Accessibility and Usability Considerations for UOCAVA Remote Electronic Voting Systems

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1 Introduction

The Technical Guidance Development Committee (TGDC) of the Election Assistance Commission (EAC) has requested that the National Institute of Standards and Technology (NIST) conduct a short-term (several months) research study on accessibility and usability considerations for remote electronic Uniformed and Overseas Citizens Absentee Voting Rights Act (UOCAVA) [19] voting. The requested result of the study is this white paper[1].

This white paper describes findings from the research NIST performed in accordance with the TGDC request. It identifies issues pertaining to accessibility and usability for UOCAVA voters using the most common approaches to remote voting systems including Web browsers, Web ballot repositories, online ballot markers/electronic form fillers, e-mail, kiosks, telephone-based interfaces and fax machines. The Appendix summarizes recommendations to resolve the issues. The audience of this paper is members of the TGDC, the EAC, election officials, the Federal Voting Assistance Program (FVAP) [4], and parties involved in the implementation and deployment of UOCAVA systems.

1.1 Scope and Purposes

This paper limits its scope to accessibility and usability topics that impact UOCAVA voting. This paper uses the following definitions of accessibility and usability.

Usability is a measure of the efficiency, effectiveness and satisfaction achieved by a specified set of users performing specified tasks with a given product [10].

Accessibility is a set of measurable characteristics that indicate the degree to which a system is available to, and usable by, individuals with disabilities. [13]

[1] Note: this paper parallels “Security Considerations for Remote Electronic UOCAVA Voting” [6], although for UOCAVA usability and accessibility concerns.

Some consider accessibility to be the end of the usability spectrum. However, the intention behind accessibility is rooted in civil rights. Accessibility design requirements provide an assurance of technological non-discrimination.

The Rehabilitation Act [16], also called Section 508, requires federal agencies that develop, procure, maintain or use electronic and information technology to make that technology accessible. The Help America Vote Act (HAVA) [7] specifies human factors, accessibility and usability among the principal concerns to address in voting [7]. The Voluntary Voting System Guidelines Recommendations to the Election Assistance Commission, also known as VVSG 2.0 [23], addresses usability for all voters and poll workers and accessibility for voters with physical (visual, auditory, mobility, dexterity, speech) and cognitive and learning disabilities. UOCAVA does not specifically address human factors, accessibility and usability; the intention of this paper is to raise awareness of the applicability of human factors, accessibility and usability for remote UOCAVA voting.

The primary purposes of this paper are to:

- Identify important accessibility and usability issues pertaining to UOCAVA voting
- Recommend steps to make UOCAVA remote electronic voting platforms more usable by all voters and accessible to voters with disabilities to allow them to vote independently

Issues and guidelines discussed herein were identified through an assessment of voters' needs within the context of remote voting tasks, hardware environments and software technologies. Environment and technology descriptions were derived from Security Considerations for Remote Electronic Voting [6] and A Threat Analysis on UOCAVA Voting Systems [15]. Readers are referred to these documents for more detailed discussions of remote voting hardware environments and software technologies.

These remote voting environments and technologies were examined to identify human factors related accessibility and usability issues relevant to UOCAVA voters. These human factors pertain to voter characteristics that are physical (e.g., manipulation of a ballot and manipulation of a voting device), behavioral (e.g., memory limitations)

and demographic (e.g., age and familiarity with electronic devices such as those used for voting, including computers and kiosks).

Recommendations to resolve the issues reflect accessibility and usability requirements and practices from the following:

- Chapter 3 of VVSG 2.0 [23]
- Web Content Accessibility Guidelines (WCAG) 2.0 [26], developed by the World Wide Web Consortium Web Accessibility Initiative (W3C/WAI) [25]
- Section 508 Electronic and Information Technology Accessibility Standards [17]
- Draft Information and Communications Technology (ICT) standards and guidelines [1], also known as the "Section 508 Refresh"

Further, accessibility and usability recommendations in this paper derive from well-established accessibility and usability best practices. This paper also offers recommendations for universal design approaches drawn from principles commonly followed by accessibility, usability and human factors practitioners. Universal design is the design of products and environments to be usable by all people, including those with disabilities, to the greatest extent possible, without the need for adaptation or specialized design. However there is no intention to imply that any universal design solution alone resolves all the accessibility issues related to any disability or to every kind of disability. While universal design resolves some issues pertaining to disabilities, other issues require disability-specific accessibility solutions. VVSG 2.0 [23], in particular, is based on universal design principles that apply to voting in general and extend to UOCAVA voting. Examples of specific and universal guidelines are provided at usability.gov [21] and WCAG 2.0 [26].

Both issues and recommendations were derived using a user-centered perspective. The term *user-centered* refers to the fact that issues and recommendations pertain to the user experience. Therefore, in this white paper, the concept of *user-centered* is synonymous with the concept of *voter-centered*. In the case of UOCAVA remote voting, a user-centered perspective places the requirement to provide

accessibility and usability primarily on the voting system. Voters should not encounter obstacles to their using a UOCAVA voting system "comfortably, efficiently, and with justified confidence that they have cast their votes correctly" [23], Section 3.1.1. The EAC Board of Advisors has also recommended that the VVSG include a requirement for an industry standard jack to connect a personal assistive technology switch to the voting system for those voters with disabilities that bring their along their own devices such as manual input switches. The use of personal assistive technologies expands the range of voters with disabilities that can be accommodated beyond what universal design can provide.

This paper does not address the following topics:

- Voter registration, although some of the best practices noted in this paper may apply.
- Usability and accessibility for poll workers. Because poll workers play a limited role in remote voting, this paper focuses on UOCAVA voters. Note that VVSG 2.0 [23] Section 3.2.8 discusses usability for poll workers, including usability of the documentation provided to poll workers for use when setting up, operating, and shutting down voting systems. It is possible that poll workers may perform these tasks at remote locations where US citizens are provided access to voting systems, e.g., U.S. embassies.

1.2 Paper Structure

This paper is organized according to relevant voting system technology. To establish a user-centered focus, Section 2 describes voters.

Section 3 sets out general issues applicable to all voting system technologies. Sections 4 through 10 discuss issues that pertain to specific voting system technologies: Web browsers (Section 4), Web ballot repositories (Section 5), online ballot markers (Section 6), e-mail (Section 7), kiosks (Section 8), telephone-based interfaces (Section 9), and fax machines (Section 10). Each of these sections provides a technology description and discusses how a voter interacts with the technology. Each identifies issues and offers recommendations.

Section 11 presents next steps to begin addressing the accessibility and usability issues that pertain to UOCAVA voting. Section 12 contains conclusions. Section 13 references documents cited in this paper. The Appendix summarizes all recommendations in this document.

