit voter registration data electronically. Election department staff still reviews each registration, but speeds the process by eliminating the need to re-enter the voter data.

Voter information portals. Online technologies have also benefited voters who are preparing to vote, as many states now allow voters to check their registration status, change their preferences for communication with the elections office, find their polling places and view sample ballots and voter guides online.

Increasingly, voting information is available online from many sources, in addition to the official election offices. Projects like the Voter Information Project (a partnership between The Pew Charitable Trusts, Google, and the States) have created access to official voting information. These apps can run on text messaging services, web, mobile platforms like Apple’s iOS and Android, proving a wide range of options for voters.

Understanding Online Voter Registration

<http://www.pewtrusts.org/projects/election-initiatives>

NCSL Elections and Campaigns

<http://www.ncsl.org/research/elections-and-campaigns.aspx>

Voter Information Project

<https://www.votinginfoproject.org>

Rock the Vote

<http://www.rockthevote.com/about-us/>

Ballot delivery. In some states, certain voters are allowed to mark Instances of online ballot marking and casting are usually reserved for voters outside of the country, under the Uniformed and Overseas Citizens Absentee Voting ACT (UOCAVA). These voters may be unable to complete and mail in their ballots without electronic assistance. However, a few states have allowed their online ballot marking tools to be used by individuals with disabilities so that they may have an accessible ballot marking option. Most recently, Maryland was required to make their online ballot marking tool available to voters with disabilities. The accessible ballot marking tool originally failed to be certified by the State due to security concerns, but issue was later brought before a federal judge who ordered that the ballot marking option be made available to all voters with disabilities.

Online ballot casting. The extent to which a ballot can be delivered, marked, and cast online varies by state. UOCAVA allows an option to submit a ballot electronically, usually with

the official ballot also sent by mail. Although there are policy and election integrity issues with online voting interactions, the usability and accessibility of the voter interface is also an issue.

Currently, Alaska is the only state that allows all registered voters (not just UOCAVA voters) to transmit their ballot either by fax, email, or an online submission system as a way to increase turnout for the State's geographically isolated population.

The Overseas Vote Foundation's End-to-End Verifiable Internet Voting Project is also working on how to make cryptographic systems accessible and usable as well as secure.

Electronic poll books. Web enabled technologies are also finding their ways into polling places, as certain jurisdiction have begun using electronic poll books (e-poll books) in place of paper voter rolls. While voting systems themselves cannot be connected to a wireless network due to potential security risks, networked e-poll books provide the poll workers with several useful features that help to facilitate the voting process.

E-poll books can:

- Alert poll workers if an individual has already voted
- Look up the correct polling place for any voter in the area, even if they have come to a polling place that is not their own.
- Eliminate the costs of printed voter rolls
- Improve the check-in process with features such as photo verification and electronic signatures

Elections are adapting to changes in technology and legislation

Though many states were able to update their voting systems with federal funding via HAVA, jurisdictions are still finding that their systems become quickly outdated as a result of changes in technology and legislation. While some states may be using voting systems that are up to 20 years old, others have had to replace relatively new DRE machines with optical scan devices in order to accommodate changes to the law. Even with the purchase of a new voting system, counties have no guarantee as to how long the system might be useful. As a result, some states and jurisdictions are looking for more flexible

UOCAVA Overview
<http://www.fvap.gov/info/laws/uocava>

Military and Overseas Voter Empowerment (MOVE) Act
<http://www.justice.gov/opa/pr/fact-sheet-move-act>

Overseas Voting Foundation
<https://www.overseasvotefoundation.org>

options that will provide them with a long-term voting solution

Colorado. In 2013, the State of Colorado formally requested vendor proposals for the development of a new voting system under the direction of their Uniform Voting System initiative. The goal of the project was to choose a single voting system that could be used by all 64 counties in the State. Their requirements for the new voting system were that it be:

- Scalable to accommodate counties of all sizes
- Accessible to accommodate all types of voters
- Flexible so systems can change if new legislation requires it
- Easy to set-up for transportation during elections
- Cost effective over time with low cost maintenance and upgrades

Under the Uniform Voting System, voters in Colorado can choose between the standard of voting by mail, or coming to a vote center to vote in person. This provides flexibility for voters, allowing them to vote in person if they prefer to or if they need accessibility features available at the vote centers.

Los Angeles, California. Similar system guidelines were set forth by the Voting Systems Assessment Project (VSAP) in Los Angeles County. VSAP was originally created to address Los Angeles County's aging voting systems. Faced with the possibility of having to adopt a voting system that would ultimately fail to meet the needs of their diverse community, county administrators commissioned the creation of a new voting system that would be able to change alongside any developments to state legislature or voting technology.

Like Colorado, this project also aims for flexibility through the use of

commercial, off-the-shelf (COTS) technology, in place of expensive voting kiosks. Voting systems developed using COTS technology, are not device dependent since the county will own the code needed to install the voting program on the device of their choice. When it is time to update the system, the county will be able to either alter the code or upgrade the COTS device.

The VSAP voting systems will be design to be universal, with all voters using the same system. They include options for voters to select their language; adjust the display for text size, color, and contrast; or choose to use the tactile controls or audio ballot. The system is a ballot marking device, producing a printed list of the voters' choice. This ballot is automatically deposited in a ballot box after the voter has reviewed it. Los Angeles plans to

Colorado Uniform Voting System
<http://www.sos.state.co.us/pubs/elections/VotingSystems/UniformVotingSystem.html>

Los Angeles County Voting Systems Assessment Project
<http://apps1.lavote.net/voter/VSAP/>

Travis County Elections STAR project in Discover Magazine
http://www.traviscountyclerk.org/clerk/Content.do?code=news.discover_magazine

continue to count the official ballots at a central facility, using high speed scanning of either a barcode or through optical character recognition (OCR).

Travis County, Texas. Though COTS technology will help to improve flexibility and usability in voting systems, modern systems must also address the growing security concerns surrounding electronic voting. Recent research has indicated that end-to-end cryptography may be a solution for providing secure, verifiable elections. The first attempt at integrating end-to-end cryptography into a voting system is the STAR voting project in Travis County, Texas. The proposed STAR system would take advantage of the many benefits of using COTS devices, adding security measures to ensure the ultimate goal of verifiable voting.

In the proposed STAR system, each polling place would have system that includes a registration machine, a controller machine, individual voting terminals, and a ballot box. STAR's networked registration machine is an e-poll book, capable of looking up any voter registered in the county, checking them in, and assigning them the proper ballot type, turning each polling place into county-wide voting center.

The STAR system aims to provide usable security to increase voter confidence. For example, when after voters cast their ballot, they are provided with a physical receipt that will allow them to check that their vote was counted on a public bulletin board.

Maryland. In 2012, the State of Maryland launched a new ballot marking tool which allowed absentee and UOCAVA voters to receive and mark absentee ballots online. The state Improving Access to Voting Act expanded use of the ballot marking tool to people with disabilities, providing them the opportunity to mark their ballot using the assistive technology already in use on their computer. In an example of a growing trend for states to build their own systems instead of relying completely on external vendors, Maryland worked with the National Federation of the Blind and the University of Baltimore to improve the accessibility of ballot marking tool.

However, due to concerns over security of the online interaction, the Maryland State Board of Elections failed to certify the system for use in future elections. In a lawsuit brought by the

**University of Baltimore
report to the Maryland
State Board of Elections
on the Online Ballot
Marking Tool**

http://www.elections.state.md.us/press_room/documents/OnlineBallot_UsabilityTestResults.pdf

**Online Absentee Ballot
Ruling**

<http://www.scribd.com/doc/238660968/Online-absentee-voting-ruling>

**National Federation of the
Blind**

<https://nfb.org/hava-intro>

National Federation of the Blind, a federal judge eventually ruled that the State of Maryland must provide access to the tool for voters with disabilities because withholding the tool would deny “meaningful access to the State’s absentee ballot voting program as mandated by the Americans with Disabilities Act and the Rehabilitation Act”. This decision establishes a precedent for ensuring that each method of voting (absentee, at a vote center, or at a polling place) must include accessible options.

Usability and Accessibility of Current Voting Systems

Since the publication of the VVSG in 2005, significant improvements have been made to the usability and accessibility of voting systems. However, implementation of these guidelines has not closed the participation gap between voters with and without disabilities. Physical access and system accessibility barriers still exist at many points in the voting process and, as of the 2012 elections, turnout for voters with disabilities was still 5.7 percentage points below that of voters without disabilities. Though a disparity in voter participation still exists, improvements to the accessibility in elections has helped to close the gap within the last 20 years.

Accessibility challenges still exist in current voting systems

Despite a strong body of industry standards, and the VVSG usability and accessibility requirements, current voting systems continue to create barriers for many voters. There are several different types of problems:

- Some systems can meet design requirements but fail to provide an adequate level of usability and accessibility because of poor implementation. Issues like cumbersome ballot navigation or confusing buttons have the potential to cause voters frustration and errors.
- The current requirements for standard accessibility options (such as increased ballot magnification or inverted contrast) is not enough to ensure success for voters with disabilities, especially voters with less experience with technology, low literacy and other cognitive disabilities, and other disabilities not specifically addressed in the VVSG requirements.
- Poor designs for functions to allow voters to review their ballots exacerbate the problem when voters do not notice errors in marking their choices, leading to votes being cast not as intended.

Availability of the accessible systems are also a concern in jurisdictions where accessible voting is separated from the standard voting procedures. Polling places may choose to only set up accessible machines as the need arises, especially in jurisdictions that have returned to paper ballots.

Ethnographic research that observed voter interactions at the polling place showed that awaiting the set-up of an accessible machine can lead to frustration, delay, and even embarrassment for voters with disabilities.

Isolating accessible machines from standard voting systems also prevents the poll worker from gaining experience with the accessible system. The poll worker's lack of familiarity with the accessible machine may impede his or her ability to provide voter support. In extreme cases, where only one accessible system is available, damage to the machine may force voters to sacrifice their privacy and request assistance voting on a non-accessible machine.

The challenges are not limited to polling place voting systems, as these problems have been reported in other elections systems, suggesting that even with well-established existing standards and laws, new uses of electronic technology in elections may need some level of oversight to ensure that they provide good usability and accessibility for voters.

In 2014, a review of online voter registration systems by the ACLU showed that "Only one online voter registration site in the country, California, is fully accessible to people with disabilities – and most state sites do not meet even minimal standards of accessibility."

Another recent study conducted by OCAD University for the City of Toronto revealed serious accessibility barriers in three systems being evaluated for use by voters with disabilities. Though the original Request for Proposal (RFP) required the systems to meet Level AA criteria as specified by the WCAG 2.0 guidelines, none of the three systems even met the Level A criteria, as would be required by the Accessibility for Ontarians with Disabilities Act. The report noted that though each system has some level of accessible design, significant barriers still existed within each interface.

Universal design reduces barriers for all voters

Voting systems that are designed with accessibility and usability practices in mind have the potential to greatly benefit both voters with and without disabilities. Creating a single system to be used by all voters ensures that accessibility options are available to all

Reports from the Research Alliance for Accessible Voting

<http://www.accessiblevoting.org>

Reports from the Accessible Voting Technology Initiative

<http://elections.itif.org/resources/working-papers/>

City of Toronto Voting System Accessibility Evaluation

<http://s3.documentcloud.org/documents/1310861/toronto-internet-voting-accessibility-report.pdf>

who may need them, even if they do not identify as having a disability.

Four research projects developed under grants funded by EAC to advance accessible voting, Prime III, EZ Ballot, Anywhere Ballot, and LEVI, use elements of universal design to create voting systems that can be used by all. While all of the prototypes were designed to accommodate a wide range of user abilities, the approaches differ greatly.

- **Prime III** accommodates voters through the combination of a touch screen and voice activated headset. Sighted voters with sufficient dexterity are able to select candidates using the system’s touch interface. Voters are also given the option to hear the audio ballot using a headset. If the voter is unable to see or reach the touch interface, they are able to say “vote” or blow into the microphone in order to select the candidate of their choice. (<http://primevotingsystem.org/>)
- **The EZ Ballot** focuses on a “linear layout” to provide a simplified voting experience. Voters are asked a series of yes or no questions in order to vote their ballot. Voters are given the option to vote along party lines or to vote in each contest individually. EZ Ballot was designed to work with multiple input options including physical tactile buttons, touch screen buttons, and gestural inputs. (<https://www.youtube.com/watch?v=NdQ07pa65Ag>)
- **The Anywhere Ballot** looks beyond hardware, instead choosing to focus on creating a ballot prototype that could be used on any device. The Anywhere Ballot’s use of plain language and plain interaction allows it to be accessible to a wide range of users, including those with low literacy and mild cognitive impairment. (<http://civicdesign.org/projects/anywhere-ballot/>)
- **Low Error Voting Interface (LEVI)** explores ways to make it easier to mark a ballot on-screen without error, though strong feedback mechanisms (<http://researchinaccessiblevoting.bitbucket.org/levi2/src/index.html#/>)

Challenges in voting system standards

Voting standards continue to evolve as the need for more usable systems becomes apparent. Performance standards are currently used as a way to provide vendors with basic voting system requirements without placing limitations on their design; however voting systems are still falling short of modern expectations. Current standards fail to assess a system’s overall level of usability, and the recommended testing procedures only concern system usability at the end of the design process. Research into other types of certification processes may provide insight into how to improve voting

standards as to encourage higher levels of voting system usability from vendors.

Voting standards have complex requirements

The primary goal of a voting system is deceptively simple: provide all eligible voters an equal opportunity to accurately and privately cast their ballot. However within this singular goal there are a number of significant challenges, including issues of security, reliability, privacy, usability, and accessibility:

- The security of voting systems is often one of the most pressing issues concerning the design of a voting system. The increased use of electronic voting systems has led to concerns over system tampering, hacking, and other types of voter fraud.
- The reliability of a voting system is critical for accurately casting and counting a voter's ballot. Software bugs, hardware failures, and even power outages, have the potential to alter or erase votes recorded on the system.
- Voters have the right to vote privately, meaning all voters must be able to vote with the same degree of independence regardless of their ability. Voting systems must not record the use of any accessible setting as it can risk revealing the voter's identity.
- A voting system's level of usability and accessibility greatly affects a voter's experience. In order for voters to mark and cast their ballot as intended, within a reasonable amount of time, voters must be able to properly hear or see the ballot, understand the language of the ballot, and understand how to mark the ballot based on the instructions provided.

