Abstract

Mobile communication technology such as smartphones and tablets are increasingly integrated into our everyday lives but some aspects of our society are yet to see the full benefits that this technology has to offer. This thesis will present a vulnerability analysis on key challenges of mobile internet e-voting, which will be discovered utilising scholarly literature and research, past trials and anonymous survey's which will be conducted amongst the general public and government officials.

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Research Topic

Thesis Title
A vulnerability analysis on the adoption of mobile internet e-voting in Australia.

Background and Research Problems
Mobile communication technology such as smartphones and tablets are increasingly integrated into our everyday lives but some aspects of our society are yet to see the full benefits that this technology has to offer.

In 1855 Australia was an innovator with the development of the Australian Secret Ballot system. This ballot system is a paper based manually processed form which is still in use today. This system has a number of disadvantages:

- **Time consuming** - This system is very time consuming and slow (Mayur Patil, Vijay Pimploodkar, Anuja R. Zade, Vinit Vibhute, & Ratnakar Ghadge, 2013, p. 115). Even if we were to remove the time taken to get to a polling station, the time an elector takes to cast a ballot is relatively slow. This can even extend further if there isn’t enough polling booths resulting in having electors having to queue.

- **Low Tally Speed** - Once the voting session is closed, all the ballots need to be transported to specific locations to be manually counted.

- **Complicated Administration** - Paper based voting system require a great deal of administration prior to Election Day. This include organising such things as polling stations, officials, collateral, printing ballots and transportation to name a few.

- **Waste** - Paper based ballots are wasteful, requiring paper, print and other stationary to conduct an election.

- **Incomplete Votes** - As paper based ballots require secrecy the voters can actually submit an incomplete ballot. This could be either submitting a blank ballot or an invalid entry such as marking multiple candidates as the same preference.

- **Coercion and Influence** - For a secret ballot to be effective the processes needs to guarantee the free expression of the will of the electors, without fear or intimidation (Electoral Council of Australia and New Zealand, 2013, p. 47). As electors are required to attend polling stations to cast a ballot; as observed during the last federal election; electors are swamped by political party representatives handing out how to vote cards which show preferential voting ballot imagery for the respective political party. This could potential sublimely sway how an elector casts their ballot. Even though there are measures that have be put in place to prevent coercion and influence in the polling booth by the AEC (Australian Electoral Commission, 2013), these laws don’t prevent against the aforementioned scenario.

Mobile communications based (mobile internet e-voting) has the perceived potential to address these shortcomings by...
• **Mobility** - Being mobile, allows electors to cast a ballot at anytime and anywhere during an election session provided there is an available internet connection. This will render the requirement to attend polling stations and could potential reduce the amount of polling stations required during an election session. Mobility in turn also addressed the challenge of coercion and influence.

• **Immediate Accurate Tally** - With the digitisation of ballots, electronic votes could potentially be counted and present as soon as possible after the conclusion of a voting session, and also potentially remove human error for the tally count.

• **Reduced Administration** - The ability to have automated systems in place; such as registration and ability to cast a vote online; will reduce the amount of administration required in organising an election session. This might not be evident during the first use of the system, but will more than likely be seen once the system has been implement a number of times.

• **Reduced Waste** - As the votes are cast online, there will be a reduced requirement for paper and other materials used.

• **Vote Casting Validation** - The system can have validation implemented that could potentially remove incomplete ballots (when cast online). This validation could warn electors prior to submission if a vote is complete and provide validation messages to help complete said vote.

Adoption of a mobile internet e-voting solution is not without challenges. Specific challenges faced by implementations of mobile internet e-voting include:

• **Secrecy** - At no time should it be possible to determine how an elector has voted.

• **Auditable** - As with most binding systems, auditability is a key challenge. To put it another way, if the results are ever challenged then the ballots can be recounted to check the result (Jordi Barrat i Esteve, Ben Goldsmith, & John Turner, 2012, p. 86).

• **Cost** - The solution needs to able to justify potentially reduce the cost to conduct an election (Delvinia, 2004, p. 5).

• **Inequality** - Inequality applies to two area. Age differences in electors must be addressed. For instance, younger voters might potentially find that it is easier from them to utilise the solution as opposed to elderly electors. This challenge also applies to access to the technology required to cast a vote during an election. Some electors might not have the access to smartphones to be able to cast a ballot using mobile internet e-voting.