2 UOCAVA Voters

UOCAVA [19] allows registration and absentee voting in Federal elections by six million US citizens. UOCAVA covers three categories of US citizens:

- Military and merchant marine personnel
- Families of military and merchant marine personnel
- Citizens residing abroad

All three categories of voters are subject to various types of accessibility and usability issues. Each category of voters with disabilities is served by specific classes of assistive technologies or sets of design approaches. Some issues relating to accessible voting remain unresolved. For example, accommodating voters with limited manual dexterity continues to be a difficult issue for voting systems in general and for voting systems on public kiosks in particular. For the UOCAVA voters, some of the technologies allow built-in accessibility as well as a capability to use personal assistive technologies.

Personal assistive technologies (PAT) are devices used in conjunction with technologies such as electronic voting systems. PAT promote accessibility for voters that regularly use PAT and can help voters with disabilities to vote independently. For example, switches are devices used to activate keyboard and mouse functionality. Switches alternate between states to enable a voter with a manual dexterity disability to navigate a ballot and make selections, for example, by pressing one or more large buttons. There are many varieties of switches to accommodate a range of disabilities. Such variation is typical of PAT. Switches can be activated by a finger, a hand or other body part, e.g., a side of a voter's head or a foot. Switches come in a variety of sizes. A common example is the jelly switch or jelly buttons which are sensitive to less than two ounces of pressure. A more complex switch

is the dual switch sip-and-puff device. By exhaling or “puffing” into a tube, the voter controls a cursor. The voter inhales or "sips" to select. Most switch hardware needs to interface directly to the voting system; some switches are wireless. Switches can integrate with other assistive devices. Switches can make it possible for soldiers with limb injuries or voters with manual dexterity disabilities to vote.

Table 1 gives examples of PAT and the disabilities they address. Section 3.3.1-C of VVSG 2.0 [23] states, “It shall not be necessary for the accessible voting station to be connected to any personal assistive device of the voter in order for the voter to operate it correctly.” VVSG 2.0 does not preclude that voting systems can provide interfaces to PAT, but it does not provide requirements for those interfaces. VVSG 2.0 does not address PAT for a remote voter’s own personal computer or computing device.

Table 1 Examples of disabilities and assistive technologies to make computing technologies accessible to people with those disabilities

Disabilities	Examples of Assistive Technologies
Blindness	Screen reader
Visual disabilities such as low vision	Screen magnifier
Manual dexterity disabilities	Switches Speech Recognition

There is a wide range of variability for PAT and voters often have personal preferences for assistive technologies. Screen readers offer an example of these preferences. A screen reader is a software application that processes text content displayed on a computing device screen or input to a computing device. It passes that content to a Braille display or to a speech synthesizer that “reads” it aloud. Out of

1,121 respondents to a survey on screen reader usage, 74% use JAWS (Job Access with Speech), 23% use Window-Eyes, 8% use NVDA, (NonVisual Desktop Access) and 6% use VoiceOver [22].

A wide variety of disabilities impact the voting experience. Tables 2 and 3 give examples with design solutions. Some solutions are specific; others are universal. Universal design solutions strive to accommodate multiple populations. For example, accommodations for people with color blindness include providing an additional signal such as text labels or shape to distinguish function when an interface uses color distinctions. This text can be large, bold font to ensure that the text is more legible for voters with poor vision. The operative universal design principle in this case is that redundant signals work together to produce good design and better usability for a variety of voters. In addition to helping voters with color blindness, this solution serves soldiers with eye injuries that require accommodations.

Table 2 Examples of disabilities and design accommodations to make computing technologies accessible to people with those disabilities

Disabilities	Examples of Accessible Design Accommodations
Blindness	Speed control of audio output
Cognitive disabilities	Clear instructions Functionality to replay instructions
Color blindness	No distinctions that rely solely on color-coding
Hearing disabilities	Compatibility with hearing devices
Mobility disabilities	Controls that are reachable from a wheelchair

Speech disabilities	An alternative to speech input

The number of UOCAVA voters who are senior citizens is rising. These voters often have one or more of the physical and cognitive disabilities discussed in Table 2. One universal design solution is consistent navigation that helps all voters to move through a ballot in an expected sequence. This strategy helps to reduce errors for everyone, but, in particular, also helps voters who have diminished short-term memory due to old age and voters who are under stress.

Table 3 Examples of causes of lack of reading proficiency and assistive devices and design remedies that address a lack of reading proficiency

Causes of Lack of Reading Proficiency	Examples of Assistive Technologies & Design Remedies
English learned as a foreign language	Plain language
Dyslexia	Synchronized audio and visual content presentation
Cognitive disability	Clear instructions Plain language

UOCAVA voters will vote from a variety of locations. The VVSG does not set out requirements for PAT and compatibility with PAT at official polling locations in the United States. The VVSG does include requirements for universal design and built-in assistive technology for

accessibility at these traditional polling locations. For UOCAVA voters with disabilities, there are at least five voting location scenarios, each with its own accessibility implications. This introduces the question of how to include built-in accessibility while designing for the use of PAT or compatibility of PAT at all possible UOCAVA voting locations. UOCAVA voters may vote at the following:

1. Home, using their own equipment which may be integrated with their own PAT

2. Public places such as an embassy or military base that provide voting equipment which could include built-in accessibility as described in the VVSG

3. Their workplaces using equipment and PAT provided by their employers

4. Public places such as an Internet café, library, or a public phone where there is no PAT provided and where equipment may or may not accommodate their own PAT. (Some public libraries may provide PAT).

5. Private equipment owned by people other than themselves which may or may not accommodate their own PAT

However, it is not possible to ascertain the availability of PAT or compatibility with PAT at all possible UOCAVA voting locations.

3 General Accessibility and Usability

This section discusses the principal accessibility and usability issues pertaining to UOCAVA voting systems. A principal challenge is to provide UOCAVA voters with voting systems that they can use comfortably, efficiently, independently, privately and with confidence that they have completed all voting tasks correctly. For example, human error constitutes a risk to successful UOCAVA voting. User-centered design and performance testing recommendations focus on minimizing the potential for human error. In worst case scenarios for inaccessibility, a UOCAVA voter with a disability may not be able to vote remotely at all because the available technology does not interface with PAT or provide built-in accommodations. Examples of

this include a kiosk that does not provide high contrast and large fonts and a web site accessed by a personal computer that is incompatible with screen readers. It should be noted that applying WCAG 2.0 and Section 508 standards (where required by law) provide a minimum accessibility. An open issue is the degree to which built-in accessibility, such as magnification and screen reading without the need for PAT should be required.

3.1 Issues and Recommendations

Issue: There is a need to systematically apply accessibility and usability best practices and guidelines to design and testing of all UOCAVA voting systems.

For example, voting systems should be designed according to universal design principles and tested against these principles. This will help a wide range of UOCAVA voters to achieve efficiency, effectiveness and satisfaction while using remote voting systems to request, receive, complete, cast and return ballots. During design and testing, attention should be given to interoperability with PAT to resolve accessibility issues. For example, design and testing should aim to make voting errors easy to correct for all voters, including voters using PAT.