The creation of a successful voting system requires the resolution of this complex set of challenges in a single system. While this task may seem daunting, the VVSG has consolidated these challenges into a set of attainable and measurable performance goals.

Performance standards can provide guidance without limiting innovation

Current VVSG standards provide usability primarily through design guidelines, but do not include requirements to show how the whole system performs for voters.

- **Design standards** ensure that specific requirements, such as minimum font sizes and standard colors, known to support usability and accessibility, are met. They have the benefit of being easier to test, but are often written with specific technology implementation in mind. But, meeting a set of detailed design standards does not mean that even a voting system that meets all of the design requirements will be usable and accessible.
- **Performance standards** for usability and accessibility focus on the actions that users of a voting system must achieve without specifying how they are to be accomplished. They are usually written as a small set of broad principles, so they are easier to write (and read), and are applicable to a wider range of technologies. They also provide vendors with the opportunity to innovate and explore new approaches without being limited by the specificity of design standards.

To support the goals of performance standards, vendors are required to conduct realistic usability tests on their system and report the results as a part of the certification process. Though the tests themselves are not standardized, the use of a Common Industry Format (CIF) report created specifically for Voting System Test Laboratories ensures that the test could be replicated. Usability benchmark standards may also work as a progress indicator for vendors seeking to improve their products. As the test methodology would be standardized and publicly posted, vendors would have the opportunity to test their system and fix usability issues prior to conformance testing.

Usability testing of voting systems by several research teams has shown that even systems certified to VVSG 1.0 have usability or accessibility issues that can affect voters using them in an election. Recognizing this potential problem, NIST and the Technical Guidelines Development Committee (TGDC) worked from the beginning to develop a valid and repeatable performance test method part of certification testing. The goal of the Voter Performance Protocol (VPP) was to generate impartial and repeatable metrics that would make it possible to distinguish systems with high levels of usability from those with poor usability.

The VPP proposed three benchmarks to be used to measure a system's accuracy and effectiveness:

- **Total Completion Score:** the percentage of test participants who were able to complete the process of voting and cast their ballots so that their ballot choices were recorded by the system.
- **Voter Inclusion Index:** a measurement that combines accuracy with the variability in the level of accuracy among individual test participants, and

- **Perfect Ballot Index:** a measurement for detecting a systemic design problem that causes the same type of error by many test participants, by comparing the number of participants who cast a ballot without any errors to those that had at least one error.

The efficiency and user satisfaction of a voting system would also be measured via Average Voting Session Time and Average Voter Confidence (based on questions developed specifically for the VPP) respectively. All of these measures can be used to evaluate any voting system, allowing election officials to compare systems to a consistent standard.

The TGDC proposed the VPP and set benchmarks for certification in the 2007 TGDC Recommended Guidelines draft (VVSG 2.0). Ultimately, however, the VPP was not included in VVSG 1.1.

The VPP remains relevant as one of the few examples of a usability test used in a certification process, and could be the basis for a revised approach to performance-based standards, though the benchmarks from 2007 are now outdated.

More recently, the National Association of State Election Directors (NASSED) Voting Systems Panel is working to develop a set of principles that could be used as a basis for performance standards.

User-centered design builds usability into the process

Despite the presence of performance standards, and the freedom of design afforded by them, vendors may still require additional guidance in order to produce the type of modern voting systems that jurisdictions require. The increasing need for custom voting solutions, such as those being created by Los Angeles and Travis County, show that current systems are not meeting the needs of modern voters. While standards help to establish that the final design of a voting system is usable, there is little done to ensure that usability is a consistent factor throughout the design process.

A user centered design (UCD) process (also called human-centered design) incorporates consideration of the users' needs into every stage of the design process. Instead of conducting usability testing only at the end of the design and development process, testing occurs at each stage so that errors are caught early on and are resolved during design. Errors caught early in the design process are easier, and less expensive, to fix and may lead to better system performance in the long term. UCD principles are part of in the Los Angeles Voting System Assessment Project's work to

Work at NIST on the development of the Voting Performance Protocol
<http://vote.nist.gov/publications>

create a voter-centered voting system. VSAP has gathered research, interviewed stakeholders, created technical specifications, and is working with design partners in order to develop this system.

Looking outside of the world of elections, the process to create a certification of Electronic Health Records (EHRs) systems has some relevant parallels. Voting and EHR systems share many of the same design challenges. Both systems must maintain data privacy, consider scalability (e.g., for differently sized hospitals), be usable for a wide range of users (e.g., doctors from different specialties or hospitals), and minimize errors. Process standards play an important role in the certification of both systems, as EHR vendors are also required to submit summative usability testing results in a modified CIF template (specific to EHR systems).

However, the major difference in the certification of these products is that instead of requiring adherence to specific usability requirements, EHR vendors are required to submit documentation of having followed user-centered design processes used for each technology capability submitted for testing. Increased emphasis on process-based standards ensures that the designers and developers of EHR systems are taking advantage of current best practices and have an understanding of the principles of user centered design.

Providing vendors with best practice guidelines could also be an effective way to ensure that vendors are building on current research in the field and progressing toward more modern designs. In response to a previous study that showed low levels of accessibility among UK websites, the publication of a set of best practices for commissioning accessible websites helped to improve the state of accessibility in the United Kingdom

ISO 9241-210:2008 Human-centered design processes for interactive systems

BSI 8878:2006
Web accessibility code of practice

ISO/IEC 25062:2006
Common Industry Format (CIF) for Usability Test Reports

Similar to the accessibility issues observed in modern voting systems, the poor accessibility ratings were not a result of a lack of standards (as WCAG 1.0 was available at the time, and WCAG 2.0 already under development) but rather that the guidelines did not provide proper guidance on how to implement accessibility changes and why it was important to do so. This standard aimed to provide website owners with an understanding of how people with disabilities used the web and placed the guidelines within a larger human context. The additional guidance helped to create a change in the states of accessible sites in the UK.

Standards can include other standards

One approach to simplifying a standard is to include existing standards by reference.

The U.S. Access Board took this approach in the proposed update to the Section 508 accessibility standards for electronic and information technology used or purchased by the federal government. Section 508 requirements are issued under the Rehabilitation Act and apply to a wide range of technologies including hardware, software, websites, multimedia, and copiers.

The proposed update includes WCAG 2.0 and several other standards by reference instead of creating a similar set of requirements. This simplifies the Section 508 standard document and incorporates a mature industry standard.

W3C WAI WCAG 2.0

Web Content Accessibility Guidelines

<http://www.w3.org/WAI/intro/wcag.php>

United States Access Board

<http://www.access-board.gov/>

Section 508 Refresh Draft Rule (2011)

<http://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-ict-refresh/draft-rule-2011>

Mapping the Voter Journey

The Voter Journey

Before we could begin work on the roadmap itself, we first had to explore the entirety of the election process. Work on election systems often emphasizes the act of casting a ballot, when the election process encompasses a wide range of activities, from learning about an election to receiving the results – with many steps in between. By identifying each of these steps and exploring them individually, we were able to create the voter journey.

At its simplest, the voter journey is a rich description of the voters' experiences during the election process. However the voter journey does more than list these experiences, it maps the relationships between the people, policy, processes, and products that take place during an election.

Although we call this a 'voter journey' it also includes all of the other users of election systems, especially poll workers and election officials. The usability and accessibility of the systems they use affect not only their experience, but how well they can serve voters.

By using the voter journey as an organizing principle, we were able to keep the scope of the roadmap grounded in the voter's experience rather than the technology or standards. More importantly it allowed us to think about how to design all interactions in the voting process so that they are more usable and accessible

Most of all, focusing on the voter journey allows us to explore complexity of the entire election experience.

What is a journey map?

The idea of a journey map (also called an experience diagram) comes from user experience practice, where it is used to help design interactions that take place over time, involve many different systems or groups of people, and do not have a single fixed path.

For example, even something as simple as planning a trip can involve several steps and interactions. This could include numerous visits to a travel web site, transactions to sign up for a service or order tickets, communications before and during the trip, and coordination with several different people and customer service staff. Projects like these are often called *service design*. The academic center, the [Service Design Network](#) uses this definition:

Service design is the activity of planning and organizing people, infrastructure, communication and material components of a **service** in order to improve its quality and the interaction between **service** provider and customers

Service design work includes not only e-commerce, but a wide variety of commercial and government services.

In thinking about the service design of elections, we identified touchpoints for voters including all the steps from learning about an election, registering to vote, deciding what voting options to use, and through all the steps to cast a ballot. The voter journey map is a way of describing all of these steps and identifying the systems, people, and policies that are part of the interactions.

It is also an analytic tool. As we created the roadmap, we used the voter journey map to unpack the complexity of elections in several ways. It was also useful during the workshops as a way of organizing output of the group activities and discussions.

To create the voter journey map, we started from the questions voters have about elections at each stage of the process. They will have these questions even if their individual path in the journey is not always in the same order.

We associated the activities (like “register to vote”) with the systems used to complete the activity. This let us compare different options and their usability and accessibility. For example, a voter might have the option to register in person, by mail, or online.

We could also see where systems were isolated, used for only one part of the voter journey, and where they handled several different steps. When placed on the diagram, the number of systems involved in a typical election becomes more obvious. The opportunities for gaps as a voter moves from

one system to another are easily visible, as are the places where a smooth hand-off from one system to another would make a better voter experience.

How the voter journey map is organized

The voter journey map is a two-dimensional diagram that organizes the information, activities, systems and other aspects of an election by the stages of the voter’s experience.

	Preparing to vote	Choosing how to vote	Checking in/ getting ballot	Marking the ballot	Casting the ballot	Verification & results
Learn	What is on the ballot? Am I/How do I register?	Where do I go to vote? What are my choices?	How do I get my ballot?	How do I mark as I intend?	How do I cast my ballot?	Who won? Did my vote count?
	Register to vote	Access to 'Polling Place' Request a VBM (or other)	Receive 'ballot' Authenticate/ Sign In	Mark the ballot Activate or open the ballot	Review the ballot Cast the ballot	See election results Verify ballot was received
Use	Registration Forms/OVR	Online VBM SYstem	Pollbook or Sign-in	Pre-Marked Ballot	Mail Ballot Return	EZE Verification System
	"My Voter" Portals	"My Voter" Portals	Ballot Delivery System	Ballot Marking System	Electronic Casting	VBM/Ballot Tracking
	Elections Web/ Phone	Elections Web/ Phone	Transportation to Polls	Ballot	Ballot Scanner	Elections Web/ Phone

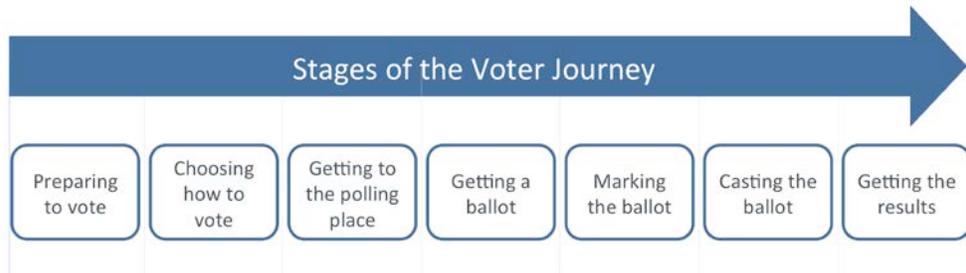
An early version of the journey map, showing the organization in rows and columns

We deliberately kept the map simple, limiting the number of stages and dimensions we included.

As part of the work on any objective in the roadmap, it would be useful to look more closely at the relevant parts of the journey, adding to the detail in the map. For example, there could be an entire journey map just to explore the details of learning about an election or marking a ballot. Similarly, it can be useful to map all of the options individually, and then look for ways they can be combined or compared. Carefully mapping different ballot marking options, for instance, can make it easier to compare the usability or accessibility of the different options.

Stages of the journey

The stages of the journey are represented by the columns going from left to right.



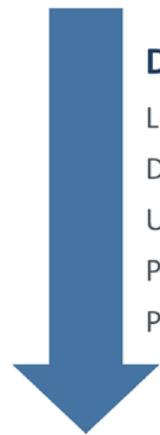
The stages of the journey map identify the activities in an election from the voters’ perspective. They include all voting options, such as voting in a polling place on Election Day, early voting, vote centers, absentee or vote-by-mail, UOCAVA, and any future choices.

Stage of the journey	Activities in this stage
Preparing to vote	Learning about the election, including what is on the ballot, the dates of the election, and registering to vote, or learning how to register on election day.
Choosing how to vote	Learning about options for voting, making choices, and activities to implement those choices, such as applying for a vote-by-mail ballot.
Getting to the “polling place”	This includes going to a physical polling place, vote center, requesting a vote-by-mail ballot, seeing an outreach poll worker, or using any digital service to request or download a ballot.
Getting a ballot	Once at the polling place, or having requested a ballot, this includes all of the activities to obtain the ballot, whether signing a poll book, receiving a ballot by mail, or downloading a blank ballot.
Marking the ballot	Preparing to cast a ballot by indicating choices, whether done digitally or on paper
Casting the ballot	All of the steps required to cast a ballot once marked, including packaging a vote-by-mail ballot to return or scanning a paper ballot.

Stage of the journey	Activities in this stage
Getting the results	All post-election activities including verifying a vote or learning about the results and canvass.

Dimensions of the journey

The rows in each column show different elements in each stage of the journey.



Dimensions of the voter journey

- Learn Voter questions
- Do Voter activities
- Use Election systems
- People Voters interact with
- Policy Election law

Dimensions	What this dimension includes
Learn	Questions voters want to answer in each stage of the journey
Do	Activities associated with the stage, phrased in a neutral way with regard to technology
Use	Systems or process used in the stage
People	Roles with primary responsibility in the stage
Policy	Election law or regulations that constrain or set requirements important in this stage

A spreadsheet with the current version of the voter journey is available online:

<http://civicdesign.org/projects/roadmap/>

Voter Journey: Preparing to vote

This stage includes learning about the election, including what is on the ballot, the dates of the election, and registering to vote, or learning how to register on Election Day.