• **Trust** - Trust is where it all comes down to. For a solution to be implemented, especially one that is utilised for an election, electors must be able to trust the solution. An example of trust would be electors trusting that by using the solution their respective votes are counted correctly.
These challenges must be addressed before mobile e-voting can be adopted. A key strategy to address these challenges is to provide a mobile internet e-voting solution that can be trusted and have viable alternatives to be able to cast a ballot in the event that mobile internet e-voting is not possible (a backup). Trust can be achieved simply by transparency and education. If the public are provided and educated with the process of casting an electronic ballot as well as taken through the process of what happens after the vote is cast, they might be more inclined to trust the method of casting a vote.

This thesis will present a vulnerability analysis on key challenges of mobile internet e-voting, which will be discovered utilising scholarly literature and research, past trials and anonymous survey’s which will be conducted amongst the general public and government officials. The collation of the challenges that will be addressed by the vulnerability analysis, a sample of the challenges will be addressed and existing or potentially newly discovered solutions will be recommended. This will be a contribution to the potential of eventual adoption of mobile internet e-voting in Australia.

**Research Aims and Objectives**

This research will be used to provide an important assessment on the readiness of mobile internet e-voting for use in Australian elections. The aims and objectives of this research will encompass the following:

- Provide a basis on what internet e-voting is, more specifically what is mobile internet e-voting;
- Analyse past and current trials and implementations of internet e-voting around the world;
- Define what is required to implement internet e-voting and what cryptographic primitives are implement to address challenges for internet e-voting;
- What we believe through research of scholarly documents is required to develop trust with internet e-voting;
- Conduct a vulnerability analysis on mobile internet e-voting in Australia;
- In particular to conduct a survey on what are the impediments believed to be holding survey groups from utilising mobile internet e-voting technology.
- Analyse the findings and recommend solutions a possible solution to alleviate the found concerns;
- Utilise the research to give a perceived perspective on readiness of mobile internet e-voting for use in Australian elections.

**Significance and Innovation**

The significance of this research is not only having a qualitatively and quantitatively supported set of challenges that a mobile internet e-voting solution needs to address in order to be successful, but also to define either researched proven solutions to the challenges discovered, or recommend potentially new innovations.

In the perspective of the data collection, this research will be utilising opinions and attitudes of general public as part of the identification and assessment process. This will give the research a unique and exciting position to which the foundations of vulnerability analysis are laid.
Background and Context of Study

How did the problem or issue arise?

With the emergence of the internet and other e-commerce technologies, governments have had to adopt new channels in which they deliver services (e-government) (Alexander Prosser & Robert Krimmer, 2004). As society becomes more wirelessly connected, these channels provide a universal medium to which paper based elections can be "upgraded" to digital elections.

For mobile internet e-voting to ensure success (in Australia), the solution needs to accomplish two primary challenges. 1) Provide the ability to conduct of free, fair and credible elections, and 2) provide an overall benefit than the current paper based election system.

According to the Australia Bureau of Statistics (2013), by the end of December 2012 there were 6 million wireless broadband connections in Australia. This equated to 49.7% of the way people connected to the internet, as opposed to 1.6% at the end of June 2006. This trend is not only valid for Australia, a report conducted by Cisco (2014) claimed that global mobile data traffic had grown by 81% in 2013. More specifically with regards into smartphone technology, the Australian Communications and Media Authority (2013, p.6) stated that as of May 2012, the percentage of smartphone owning adults in Australia was at 49%.

![Proportion of subscribers by connection type, Dec-2012](image)

*Figure 1 - Proportion of subscribers by connection type (*8153.0 - Internet Activity, Australia, December 2012,* 2013)*

Internet e-voting is not a new concept, it has been trialed and used in a multitude of countries around the world. Australia is not new to e-Voting, since 2001 e-voting has
been used for various Australian elections. In 2011 the New South Wales government implemented a remote telephone and internet voting scheme called iVote.

Internet e-voting has been introduced in elections as part of a strategy to increase voter engagement (Delvinia, 2004, p. 7). The Council of Europe Committee of Ministers & Council of Europe Directorate of Legal Affairs (2005, p. 24) set the following recommendations for electronic voting to be a viable solution:

1. enabling mobility of the voters
2. facilitating the participation in elections from abroad
3. raising voter turnout by offering additional channels
4. widening access for citizens with disabilities
5. reducing cost
6. delivering voting results reliably and more quickly

As mentioned previously for internet e-voting to be successfully implemented into an election there are two primary challenges; 1) provide the ability to conduct of free, fair and credible elections, and 2) provide an overall benefit than the current paper based election system; there is also another overall challenge. The solution needs to have Trust. Trust (in relation to this research) is an umbrella term which refers to challenges in acceptance of the mobile internet e-voting solution. The solution needs to be able to establish trust with all parties involved if it is to successful succeed paper based voting. This is where the vulnerability analysis will assist.