Recommendation: Follow VVSG 2.0 accessibility and usability guidelines and test methods.

VVSG 2.0 [23] requirements are built on accessibility and usability best practices. Use the NIST tests to verify that the VVSG requirements are met. These include performance tests, which are usability tests with voters. The VVSG also requires that voting system developers perform usability tests and report the results in the Common Industry Format (CIF), ISO/IEC 25062:2006 [11]. VVSG requirements include testing with voters who are blind, have limited vision, manual dexterity disabilities and mobility disabilities.

It is also essential to test UOCAVA voting designs for at-home use and unstaffed use by voters. It is essential that accessibility testing of UOCAVA voting designs include voters who have the full range of disabilities discussed in the VVSG. It is essential that the voters test the voting designs while using PAT. Without involving voters with

disabilities in testing, it is impossible to determine whether UOCAVA voters accomplish voting goals.

People who have been involved in development of the voting system should never participate in testing as voters because of their familiarity with the voting system and its operation.

Recommendation: Test for accessibility with voters who have disabilities performing voting tasks in environments like the ones where they will actually perform UOCAVA voting.

In particular, the assistive technology used during the test must pertain to the disability of the voters who participate in that test. Test for accessibility to voters with the full range of each disability discussed in the VVSG. If the expectation is that the voting will be performed without a poll worker available to assist, testing should reflect this.

It is essential that accessibility and usability experts who are experienced in user-centered testing perform the accessibility and usability testing. Start testing early in the design and development lifecycles and continue throughout these lifecycles. Perform product conformance testing against accessibility and usability requirements.

Issue: Accessibility standards do not specifically address Web-based voting systems.

VVSG 2.0 does not address Web-based voting systems or PAT for Web-based voting systems. Web-based voting systems present issues that do not pertain to other electronic voting systems.

Recommendation: Develop requirements based on existing Web-based standards.

There is a need to develop requirements based on universal Web-page design solutions and accessibility design guidelines. Use existing web accessibility standards modified as needed for voting systems. Sources to inform accessibility and usability standards for Web-based voting systems include WCAG 2.0 [26], Section 508 [17] and the Section 508 Refresh [1].

Issue: Voting system design does not always consider voter privacy and voters' need to vote independently.

All voters must be able to vote privately and independently. However, designers sometimes assume that a caregiver will assist the voter.

Recommendation: Follow VVSG 2.0 requirements for privacy and independence.

The VVSG sets independence for voters with accessibility as a high level goal that is served by factors such as privacy. Section 3.2.3 of VVSG 2.0 [23] contains the relevant requirements. These are designed to assure that bystanders cannot discover voters' choices. For UOCAVA remote voting, these requirements also apply to kiosk-based architectures. For architectures designed to support any part of the process of voting from a personal computing device, privacy cannot be strictly enforced. However, features that support voting independently at least provide some measure of privacy.

Issue: To improve accessibility for all remote voters, UOCAVA voting systems should be designed to interface with PAT.

Some voters with disabilities require PAT for UOCAVA voting, for example, those using personal computers at home.

Recommendation: To make UOCAVA voting accessible, provide options that interface with PAT.

Voters with disabilities using their own equipment will have their own computing environment set up to include their own PAT. For any part of the voting process that will occur in this personal computing environment, remote voting applications should be designed to be compatible with the PAT. Kiosks, telephone-based interfaces and fax machines purchased by the Federal Government must comply with accessibility legislation such as Section 508 [16]. Ideally, either the device itself must be accessible, or it must interface with PAT. Unfortunately, it is impossible to ensure this in many remote computing environments. Avoid options when it is known that these options diminish or exclude interoperability with PAT where possible.

Issue: There is a need to consider security policy, privacy policy, accessibility, and usability as four integral factors during requirements analysis for UOCAVA voting systems.

There is a need to consider all four factors from the very beginning of UOCAVA voting system design.

Recommendation: The design team and the security team need to work together from the beginning of the design process. Policy decisions should consider usability, accessibility, security, and privacy as a whole.

There must be open dialog about the tradeoffs, for example, between security and usability. This dialog is especially important during requirements analysis and design.

Recommendation: When implementing security technologies, follow user-centered practices.

Verify that security technology implementations are usable and accessible through accessibility and usability testing.

Hastings, Peralta, Popoveniuc, and Regenscheid [6] discuss security strategies. § 1194.21 (b) of the Section 508 Standards [17] Specifically, “Applications shall not disrupt or disable activated features of other products that are identified as accessibility features, where those features are developed and documented according to industry standards.”

Issue: Some authentication approaches conflict with accessibility and usability best practices.

For example, CAPTCHAs (Completely Automated Public Turing test to tell Computers and Humans Apart) [3] often violate accessibility best practices. CAPTCHAs are randomly generated images of words or letters. The display of a CAPTCHA is distorted to prevent software from making sense of it. Users type the displayed CAPTCHA to authenticate that they are human.

Recommendation: Design authentication to be usable and accessible.

Do not build barriers that make authentication inaccessible to voters with disabilities. For example, if CAPTCHAs must be used to request a ballot or accept ballot delivery, follow accessibility design guidelines. Examples of accessible CAPTCHA design guidelines include providing readouts for the text; making CAPTCHAs resizable; adequately contrasting the CAPTCHA from its background; and not using shadows. See [18] for an example of additional information on CAPTCHA accessibility.

Issue: Some approaches to acquiring Personally Identifiable Information (PII) conflict with accessibility and usability best practices.

When a voter requests or returns a ballot electronically, PII, e.g., a voter identification number, may be required to verify that the voter is registered or to assure that the ballot is for the appropriate jurisdiction. Examples of accessibility and usability best practices that apply to provision of PII are

- Ease of use
- Assuring voters that they are in control of the provision of their PII
- Assuring voters that their PII will not be compromised
- Never requiring voters to supply unnecessary PII

Recommendation: When PII disclosure is required, provide a secure and easy-to-use way for the voters to provide PII directly to the voting authority and give voters obvious assurance that the means they use to supply PII is secure.

For example, if the voter will provide PII over the Web, provide an obvious notice on the Web page that the page is secure. Provide voters with verification that their PII has been received by the appropriate authorities. An authentication mechanism that requires PII should not require disclosure of sensitive information to a third party.

Recommendation: Never require voters to supply unnecessary PII. Only ask voters to supply the required PII.

Issue: There is a need to integrate PAT with voting system architectures, including complex architectures.

It is important to assure that there are no interoperability problems when PAT is integrated with voting systems. For example, there is variation among switches. Some solutions require a single switch, others more than one switch. The architecture must accommodate all commonly used switch configurations.