Dimension	Elements in Preparing to vote
Learn	<ul style="list-style-type: none"> • What is on the ballot? • Am I registered? • How do I register? • When is the election? • How do I vote? Can I work with a practice ballot? • What happens at a polling place?
Do	<ul style="list-style-type: none"> • Register to vote • Get a sample ballot • Mark a practice ballot
Use	<ul style="list-style-type: none"> • Registration forms and online voter registration • Elections office web site or phone • "My Voter" portals • Public election information apps • Social media from election offices or the public web
People	<ul style="list-style-type: none"> • Election office or advocacy groups • Voter education • Voter registration
Policy	<ul style="list-style-type: none"> • Voter eligibility rules • Voter Guide/Sample Ballot requirements

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none"> • Improve access to information • Improve the readability of information • Support voters who don't have smart phones or digital access 	<ul style="list-style-type: none"> • Inaccurate information • Not in plain language • Equal access to information • Technical knowledge and digital literacy • Trust in the system

Voter Journey: Choosing how to vote

This stage includes learning about options for voting, making choices, and activities to implement those choices, such as applying for a vote-by-mail ballot

Dimension	Elements in choosing how to vote
Learn	<ul style="list-style-type: none"> • Where do I go to vote? • What are my options for how and where to vote? • Do I need ID? • What are the deadlines? • What am I voting on?
Do	<ul style="list-style-type: none"> • "Rehearse" or plan • Identify preferences • Practice using a voting system or marking a ballot • Chose level of communications from elections office
Use	<ul style="list-style-type: none"> • Elections Web / Phone • "My Voter" portals • Voter Guides • Public Apps • Social Media /Public Web
People	<ul style="list-style-type: none"> • Voter education • Elections office • Voter outreach groups
Policy	<ul style="list-style-type: none"> • Voting Options • Hours/Places

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none"> • Allow voters equal and convenient choices 	<ul style="list-style-type: none"> • Coercion • Equal access • Making all choices equal • Unknowns

Voter Journey: Getting to a “polling place”

This stage includes going to a physical polling place, vote center, requesting a vote-by-mail ballot, seeing an outreach poll worker, or using any digital service to request or download a ballot.

Dimension	Elements in getting to a polling place
Learn	<ul style="list-style-type: none"> • How do I get there? • What is the "address"? • When is it “open”? • Is it accessible? • Is my language available?
Do	<ul style="list-style-type: none"> • Go to the “polling place” • Request a vote-by-mail ballot, or blank ballot • Find directions or transit information • Make an appointment
Use	<ul style="list-style-type: none"> • Online vote-by-mail or ballot request system • Transportation to a polling place • Maps or directions
People	<ul style="list-style-type: none"> •
Policy	<ul style="list-style-type: none"> • Voter ID rules • Provisional ballot rules • Polling place dates and hours

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none"> • Make it easy for voters to go to a polling place or use online support tools 	<ul style="list-style-type: none"> • Transportation availability • Convenience • Language and accessibility

Voter Journey: Getting a ballot

Once at the polling place, or having requested a ballot, this stage includes all of the activities to obtain the ballot, whether signing a poll book, receiving a ballot by mail, or downloading a blank ballot.

Dimension	Elements in getting a ballot
Learn	<ul style="list-style-type: none"> • How do I get my ballot? • What does my ballot look like?
Do	<ul style="list-style-type: none"> • Authenticate or sign In • Receive ballot • Activate or open ballot
Use	<ul style="list-style-type: none"> • Poll book or Sign In • Ballot Delivery System • Personal Technology • Ballot "Activator" • Passbook / Wallet / Stored Preferences
People	<ul style="list-style-type: none"> • Poll workers • Election office
Policy	<ul style="list-style-type: none"> •

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none"> • Easier setup for personal needs and preferences 	<ul style="list-style-type: none"> • USPS not reliable • Wait times, long lines • Receiving the correct ballot • Trust in the system • Availability of system • Identification challenges

Voter Journey: Marking the ballot

This stage includes preparing to cast a ballot by indicating choices, whether done digitally, on paper, or through any medium.

Dimension	Elements in marking the ballot
Learn	<ul style="list-style-type: none"> • How to I mark my ballot? • What if I make a mistake? • Can I use my own accessibility technology?
Do	<ul style="list-style-type: none"> • Mark the ballot • Correct the ballot (if needed) • Print ballot
Use	<ul style="list-style-type: none"> • Pre-marked ballot/interactive sample ballot • Ballot Marking System • Ballot • Personal Technology
People	<ul style="list-style-type: none"> • Poll workers
Policy	<ul style="list-style-type: none"> • Voter Assistance Rules

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none"> • Universal design and equal access • Better support for preferences and accessibility needs • Wider range of assistive technology available at the polling place. • Ability to use personal assistive technology 	<ul style="list-style-type: none"> • Unclear instructions • Poor accessibility or support for preferences • Coercion by assistants • Availability of accessible system •

Voter Journey: Casting the ballot

This stage includes all of the steps required to cast a ballot once marked, including packaging a vote-by-mail ballot to return or scanning a paper ballot.

Dimension	Elements in casting the ballot
Learn	<ul style="list-style-type: none">• How do I cast my ballot?
Do	<ul style="list-style-type: none">• Review the marked ballot• Prepare a vote-by-mail ballot to return• Cast the ballot
Use	<ul style="list-style-type: none">• Mail ballot return• Ballot scanner• Electronic casting• Electronic ballot return
People	<ul style="list-style-type: none">• Poll workers
Policy	<ul style="list-style-type: none">• Counting rules• Voter assistance rules• Vote-by-mail rules

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none">• Easy and effective methods to cast a ballot• Effective review process• Improve convenience through technology• Universal design/equal access	<ul style="list-style-type: none">• Trust in the system• Coercion• Which ballot counts• USPS not reliable

Voter Journey: Getting the results

This stage includes all post-election activities including verifying a vote or checking that a ballot was received and counted.

Dimension	Elements in getting the results
Learn	<ul style="list-style-type: none">• Who won?• Did my vote count?
Do	<ul style="list-style-type: none">• See election results• Verify ballot was received• Track my ballot
Use	<ul style="list-style-type: none">• E2E Verification System• Vote by Mail Ballot Tracking• Elections Web / Phone
People	<ul style="list-style-type: none">• Elections office• Voter advocacy groups
Policy	<ul style="list-style-type: none">• Audits / Canvas rules• Ballot records access• Availability of vote-by-mail tracking

Design goals for this stage	Risks to the voter experience
<ul style="list-style-type: none">• Trust in the system• Making verification or tracking easy and accessible	<ul style="list-style-type: none">• Trust in the system

Priorities for Future Work:
Supporting the Voting Experience

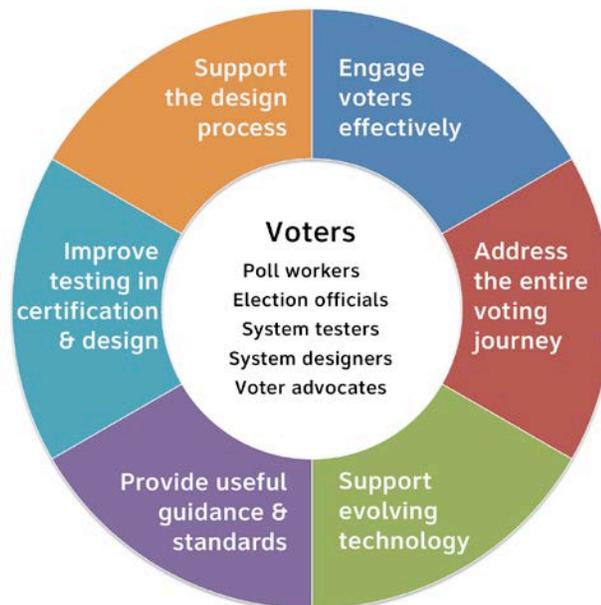
How the Roadmap is Organized

The roadmap is organized into six priority areas, each with specific objectives.

The Six Priority Areas

There are six priority areas for future work based on analysis of problems identified in information-gathering workshops and solutions suggested to address those problems. Although the priority areas are numbered for convenience, this does not reflect any relative importance among the areas and the objectives within them.

As appropriate for a human factors roadmap, people—voters, poll workers, election officials, system designers, system testers, and voter advocates—are in the center of the work, and the diagram below.



The priority areas are:

1. Support the design process
2. Engage voters effectively
3. Address the entire voter journey
4. Support evolving technology
5. Provide useful guidance and standards
6. Improve testing in design and certification

The Objectives

Within each priority area, there are a number of objectives that represent approaches to improve the usability and accessibility of the voter experience. They include research to fill gaps in current knowledge, work on guidance, exploratory work or analysis to support new ideas, and improvements in how the guidance and standards are communicated.

Each objective includes:

- A brief narrative describing the objective and its benefits
- Challenges the work must address
- Risks associated with not completing the objective
- A brief outline of the steps to complete the objective
- A preliminary list of resources, such as research or related work that could contribute to each objective

The priorities and objectives are inter-related, as they are all part of a general goal, but cover different aspects. In addition, we consider which stakeholders are most affected. For example, making requirements and guidance easier to use will have a benefit for voters, but will more directly affect system designers and evaluators.

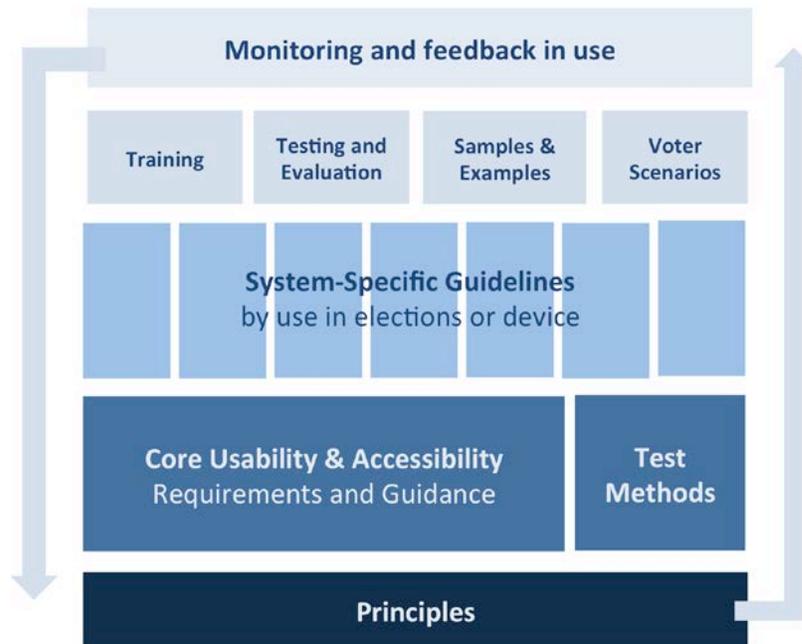
Guidance: Standards, Guidelines and Best Practices

We have chosen the general word “guidance” to include standards, guidelines, best practices, training or other information, so that we are not making decisions in advance about the final format of the output of any objective.

All of these elements have a relationship, which we have visualized as a stack, with principles supporting it at the base and continuous monitoring and feedback anchoring the top.

This view of the usability and accessibility guidance for election systems envisions tight relationships among all the materials from principles to ongoing monitoring and feedback in use. Much of this material already exists, but is in separate silos. This structure can bring all these pieces together.

As each objective is developed, it will be important to consider which forms of guidance are appropriate to support implementation, and how they fit into this model for a holistic view of the human factors “body of knowledge” for election systems.



Elements of Guidance

Type	Description
Principles	Clear statements of overarching goals that help everyone understand the reason for any requirement or guideline.
Core usability & accessibility requirements	Guidelines and requirements that apply to any interactive system or election function.
Test methods	Test methods for certifying that the core requirements are met.
System specific guidelines	Extensions to the core requirements that apply to different election systems or specific types of devices.
Training	Knowledge transfer and support for those new to the field or for continued learning.
Testing	Evaluation and testing methods that can inform the design of any election system.
Samples and examples	Illustrations and code samples that show best practices for meeting both core and system-specific guidance.
Voter scenarios	Short narratives that illustrate guidance in action, helping show how it supports the

Type	Description
	principles and meets voter needs.
Continued monitoring and feedback	Including both formal and informal feedback, monitoring allows regular review of the guidance and principles.

This structure also acknowledges a strong concern expressed in the workshops about the level of human factors knowledge in elections. The training, testing guidance, samples and examples, and voter scenarios are designed to help fill that gap.

Uniform core guidance on human factors that applies to all systems can help make those systems more consistent for voters and other users, raising the overall accessibility of the entire election journey. This split between core and system-specific guidance can also help keep each document or standard shorter, avoiding repetition (and possible inconsistency).

Each system-specific set of guidelines can focus on a single election function, such as informational websites, interactive web features (like voter registration or “my voter” portals), poll books, voting systems, and election management systems. It might also include specific guidance for types of devices, for example, very small or very large screens.

Terminology: Human factors, usability and accessibility

There is overlap in how terms to describe aspects of the user experience are defined.

Human factors. We have chosen the term “human factors,” to incorporate both usability and accessibility in the VVSG. For brevity, when we mean both usability and accessibility, we will use “human factors.”

Usability. This document uses the term “usability” to describe a quality of the interaction with a system that is efficient, effective, and can be completed with confidence. Usability also considers the role of the person and the context of use. Specifically, usability must be considered for poll workers, election officials, and voters for their specific interactions with voting equipment and election processes.

Accessibility. We use this term for the ability of people with a wide range of capabilities to interact with a system. Accessibility covers the

See Objective 5.2 – Simplify guidance by focusing on principles.

This objective focuses on how to organize guidance by principle.

full range of disabilities, including age-related disabilities, and perceptual, mobility and dexterity disabilities, whether the voter is classified as “disabled” or not.

Terminology: People and roles

Roles are defined by their activities and responsibilities. We have chosen to avoid the terms “vendor” and “test labs” because those are specific types of organizations.

Voter – includes any voter.

Poll Worker – anyone running a polling place or vote center, whether a temporary or permanent worker.

Election Official – includes state and local election offices and their staff.

System Designer – anyone contributing to the design of a voting system, including voting systems vendors, and people working in or for election offices.

System Tester – anyone who evaluates voting systems, including teams at test labs, the EAC, and state or local election offices and certification programs.

Voter Advocates – includes good government and specific advocacy groups who play a role in voter education, voter advocacy, and get-out-the-vote activities like voter registration.