It is worth mentioning that there is an alternative to mobile internet e-voting, kiosk remote voting (or kiosk voting). Kiosk voting is the ability to cast an online ballot via a designed electronic polling booth. Kiosk voting falls under the category of a non-remote controlled environment (Electoral Council of Australia and New Zealand, 2013, p. 14).

Kiosk voting unlike internet voting, according the Elections Canada (“Elections Canada Online | A Comparative Assessment of Electronic Voting,” n.d.), has a potential to positively impact the electoral process. They continue to state that, even though this potential exists, there has been little on remote kiosk voting, the need to secure data, lack of a paper trail for recount and auditing purposes, and the susceptibility to machine malfunctions are concerns. Fallibility of kiosk voting machine eventually caused the end of trials of kiosk voting in Ireland and the Netherlands (“Elections Canada Online | A Comparative Assessment of Electronic Voting,” n.d.).

The vulnerability analysis will not solve all aspects of the challenge of trust but it will provide a bases for areas within the umbrella of trust and the attempt to establish a case for a mobile internet e-voting solution.

**Why is this an important area to study?**

This research has the potential to fundamentally change a key aspect of Australian life, voting and the democratic process. For over one hundred years the process of voting in Australia has remained essentially unchanged. Electors have travelled to polling booth or received a postal vote, indicated their preferred candidate on a paper ballot and return their ballot to an electoral officer for subsequent vote tallying.

The delays and controversies of the 2013 Australian federal election which involved a number of issues including lost ballots (“Australian Electoral Commission statement: WA
Senate recount - Australian Electoral Commission,” 2013) and a number of vote recounts highlights the limitations of the current paper based voting system.

Technological innovations have provided us with the opportunity to produce better solutions and modernise the voting process. E-voting, which is a form of electronic (paperless) voting typically involving the internet is one promising solution. It offers the opportunity to greatly reduce the paper used to cast votes and also allows almost instantaneous counting of all votes.

Mobile internet e-voting goes one step further and allows the voter to cast their vote using an internet connected smart device (smartphone or tablet) not even requiring them to attend a polling station. Automated alerts can even be sent to registered voters to inform them when an election occurs ensuring that they don’t ever forget a vote, including two step verification when casting an online ballot can also utilise smart device technology.

Despite extensive research and the numerous apparent benefits of e-voting it has been slow to be adopted in democratic countries. The hypothesis investigated in this thesis is that core to use of e-voting technology is the establishment of trust in the system by voters and politicians. In order to achieve the required trust, a key fundamental step is to conduct a vulnerability analysis. This thesis will conduct such a vulnerability analysis in the context of mobile internet e-voting in Australia.

The specific objectives (outcomes) of the research described in this thesis are:

1. Establish what e-voting is and new e-voting classifications will be defined.
2. Review trials and implements of internet e-voting around the world
3. Define what is required to achieve mobile internet e-voting in the Australian context
4. How to establish trust with mobile internet e-voting
5. Review what a vulnerability analysis is and how it will be conducted
6. Perform a survey to be used in conjunction with the vulnerability analysis and scholarly research
7. Conduct a vulnerability analysis of mobile internet e-Voting for Australia and analyse survey results

The fundamental objective of this research is first discover scholarly and stakeholder views of what challenges need to be overcome to establish a trusted mobile internet e-voting, and to address these challenges.

Underlying assumptions

- Internet e-voting has the potential to succeed paper based voting;
- Smartphones and/or other connected devices are accessible by most Australians. For electors who don’t have access, alternative methods (such as postal voting, or polling stations) are available.
- Protocols have been defined and proven by other research, trust is the key barrier to implementation of a mobile internet e-voting solution
- The survey respondents will be truthful
• The number of respondents surveyed will be determined using power analysis. The survey respondents will be a minimum of $n = 1,000$ people (power analysis needed to determine $n$).

**Key terms and Concepts**

• **E-voting** refers to an election or referendum that involves the use of electronic means in at least the casting of the vote (Caarls, 2010, p. 7).