Recommendation: Design and test voting system components against standards and guidelines for interoperability and test

all likely configurations.

The variety of system components which must run simultaneously include hardware, operating systems, browsers, voting software and PAT. Design must address and assure their interoperability. For example, a web application must display properly with any of the Web browsers and screen readers in common use. All testers and voters involved in testing with PAT must be familiar with using the PAT.

Issue: Sometimes ballots are designed without regard to the accessibility issues that make them legible for voters with vision disabilities.

For example, ballots may be in the form of a .pdf document. Voters with limited vision disabilities have no way of enlarging the font in the printout of a .pdf.

Recommendation: If the ballot is a .pdf intended to be printed, consider the use of form filling online so that the voter doesn't need to fill out a paper blank ballot by hand.

See Section 6, for a discussion of electronic form filling. This allows the voter to make use of built-in magnification or audio screen reading or the use of PAT to fill out the ballot prior to printing.

Issue: Voters will need to view ballots onscreen, including ballots created as .pdf documents.

Some voters with low vision disabilities will need to view the .pdf document onscreen at an enlarged size.

Recommendation: Create .pdf documents that contain text rather than images of text.

With this solution, voters can enlarge fonts onscreen without pixilation by using the zoom function. The tradeoff is that after zooming, some content may not fit on screen, causing the voter to repeatedly navigate horizontally to view the width of the .pdf document page. A benefit is that using text rather than images of text in a .pdf makes content accessible to screen readers.

Recommendation: To support onscreen legibility for voters with low-vision disabilities, test to ensure that the Adobe Reader

reflow feature performs properly for displaying .pdf documents to be used with UOCAVA voting systems.

This entails testing with voters who have low-vision disabilities to ensure that they can comfortably read the voting .pdf documents onscreen.

Issue: When ballot choices are represented in a printout as filled-in bubbles, text-to-speech (TTS) technology cannot read out the voter's choices.

This issue applies also to filled in arrows or other designated areas such as the area between two lines. Voters may print ballots to verify that their intended choices are represented on the ballot. Blind voters may "read" the printout using TTS for paper. An example of such a system is the Kurzweil reading machine which scans and recognizes text on paper, then converts it to sound. This issue pertains to printing out ballots for checking that the intended votes are being cast. It does not apply to printing out ballots to send to the voting jurisdiction.

Recommendation: For printing ballots, offer the option to print only the choices.

If a blind voter wants to process a printout with TTS technology, the TTS reader will not recognize filled-in bubbles. However, TTS will read out text containing the voter's choices. This recommendation pertains to printing out ballots for checking that the intended votes are being cast. It does not apply to printing out ballots to send to the voting jurisdiction.

Recommendation: Avoid the problem of unreadable voter choices by offering an option that is readable by a TTS.

This recommendation requires using a .pdf ballot and filling in the fillable area using a printable character such as the letter "X". Alternatively, a printable character could be added to the electronic ballot. The TTS would read out the entire ballot, reading an "X" with each selection the voter has made. This recommendation pertains to printing out ballots for checking that the intended votes are being cast. It does not apply to printing out ballots to send to the voting jurisdiction.

Recommendation: If the ballot is a .pdf intended to be printed

and must be completed on paper, provide a large print ballot format for voters with low vision disabilities.

Voters may need to print out a ballot that they have received from a Web ballot repository. They will have to print out ballots that they intend to return by fax, postal mail or courier service. This is analogous to States providing large print ballots at the polls.

Issue: When a printed .pdf is to be faxed, mailed or sent by courier to the election jurisdiction, the voters' choices may have to be re-entered manually by an election official. This can result in a loss of privacy for the voter.

Manual entry is necessary when the printout paper is inappropriate for optical scanning. Scanner vendors recommend paper weights ranging from 60 to 100 pounds. This paper is much heavier than paper generally used for printing and faxing. This issue pertains both to paper used by voters and paper used by election officials. There is no usability recommendation for this issue.

4 Web Browsers

A Web browser is software used for information presentation on a Web site and for human interaction with the content of a Web page. The most commonly used browsers are Internet Explorer and Firefox [24].

4.1 Technology

Voters access a UOCAVA provider Web site by using a Web browser. The technology is highly interoperable and accessible if designed properly.

Voting Web sites will provide a variety of applications for voting tasks. For example, there may be a Web form to collect authentication information about the voter.

The owner of the server where a Web site resides may grant different voters access to different information. Web sites with restricted content, such as sites that house a State's voting ballot, usually require the voter to log-in using authentication such as a user name

and password to access that subset of the site's information which the voter has permission to access.

4.2 Interaction

UOCAVA voters can use personal computers or other computing devices that run Web applications to request blank ballots and receive blank ballots. Using a Web browser, a voter accesses the pages of an election-official-operated Web site. Voter options for accessing a ballot include using an interactive form on a Web page or using a printer to print out a ballot. Voters may also receive a ballot by postal mail or courier service.

Using a personal computer or mobile device that runs Web applications, UOCAVA voters can complete ballots on an election-official-operated Web site and can submit completed ballots. Upon logging on to a voting Web site, the voter will only have access to information for which he or she has access permission. For example, a voter will be able to see a ballot for his or her own voting district, but not another district.

4.3 Issues & Recommendations

Issue: Election Web sites and their applications must be compatible with a variety of browsers and a variety of versions of a browser.

Many voters will have a need or personal preference for a specific browser or browser version. For example, some voters with disabilities will need to use a specific browser because it works best with their own PAT. Some organizations providing public voting systems for UOCAVA voting will require that certain browsers be used. Workplaces where UOCAVA voters may vote may also have such requirements.

It is essential that voters be able to perform voting tasks using a Web browser and Web applications with which voters are familiar and comfortable. Voters must not be restricted to certain browsers because an election site is not compatible with the browser the voter needs or chooses to use. Election sites must also be compatible with browsers that are required by organizations providing public voting systems for UOCAVA voting or workplace computers that will be used for UOCAVA voting.

Recommendation: Test to make sure that the Web site and its applications are compatible with at least the most commonly used versions of the most commonly used browsers.

Commonly used browsers include Internet Explorer and Firefox. Not all voters will choose to use the most recent version of a browser. Not all voters will be able to use the most recent version of a browser. Compatibility includes both accessibility and usability. For example, blind voters must be able to easily and confidently navigate the Web site and use its functionality while using a screen reader. When testing for compatibility with browsers, also test with commonly used PAT such as commonly used screen readers. Involve users with disabilities in tests with PAT.

Issue: Voters need voting Web sites that are designed according to universal and disability-specific ease of use and learnability design best practices.

Not all voters are highly Web literate. They do not access the voting sites often, so they cannot be expected to remember how to accomplish voting tasks from visit to visit.

Recommendation: To accommodate the widest range of computer literacy, ensure that the voting Web site conforms to universal design principles.