The Priority Areas and Objectives

Priority Area 1: Support the design process

- 1.1 Design standards and guidance so they are easier to use
- 1.2 Share best practices and techniques that meet human factors goals
- 1.3 Create educational programs on human factors for system designers
- 1.4 Create guidance on effective design processes

Priority Area 2: Engage voters effectively

- 2.1 Create guidance on effective election communications and personalization
- 2.2 Make voter education available to everyone, including practice with real voting systems
- 2.3 Improve voter guides, making them more usable and accessible

Priority Area 3: Address the entire voter journey

- 3.1 Support voters as they move between election systems
- 3.2 Create a risk model that includes human factors and security
- 3.3 Enable “anywhere voting”

Priority Area 4: Support evolving technology

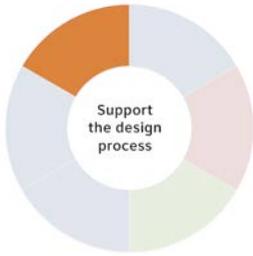
- 4.1 Use universal design to create systems that work for more voters
- 4.2 Enable the use of personal devices and assistive technology to vote
- 4.3 Update voting guidance to address new technologies and interactions
- 4.4 Create guidance for election systems outside of the “voting system”

Priority Area 5: Provide useful guidance and standards

- 5.1 Merge usability and accessibility into a single universal standard
- 5.2 Simplify guidance by focusing on principles
- 5.3 Develop performance metrics
- 5.4 Develop process standards

Priority Area 6: Improve testing in design and certification

- 6.1 Improve ways to test systems, including pilot testing as part of certification
- 6.2 Certification of open, component-based election systems
- 6.3 Establish qualifications of human factors evaluators



Priority Area 1 Support the design process

Improve knowledge of human factors in elections design

The first priority area looks at challenges to a more usable and accessible election experience and how election systems reflect the current state of industry knowledge.

Many comments during the workshops suggested that people who work with election systems, from designers to election officials, often have a weak understanding of human factors, especially accessibility. This makes it difficult to use the VVSG standard and other guidance documents effectively.

If the documents themselves are designed to be more useful and usable, we will ultimately have better systems, designed to meet standards and best practices. This priority also envisions providing support guidance, examples and training in addition to the standards.

Problems that objectives in this priority area can address include:

- People working on voting systems don't think broadly enough about voters and their abilities because they have little contact with voters with disabilities.
- Standards and guidance are difficult to interpret or design for because of a weak understanding of the problems they address.
- It is difficult to learn about what has worked – and what has not – in election systems, so election design is slow to learn from best practices or avoid known problems.
- It is difficult for researchers to get access to voting systems to understand the design and human factors challenges.

Objectives in this priority area

- 1.1. Design standards and guidance to be easier to understand and use
- 1.2. Share best practices and techniques that meet human factors goals
- 1.3. Create educational programs on human factors for system designers
- 1.4. Create guidance on effective design processes



1.1 Design standards and guidance to be easier to understand and use

Priority Area: Support the design process

Roles: System designers, evaluators, election officials

People who work with election systems, from designers to election officials often have a weak understanding of human factors, especially accessibility. This makes it difficult to use the VVSG standard and other guidance documents effectively. One of the first resolutions of the Technical Guidance Development Committee called for “usability of the standard,” recognizing that a large body of information is difficult to use.

This objective is based on the assumption that if the guidance documents themselves are more useful and usable, election systems designed using them will meet the aims of the requirements more effectively, resulting in better usability and accessibility.

Challenges for this Objective	Risks to this Objective
How will different parts of the guidance be harmonized and kept up to date?	The body of material might get more complicated.
Can the standard be published as a web-based, hyperlinked document to make it easier to connect related material?	Legal issues in understanding compliance requirements.
How will success in meeting this objective be measured?	Guidance can get out of date as technology changes.

Description

Designing a standard (or any document) to be easier to navigate and use is a design project like any other.

Work to meet this objective includes:

- Identify user goals, such as finding relevant requirements and related information more easily.

- Identify the types of content that might be associated with the standard, such as test methods, notes or other guidance.
- Investigate an online design that includes interactive features such as links and filters based on metadata.
- Investigate ways of identifying requirements that are legally required for accessibility under voting rights laws and the ADA.
- Prototype and test the designs with people who will use the standard.

Resources (in progress)

Work on this objective can draw on examples from other regulatory documents and the processes that created them, including:

- The NYC Zoning Handbook
<http://www.nyc.gov/html/dcp/html/pub/zonehand.shtml>
- The Washington State Licenses & Inspections Core Rules
<http://www.lni.wa.gov/safety/rules/find/>
- Consumer Financial Protection Bureau on updated mortgage disclosures
<http://www.consumerfinance.gov/knowbeforeyouowe/>

Other useful guidance includes:

- The Federal Plain Language Guidelines
<http://www.plainlanguage.gov/howto/guidelines/FederalPLGuidelines/index.cfm>
- Style Guide for Voting System Documentation (NISTIR 7519)
<http://www.nist.gov/itl/vote/upload/NISTIR-7519.pdf>



1.2 Share best practices and techniques that meet human factors goals

Priority Area: Support the design process

Roles: System designers, evaluators, election officials

Access to voting research and testing information remains an issue for people working with voting systems. System designers often do not have access to (or are unaware of) academic resources concerning human factors research and usability testing. Conversely, the lack of published data on voting systems testing makes it difficult for researchers to understand the design and human factors challenges faced by voting systems. These informational barriers make it difficult to identify what is and is not working in elections, slowing down the progress and evolution of voting systems.

This objective addresses the need for a collaborative space for vendors, election officials, and researchers to share information. The creation of a clearinghouse for pilot studies, testing data, conference papers, and journal articles can help disseminate knowledge to all parties involved with election systems. Sharing best practices will help system designers avoid known problems and will improve the overall usability and accessibility of voting systems.

Challenges for this Objective

How to encourage system designers to publish test results?
Ways to make it acceptable to share failures as well as successes?
How to ensure high quality information?
What is the best format for this information?
Who will own and maintain the best practices information?

Risks to this Objective

Transparency can be a challenge for information treated as a trade secret.
The best practices information may not keep up with current technology or research knowledge.
The information shared must be curated and organized.

Description

A best practices repository might include:

- Examples of test protocols
- Examples of design patterns
- Sample code and design guidelines
- Usability test reports (from pilots, summative testing, etc.)
- Relevant human factors research from work on elections and other relevant fields such as privacy, communications, and accessibility

Both the repository interface and the presentation of the information must be designed for, and tested with, the people who will use the information.

Work on this objective will include identifying an “owner” for the repository and the process by which new material is added to it.

Resources (in progress)

- [AccrualNet](#) – An example of a research and best practices repository from the National Cancer Institute
- [Civic Design Bibliography](#) – An annotated bibliography of elections research
- [UK Government Service Design Manual](#) – An example of best practices in government design
- Github repositories as examples of good practices



1.3 Create educational programs on designing for usability and accessibility

Priority Area: Support the design process

Roles: System designers, evaluators, election officials

While best practices offer guidance on what is working well in elections, this type of direction does not address the overall low level of understanding of human factors by people working with voting systems. Knowledge of core accessibility and usability principles is necessary to properly understand best practices and implement human factors techniques. Educational programs have the potential to bridge this gap for system designers, evaluators, and election officials. Training can help to improve knowledge of system requirements, increase their familiarity and skill with human factor techniques, and raise awareness of the challenges faced by different kinds of voters.

As with all of the objectives in this theme, increased knowledge and understanding of human factors, especially accessibility, will result in systems that work better for everyone who uses them.

Challenges for this Objective	Risks to this Objective
How to identify the specific gaps in skills and knowledge?	Keeping the information in the training up to date.
Who will set the curriculum?	Responsibility for maintaining the content of the training.
Who will deliver the training?	Evaluating the efficacy of the training in meeting objectives.
Where and how will training be made available?	
Will training be required for certification in the future?	

Description

This objective could include:

- Training courses (offered online, through EAC, Election Center, state election associations, or universities)

- Mentoring programs
- Usability test days at academic centers
- Cadre of experts offering advice and mentoring
- Access to assistive technology
- Education specifically on the goals of the human factors requirements in the VVSG

Other tasks might include:

- Creating a catalog of existing training programs and other resources
- Analyzing existing resources for gaps
- Setting up a portal for access to resources

Work on this objective could be done in parallel at different organizations, but would benefit from coordination.

Resources (in progress)

- Training developed by the EAC-funded [RAAV project](#)
- [Assisting Voters with Different Needs](#) training course developed by Georgia Tech for the EAC-funded AVTI project
- Courses for election officials run by the Election Center, NACRC, IACREOT, and state elections conferences
- Portals for state election officials, like the page [Information for Election Officials at the Michigan Board of Elections](#)
- Online university courses using platforms like Coursera, Udemy or other MOOCS that might be appropriate for teaching usability and accessibility to election officials
- [Web Accessibility Initiative](#) online training in accessibility



1.4 Create guidance on effective design processes

Priority Area: Support the design process

Roles: System designers, voters, advocates

Despite the public nature of voting systems, there are relatively few opportunities for voters to have direct input on a new system, or for system designers to work with voters in a collaborative design process.

User-centered design (UCD) is one of the most common processes for incorporating usability into a design and development process. As described in an international standard (ISO 9241:20), UCD features direct involvement of users throughout the design process, as well as an iterative approach that uses frequent usability testing to refine the system's design.

A user-centered design process provides system designers with a deeper understanding of voter needs and preferences, promoting the creation of new usable systems. Additionally, this inclusive approach allows advocates and voters to be part of the design process in a collaborative, rather than adversarial way.

Challenges for this Objective	Risks to this Objective
How to make UCD a regular part of the design process?	Disagreements about the value and application of UCD.
How to balance user representation, so system doesn't help one group and leave others out?	If the right voter representatives aren't recruited, UCD processes could be unhelpful.
How to ensure that system designers are trained in UCD techniques?	

Description

Work to meet this objective could include:

- Gather and analyze ways different UCD options can be adapted for use in election design process
- Write how-to guides or training

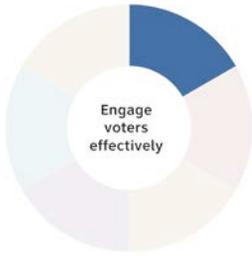
- Pilot use of the guides
- Promote wider use of the guidelines
- Create a portal or other repository

Resources (in progress)

See objective: 5.4 Develop process standards

See objective: 1.3 Create educational programs

- Existing citizen/voter panels and advocacy group processes
- Online consultation engines
- ISO 9241:20 (formerly ISO 13407) – Human Centered Design Process
- Structured negotiations
- CIF for voting (as example of adaptation)
- UCD process standards for electronic health records
- UCD process for FDA approvals



Priority Area 2 Engage voters effectively

Best practices for election information and voter guides

This theme explores opportunities to increase voter engagement through social media and other electronic communications. The use of effective engagement methods throughout the voter journey is an important factor for ensuring voter success. Engagement through education and voter guides can help to improve a voter's confidence and performance while at a polling place.

However, the availability and accessibility of these resources are not guaranteed. This lack of guidance and consistent support for best practices during the voter journey makes the voting process a disjointed experience for both the voter and the election officials.

If we can improve the accessibility and usability of voter engagement methods, we can provide voters with greater support outside of the polling place. Universal access to voter education programs will also provide voters with the confidence needed to succeed at the polls.

Some of the problems that objectives in this priority can address are:

- Voters – especially voters with disabilities - need access to voter education on real systems to reassure and engage them
- Other types of election software are not held to the same standards as voting systems, resulting in voter guides with poor usability and accessibility
- Poll workers and election offices include few people with disabilities are who can provide guidance on the best ways to reach specific communities.

Objectives in this priority area

- 2.1. Create guidance on effective election communications and personalization
- 2.2. Make voter education available to everyone, including practice with real voting systems
- 2.3. Improve voter guides making them usable and accessible



2.1 Create guidance on effective election communications and personalization

Priority Area: Engage voters more effectively

Roles: Election officials, advocates, voters

Keeping voters informed at every step of the voter journey is necessary to ensuring their engagement throughout the entire election process. The use of electronic media has increased the opportunities for election officials to communicate directly with a majority of the voting population. Voters can now receive updates on their registration or absentee status, or even receive tailored information to assist them on Election Day (such as voter guides, Election Day wait times, and directions to polling places or vote centers). However, much like voting systems, the design of election communications will require guidance to make them a usable and effective tool for voters. These communications will require special guidelines to address the potential for personalization (allowing voters to customize options such as format, frequency, and type of notification). Storing these options in the voter registration database may also help to ensure future engagement.

As the quality of election communication increases, so will voter engagement. Direct communication with elections officials will provide voters with convenient access to election information, while personalization features will improve the voter’s overall experience.

Challenges for this Objective	Risks to this Objective
What personalization options are important for voters and how should they be presented?	Fraud or misinforming voters by non-official sources.
What technical APIs are needed for effective interconnectivity of systems?	Overreliance on technology means that if it fails, you fail.
How would integration with state voter registration database work?	Over-saturation of messages can disengage voters.
How can options and information be written in plain language?	More technologies for election offices to manage.

Description

Ideas for effective communication with voters include many that are already in use in some jurisdictions, including:

- Electronic “I voted” stickers, friendly competition, and other gamification and personal monitoring devices.
- Personalization options and how to present them.

Activities in this objective might include:

- Collect best practices from election administrators and research.
- Create a checklist for ways to encourage local participation
- Encourage collaboration between election officials and researchers to validate and measure impact.
- Identify best practices for accessible communications.
- Investigate effectiveness of modern communication methods (push notifications, social media messaging, etc.).
- Investigate the range of personalization options and how to present them.

Resources (in progress)

- [Global Public Inclusive Infrastructure](#) and [Personalization for Global Access](#)
- Workshop concepts from AVTI:
 - [Personal Voting Guidance System](#)
 - [Express Voting Profiles](#)
 - [A National Standardized Framework](#)



2.2 Make voter education available to everyone, including practice with real voting systems

Priority Area: Engage voters more effectively

Roles: Election officials, advocates, and voters

Many different kinds of voters can benefit from the opportunity to practice voting or mark their choices before arriving at a polling place. At-risk voters (such as those with cognitive disabilities or those who require assistive technology) often have difficulty relearning voting systems every few years and would benefit from voter education programs that make it easier to practice on real voting systems. Voter education can also reduce the anxiety of first time voters or even encourage potential voters, familiarizing them with the voting process before their first experience in a polling place.

Voters who have had a chance to practice voting in advance will be more confident at the polling place and will require less support from poll workers, leading to quicker vote times and shorter lines.

Challenges for this Objective

How can this voter education be provided universally without undue burden to election officials?

How to ensure voter education is provided to at-risk voters?

How to communicate the benefits of voter education to voters?

Could good government groups provide training, using official materials?

Can voting systems be made available for voter education or can the voting system be simulated?

Can voters use self-paced training, or do they need live instructors?