• **Mobile internet e-voting** refers to the ability to cast a ballot via a connected device at anytime from anywhere (provided a sustainable internet connection is available).

• **Cryptographic Primitives** refers to low level highly reliable cryptographic algorithms developed by researchers to produce e-voting schemes.

• **Vulnerability Analysis (or vulnerability assessment)** is the process of conducting an assessment, identifying deficiencies and utilising data and research address the deficiencies (Boyce, 2001).

• **Smartphone** refers to in this context, any smart device that is connected to the internet, either by way of cellular internet or Wi-Fi.

• **Uncontrolled Internet Voting** systems allows electors to cast an online ballot via their own internet connected device.

• **Non-Remote Controlled Internet Voting** is the ability to cast a vote at a designated location on a device that has been provided and maintained by the election body.

• **Remote Controlled Internet Voting** is the ability of an elector to cast a ballot at any location on a device that is controlled and maintained by the election body.

**Limitations/Boundaries imposed**

Even though this research will include data from countries around the world, the outcome is primarily focused on Australian elections. More specifically the potential of adopting a mobile internet e-voting solution for use during Australian elections.
Methodology

Research Strategy
This research will combine both quantitative and qualitative studies. In particular it will:

- Use qualitative studies by use of a survey to gather data of opinions, feelings and a general concessions' of public stakeholders and provide baseline for challenges to be utilised in the vulnerability analysis. The qualitative study will also be used in relation to past trials of internet e-voting and identify challenges encountered.

- Use quantitative studies to validate or reject the hypothesis of this research. It will be used to analyse numerical data such as costing, past internet e-voting trial measures and closed survey questions.

Key issues identified in the qualitative and quantitative studies will inform the vulnerability analysis.

The benefits to this project from adopting both approaches is that it provides the vulnerability analysis with a set of challenges and direction towards focus areas for this research.

The advantages of the qualitative methods are it allows the research to gather data on feelings and thoughts towards mobile internet e-voting with could yield unidentified challenges. Whilst the advantages of the quantitative methods are it can provide some foundation to challenges identified through scholarly research and how these challenges are perceived by the Australian public. Quantitative research will also provide data for a comparative analysis. An example of this is that it can provide an objective scale against which measures such as cost saving.

Using both methods allows for the compensation of the limitations encountered when solely relying on a single method. Results from both the quantitative and qualitative will be combined using a mixed methods approach (Bulsara, n.d.) which will maximise the insight to be gained by the use of both approaches.

Research Methods
The methodology adopted in this thesis is reflective of the qualitative and quantitative aspects to the research strategy. Methodology will be designed to cohesively transition from one phase of the research strategy to the next.

Specific methods adopted will include:

- The combination of these approaches (quantitative and qualitative), which will build towards a comprehensive research strategy. This strategy will utilise both methods to be complementary rather than clashing (Triangulation (Jick, 1979)).

- Case studies of past trials of internet e-voting. These case studies will be sourced by a detailed review of the literature followed by a considered qualitative comparison of all of the issues encountered during the trials which might serve as barriers to adoption. These limitations will be compared and contrast within the
contextual framework of mobile internet e-voting solutions for Australia. Key issues or barriers will be identified as candidate points for the vulnerability analysis.

- Subject to human research ethics committee approval, a stratified random sampling strategy will be devised to seek feedback from approximately n = 1000 (power analysis needed to determine n?) respondents across a range of socio-demographic categories (e.g. urban as compared to rural) using survey questionnaires. Responses will be of nominal polytomous and short-answer format. Statistical analysis using linear models will be used to detect significant differences between cohorts.

- Comparative analysis of perceived challenges. With the use of survey questionnaires and reports released by the Electoral Council of Australia and the Australian Government bodies, a qualitative comparison will be conducted to see where the greater set of challenges lies. With the public or with the government.

- A public awareness campaign will also be initiated in relation to the research by use of social media and a website. This website will capture information of interest members of the public and could potentially deliver the sampling pool for the survey. This research will also be communicating with members of government and potentially other media channels (print news and television media). Public awareness will potentially increase interest in the survey. With regards to this campaign, this research will need to be open to accept both criticisms and support towards mobile internet e-voting, in an effort to avoid selection bias.

- Target interviews (n = 25-50 depends on size of interview and resources) will also be completed from respondents identified during a state government election (which) in order to provide more detailed information on the issues around trust identified from the case study and survey questionnaire analysis.