Universal design principles will help all voters to accomplish their Web-based UOCAVA voting tasks. These principles include using plain language. For example, voters may have to download an application to receive or fill in a ballot. Provide information in plain language on how to initiate and complete the download process. Notify the voter in plain language when the download is complete.

In addition to VVSG 2.0 [23], for research-based Web accessibility and usability design guidelines see [20]. For information about plain language, see [13]. Many WAI [25] guidelines derive from universal design principles.

Issue: Innovative combinations of Web technologies are currently emerging and will continue to do so in the future.

Because they are innovative, sometimes they do not meet voters' expectations for interaction. For example, Asynchronous JavaScript

and eXtensible Markup Language (AJAX) [5] asynchronously enables dynamic client-server interactions within Web applications. AJAX is used with common Web technologies such as HTML/XHTML and Cascading Style Sheets (CSS). AJAX requires that JavaScript be turned on. Although one benefit is faster interaction, there are tradeoffs [5].

Contrary to voters' expectations, AJAX quickly and incrementally updates content of a Web page without reloading the entire page. For voters using screen readers, the effects can be serious. Screen readers "read" content that is in focus. AJAX updates may appear on a part of the page that is not in focus. If the screen reader automatically resets focus to the location of the update and then reads the update, the voter workflow will be interrupted each time the focus shifts to a part of the ballot where the voter no longer intended to work. These interruptions and unexpected movement through the screen could cause the voter to become disoriented. Voting is done infrequently, and ballots have different content from election to election. Therefore, voters cannot be expected to remember content presentation order from election to election. They need a frame of reference. AJAX could deprive the blind voter of the needed frame of reference for navigation by making it impossible to navigate sequentially through the ballot. Even the most experienced screen reader users could experience negative impacts.

Conversely, if the screen reader works linearly, it may be unaware of a change in another part of the interface that is out of focus. The result is that the screen reader will not read the change. If the screen reader is unaware of dynamic changes, it cannot inform the voter about them.

In the case of Java applets, when focus shifts to the applet, e.g. to exit, keyboard commands no longer work; this disables screen readers. Some browsers do not run JAVA applets, making their functionality unavailable to voters.

Recommendation: Follow best practices for implementation of new technologies and new combinations of technologies such as AJAX.

For example, use best practices such as the WCAG 2.0, W3C protocols, and WAI-ARIA (Accessible Rich Internet Applications). When it is necessary to use a technology that may cause the browser to act in a

way that a voter may not expect, inform the voters in plain language, in the instructions, that this may happen. For example, if there is a possibility that keyboard commands will no longer work, state this in the voting instructions using plain language. Provide a remedy for the voter. If there is no remedy possible, the implementation is not acceptable.

5 Web Ballot Repositories

Jurisdictions may post blank ballots on Web sites. These storage areas on the Web are called Web ballot repositories.

5.1 Technology

Web ballot repositories offer a security benefit over e-mail due to widely used technologies that protect the confidentiality and integrity of information in transit. It is also important that the ballot itself is constructed to be secure. For example, an effective means to protect ballot secrecy is to construct the printable ballot using software that runs solely on the voters' computers.

5.2 Interaction

Voters access Web ballot repositories to download ballots. Voters provide information about themselves to show the ballot providers that they have requested the correct ballot. For example, the voter may be asked to provide home address information. Voter authentication is not necessarily required for downloads if voters are permitted to download their ballots more than once. However, authentication is required in circumstances where voters will receive return identification information that will be used as a secondary voter authentication mechanism when returned ballots are processed.

5.3 Issue & Recommendation

Issue: The process of interacting with a Web ballot repository is not always based on accessibility and usability best practices.

For example, voters may have to provide information that is not readily on hand, such as the number of a voting district. How to find this information on the Web may be unclear to the voter, especially if it requires navigating to a different Web page.

Recommendation: Lead voters through the steps of requesting a ballot in a logical manner that simplifies the process.

Explain the voting process clearly in plain language that leads the voter through the process step by step. An example of explaining the process clearly is telling voters where to find a voting district number. An example of simplifying the process is to provide functionality whereby the system identifies a voting district when a voter inputs a home address or voter identification number. The system must notify the voter when the ballot is completely downloaded. Section 3.1 of this white paper discusses accessibility of downloading ballots, related authentication issues and related PII issues.

6 Online Ballot Markers/Electronic Form Fillers

The terms online ballot marker and electronic form filler refer to any technology that a voter uses to electronically enter information into a form on a Web site.

6.1 Technology

Online ballot markers and electronic form fillers are Web applications that run in a Web browser, usually using a client-side scripting language in addition to standard HTML.

6.2 Interaction

A voter uses an online ballot marker or electronic form filler to fill in an electronic ballot on a Web site in a browser window. An alternative to using an online ballot marker is to download and fill in a .pdf document using an electronic form filler.

In either case, voters print the completed ballot form and then return it by fax, US mail or courier service.

6.3 Issue & Recommendation

Issue: Voters with disabilities cannot use online ballot markers or electronic form fillers on forms that are not accessible.

This is a form design issue. For example, Section 4.3 of this white paper discusses Web pages that use AJAX. When those Web pages contain forms, the navigation problems discussed in Section 4.3 apply to using an online ballot marker or electronic form filler.

Recommendation: To make online ballot markers and electronic form fillers accessible to people with disabilities, follow Section 508 Standards and WCAG 2.0 on designing forms that are accessible.

Section 508 Standards [17]] require electronic form accessibility. § 1194.21 states, "(l) When electronic forms are used, the form shall allow people using assistive technology to access the information, field elements, and functionality required for completion and submission of the form, including all directions and cues." § 1194.22 repeats this requirement specifically for on-line forms. WCAG 2.0 provides guidelines for web content accessibility. Test with screen readers.

7 E-Mail

Electronic Mail (e-Mail) is software that transmits text and/or files from one computer to another over the Internet.

7.1 Technology

e-Mail is transmitted from a sender's computer to his or her e-mail server which is often operated by an Internet Service Provider (ISP). E-mail is then routed through a series of intermediate servers before delivery to the recipient's e-mail server, which is often operated by an ISP, workplace or commercial e-mail provider.

7.2 Interaction

UOCAVA voters can use e-mail to request a blank ballot. If the ballot arrives as an e-mail attachment, the UOCAVA voter can receive a

ballot to print out, fill in and return by fax, postal service or courier service.

Voters may receive an electronic ballot as an e-mail attachment. This ballot is accessible for completion on a computer using an electronic form filler. The voter then prints out the ballot and returns it.

Instead of an attachment, the e-mail can contain a link to a ballot on the Internet. Such a ballot can be a .pdf or a scanned .pdf. The voter can complete the ballot on a computer and print it out for returning. Alternatively, the voter may print out the ballot, complete it by hand and return it.

The e-mail can contain a link to a Web form to complete, print and return. Section 6 of this white paper discusses issues pertaining to using a Web form.