Risks to this Objective

Voter education might not be effective.

At-risk voters, including those from language minorities, might not have access to the training.

Voters might post about the training or voting system with negative comments.

Description

As with other objectives to create training and best practices resources, work to meet this objective includes gathering examples of existing materials and creating a portal or clearinghouse of resources.

Ideas proposed at the workshops include:

- Mobile “voter vans” to bring voter education to local neighborhoods, especially for voters whose disabilities affect mobility (e.g. elderly, cognitively impaired, etc.).
- Voter education on security and privacy issues.
- Use students to teach others in their community.
- Establish guidance for how to provide training or assistance to voters with disabilities.

Resources

See objective: 1.3 Create educational programs on designing for usability and accessibility

- AVTI research on voters with disabilities and poll worker training course
- RAAV research on voters with disabilities and how they are trained to use voting systems
- Training available from advocacy groups
- AVTI-OpenIDEO challenge competition winning concepts:
 - [Voting Vans](#)
 - [Voter Help Hub](#)



2.3 Improve voter guides making them usable and accessible

Priority Area: Engage voters more effectively

Roles: Election officials and voters

Voter guides act as a significant source of engagement prior to the voter's arrival at a polling place. These guides support voters during several stages of the voter journey, making the proper design and implementation of these guides critical to effectively engaging voters. While voting guides are designed to help voters successfully navigate the election process, guides that lack usability and accessibility considerations can create additional barriers to voting.

Requiring voter guides to meet accessibility and usability standards will result in improved access to election information for a much larger audience of voters. Since voter guides do not have the same proprietary limitations as voting systems, it is possible for jurisdictions to work together to develop guidelines, or to even create a common voter guide format that integrates usability and accessibility best practices into the guide.

Challenges for this Objective

How do we identify best practices across the wide variety of election practices?

What information do new, disengaged, and regular voters need?

What is the best way to present election information online?

How can information about candidates and measures be collected for each election?

How to provide accessibility for people with a wide variety of disabilities and needs or preferences?

Risks to this Objective

Added complexity of the election administration process.

Description

Several different activities could be done in parallel, leading to a process to design, test, and pilot a model for an accessible online voter guide.

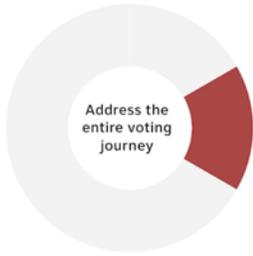
- Collect examples of online voter guides.
- Test them for usability and accessibility with a range of voters with disabilities, including vision, cognitive, literacy and language.
- Make recommendations for improving the human factors of online voter guides.
- Create a sample or pilot guide and test it.
- Create templates and sample code for others to use.

This objective might also explore the election administration issues of online voter guides, including:

- Identifying restrictions or requirements in state laws (and possibly creating model regulations).
- Identifying possible workflows to make it easier to collect this information from candidates and sponsors of ballot questions.

Resources (in progress)

- [Future of California Elections research on voter information](#)
- [EAC Effective Designs for the Administration of Federal Elections and Quick Start Guides](#)
- Pilot election department web sites created by ELECTricity



Priority Area 3

Address the entire voter journey

Support a coherent voter experience across all activities

A voter's journey is often a disjointed experience, occurring at different times, at different locations, using different devices. However, improvements to voting technologies have the potential to create a cohesive experience for the voter. A voting system that is integrated across the entire voter journey would support voters from their initial registration to the verification that their vote has been cast.

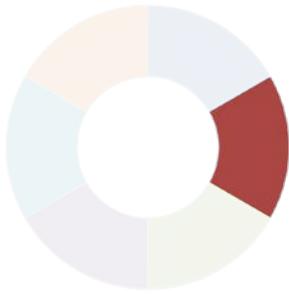
Current standards and guidance tend to focus on the experience of the voter in the polling place, even though the voter journey does not begin or end at voting. The voter journey does not always follow a clear linear progression. We must begin to take a holistic approach to elections, where we consider the entire journey rather than the individual steps.

Some of the problems that objectives in this theme can address include:

- How should voting be similar to and different from everyday processes?
- How to make voting delightful, and have it be one of the easiest interactions with government?
- How can voting systems be integrated with other election technology for a more cohesive experience?
- How can election systems allow marking a ballot from anywhere? (Some parts of the voting process such as ballot marking are easier to make secure than other parts such as vote casting.)
- Can voting be personalized and socialized better?
- How can guidance address usability, accessibility, and security together?

Objectives in this priority area

- 3.1. Support voters as they move between election systems
- 3.2. Create a risk model that includes accessibility, privacy, and security
- 3.3. Enable "anywhere voting"



3.1 Support voters as they move between different election systems

Priority Area: Address the entire voter journey

Roles: Voters

Integrating the entire voting process would have several advantages, including making it easier for voters to learn and use. As elections offices put together their individual systems that are part of the voter journey, they need to support voters in moving between them with a consistent interface with clean “hand-offs” between systems, or design a pathway that would guide voters through the experience rather than leaving them on their own to find the next step.

Systems could be tightly integrated. For example, an electronic poll book that communicates voter preferences for setting up a voting system for a specific voter. Integration could be managed indirectly, such as a voter registration management process that triggered reminders to find an online voter guide.

Many of these systems are built and managed by election departments, so this is also an opportunity for them to work together to increase availability of good technology, or for small businesses to contribute by filling in gaps in accessible technology with component products.

Challenges for this Objective	Risks to this Objective
How to ensure interconnectivity of devices and easy hand-offs between different systems?	Creating points of failure if the architecture is too rigid or not open enough.
How to store and communicate voter preferences?	Creating advantages for some voters with better access to digital technology.
	Differences in state requirements may create difficulty creating a cohesive system.
	Creating opportunities to “hack the election” or bias voters.

Description

Activities in this objective could involve work by election departments as they put together their election systems as well as work to promote interoperability to make that job easier.

- Identify touchpoints in the voter journey where it is useful to have a hand-off between systems.
- Identify personalization and preferences information for voters, especially accessibility options for voters with disabilities.
- Identify options for storing voter preferences options and how they can be communicated to different systems.
- Create standards (such as those in progress at VSSC 1622) to support interoperability and hand-offs.

Resources

See objective: 2.1 Create guidance on effective election communications and personalization

See objective: 6.2 Certification of open, component-based election systems

- [Personalization for Global Access](#)
- IEEE VSSC P1622 standards for interoperability
- Voting Technology Project “Polling Place of the Future”



3.2 Create a risk model that includes accessibility, privacy, and security

Priority Area: Address the entire voter journey
Roles: System designers, election officials, voters

Security experts, human factors experts, and voters with disabilities seem to perceive risk in voting systems in widely different ways. These differences in perspectives have made it harder to create systems that are both technically secure and which have good usability and accessibility.

This objective proposes engaging security and human factors experts to work together to build a trust and risk model that analyzes the barriers to voting along with the human factors involved in trust, and that integrates the findings into current security threat models.

Even with no perfect answer, it is important to continue to make progress towards a unified risk model.

Challenges for this Objective	Risks to this Objective
How do we bring together multiple definitions of trust, privacy, and security?	Failing to come to a common understanding of both technological and human risk.
What are the attack risks?	Lack of understanding how important privacy is by the new generation.
What are emotional trust issues?	Voter suppression and coercion.
How to balance the security and trust risks of different election systems?	

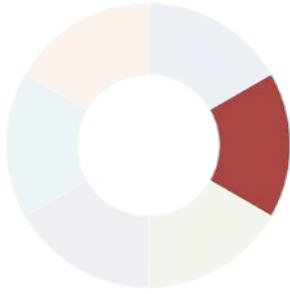
Description

Risks to election systems include traditional (and novel) attacks, but there are also risks based on what and who voters trust in their interactions with an election. This objective will bring these two perspectives on risk together, so systems can be designed to meet both needs.

- Bring together a cross-disciplinary group to explore risks from all perspectives.
- Create a model that will help designers and election officials make choices to minimize risks, or put in place steps to mitigate those risks.

Resources (in progress)

- Existing election risk models
- Risk models for health and medical systems
- FDA risk analysis and mitigation processes
- Technologies like NFC, QR codes and other ways to transport information between systems



3.3 Enable anywhere voting

Priority Area: Address the entire voter journey

Roles: System designers, election officials, voters

The goal of anywhere voting (or ballot marking) is to increase the flexibility and options for voters in where and how they mark and cast their ballot. In recent years we have seen a rise in convenience voting, resulting in an increase of online ballot delivery and ballot marking systems. These online systems allow voters to use their personal devices (such as tablets, phones, and computers) and/or assistive technology during the voting process. This is especially beneficial to people with disabilities who are accustomed to their specific type of assistive technology or personal devices, and have difficulty learning a new system at the polling place.

Anywhere voting benefits the voter by affording them greater convenience and flexibility when choosing when and where to vote, increasing the voter’s satisfaction with election process. Additionally, the shift away from polling place voting has the potential to reduce the cost and burden of elections on the state by allowing election officials to use less expensive consumer devices.

Challenges for this Objective	Risks to this Objective
How to design for multiple platforms and multi-vendor implementations?	Cost and skills needed to assist with multiple device options.
How to provide voter assistance across such a large range of devices and locations?	Possible bias from different interfaces and security risks from differences between channels.
How to meet voters’ expectations of performance and consistency with little control over hardware and platforms?	Poor understanding of security and privacy by voters. Rapid change in consumer technologies.
How to balance security risks and convenience?	Digital divide issues. Having their own device doesn’t mean the voter can accurately use the device.
How to ensure that voters understand the process and are able to complete voting and cast a ballot correctly, even if not at a polling place?	Legal and regulatory constraints in states.

Description

This objective is closely related to several others.

Like 4.2, it envisions the uses of personal devices and assistive technology, so that voters can use familiar systems to mark their ballot, with all of their personalization and preferences supported.

Like 3.1, it requires the ability to connect between different parts of the election system, for example to receive a ballot from the election office so that it can be marked, and then returning the data to an official election system to be counted and cast.

It also requires a strong understanding of the risks of “anywhere” ballot marking and the relationship between convenience and security, also a concern for 3.2.

Work needed to meet this objective includes:

- Design research on how to create a ballot that with a consistent display and interaction style across a wide variety of personal devices.
- Work to create a system design that reduces security and privacy risks.
- Understanding how to support voters using devices that the election office or poll workers might not be familiar with, including specialized assistive technology.
- Prototyping and testing systems with voters, including the user interface and the complete ballot marking process.

Resources (in progress)

See objective 3.1 Support voters as they move between election systems

See objective 3.2 Create a risk model that includes human factors and security

See objective 4.2 Enable the use of person devices and assistive technology

- Technologies like NFC, QR codes and other ways to transport information between systems
- Prototypes and systems in use that support ballot marking
- Work at the Los Angeles VSAP on an “interactive sample ballot”
- UOCAVA blank ballot delivery systems



Priority Area 4 Support evolving technology

Include a wider range of technology in elections

Technology has changed since HAVA and VVSG 1.0. New technologies have brought changes in expectations for use of personal devices in daily life, and these devices are making their way into elections. This priority looks at ways to create guidance to address the novel interactions for using these new devices.

One of the most commonly mentioned challenges for new technologies or styles of interaction is that the VVSG 1.0 was written before mobile devices became commonplace. The human factors requirements did not anticipate the wide adoption of small screens, and the use of gestures like tapping and swiping.

This priority has particular urgency for accessibility because of advances in the level of accessibility features in mobile operating systems. Mobile devices are also critical in considering digital divide issues, as some groups of voters—especially younger and some lower socio-economic demographic groups—use them as their primary computer.

Problems that objectives in this priority can address include:

- A lack of interconnectivity and interoperability that make it hard to use new technologies and personal devices in a voting system.
- The challenge of making voting systems that work for a larger number of voters by being flexible to meet their needs.
- A lack of guidance for use of new forms of interaction, like gestures, in election systems (especially in voting systems).

Objectives in this priority area

- 4.1. Use universal design to create systems that work for more voters
- 4.2. Enable the use of personal devices and assistive technology to vote
- 4.3. Update voting guidance to address new technologies and interactions
- 4.4. Create guidance for election systems outside of the “voting system”



4.1 Use universal design to create systems that work for more voters

Priority Area: Support evolving technology

Roles: System designers, voters

Universal design is an approach that has the goal of making products (including digital products, physical devices, and the environment) inherently accessible to people with and without disabilities.

An early resolution of the TGDC called for voting systems that accommodate a wide range of human abilities so that as many people as possible could vote without the need for extra adaptation or specialized assistive technology. This approach also acknowledges that “accessible” features often benefit everyone.

It also suggests that innovation can come from solving extreme problems, rather than trying to add accessible features after a system is designed. This could be an approach to get beyond minimum requirements to make election systems delightful for everyone to use – including voters, poll workers, and election officials.

Implementing principles of universal design also means focusing on:

- Personalization to allow voters to set the display and interaction styles that work best for them, with these options easily available to everyone.
- Plain language and plain interaction to support people with low literacy and low digital literacy, while making the design simpler for everyone.

Challenges for this Objective	Risks to this Objective
Ways to test with all types of voters?	Varieties in hardware.
What are the common requirements for the largest number of voters?	We will never have a perfect system.
Are different requirements needed for different types of voting systems?	Could make systems more expensive if not designed well.
Can poll workers have a similar interface across many devices?	Need for education in universal design approaches.
	Could lead to a reduced range of accessibility features.

Description

Steps to meet this objective include:

- Identify both the common requirements that apply to all voters and those that are needed for just one type of disability.
- Identify any conflicts in requirements.
- Create an approach to testing that covers a wide enough range of capabilities, while being feasible and practical.
- Identify universal design solutions in general use that can be applied to voting systems, looking especially for features that benefit a wide range of people.
- Create training in universal design emphasizing the unique nature of election systems.
- Contribute to a best practices repository.

Resources (in progress)

See objective: 1.2 Share best practices and techniques that meet human factors goals

See objective: 4.2 Enable the use of personal devices and assistive technology

- IEEE VSSC P1622 standards for interoperability (so many different systems can use the same ballot definition)
- GPII Preferences for Global Access
- Center for Universal Design and other universal design research institutes



4.2 Enable the use of personal devices and assistive technology in elections

Priority Area: Support evolving technology

Roles: System designers, voters

The first objective for elections technology is to use universal design to meet the needs of as many voters as possible without additional accommodation. However, the second objective in making election systems flexible is to allow voters to use their own personal assistive technology.