- In addition to the online survey questionnaire, and subject to human research ethics committee approval, a stall will be setup in one of Australia’s capital city where minimised surveys and potential video testimonials of concerns will be recorded and included in the vulnerability analysis. This method will be intended to be the medium to which the target interviews are conducted.

- With the previous issues of past e-voting trials and the key issues of trust associated with e-voting identified amongst the Australian populace the next step will be to perform a vulnerability analysis. A vulnerability analysis (or vulnerability assessment) as previously defined is the process of conducting an assessment, identifying deficiencies and utilising data and research to address the discovered deficiencies. Discovered deficiencies through literature and analysis, will be addressed by previously researched and proven solutions. If deficiencies are discovered that there is minimal or no previous solution, this research will endeavour to discover and formulate a solution to the newly discovered deficiencies.
• This research will be explored with the assistance of national projects including the Australian Urban Research Infrastructure Network (AURIN – www.aurin.org.au) which provides seamless, secure access to a wide range of distributed data sets and services including voting data (from the Australian Bureau of Statistics); voting catchment areas; voting booth locations, with a range of tools for visualisation and analysis of these data sets in particular urban/spatial contexts. This will allow real time patterns of voting data to be displayed and used to identify potential fraudulent voting behaviour, e.g. strong swings between parties in given districts.

• Once deficiencies have been identified they will be prioritised and categorised accordingly to severity as well as perceived trust. A key part of the vulnerability analysis to is address the deficiencies found. Deficiencies will be categorised and rated then the top 5 rated (or most serious) deficiencies will be addressed as part of this research.

• A follow-up survey will also be scheduled once the vulnerability analysis is completed. The purpose of this survey is to increase public awareness of what the research had discovered and ask the respondents in the form of a questionnaire what if their view has changed and if the proposed solution had addresses their concerns.

• A demo app will be developed to demonstrate the interface in which internet e-voting could potentially present. This app will be presented prior to the respondent taking the second (follow-up) and the targeted interview survey. The purpose of this app is to receive feedback on how electors would use the app and trust being perceived in regards to mobile e-voting in practice.
Figure 2 - Research Approach
Tools of data collection

- Scholarly Databases
  - Google Scholar
  - ACM
  - Thomson Reuters Web of Science
  - UNE Library databases
- Australian Urban Research Infrastructure Network (AURIN)
- Online Questionnaire. The method of delivering the survey, the number of respondents required and the style of questions will be defined as the research continues.
- In person survey. As previously mentioned this will be defined as the research continues.

Location and availability of data

- Scholarly documents and literature. Literature will be source from scholarly databases such as Google Scholar, ACM, UNE Library databases and Thomson Reuters Web of Science. This research will also be referring to regular conferencing proceedings of the Competence Center for Electronic Voting and Participation (http://www.e-voting.cc/).
- Survey results: stored electronically as a database. As mentioned the method and storage will be subject to the style of questions as research continues.
- Statistical and spatial data sourced from various sources utilising the AURIN system (http://aurin.org.au/)

Methods of data analysis and interpretations

See previous comments and description given in methodology above.

Experimental design and power analysis will be performed prior to the conduct of the surveys to ensure statistical rigor. Survey responses will be analysed in a linear modelling framework to test model hypotheses and obtain estimates model parameters. All analysis will be constructed using the statistical computing software R (http://www.r-project.org/).

Ethical implications

- The aforementioned survey’s need to be approved by the human research ethics committee. The primary issue relates to unsolicited contact in regards to the survey and potentially approaching people at survey booths. Solution is to carefully review and follow human research ethics guidelines and confidential, de-identified storage of responses.

- If an mobile internet e-voting solution is adopted within Australia as a result of this research, the following implications need to be considered:
  - Are electors required to have a smartphone to cast a ballot during an election? If so what devices are compatible?
  - Socio-demographic implications
  - Information Literacy
- An elector casting their own vote and not selling their "access" to cast a vote to another party

These implications mentioned above can be addressed with the following actions:

- During an election their needs to be an alternative method for an elector to cast a ballot, such as telephone voting or keeping a minimal amount of polling stations available.
- Considering socio-demographic data sourced from the AURIN network around voting catchment areas.
- Considerations taken into account when designing demo app to and potential workflow to prevent this from occurring.
## Problems that may be encountered in the conduct of the research