7.3 Issue and Recommendations

Issue: e-Mail ballot delivery may be marked as spam or blocked as spam.

Recommendation: In instructions for e-mail voting, inform voters that they need to check to see if e-mail containing the ballot or a link to a ballot is treated as spam by their e-mail provider.

Voters will require additional instructions in plain language on how to remedy this problem. For example, give voters keywords to use when consulting their email software help on setting spam parameters.

Recommendation: Jurisdictions should send emails to test accounts set up with common e-mail providers to verify that the e-mail is not treated as spam.

8 Kiosks

Kiosks are interactive computers intended for public use. A kiosk may be a Web application running on a personal computer inserted into a kiosk housing. Alternatively, it may be an ATM-like kiosk.

8.1 Technology

The principal difference between kiosks and electronic voting systems used at polling places is that kiosks typically have an application that runs on a browser.

8.2 Interaction

Voting kiosks are usually located in a public place other than the polling place. Kiosks may or not be monitored by a human facilitator. The UOCAVA voter interacts with a kiosk using a touch screen, dials and buttons, voice input (when voice input does not violate privacy), or through a PAT such as a switch device. Voters with some low vision disabilities may also use earphones to hear audio output of the ballot.

8.3 Issue and Recommendation

Issue: Kiosk design inherits most of the same issues addressed in the VVSG for electronic voting systems because kiosks have characteristics of electronic voting systems.

Some of these issues can be addressed by universal design and others require disability-specific design solutions.

Recommendation: In all aspects where kiosks have the characteristics of electronic voting systems, conform their design to VVSG Chapter 3 guidelines for usability, accessibility, voter independence and voter privacy.

For example, to be accessible, kiosks need built-in accessibility such as audio ballots. They may need interfaces to earphones. Configure kiosks to accommodate a voter sitting in a wheelchair.

Recommendation: Where possible, design to include interoperability with PAT.

As mentioned earlier in this paper, it is an open issue as to what level of accessibility needs to be built-in versus accessible by PAT. It is a safe assumption for a kiosk to follow VVSG 2.0 and also include an industry standard jack for PAT and provide the associated software interoperability.

9 Telephone-Based Interfaces

Telephone-based interfaces use a telephone and a telephone network for information exchange.

9.1 Technology

The Public Switched Telephone Network (PSTN) provides two-way communication between telephones. The PSTN is a global circuit-switched network consisting of a digital communications backbone with automated telephone exchanges that route calls to their destinations. In most cases, there is an analog bridge from the backbone to users' telephones. Information can be communicated over the telephone network either orally or by entering numbers on a touch-tone dial pad.

9.2 Interaction

A voter can request a blank ballot orally or by pressing keys on a telephone keypad. It is possible that there may be human-to-human interaction in requesting a blank ballot. Otherwise, in both ballot requesting and ballot execution, the voter hears recorded or machine-generated spoken prompts and responds by saying commands or by pressing keys on the telephone keypad.

Using a telephone keypad to vote, a voter follows a menu to enter or modify voting choices, to verify that the desired choices have been registered and to submit a completed ballot. This menu is sometimes called a telephone prompt tree because of its hierarchical structure. Telephone-based voting systems can impose memory burdens and therefore may not be appropriate for voters with cognitive disabilities. At the time this paper is written, telephone voting is not robust enough to provide a reasonable range of access features for UOCAVA voters with disabilities. For example, using a telephone-based interface requires the ability to hear the prompts. Senior citizens may have more difficulty understanding synthetic speech prompts than human digitized speech. To use the telephone keypad, some voters need manual dexterity or assistive devices and an adaptive telephone that interfaces with these devices. These requirements make telephone-based interfaces inappropriate for some voters with hearing disabilities and others with manual dexterity disabilities.

Usability guidelines for interactive voice responses are available at [12] . Many of these guidelines are based on universal design principles.

9.3 Issues and Recommendations

Issue: Using a telephone-based interface without a screen requires the ability to hear the prompts, but there is no standard to address this need.

Voters with hearing disabilities may not be able to hear the prompts. This issue is accommodated in VVSG 2.0 [23] for voting systems by requiring an additional visual prompt, but a visual prompt is not possible for telephones without screens.

Note: In the future, this may become less of an issue as phones with visual interfaces become more common.

Recommendation: Develop a standard that provides that sound prompts must be clear and loud enough to be heard. In writing the standard, accommodate the fact that hearing may be diminished at higher frequencies.

Recommendation: Require non-auditory alternatives to telephone-based interfaces for people with hearing loss. These include both tactile and visual alternatives.

Recommendation: Require non-manual alternatives to telephone-based interfaces for voters with manual dexterity disabilities. These include auditory alternatives.

Issue: Telephone-based interfaces must be compatible with hearing aids.

Voters who normally use a hearing aid may require the hearing aid to interact with a telephone-based interface for voting.

Recommendation: Follow VVSG 2.0 Section 3.3.3-C.2 requirement for T-Coil coupling.

VVSG 2.0 [23] states, “When a voting system utilizes a telephone style handset or headphone to provide audio information, it SHALL provide a wireless T-Coil coupling for assistive hearing devices so as to provide

access to that information for voters with partial hearing. That coupling SHALL achieve at least a category T4 rating as defined by the American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19." [2]

Issue: Telephone prompt trees are not always designed according to usability best practices; voter confusion and frustration can result.

This is a universal design issue.

Recommendation: Design prompt trees so that voters always feel in control of the UOCAVA telephone-based voting session.

For example, voters must have control over navigation through the phone tree, moving back up or down the tree as desired and pausing at will. Voters need confirmation that they have succeeded in casting their votes as desired. Examples of usability design standards for interactive voice response systems include ANSI/HFES 200:4 [8] and ISO/IEC 13714:1995 [9].

Issue: Some voters may have difficulty understanding speech in interactive voice response systems.

For example, some voters have difficulty hearing synthetic speech prompts. This is a universal design issue.

Recommendation: Follow best practice guidelines and test with voters who have a range of hearing disabilities to ensure that speech in interactive voice response systems is intelligible.

This is a universal design solution that can help voters with a range of hearing disabilities. Test with voters who have a range of hearing disabilities to verify that voters can hear the speech prompts. VVSG 2.0 [23] sets out standards for audio features and characteristics in Section 3.3.3-C. In particular, VVSG 2.0 Section 3.3.3-C.7 addresses intelligible audio.

Issue: Features supporting accessibility within the U.S. telephone infrastructure may not exist in other telephone infrastructures.

For example, technologies supporting accessibility may not exist in all telephone infrastructures around the world. While Section 255 of Telecommunications Act of 1996 (http://www.access-board.gov/about/laws/telecomm.htm) requires telecommunications products and services to be accessible to people with disabilities in the U.S., this would not necessarily be the case for overseas voters using phone-based equipment. There is no accessibility recommendation for this issue.