Personal technology includes specialized technologies like refreshable braille and personal mobile devices. Both make use of the election system easier by allowing voters to use it in the same way that they interact with other systems.

Although using familiar personal technology has strong benefits for users, it also presents problems for the security of voting systems. The goal of this objective is to identify the ways in which personal devices can be safely used in elections and the technical requirements for that use.

Challenges for this Objective	Risks to this Objective
What functions in an election system are appropriate for personal devices?	Lack of interoperability.
How do personal devices communicate with the election system?	Poll workers and election officials may not be able to support voters in using personal technology.
What interoperability or connector standards are needed to allow personal technology to be used?	Personal technology creates a security risk.
How can personal technology meet security requirements for voting systems?	Lack of standards for AT interoperability.

Description

This objective is similar to objective 3.3 Enable “anywhere voting.” The difference is that this objective includes using personal technology as an assistive device in the polling place.

There are several technical challenges, including managing connecting a personal device to the voting system in a safe way, and how poll workers support voters using potentially unfamiliar devices.

Work needed to meet this objective includes:

- Identifying possible personal assistive technology that might be used in a polling place.
- Identifying connection and interoperability standards that could be used to connect that technology to a voting system.
- Work to create a system design that reduces security and privacy risks of using personal technology.
- Understanding how to support voters using devices that the election office or poll workers might not be familiar with, including specialized assistive technology.
- Prototyping and testing with voters.

Resources (in progress)

See objective 3.3 Enable anywhere voting

- IEEE VSSC P1622 standards for interoperability
- Connection technologies such as Bluetooth, RFID, NFC



4.3 Update voting guidance to address new styles of interaction

Priority Area: Support evolving technology

Roles: System designers, voters

Interactions like touch, voice, and gesture are part of the interfaces for mobile devices and tablets, though rare on kiosk- or desktop-style systems. The VVSG was written before new forms of interactivity became commonplace. As a result, there is little guidance on how to incorporate these interactions into election systems, with good human factors and, especially, good accessibility.

This gap is particularly important any official systems provided by an elections office. We do not know how well the current VVSG requirements apply to these new interactions, or if they provide appropriate guidance for designing systems that use them.

In some cases, interactions that have poor human factors on one type of system but not on another. A good example is scrolling, which has such poor usability that it is prohibited in the VVSG, but which is more intuitive on mobile devices that use swipe gestures.

This objective will benefit system designers by providing clear guidance on how to incorporate new styles of interaction effectively.

Challenges for this Objective

- What interaction styles are not included in the current guidance?
- What new guidance is needed to address these new interaction styles?
- Are there interaction styles that are not appropriate for some election systems?
- How can guidance be written so that it clearly applies to the appropriate technologies?

Risks to this Objective

- Increasing the complexity of the VVSG and other guidance.
- Lack of standards for AT interoperability.

Description

Work to meet this objective starts by identifying a list of new interaction styles to be considered. They might include:

- Screen-based gestures, such as swiping and tapping
- Gestures with a device, such as shaking a device
- Non-device gestures, such as pointing or waving
- Voice input to control a system

Then, for each interaction:

- Complete an analysis of the VVSG human factors requirements for how they would apply to the interaction and identify any gaps or inconsistencies.
- Review existing uses of the interaction in generally available commercial products, current election systems, and research prototypes.
- Review existing standards and research literature for guidance appropriate to election systems.
- Conduct usability testing with voters using typical systems with the interaction.
- Propose updates or additions to the current guidance.

Resources (in progress)

See objective 4.2 Enable the use of personal devices and assistive technology in elections

- Prototypes for voting systems including EZBallot, Anywhere Ballot and Prime III, and Levi2 that use mobile or tablet devices with new interactions and current election systems designed for new technologies.
- WAI WCAG 2.0 and other accessibility guidelines.
- NIST research on designing for mobile devices.
- ACCURATE/Rice University research on voting on mobile devices.



4.4 Create guidance for election activities outside of marking and casting a vote

Priority Area: Support evolving technology

Roles: System designers, system testers

The VVSG applies only to voting systems—systems that assist a voter in marking and casting a ballot. The VVSG human factors requirements may also be useful in creating systems to support other election activities, including voter registration, signing the voter register, or requesting a ballot.

This objective explores effective ways to make good human factors guidance available for all election systems. One proposed approach is to create a set of core requirements that apply universally and consistently to all elections systems, especially those voters interact with.

The goal is to produce a small set of core requirements that system designers and testers can learn once, augmented with guidance for specific election functions.

Challenges for this Objective

What are the core human factors requirements?

Can core requirements address different devices and interaction styles in a single document?

Will a small set of core requirements be easier to understand, supporting the objective of increasing human factors knowledge and design skill?

Risks to this Objective

Adding to the complexity of the guidance instead of making it clearer and easier to use.

Description

This objective requires analysis to determine if there is a core set of human factors requirements that can apply across different election systems. It proposes analysis of the VVSG to determine if this approach is practical. If the approach does turn out to be practical, it will result in guidance that is useful for system designers and effective in encouraging more usable and accessible systems.

- Analyze requirements in the VVSG to identify core human factors requirements or those specific to voting systems.
- Conduct an analysis of the core human factors requirements to identify gaps in meeting needs of voters or a range of devices.
- Review other usability and accessibility standards for contributions to the core requirements, or as a candidate to be that core set of requirements.
- Propose a set of core human factors requirements for all systems.
- Create a draft human factors chapter of the VVSG showing how it could be broken into core requirements and those specific to voting systems.

Resources (in process)

See objective: 5.2 Simplify guidance by focusing on principles

See objective: 1.3 Create educational programs on designing for usability and accessibility

- WCAG 2.0 and “Guidance on Applying WCAG 2.0 to Non-Web Information and Communications Technologies (WCAG2ICT)”



Priority Area 5 Provide useful guidance

Make standards and other materials effective

Like most technical standards, the VVSG is large. The number of detailed, testable requirements can make it difficult to see the big picture of the goals of the standard.

In addition, the current development and certification environment, even with good requirements, has not been completely successful in creating systems that have good human factors for voters, poll workers, and election officials.

This objective aims to simplify the standard itself and making it easier to read. It will start from high-level principles that can be connected to more detailed requirements and performance metrics.

The objectives in this priority suggest several different ways to improve the guidance and requirements that can raise the bar for the process of creating any election system, whether it is certified or not.

Objectives in this priority area

- 5.1. Merge usability and accessibility into a single universal standard
- 5.2. Simplify guidance by focusing on principles
- 5.3. Develop performance metrics
- 5.4. Develop process standards



5.1 Merge usability and accessibility sections in the VVSG and other guidance

Priority Area: Improve guidance and standards

Roles: System designers, system testers

In the VVSG, the human factors requirements are divided into two parts, one for all systems and one for “accessible voting systems.” Both VVSG 1.0 and 1.1 (draft) include some requirements for all systems aimed at giving voters the best possible accessibility, including those with mild or age-related disabilities who may not opt for an accessible voting system.

This supports a universal design approach, where the goal is one system for all voters, with no isolation of an underused and often unavailable accessible voting system. It also acknowledges the overlap between usability and accessibility, especially flexibility for voter preferences such as choice of text size and contrast or audio reading of text, which benefits many voters.

Work for this objective would examine the feasibility and impact of merging the entire chapter into one group of requirements that apply to all systems. If this works, this approach can be used in all guidance.

The benefits for the election process include a simpler standard and easier certification with a single set of requirements for all voting systems. One system for all voters can also make it easier to manage and set up the voting system.

Challenges for this Objective

How can the two sections of requirements be merged effectively?
How should requirements for an accessible system be identified?
Should there be “levels” of accessibility?

Risks to this Objective

Change to the structure of the VVSG.
Clearly identifying success or failure in meeting HAVA and ADA accessibility requirements.
Integration with component certification.

Description

Meeting this objective requires analysis and a proposal to change the structure of the VVSG.

- Analyze the current VVSG requirements and determine how the two parts of the chapter could be merged.
- Propose an organization for the merged requirements, for example, by function or interaction feature, rather than by disability area.
- Propose a way of identifying requirements that are critical for matching voting system requirements to those in other standards, like the Web Content Accessibility Guidelines (WCAG 2.0).

In addition, work in this objective should explore the possibility of incorporating other standards by reference, similar to the Access Board proposal for making WCAG 2.0 part of the Section 508 standard.

Resources (in progress)

See Objective: 4.1 Use universal design to create systems that work for more voters

- Principles of universal design
- WCAG 2.0 principles
- Accessible UX principles
- Current voting systems and prototype that aim for a universal design



5.2 Simplify guidance by focusing on principles

Priority Area: Improve the guidance
Roles: System designers, election officials, advocates,

One of the criticisms of the VVSG and other standards is that the detail of the requirements makes them large, cumbersome, and difficult for non-technical readers to understand. One result is that the standards can stifle innovation.

If the guidance was focused on high-level principles—in this case for usability and accessibility—the detailed requirements and other guidance could be organized to show how to meet these principles.

Organizing guidance around a common set of principles would have several additional benefits:

- It would make it easier to show the context for any requirement.
- The principles can be a way of connecting material from different sources.
- They could provide a way to compare designs, implementation, and testing across all elections systems.
- An appropriate set of principles can be the foundation for performance-based testing for certification.

Challenges for this Objective	Risks to this Objective
How to identify a set of principles that are meaningful enough to be useful? How to achieve consensus on the principles?	Voting and other election systems seem to meet the principles, but do not meet voter or other user needs.

Description

This objective could include:

- Analyze principles that have been proposed in other projects to create a consolidated list of human factors requirements.
- Test the principles with system designers, election officials, and advocates to ensure that they communicate their intent clearly.
- Propose ways to organize the VVSG and other guidance using the final list of principles, or connecting requirements to those principles in some way.

Resources (in progress)

- Design principles from other projects, including PCEA/BPP, NASED
- Principles of Universal Design, WCAG, Accessible UX principles
- Principles from related areas, such work on electronic health records and FDA approval processes



5.3 Develop performance metrics

Priority Area: Improve guidance and standards

Roles: System designers, system testers

Design requirements can be constraining. They can restrict innovation because more effort goes into meeting requirements than finding new solutions. And, they are inevitably anchored in past experience. Performance metrics, when tied to goals and principles, can meet the challenges of changes in technology or election procedures better.

Performance metrics could cover a single interaction (such as marking and casting a ballot) or could be extended to cover other functions, such as voter registration or requesting absentee ballots. They should also apply equally to all options for completing an activity. For example, metrics for marking and casting a ballot should apply to vote-by-mail, vote centers, and voting at a polling place.

Performance metrics can have several benefits:

- Requirements are simpler to write because they do not need to include detailed design specifications.
- Allows for tradeoffs that take context of use into consideration.
- Making standards comparable across different voting methods is helpful for ensuring that all voters have equal access.

Challenges for this Objective	Risks to this Objective
How to determine minimum requirements?	Opportunities to “game” the system in reporting performance.
What are the appropriate principles to meet election objectives?	Performance standards are more open to interpretation.
What is the range of acceptable performance?	Trade-offs might disadvantage some voters, or create barriers.
How to require testing with people with disabilities?	Difficulty of identifying and testing with a representative sample.

Description

This objective would apply the work used to develop the Voter Performance Protocol in determining the correct metrics and benchmarks.

Explore whether performance metrics could also have levels of performance, to encourage improvements in the level of design. Levels of performance may include:

- A minimum performance requirement
- A level that reduces risk based on poor human factors
- An “ideal” system for the voter experience

Resources (in progress)

See objective: 5.2 Simplify guidance by focusing on principles

- NIST work on the Voter Performance Protocol
- The FDA decision to qualitative metrics because of problems gaming the system.
- FDA procedures to allow companies to mitigate performance gaps and risks in different ways, including approaches like additional training.
- Civic design and community organizations that can connect to voters for testing.



5.4 Develop process standards

Priority Area: Improve guidance and standards
Roles: System designers, system testers

One approach to ensuring that human factors are properly considered in the design and development process is to create process standards and require that vendors show that they have followed that process in creating a system for certification.

Process standards could:

- Ensure that human factors are considered during the design.
- Encourage the involvement of voters with disabilities, low literacy, and language minorities.

Challenges for this Objective	Risks to this Objective
What steps and documentation should be required?	Variations in state laws, and other political issues.
What are the metrics for accepting the documentation of the process?	Meaningless reports that are loopholes allowing designers to 'game' the process.
How to require usability testing without over-specification?	It could be possible to meet the process, but not produce a high quality system.

Description

- Review existing process standards and analyze their steps for their relevance to elections design.
- Propose a set of process steps to be required.

Resources (in progress)

See objective: 1.4 Create guidance on effective design principles

See objective: 6.1 Improve ways of testing systems including piloting

- Quality standards such as ISO 9001
- FDA process and 7-point documentation requirements
- ISO 9241:200 – Human Centered Design Process for User Experience
- Common Industry Format (CIF) format for reporting usability results



Priority Area 6: Improve testing in design and certification

Make the process effective

The federal certification process is set up to test voting systems to the VVSG requirements. Like all testing to a standard, it focuses on the products, which is both a strength and a weakness. Its strength is in the specificity of the requirements and the consistency with which they are tested. The weakness is that the actual human factors are only tested indirectly, so even rigorous compliance with the standard does not ensure that systems will work for voters and election administrators.

Some of the problems that objectives in this priority can address include:

- Systems may not have been designed and tested with the people who matter, especially at-risk voters and voters with disabilities.
- The design process may not have included the sort of iterative design and testing that ensures that human factors are considered throughout the design and development process.
- Systems are certified without pilot testing experience, making it easier for them to meet the requirements without being usable and accessible in a live election.

Objectives for this priority

- 6.1. Improve ways to test systems, including pilot testing as part of certification
- 6.2. Certification of open, component-based election systems
- 6.3. Establish qualifications of human factors evaluators



6.1 Improve ways to test systems, including pilot testing as part of certification

Priority Area: Improve testing
Roles: System designers, evaluators, election officials

Voting systems, in general, do not get sufficiently robust usability and accessibility testing, either during design and development or as part of the certification process. New ways of testing systems might include:

- Shadow elections (vote on a new system after 'really' voting)
- Student mock elections
- Using voting systems for non-government elections
- Pilot testing as part of the certification process

Some state and local jurisdictions currently include pilot testing as part of a procurement process. But in some areas, rules about the use of new systems in real elections make this difficult.

The benefit of better testing is that the final systems will be improved through more evidence-based input to their design.