<table>
<thead>
<tr>
<th>Risk</th>
<th>Estimated Probability (0 - Not Possible, 10 - Certainly)</th>
<th>Severity to research</th>
<th>Possible Resolution should risk occur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Result Inconsistency - Survey results could potentially produce data that does not have a common base to which deficiencies (or challenges) can be deduced for a vulnerability analysis. <strong>Note:</strong> This will be addressed by carefully considering the questions and several cycles of review post the completion of one survey and the start of the next.</td>
<td>6</td>
<td>Medium</td>
<td>An alternative survey would be developed. If this is not viable, research will need to focus of literature.</td>
</tr>
<tr>
<td>Non-respondents</td>
<td>5</td>
<td>Medium</td>
<td>Research will need to focus of literature.</td>
</tr>
<tr>
<td>Timeline for completion of candidature due to external influences early in the research.</td>
<td>3</td>
<td>Low</td>
<td>Extension to complete research</td>
</tr>
<tr>
<td>A viable internet solution could be introduced for use in Australian elections</td>
<td>2</td>
<td>High</td>
<td>Perform analysis on solution and adjust outcomes of research</td>
</tr>
<tr>
<td>Unable to evaluate survey results to discover trends of trust (or lack thereof) towards mobile internet e-voting</td>
<td>5</td>
<td>High</td>
<td>Utilisation targeted interviews and literature</td>
</tr>
</tbody>
</table>

*Table 1 - Identified Risks of Research*
Literature Review

Voting is an essential component of modern democracies, as stated in the Commonwealth Electoral Act 1918, “it shall be the duty of every elector to vote at each election” (Commonwealth Electoral Act, 1918). As highlighted by Holmes (2012, p. 2), the aforementioned Act, requires that Australian citizens aged 18 years and over to enrol (although persons of ‘unsound mind’ and persons who have been convicted of treason or treachery are not entitled to enrol or vote; nor are prisoners serving more than three years). In simple terms, Voting is compulsory in Australia.

As an innovator in the paper ballot system, Australia in 1855; more specifically Victoria; was the first to introduce the secret ballot as a system to ensure secrecy when casting a ballot. This was later known as the Australian Secret Ballot (Australian Government Department of Foreign Affairs and Trade, 2008). Consequently, when introduced into the USA in the late 1800’s, the system became known as the “Australian ballot” (NSW Electoral Commission, 2010). The system worked on basis that the government printed the paper ballot with the candidate names and issues in a fixed order. The ballots where then counted by hand.

The Australian ballot’s effectiveness has been as subject of great debate worldwide. Esteve, Goldsmith, and Turner (2012, p. 48) conclude that the Australian ballot fosters a privatization of elections so that voters may cast a ballot taking into account only their privative interests and not common goods. Access to the internet immediately prior to casting a vote may allow the voter to research each candidate and discuss opinions on key issues with peers via the use of social media. As observed by the Electoral Council of Australia and New Zealand (2013 p. 11) internet-based activities continue to dominate many other fields ofendeavour, it stands as a stark contrast and highlights the extent to which internet voting (e-voting) is yet to be embraced.

As defined earlier, e-voting refers to an election or referendum that involves the use of electronic means, in at least the casting of votes (Caarls, 2010, p. 7).

Buchbaum (2004, p. 2) identifies two main types of e-voting:

- e-voting supervised by a physical presence of representatives of government or independent electoral authorities, e.g. electronic voting machines at polling stations
- e-voting within the voter’s sole influence e.g. voting on a personal computer (i-voting)

Buchbaum also continues to state that remote e-voting as the action of casting an e-ballot without the physical supervision of a government official, which is mainly respects is not to dissimilar from postal voting.

The concept of e-voting has been around for over a decade, it was first used in 1996 in the United States Reform Party Presidential primary election ("Historical Timeline - Voting Machines - ProCon.org," 2013) and has continued to evolve a greater range of election types and integration of various technologies and mediums. E-voting has been trialled and used in a multitude of countries around the world (Esteve, Goldsmith, and Turner, 2012; Holmes, 2012). Australia is not new to e-Voting, since 2001 e-voting has been used
for various Australian elections. In 2011 the New South Wales government implemented a remote telephone and internet voting scheme called iVote (PwC, 2011).