10 Fax Machines

A fax machine is a device that transmits and receives signals over telephone lines. A fax machine encodes paper representations as electronic representations.

10.1 Technology

A fax machine scans a document and transmits an encoded representation of it over the telephone network to another fax machine. The receiving fax machine decodes the information and prints a copy of the scanned document. Some fax machines create an analog representation of the document in a manner similar to analog television; others create a digital representation. The digital or analog representation is sent to a telephone network using analog signals.

10.2 Interaction

A UOCAVA voter can request, receive or submit a ballot using a fax machine. The voter can vote their requested ballot by hand or electronically. Before using a fax machine to fax a completed electronic ballot, the voter must print the ballot.

As an alternative to requesting, receiving, or sending a ballot using a fax machine, a voter may fax and receive a fax using a computer. Using a computer that interfaces with PAT can avoid accessibility problems related to using fax machines. Accessibility issues that impact on voting using a fax machine include the need to handle paper and the need to verify the content of a printed ballot before faxing in addition to the use of the fax machine itself.

The voter may be required to provide a signature for validation by the election authorities. The voter who returns the ballot by US mail or courier service inserts the voted ballot into an envelope and signs the envelope. If faxing, the voter may be required to fax an image of the signed envelope. Upon receiving the ballot, election officials verify the voter's signature on the envelope before counting the vote. Election officials verify the signature by comparing it to a signature they have on file from the voter.

10.3 Issues and Recommendations

Issue: It is possible that usability, accessibility, and privacy issues will arise when ballots are faxed.

There is a possibility of voter error with fax dialing. This, in turn, opens the possibility of faxing one's private ballot to a destination other than the intended destination. Voters need verification that a ballot has arrived at the intended, authorized fax destination.

Recommendation: Follow accessibility and usability best practices and VVSG guidelines to ensure privacy when sending ballots by fax.

For example, the receiving fax machine must provide immediate feedback, such as a confirmation sheet, to inform voters when they have successfully transmitted a fax to the appropriate authorities at the intended destination. An automatic response will provide immediate notification. Warn voters ahead of time, in plain language, to dial carefully. Make the fax number notification obvious and large enough to be read by voters with limited vision by presenting it in bolded font where no capital letter is smaller than 3.0 mm (VVSG 2.0, [23], Section 3.2.5-D Minimum Font Size) and where the font is a sans serif font (VVSG 2.0, [23], Section 3.2.5-F Use of Sans Serif Font).

Issue: Voters may be required to take unexpected extra steps to use a fax.

For example, some fax machines cannot accommodate documents smaller than letter-size. A copy of a voters' registration card may be required when requesting a blank ballot. A copy of a signed envelope may be required for ballot submission. Such cases will necessitate

scanning or photocopying a document onto letter-sized paper before faxing it.

Recommendation: Explain to voters in plain language how to carry out any unexpected extra steps.

For example, explain in plain language that if they are faxing paper, they must use letter-sized paper.

Issue: Accessibility and usability issues related to faxing include accessibility of the fax machine used for voting.

Fax machines procured by the Federal Government must comply with Section 508 of the Amended Rehabilitation Act of 1998 [16]. However, the Section 508 requirements for standalone machines do not completely address accessibility. Further, voters may use a fax machine in a setting other than a Federal government location.

Recommendation: If voters are to use fax machines procured by the Federal Government, verify that the fax machines are in compliance with the Section 508 requirements.

This recommendation provides only partial assurance of accessibility.

11 Next Steps

This paper has presented issues that impact UOCAVA remote voting. It has offered solutions. Within these issues and recommendations there are trends that point to the steps that should be taken next.

There is a high priority need for accessibility and usability standards for UOCAVA voting systems. For example, there is a need for user-centered standards to address Web-based voting systems and PAT for Web-based voting systems.

There is an immediate need for a general requirement that the design of UOCAVA voting systems must follow accessibility and usability best practices. For example, voters need voting Web sites that are designed according to universal and disability-specific ease of use and learnability design best practices.

There is an immediate need for a general requirement for testing conformance to accessibility and usability best practices. It is most important to involve voters in usability testing and voters with disabilities in accessibility testing. Testing with voters who have the range of disabilities stated in the VVSG test methods is critical for both the user interface and for interoperability because interoperability supports accessibility and usability. Testing of UOCAVA voting systems must include testing of all system components against standards and guidelines for interoperability. All likely configurations must be tested, including configurations that integrate PAT.

It is also important to test authentication approaches because authentication often conflicts with accessibility and usability best practices. Accessibility testing must address PAT.

12 Conclusions

This paper has addressed some of the critical accessibility and usability issues related to UOCAVA voting. Remote electronic voting, using the technologies described in this paper, inherits all the accessibility and usability issues related to voting at the polls; it adds new issues related to the technologies that enable remote electronic voting. Accessibility and usability of remote electronic voting systems present complex challenges that must be resolved to ensure voter efficiency, effectiveness, satisfaction, privacy and independence when voting remotely.

13 References

[1] Access Board (United States Architectural and Transportation Barriers Compliance Board). Draft information and communication technology (ICT) standards and guidelines. http://www.access-board.gov/sec508/refresh/draft-rule.htm

[2] American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4233252&tag=1

[3] CAPTCHA: Telling Humans and Computers Apart Automatically. Carnegie Mellon University. http://www.captcha.net/

[4] Federal Voting Assistance Program (FVAP). http://www.fvap.gov/

[5] Gibson, V. AJAX accessibility overview. http://www-03.ibm.com/able/resources/ajaxaccessibility.html

[6] Hastings, N., Peralta, R., Popoveniuc, S. & Regenscheid, A. Security considerations for remote electronic voting. NIST white paper for the TGDC.

[7] Help America Vote Act (HAVA) of 2002. Public Law 107-252. http://www.gpo.gov/fdsys/pkg/PLAW-107publ252/content-detail.html

[8] Human Factors and Ergonomics Society. ANSI/HFES 200:4. Human factors engineering of software user interfaces part 4: Interactive voice response (IVR) and telephony. http://www.hfes.org/PublicationMaintenance/FeaturedDocuments/76/ANSI-HFES_200-Part4_TOC.pdf

[9] International Organization for Standardization (ISO). ISO/IEC 13714:1995. Information technology – Document processing and related communication – User interface to telephone-based services – Voice messaging services. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=22721

[10] International Organization for Standardization (ISO). (1998). ISO 9241-11:1998. Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=16883

[11] International Organization for Standardization (ISO). ISO/IEC 25062:2006. Software engineering -- Software product quality requirements and evaluation (SQuaRE) -- Common industry format (CIF) for usability test reports. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=43046

[12] IVRS World Usability guidelines of IVR systems. http://www.ivrsworld.com/advanced-ivrs/usability-guidelines-of-ivr-systems/