Challenges for this Objective	Risks to this Objective
What are the minimum requirements to allow a pilot test? How to ensure that the test environment and participants are representative?	Ensuring that there is sufficiently broad voters represented, including voters with disabilities. Confusing voters (and poll workers) with new procedures. Creating bias between different election procedures in the same election.

Description

This objective could include:

- Identify state and local pilot programs.
- Identify examples of other ways of testing new systems with voters.
- Identify best practices in these evaluation methods.
- Create guidance showing the benefits and drawbacks of the different evaluation methods, supporting election officials in making choices.
- Explore ways to allow piloting even before systems are certified (where appropriate).
- Set guidelines for minimum standards for a system to be piloted and how an election office can participate with confidence.

Resources (in progress)

- Minnesota (and other state) pilot testing of electronic poll books
- Prime III pilot experiences
- Piloting UOCAVA support systems
- Piloting alternative ballot and systems for outreach to voters with disabilities in Oregon, and many other states
- State certification programs



6.2 Certification of open, component-based election systems

Priority Area: Improve testing
Roles: System evaluators,

The current federal certification only handles an entire system. This makes it difficult to create components that can be added to add new features or support for specific voters to a voting systems. It is also difficult to make incremental improvements, with easy and rapid updates to the certification. Components can be hardware or software, and could include specialized accessories such as refreshable braille displays. This objective could also address how to certify software components.

A process to certify open, component-based election systems would also require a way to ensure that the completed system provides a usable and accessible experience from start-to-finish.

The ability to certify components could mean that:

- Election officials have more choice and possibly lower cost.
- Easier to add components to meet specific needs.
- Flexibility for election administrators and voters.
- Ability for voters to use their own AT.
- Opens the marketplace to allow small companies to bring specific expertise.

Challenges for this Objective	Risks to this Objective
How to create a rapid process for certification and updates?	Components do not work as an accessible whole.
How to get AT to voters?	Digital divide issues in what technology is included in a voting system.
What does certifying a software-based system mean?	Security for the assembled system.
Should all components be accessible?	Lack of standards for AT interoperability.

Description

The current program only certifies complete voting systems. The human factors advantage to certifying system components is that it will allow specialized devices to be included for voters who need them.

- Investigate connections and interoperability for assistive technology and identify connections that can be allowed for use in an election or voting system.
- Create guidance for assembling a system from components while ensuring good human factors, especially accessibility.

Resources (in progress)

- IEEE VSSC P1622 or other interoperability standards
- Open standards for connecting some kinds of AT
- GPII Personalization for Global Access
- Experience of labs in certifying updates to systems under state certifications – for example, electronic pollbooks
- FDA process for updating or extending product approval



6.3 Establish qualifications of human factors evaluators

Priority Area: Improve testing

Roles: System evaluators, system designers

The lack of qualifications for evaluating usability and accessibility is a double-edged problem: labs currently do not have a way to find the right people, and people with appropriate skills are shut out of the current process.

Neither test labs nor system designers have guidelines on what type of usability/accessibility experts should be on their team to ensure their final product is accessible.

Additionally, there is no guidance for whether a test lab should accept or reject a summative usability study. As a result, many studies are accepted despite bad study design (such as using inappropriate methods or participants) or questionable results (such as reporting that all participants completed a ballot without error).

Challenges for this Objective	Risks to this Objective
What degrees or certifications are appropriate indicators of skills? How to find people with strong enough experience in usability, accessibility, and security?	No broadly recognized accreditations in the fields of human factors. Academic vs. practical knowledge. There are few opportunities, and therefore low interest, in working in elections.

Description

NIST has previously written guidelines for how to identify qualified human factors evaluators. This process could be revived and extended to create recommendations.

- Identify skills, experience, or knowledge needed.
- Identify industry certifications or academic qualifications relevant to working to evaluate voting systems for usability and accessibility.
- Identify academic centers that might provide election-specific training.

- Propose an approach to accrediting experts as evaluators.
- Pilot any programs developed in this objective.
- Set up a monitoring program that includes evaluating improvements in election systems as a result of better evaluation skills.
- Investigate scholarships or fellowships to encourage highly skilled recent graduates and professionals to enter the field.

Resources (in progress)

- IAAP, HFES, UXPA, SIGCHI professional organizations
- Existing election research centers that work with election departments, including those in Indiana, Connecticut, and Georgia
- Academic programs that train human factors experts

How We Created This Roadmap

The input for this roadmap came from a review of current research on voting systems and active consultation with experts and other stakeholders in the field. We sought out diverse viewpoints so many different stakeholder perspectives are included.

We held two workshops with invited experts including election officials, researchers, system designers, policy experts, and disability advocates.

Workshop One

The first workshop was held in October 2014, and focused on gathering as many different ideas and visions for the future of elections and election systems as possible. It had the goal of open brainstorming to:

- Explore the promise of future technologies in voting systems for achieving usability and accessibility for all voters
- Identify gaps in the research (and how they can be filled)
- Generate new ideas for how to develop useful guidance (standards, how-to guidelines, exemplars, you-name-it) for election administrators and system designers and to ensure the guidance is followed
- Bring a voter-centered focus to improving elections for everyone

The activities started from a focus question:

What will the voter experience of elections be like in the future?

Through an interactive process called a KJ activity^{*}, the group identified 4 priority areas for breakout topics:

- Convenience voting and "Vote Anywhere"
- Accessibility and universal usability
- Trust, security and verification
- Design and evaluation of the user interface

The breakout groups identified

- Current and possible future scenarios for usable and accessible elections
- Conditions required for these scenarios for future elections
- Strategies for supporting voters in navigating across the voter journey

^{*} See *How to KJ: Setting Priorities Quickly* at <http://uxpamagazine.org/how-to-kj/>

- Conditions, challenges, or limits that could constrain these scenarios

The outcomes of these discussions were used to fill in details on a voter journey map, and to identify topics for deeper work at the second workshop.

Workshop Two

The second workshop was held in January 2015. Building on the first workshop, there were three breakout group topics:

- How can the guidance and certification process be improved for better usability and accessibility?
- How can we create guidance for the wide range of technologies in use in elections today?
- What voter needs are not being met? How can we ensure equal access to voting options?

The groups rotated through the breakout topics working on objectives for the roadmap. They used voter personas, the voter journey map, their collective experience, and ideas from other domains as input for the discussions. A theme across all of the discussions was the need to consider all stakeholders in all work, including:

- Voters
- Poll workers
- Election officials
- State election boards and standards
- Legislators
- Candidates and their campaigns

The groups identified many possible objectives for the roadmaps and worked on filling in details including benefits for voters, opportunities for the elections process, design challenges and risks of failure. In some cases, groups proposed overlapping ideas from the different starting points, creating over 20 different possible objectives.

Reports from both workshops can be downloaded from the project page:

<http://civicdesign.org/projects/usability-and-accessibility-of-next-generation-elections/>

Analysis and Synthesis

All of the material from the workshops was analyzed and organized into the structure presented in this initial version of the roadmap. This structure

started from the voter journey, but also looked at the different ways in which elections information, systems, and procedures influence the election experience and the usability and accessibility of all activities.

Next steps

This draft of the roadmap was presented at the Future of Voting Systems symposium in February 2015, with a workshop to collect input from the election community on the priority areas and objectives.

The next steps are:

- Gather further public comment
- Finalize the priority areas and objectives
- Identify the most important objectives so tasks can be prioritized
- Begin to identify who can work on various objectives to achieve them.

We hope to release a final draft of the roadmap in May-June 2015.

Participants

We wish to thank the many individuals who participated in the process of creating this roadmap.

Workshop – October 8-9, 2014

- Andrew Baranak, GTRI
- David Bjerke, Falls Church, VA
- Stephen Blosser, MSU RCPD
- Steven Booth, NFB
- Mike Byrne Rice University
- McDermott Coutts, Unisyn Voting Solutions
- Jim Dickson Nat'l Council on Ind. Living
- Jeremy Epstein, NSF
- Josh Franklin, NIST
- Bob Giles NJ Division of Elections
- Thomas Hicks, House Admin. Committee
- Merle King, Kennesaw Center for Election Systems
- Ben Long, NIST
- Christy McCormick U.S. DOJ
- Alysoun McLaughlin, Montgomery County, MD
- Whitney May, ELECTricity
- Tammy Patrick, Bipartisan Policy Committee

- Sarah Swierenga MSU UARC

Workshop – January 9, 2015

- Paul Aumayr, Maryland Department of Elections
- Doug Chapin, Election Academy and FOCE
- Drew Davies, Oxide Design
- Shari Little Elections Systems & Software
- Juan Gilbert, University of Florida
- Dan Gillette, Gillette Design, RAAV, AVTI
- Diane Golden, Assistive Technology Access Program
- Keith Instone, Overseas Voting Foundation E2E VIV
- Ed Israelski
- Jonathan Lazar, Towson University
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- Brian Newby, Jocelyn County Election Department
- Jim Tobias, Inclusive Design and GPII

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- Jaime Lee, Kathryn Locke, Emily Rhodes, and Joel Stevenson, University of Baltimore

References and Resources

Research on Election Usability and Accessibility

There is a large body of research and other reference material on human factors. Some is directly related to elections, some relevant work from other fields. We welcome suggestions for other references to add to this list.

NIST and EAC research projects

- NIST Voting Publications
<http://www.nist.gov/itl/vote/publications.cfm>
- NIST Accessible Voting Technology
<http://www.nist.gov/itl/vote/accessiblevoting/index.cfm>
- EAC Election Management Resources
http://www.eac.gov/election_management_resources/default.aspx
- EAC Voting System Testing & Certification
http://www.eac.gov/testing_and_certification/default.aspx
- Research Alliance for Accessible Voting
<http://www.accessiblevoting.org/Home.aspx>
- ITIF Accessible Voting Technology Initiative
<http://elections.itif.org/resources/working-papers/>

Other projects and portals

- Presidential Commission on Election Administration (PCEA)
<http://www.supportthevoter.gov>
- Rice Usability of Voting Systems project
<http://chil.rice.edu/projects/accurate/index.html>
- National Federation of the Blind – HAVA training curriculum
<https://nfb.org/hava-training-curriculum>
- CalTech/MIT Voting Technology Project
<http://vote.caltech.edu/>
- Future of California Elections
<http://futureofcaelections.org/>
- IEEE VSSC1622 Voting Systems Standards Committee
<http://grouper.ieee.org/groups/1622/index.html>
- Voting Info Project
<https://www.votinginfoproject.org>
- End-to-End Verifiable Internet Voting Project
<https://www.overseasvotefoundation.org/E2E-Verifiable-Internet-Voting-Project>
- Field Guides to Ensuring Voter Intent
<http://civicdesign.org/fieldguides/>

Usability and Accessibility Standards

General Usability

The most thoroughly developed international standards for usability are in the ISO 9241 series. Recently, ISO normalized their numbering system, bringing many related standards into this series:

- **ISO/TC 159/SC 4 - Ergonomics of human-system interaction** - This series includes the entire 9241 series including the process standard 210: Human-centred design for interactive systems
http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=53372&published=on

Accessibility

U.S. Federal Regulations and W3C Standards

- **Information and Communication Technology (ICT) Standards and Guidelines** also known as the Section 508 (or ICT) Refresh. The standards apply to a wide range of ICT so only a portion is relevant to voting systems. Section 508 is currently in force. The Section 508 Refresh, completed in 2011 but not in effect is organized by function. It says that web accessibility will be met by meeting the WC3-WAI Web Content Accessibility Guidelines 2.0 <http://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards>
- **ADA Accessibility Guidelines (ADAAG)** The VVSG 1.0 includes requirement from ADAAG for kiosk-based wheelchair reach. A newer version of the ADAAG was adopted in 2010, including changes for the wide variety of motorized chairs now available. The guidelines are focused on the architectural environment, and so are not as applicable to next generation devices such as tablet-based systems.
<http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/>

International standards

- **Web Content Accessibility Guidelines (WCAG) 2.0** These apply to web pages and web applications. They are somewhat general and focused on compatibility with assistive technology. There are commercial tools available for checking many of these requirements. <http://www.w3.org/TR/WCAG20/>
- **ANSI/HFES 200: 2008** Human Factors Engineering of Software User Interfaces--Part 2: Accessibility
- **ISO 9241-20:2000** Ergonomics of human-system interaction -- Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services

Guidelines from industry

Companies often publish guidance to improve IT accessibility, many of which are based on best practices design guidelines and could be specialized for voting systems. VVSG already includes some of these requirements.

- **Apple iOS Accessibility**
<https://www.apple.com/accessibility/ios/>
- **Google Accessibility**
<http://www.google.com/design/spec/usability/accessibility.html>
- **NCAM Accessible Digital Media Guidelines**
http://ncam.wgbh.org/invent_build/web_multimedia/accessible-digital-media-guide
- **BBC Future Media: Accessibility Standards and Guidelines**
<http://www.bbc.co.uk/guidelines/futuremedia/accessibility/>

Universal Usability

The original principles for universal design were focused on the architectural environment. They have since been adapted and used for more universal usability for digital products.

- **The principles of universal design – Center for Universal Design at North Carolina State University**
http://www.ncsu.edu/ncsu/design/cud/about_ud/udprinciples.htm
- **Universal usability guidelines** – in *Web Style Guide* (3rd ed), 2009
<http://webstyleguide.com/wsg3/2-universal-usability/4-guidelines.html>

- **Access by Design: A guide to universal usability** (2005) by Sarah Horton
<http://www.universalusability.com/>
- **A Web for Everyone** (2014) by Sarah Horton and Whitney Quesenbery
<http://rosenfeldmedia.com/books/a-web-for-everyone/>

Usability and Accessibility for Specific Audiences or Topics

- **Senior Citizens (Ages 65 and older) on the Web** - Nielsen Norman Group
<http://www.nngroup.com/reports/senior-citizens-on-the-web/>
- **Federal Plain Language Guidelines**
<http://www.plainlanguage.gov/howto/guidelines/FederalPLGuidelines>
- **Guidelines for Using Color in Voting Systems**
http://www.nist.gov/customcf/get_pdf.cfm?pub_id=900104
- **Guidelines for Writing Clear Instructions and Messages for Voters and Poll Workers**
<http://www.nist.gov/itl/vote/upload/032906PlainLanguageRpt-2.pdf>

Usability Testing and Performance Standards

The ISO 9241-11 definition of usability, which we use in the VVSG sets the metrics that are most commonly used to measure usability: “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”

- **Common Industry Format (CIF)** ISO/IEC 25062:2006 Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) —this is the CIF format for report usability test results in VVSG. Variations of the CIF are currently in use for certification of electronic health records and for certification of medical devices.