According to the Australia Bureau of Statistics (2013), by the end of December 2012 there were 6 million wireless broadband connections in Australia. This equated to 49.7% of the way people connected to the internet, as opposed to 1.6% at the end of June 2006. This trend is not only valid for Australia, a report conducted by Cisco (2014) claimed that global mobile data traffic had grown by 81% in 2013 with an expected forecast of 15.9 Exabyte’s per month of mobile traffic by 2018. More specifically with regards into smartphone technology, the Australian Communications and Media Authority (2013, p.6) stated that as of May 2012, the percentage of smartphone owning adults in Australia was at 49%.

![Exabytes per Month](image)

Source: Cisco VNI Mobile, 2014

With this forecasted trend of mobile usage, the emergence of the connected world, and the widespread proliferation of smart devices, such as smartphones, tablets and other connected devices, there will be eventual push towards the ability to conduct an election with "mobile casting" as means for cast a vote.
Mobile casting is in essence just that, the ability to cast a legal vote anywhere and at any time during an election session (provided an internet connection is available) on a mobile device.

Adoption of a mobile internet e-voting solution is not without challenges. Trust has been highlighted as a significant issue for internet voting in a number of studies (Electoral Council of Australia and New Zealand, 2013, p. 43). The Electoral Council of Australia and New Zealand identifies mainly factors which have influence over public attitudes toward internet e-voting, but also suggest that as the internet becomes integrated into daily life, voters could potentially become more comfortable using internet e-voting systems. The public must believe that the government has the ability to implement and integrate various systems to accurately and safely support internet e-voting (Carter & Campbell, 2011, p. 32). Even though trust has been identified as key challenge for acceptance and implementation of internet e-voting, there are key underlying trust (or lack thereof) factors that are not fully known.

An Australia mobile internet voting e-voting does not only has to address challenges such as trust, any potential solution needs to show a relative advantage (Carter & Campbell, 2011, p. 31). Relative advantage is the degree to which an innovation is seen as being superior to its predecessor. The system needs to be able to show that it can have a greater benefit than the current paper ballot system.

The ability to cast a ballot while being mobile key advantage of mobile internet e-voting. As Goodman (2014, p. 8) states remote internet voting offers electors the greatest potential accessibility and convenience and therefore has the most potential to positively impact electoral participation.

The Electoral Council of Australia and New Zealand (2013, p. 14) defines "web-based" voting can be implemented in the following ways:

1. **Kiosk Voting**: The ability to cast an online ballot via a designed electronic polling booth. Kiosk voting falls under the category of a non-remote controlled environment.
2. **Mobile Internet Voting**: Is the ability to cast an online ballot via a device that is managed and delivered by the election body.
3. **Remote Internet Voting**: This is the ability of an elector to cast a vote; either during advanced polling or on election day(s); via any personal computer device that is connected to the internet.

It is also important to mention there are forms of voting that don’t fall into the category of internet e-voting but have been used in the past to capture votes (Electoral Council of Australia and New Zealand, 2013, p. 14). These include:

- Fax voting;
- Voting through a call centre;
- Remote Telephone Voting;
- SMS Voting; and
- Voting on a designated voting device (or computer) within a closed isolated network, and not connected to the internet.
To assist in understanding the differences between implementations, the classifications aforementioned can be categorised as:

**Uncontrolled Internet Voting**

- An Uncontrolled internet e-Voting systems allows electors to cast an online ballot via their own internet connected device. This can be a computers, smartphone, tablet, etc... Goodman, Pammett, DeBardeleben, & Freeland (2010, p. 16), and Olsen & Nordhaug (2012) identify the drawbacks and risks of utilising personal computers. The device used to cast the vote could be compromised and as such certain principals of internet e-voting could be at risk, such as ballot secrecy.

**Non-Remote Controlled Internet Voting**

- Non-remote controlled internet e-Voting is the ability to cast a vote at a designated location on a device that has been provided and maintained by the election body. A kiosk voting system would be associated with this classification (Jordi Barrat i Esteve, Ben Goldsmith, & John Turner, 2012).

**Remote Controlled Internet Voting**

- Remove controlled internet e-Voting is the ability of an elector to cast a ballot on a device that is controlled and maintained by the election body. This device as mentioned in the example of Mobile Internet Voting can be accompanied by an official to the elector to cast a ballot.

Since the introduction of internet e-voting in the United States in 2000, internet e-voting has been utilised throughout the world. As with any new process, especially when it involves binding government elections, trials had to be undertaken prior to full integration into each respective countries electoral process.