[13] Laskowski, S., Autry, M., Cugini, J., Killam, W., and Yen, J. Improving the Usability and Accessibility of Voting Systems and Products. NIST Special Publication 500-256, May 2004. http://www.nist.gov/itl/vote/upload/FinalHumanFactorsReport5-04.pdf

[14] PlainLanguage.gov. Improving communication from the Federal Government to the public. Accessed June 28, 2010 at http://www.plainlanguage.gov/index.cfm

[15] Regenscheid, A. & Hastings, N. A threat analysis on UOCAVA voting systems. NIST IR 7551. National Institute of Standards and Technology, Gaithersburg, MD. 2008. http://www.nist.gov/manuscript-publication-search.cfm?pub_id=901171

[16] Rehabilitation Act of 1973, as amended (29 U.S.C. 794d). Section 508. (1998). http://www.section508.gov/index.cfm?fuseAction=1998Amend

[17] Section 508 Electronic and Information Technology Accessibility Standards. http://www.access-board.gov/sec508/standards.htm

[18] Thatcher, Jim. CAPTCHAs, CAPTCHAs everywhere. http://jimthatcher.com/captchas.htm

[19] Uniformed and Overseas Citizens Absentee Voting Act (UOCAVA), (as modified by the National Defense Authorization Act for FY 2005). http://www.fvap.gov/resources/media/uocavalaw.pdf

[20] Usability.gov. Research-based Web design and usability guidelines. http://www.usability.gov/guidelines/guidelines_book.pdf

[21] Usability.gov. Your guide to developing usable & useful Web sites. http://www.usability.gov/

[22] Utah State University Center for Persons with Disabilities WebAIM. Survey of preferences of screen readers users. http://webaim.org/projects/screenreadersurvey/#demographics

[23] Voluntary Voting System Guidelines Recommendations to the Election Assistance Commission. Draft – August 7, 2007 (VVSG 2.0). http://vote.nist.gov/VVSG-0807/VVSG-Draft-08072007.pdf

[24] w3Schools. Browser statistics, 2010. http://www.w3schools.com/browsers/browsers_stats.asp

[25] W3C Web Accessibility Initiative (WAI). WAI guidelines and techniques. http://www.w3.org/WAI/

[26] W3C/WAI Web Content Accessibility Guidelines (WCAG) 2.0 http://www.w3.org/TR/WCAG20/

Appendix: Summary of Recommendations

General Accessibility and Usability Recommendations

- Recommendation: Follow VVSG 2.0 accessibility and usability guidelines and test methods.
- Recommendation: Test for accessibility with voters who have disabilities performing voting tasks in environments like the ones where they will actually perform UOCAVA voting.
- Recommendation: Develop requirements based on existing Web-based standards**.**
- Recommendation: Follow VVSG 2.0 requirements for privacy and independence**.**
- Recommendation: To make UOCAVA voting accessible, provide options that interface with PAT**.**
- Recommendation: The design team and the security team need to work together from the beginning of the design process. Policy decisions should consider usability, accessibility, security, and privacy as a whole.
- Recommendation: When implementing security technologies, follow user-centered practices.
- Recommendation: Design authentication to be usable and accessible.
- Recommendation: When PII disclosure is required, provide a secure and easy-to-use way for the voters to provide PII directly to the voting authority and give voters obvious assurance that the means they use to supply PII is secure.
- Recommendation: Never require voters to supply unnecessary PII. Only ask voters to supply the required PII.

- Recommendation: Design and test voting system components against standards and guidelines for interoperability and test all likely configurations.

- Recommendation: If the ballot is a .pdf intended to be printed, consider the use of form filling online so that the voter doesn't need to fill out a paper blank ballot by hand.

- Recommendation: Create .pdf documents that contain text rather than images of text.

- Recommendation: To support onscreen legibility for voters with low-vision disabilities, test to ensure that the Adobe Reader reflow feature performs properly for displaying .pdf documents to be used with UOCAVA voting systems.

- Recommendation: For printing ballots, offer the option to print only the choices.

- Recommendation: Avoid the problem of unreadable voter choices by offering an option that is readable by a TTS.

- Recommendation: If the ballot is a .pdf intended to be printed and must be completed on paper, provide a large print ballot format for voters with low vision disabilities.

Web Browser Recommendations

- Recommendation: Test to make sure that the Web site and its applications are compatible with at least the most commonly used versions of the most commonly used browsers.

- Recommendation: To accommodate the widest range of computer literacy, ensure that the voting Web site conforms to universal design principles.

- Recommendation: Follow best practices for implementation of new technologies and new combinations of technologies such as AJAX.

Web Ballot Repository Recommendation

- Recommendation: Lead voters through the steps of requesting a ballot in a logical manner that simplifies the process.

Online Ballot Marker/Electronic Form Filler Recommendation

- Recommendation: To make online ballot markers and electronic form fillers accessible to people with disabilities, follow Section 508 Standards and WCAG 2.0 on designing forms that are accessible.

e-Mail Recommendations

- Recommendation: In instructions for e-mail voting, inform voters that they need to check to see if e-mail containing the ballot or a link to a ballot is treated as spam by their e-mail provider.

- Recommendation: Jurisdictions should send emails to test accounts set up with common e-mail providers to verify that the e-mail is not treated as spam.

Kiosk Recommendations

- Recommendation: In all aspects where kiosks have the characteristics of electronic voting systems, conform their design to VVSG Chapter 3 guidelines for usability, accessibility, voter independence and voter privacy.

- Recommendation: To make online ballot markers and electronic form fillers accessible to people with disabilities, follow Section 508 Standards and WCAG 2.0 on designing forms that are accessible.

Telephone-Based Interface Recommendations

- Recommendation: Develop a standard that provides that sound prompts must be clear and loud enough to be heard. In writing the standard, accommodate the fact that hearing may be diminished at higher frequencies.

- Recommendation: Require non-auditory alternatives to telephone-based interfaces for people with hearing loss. These include both tactile and visual alternatives.

- Recommendation: Require non-manual alternatives to telephone-based interfaces for voters with manual dexterity disabilities. These include auditory alternatives.
- Recommendation: Follow VVSG Section 3.3.3-C.2 requirement for T-Coil coupling.
- Recommendation: Design prompt trees so that voters always feel in control of the UOCAVA telephone-based voting session.
- Recommendation: Follow best practice guidelines and test with voters who have a range of hearing disabilities to ensure that speech in interactive voice response systems is intelligible.

Fax Machine Recommendations

- Recommendation: Follow accessibility and usability best practices and VVSG guidelines to ensure privacy when sending ballots by fax.
- Recommendation: Explain to voters in plain language how to carry out any unexpected extra steps.
- Recommendation: If voters are to use fax machines procured by the Federal Government, verify that the fax machines are in compliance with the Section 508 requirements.