Books on usability testing and measurement

- *Measuring the User Experience* (2013) by Tullis and Albert
- *Quantifying the User Experience: Practical Statistics for User Research* (2012) by Sauro and Lewis
- *Handbook of Usability Testing* (2008) by Chisnell and Rubin
- *A Practical Guide to Usability Testing* (1999) by Dumas and Redish

Standards from other domains or industries

- **Twenty-First Century Communications and Video Accessibility Act (CVAA).** This law, signed in 2010 is managed by the FCC and focuses on 21st century technologies, including new digital, broadband, and mobile innovations. It is primarily aimed at communications providers including phone companies and VOIP, and video programming. Although not directly related to voting, it is the most recent broad federal legislation for accessibility.
<http://www.fcc.gov/guides/21st-century-communications-and-video-accessibility-act-2010>
- ANSI/AAMI standards in use by FDA for medical devices
 - **ANSI/AAMI HE75:2009(R)2013 Human factors engineering - Design of medical devices**
 - **ANSI/AAMI/IEC 62366:2007 Medical devices - Application of usability engineering to medical devices**
 - **AAMI TIR49:2013 Design of training and instructional materials for medical devices used in non-clinical environments**
- **EHR certification from ONC**
<http://www.healthit.gov/sites/default/files/standards-certification/2014-edition-draft-test-procedures/170-314-g-3-safety-enhanced-design-2014-test-procedures-draft-v-1.0.pdf>
- **BS 8878:2010. Web accessibility. Code of practice. British Standards Institution**
<http://shop.bsigroup.com/ProductDetail/?pid=000000000030180388>

Other Resources

State and County Projects

- Colorado Uniform Voting System - RFP
http://www.eac.gov/assets/1/Documents/Colorado%20Uniform%20Voting%20System%20RFP%202013_10_01.pdf
- Los Angeles Voting System Assessment Project
<http://rrcc.lacounty.gov/VOTER/VSAP/>
- Travis County, Texas STAR Vote
<https://www.usenix.org/conference/ewtwote13/workshop-program/presentation/bell>
or
http://www.traviscountyclerk.org/eclerk/content/images/presentations_articles/pdf_tc_elections_2013.07.26_star.pdf
- Online ballot marking in Maryland
<http://www.mdd.uscourts.gov/Opinions/Opinions/National%20Federation%20of%20the%20Blind%20MEMO%20AND%20ORDER.pdf>

Ballot Design Research Prototypes

- Prime III
<http://www.primevotingsystem.org/>
- LEVI – Low Error Voting Interface
<http://researchinaccessiblevoting.bitbucket.org/levi2/src/index.html#>
- EZ Ballot
<http://dl.acm.org/citation.cfm?id=2384960>
- Anywhere Ballot
<http://civicdesign.org/projects/anywhere-ballot/>

Elections System Evaluations

- City of Toronto Voting System Accessibility Evaluation
<http://s3.documentcloud.org/documents/1310861/toronto-internet-voting-accessibility-report.pdf>
- Accessible Voting Technology: Analysis and Recommendations - Cook, D. and Harniss, M. 2012. ITIF AVTI Working Paper #004).
<http://elections.itif.org/reports/AVTI-004-Cook-Harniss-2012.pdf>

- Increasing the use of Accessible Voting Systems – Diane Golden, RAAV
<http://www.ataporg.org/docs/ATAP-RAAV%20Report%20Nov%202013.doc>
- Now do voters notice review screen anomalies? A look at voting system usability - Campbell, B. A., & Byrne, M. D. Proceedings of the 2009 Electronic Voting Technology Workshop/Workshop on Trustworthy Elections (EVT/WOTE '09)
[http://chil.rice.edu/research/pdf/CampbellByrne_EVT_\(2009\).pdf](http://chil.rice.edu/research/pdf/CampbellByrne_EVT_(2009).pdf)
- A Comparison of Usability Between Voting Methods – Kristen K. Greene, Michael D. Byrne and Sarah P. Everett
http://chil.rice.edu/research/pdf/GreeneByrneE_06.pdf

Accessibility analysis and guidelines

- Understanding Voting Experience of People with Disabilities – Jon Sanford, Frances Harris, et al
<http://elections.itif.org/reports/AVTI-005-Sanford-2013.pdf>
- Design Guidelines for Creating Voting Technology for Adults with Aphasia - Shaun Kane and C. Galbraith
<http://elections.itif.org/wp-content/uploads/AVTI-006-Kane-2013.pdf>
- Making Voting Accessible: Designing Digital Ballot Marking for People with Low Literacy and Mild Cognitive Disabilities - Kathryn Summers, University of Baltimore; Dana Chisnell, Center for Civic Design; Drew Davies, Oxide Design Co.; Noel Alton and Megan Mckeever, University of Baltimore, JETS Vol2 No2
<https://www.usenix.org/conference/ewtwote14/workshop-program/presentation/summers>
- Security Insights and Issues for Poll Workers – Whitney Quesenbery, Dana Chisnell, Center for Civic Design
<http://civicdesign.org/projects/pollworkers-security/>

Election Participation Analysis

- Hall, T.E. and Alvarez, R.M. (2012). Defining the barriers to political participation for individuals with disabilities (Working Paper #001).
<http://elections.itif.org/reports/AVTI-001-Hall-Alvarez-2012.pdf>
- Kessler Foundation, National Organization on Disability, & The Harris Poll (Kessler/NOD), (2010) *The ADA, 20 Years Later*.
<http://www.2010DisabilitySurveys.org/pdfs/surveyresults.pdf>
- Disability Gap in 2012 Election (Shur et al., 2013)
<http://smlr.rutgers.edu/disability-and-voting-survey-report-2012-elections>

- Internet use in the United States (Fox & Rainie 2014)
<http://www.pewinternet.org/2014/02/27/the-web-at-25-in-the-u-s/>

Voter Registration and Voting Options

- MOVE Act and UOCAVA
<http://www.justice.gov/opa/pr/fact-sheet-move-act>
- National Conference of State Legislatures (2014) Absentee and Early Voting. <http://www.ncsl.org/research/elections-and-campaigns/absentee-and-early-voting.aspx>
- NVRA Report published June 2011
<http://www.eac.gov/assets/1/Documents/2010%20NVRA%20FINAL%20REPORT.pdf>
- NVRA Report published June 2013
http://www.eac.gov/assets/1/Documents/EAC_NVRA%20Report_lowres.pdf
- The PEW Charitable Trusts, 2014
http://www.pewtrusts.org/~media/Assets/2014/01/28/Understanding_Online_Voter_Registration.pdf?la=en
- Online Voter Registration
<http://www.ncsl.org/research/elections-and-campaigns/electronic-or-online-voter-registration.aspx>
- Current State of Electronic Voting
<http://www.ncsl.org/research/elections-and-campaigns/internet-voting.aspx#Alaska>
- Beginning of Online voting in Alaska
<http://www.eac.gov/assets/1/Documents/SIV-FINAL.pdf>

Human Factors Resolutions of the TGDC

The Technical Guidelines Development Committee used a series of resolutions to guide both the committee's work and NIST's work to draft standards and conduct research to support the process. The full list of resolutions adopted from 2004-2007 are on the NIST website:

<http://www.nist.gov/itl/vote/upload/TGDCAdoptedresolutions082007.pdf>

The resolutions specifically related to usability and accessibility are included here.

Resolution #02-05: Accessible Voting Systems

The TGDC has concluded that standards for voting systems should include requirements for accessibility that meet the HAVA requirement for accessible voting by incorporating the latest available accessible technology. Further, the TGDC directs NIST to research and draft standards based on, but not limited to, existing requirements from the VSS 2002, IEEE P1583 draft 5.3.2a, ADA Accessibility Guidelines (ADAAG), 36 CFR Part 1194 (section 508) and other relevant usability and accessibility guidelines and federal laws and regulations in order to develop future accessibility requirements for voting systems.

Resolution #03-05: Human Factors and Privacy of Voting Systems at the Polling Place.

The TGDC has considered the issue of what is required to ensure both access to the voting system by voters with disabilities, and usability and privacy for all voters. It has concluded that usability, accessibility, and privacy are functions of both the system used to vote and the environment of the polling place. The TGDC directs NIST to research and draft guidance on the deployment and configuration of systems in the polling place to ensure usability, accessibility, and privacy. These guidelines should be combined with the accessibility standards described in Resolution #02-05 or the standards described in Resolution #04-05.

Resolution #04-05: Human Factors and Privacy Requirements for Capturing Indication of a Voter's Choice

The TGDC recognized the need for voting system requirements to include human factors and privacy requirements for capturing indication of a voter's choice based on current research. These requirements should be specified so that systems can be evaluated for meeting the requirements. Unclear specifications, such as "intuitive", "unambiguous", or "meaningful" should be

avoided. Further, performance-based standards are preferred over specific design standards, because performance standards address the total effectiveness of the system more directly than do design standards and typically they are not technology specific. The TGDC directs NIST to:

1. Create an outline of the human factors and privacy requirements related to capturing indication of a voter's choice,
2. Write draft human factors and privacy standards based on this outline by using existing requirements from the VSS2002, IEEE P1583 draft 5.3.2a, ADA Accessibility Guidelines (ADAAG), 36 CFR Part 1194 (section 508) and other relevant usability and accessibility guidelines and regulations,
3. Identify areas where further requirements development for capturing indication of a voter's choice is needed, noting when performance-based usability standards are possible, and
4. Write all requirements so that they are testable and the tests themselves can be conducted either by inspection by a person with reasonable knowledge of systems, user interface design, and accessibility or by performance-based usability tests with clear, repeatable protocols.

Resolution #05-05: Human Performance-Based Standards and Usability Testing

The TGDC has concluded that voting systems requirements should be based, wherever possible, on human performance benchmarks for efficiency, accuracy or effectiveness, and voter confidence or satisfaction. This conclusion is based, in part, on the analysis in the NIST Report, Improving the Usability and Accessibility of Voting Systems and Products (NIST Special Publication 500-256). Performance requirements should be preferred over design requirements. They should focus on the performance of the interface or interaction, rather than on the implementation details. When it is not possible to specify performance requirements (whether because conformance tests cannot be formulated or because they would be too onerous to implement), testable, implementation-neutral design requirements should be used. Conformance tests for performance requirements should be based on human performance tests conducted with human voters as the test participants. The TGDC also recognizes that this is a new approach to the development of usability standards for voting systems and will require some research to develop the human performance benchmarks and the test protocols. Therefore, the TGDC directs NIST to:

1. Create a roadmap for developing performance-based standards, based on the preliminary work done for drafting the standards described in Resolution # 4-05,
2. Develop human performance metrics for efficiency, accuracy, and voter satisfaction,
3. Develop the performance benchmarks based on human performance data gathered from measuring current state-of-the-art technology,
4. Develop a conformance test protocol for usability measurement of the benchmarks,
5. Validate the test protocol, and
6. Document test protocol and benchmarks so that an independent test laboratory can reproduce the testing.

Resolution #06-05: Accommodating a Wide Range of Human Abilities

The TGDC recognizes that there is a wide range of human abilities. The voting population includes not only people with specifically identified disabilities but also the aging population, language minorities, and people with other special needs. A goal of voting system standards should be to accommodate, as much as possible, this wide range of abilities to ensure the greatest usability and accessibility of those systems. This approach is sometimes called “universal design” or “universal usability.” In drafting standards, the TGDC directs NIST to:

1. Consider what accommodations to voter abilities can be included in the standards for all voting systems, using currently available technology, and
2. Develop principles for “universal design” based on existing best practices and other guidelines or standards such as 36 CFR 1194 (Section 508), to guide future standards development to aid in updating the voting system standards.

Resolution #08-05: Usability Guidance for Instructions, Ballot Design, and Error Messages

The TGDC has considered the issue of what is required to improve usability and reduce errors for capturing indication of a voter's choice. It has concluded that usability is a function of the machine used to vote as well as other characteristics of the voting system such as the instructions for voters and poll workers, ballot design, and machine error and help messages. Research and best practices in the areas of plain language

design, form design, and usability are potentially relevant to such voting system characteristics. The TGDC directs NIST to research and draft guidelines and standards where possible to improve the usability of instructions, ballot design, and error and help messages in all formats used. These guidelines should be combined with the standards described in Resolution # 4-05.

Resolution #09-05: General Voting System Human Factors and Privacy Considerations

Errors in the voting process are due to human error and the TGDC notes many examples from recent elections to support this statement. While requirements for capturing indication of a voter's choice is the primary area for human factors and privacy standards development, the TGDC recognizes that all proposed requirements that involve human interaction with the voting system should address any possible human factors and privacy implications. Therefore, the TGDC directs NIST to review all proposed requirements, assess which requirements involve user interaction, and perform the evaluation or research needed to ensure that basic usability, accessibility, and privacy is maintained when these requirements are applied to a voting system.

Resolution #10-05: Usability of the Standards

The TGDC recognizes the importance of the usability of the voting systems standards. Independent testing laboratories, election officials, and vendors need to understand these standards and also understand how a system is tested for conformance to the standards in order to have confidence in voting systems that pass the conformance tests. Therefore, to the extent possible, the voting system standards should be written in plain language, understandable by both test experts and by voting officials who are not experts in human factors or design.

Resolution #01-07: Accessibility of Paper-based Voter Verification Requirement

It is the recommendation that the TGDC accept the following language as a voting system requirement:

If the accessible voting station (Acc-VS) generates a paper record (or some other durable, human-readable record) for the purpose of allowing voters to verify their ballot choices, then the system shall provide a mechanism that can read that record and generate an audio representation of its contents. The use of this mechanism shall be accessible to voters with dexterity disabilities.

Other resolutions with implications for accessibility are:

#03-06 - The Innovation Class in VVSG 2007. Set the groundwork to establish ways of evaluating novel systems designs to determine if they meet the goals of the certification program.

#04-06: Wireless Security. Prohibited wireless communications in any equipment for official vote casting, with an exception for infrared wireless.

#06-06: Software Independence of Voting Systems. Directed the security (STS) and human factors (HFP) committees to draft usability and accessibility requirements to ensure that all voters can verify the independent voting record.

#09-06: Principal Criteria. Set the goal of the guidelines to be to produce systems that are: secure, accurate, reliable, usable, accessible, and fit for its intended use.