The following countries have conducted internet e-voting elections. These previous e-voting elections will provide good sources of information to conduct initial research investigations into system vulnerabilities and their respective experiences with internet e-voting will be analysed and an overall comparison conducted.

- Australia - NSW iVote (Allen Consulting Group Pty Ltd, 2011; PwC, 2011: Jordi Barrat i Esteve, Ben Goldsmith, & John Turner, 2012);

- Canada - Town of Markham Municipal Election (Jordi Barrat i Esteve, Ben Goldsmith, & John Turner, 2012; Kimberley Kittingerham & Andrew Brouwer, 2010; Delvinia, 2004);

- Estonia - I-voting (Alvarez, Hall, & Trechsel, 2008); and


It is also worth making mention of other countries that have conducted e-voting elections (Jordi Barrat i Esteve, Ben Goldsmith, & John Turner, 2012)

- France - 2004 - currently used in parts of the country

- India - 1999 - pilots ongoing
• Spain - 2010 - discontinued
• Switzerland - 2003 - currently used in parts of the country
• United Kingdom - 2002 - piloted and not continued
• United States - 1996 - pilots ongoing

Throughout these trials trust has been identified as a recurring challenge that has needed to be addressed (Jordi Barrat i Esteve, Ben Goldsmith, & John Turner, 2012). Trust in the technology (security, functionality, reliability), trust by the public in the system are just a couple of examples of trust in the aforementioned trials. As demonstrated by the recent failure of the Norwegian trials, government officials stated that the trials had ended because of voters’ fears about their votes becoming public could undermine democratic processes ("E-voting experiments end in Norway amid security fears," 2014).

In order to explore the issues associated with trust and other perceived and researched challenges with mobile internet e-voting, it is necessary to perform a vulnerability analysis so that key issues can be identified and addressed. Removal of these issues will help overcome the barriers to the adoption of internet e-voting.

This research will focus on mobile internet e-voting as method that most closely matches the technological proliferation of smart devices amongst the population and is well suited to addressing the challenge faced by the current paper based electoral process and voters living considerable distances from an electoral booth, which potentially offers a viable alternative to postal voting.

This literature review has additionally identified the need to modernise voting which is a fundamental democratic process and the internet e-voting provides a 21st century solution to this need. By addressing the issues trust and vulnerability it is possible to assist in mobile internet e-voting gaining wider public and government acceptance.
**Proposed Timeline**

The following is a proposed plan which expected overruns. Several months have been added as a buffer as supervisory staff will have large teaching load and hence delays in feedback is to be expected. These delays will most likely occur towards start and end of trimesters.

During the initial phases of the research unforeseen circumstances had occurred with the original supervisory team. As a result of being retrenched by the university, the research was refocused and a new direction was chosen.

The below activities in **red** indicate the original plan and revisions made once the research was recommenced.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>START</th>
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<th>END</th>
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<tbody>
<tr>
<td>Core Readings</td>
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<td>Aug-13</td>
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<td>ABSENT (Child Due)</td>
<td>Sep-13</td>
<td>3</td>
<td>Nov-13</td>
</tr>
<tr>
<td>Literature Review</td>
<td>Dec-13</td>
<td>3</td>
<td>Feb-14</td>
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<tr>
<td>Methodology Selection</td>
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<td>3</td>
<td>May-14</td>
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<td>3</td>
<td>May-14</td>
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<td>Existing Technology Review</td>
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<td>3</td>
<td>May-14</td>
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<tr>
<td>Define Objectives</td>
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<td>Development</td>
<td>Mar-14</td>
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<td>May-14</td>
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<td>Define Possible Topics</td>
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*Table 2 - Proposed Timeline*
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<td>Demo UI Development</td>
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</table>
Resources needed and available

- Online survey services - to be decided once survey plan is designed and approved
- Banners and Collateral - to be decided once targeted surveys is designed and approved
  - Potential Budget: $1,000
- IDE for demonstration app
  - Visual Studio [http://www.visualstudio.com/]
  - Xamarin [http://xamarin.com/]
- Hosted website explaining the research.
- Reward for taking the survey (random draw) - $500-$700

Note: IDE and hosting will be provided by Z Ware Development at no charge.
Bibliography


Institute for social research Oslo. (n.d.). Research and evaluation of the e-vote 2011 project.


R MICHAEL ALVAREZ, DELIA BAILEY, & JONATHAN KATZ. (2007, October). The Effect Of Voter Identification Laws On Turnout. CALTECH/MIT.


