HORDALAND FYLKESKOMMUNE

The Norwegian 2011 Internet voting project
Guaranteed secure?

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AGENDA

- **E-voting**
  - **What it is**
  - **Why it is challenging**
- **The Norwegian Internet voting system**
  - **About the project, ”E-valg 2011”**
  - **Main points of the solution**
- **Threat discussion**

E-Voting

- Electronics
  - Casts votes
  - Count votes
- Remote e-voting
  - Casting votes in an uncontrolled environment
- Advantages?
  - Quicker
  - Improved accuracy
  - Better availability?
    - Better adapted for physically challenged
  - Increased voter turnout?

Why is it so hard to design a voting system?

- **No neutral third parties**
  - **The voters can cheat**
  - **The system can cheat**
  - **Coercers and vote buyers**
- **Conflicting requirements**
  - **Verifiability vs. anonymity**
- **Any successful attack would be very high profile**

Is it possible to design and develop a secure remote e-voting system?

- **The experts are skeptical**
  - Peter Ryan: “I’m not advocating remote voting for political elections. The political context will be variable in different countries, so it will be up to the politicians to determine what risks are acceptable.”
  - Kristian Gjøsteen: “With realistic attack models (the attacker knows everything the voter knows) for remote internet voting probably make it impossible to achieve both true voter verifiability and coercion-resistance.”
  - Arent: “Voting in your underwear does not seem a valid option—at least not at this moment.”

Remote e-voting

- **Five non technical reasons against remote e-voting (Oostveen)**
  1. **Secret and free election**
  2. **”Digital divide”**
  3. **Cultural effect**
     - **Gathering of people and ”civic ritual”**
  4. **Organizational problem**
     - **Online helpdesk**
     - **Many roles (e-voting + p-voting)**
  5. **Behavioral changes**
     - **Loosing feedback from the environment**

The ”E-VALG 2011” Project

- What it is?
  - Establish and deploy a solution for electronic voting and election administration in 10 selected municipalities (<200.000 voters) in time for the ”kommunestyre and fylkesting” election in 2011
  - Started in 2008 (Pre-project in 2006)
- Some main points of the solution
  - Authentication: E-id (MinID)
  - Combines voting over the Internet with traditional poll place voting.
  - Paper vote overrides all electronic votes
  - Can revote any number of times electronically
  - Partners
    - ErgoGroup: administration module
    - Scytl: Remote e-voting module

E-VALG 2011 Solution

- **Show animation!**

Cryptographic main points

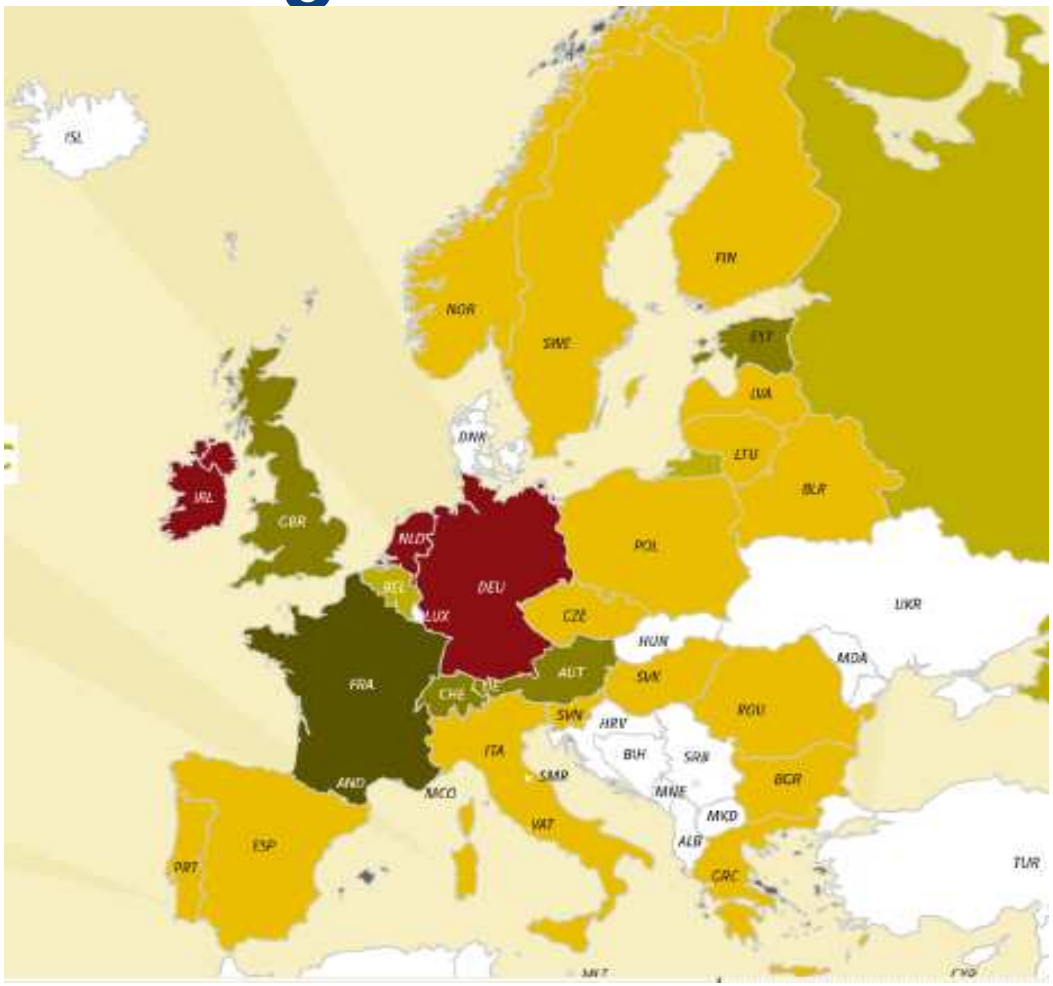
- **Double envelope system**
  - **Encrypt vote with public election key**
  - **Sign encrypted vote with own private key**
  - $\mathbf{E_{priv_{VOTER}}(E_{pub_{ELECTION}}(B))}$
- Election private keys
  - Before the election generate three secret parameters a1, a2 and a3
  - Such that a1 + a2 = a3 (mod q).
  - The ballot box gets a2
  - The receipt code generator gets a3
  - The decryption service gets a1. (Divided into shares…)

Cryptographic main points

- Reencrypion mix net
- The ballot box and a receipt generator cooperate to compute a sequence of receipt codes for the submitted ballot.
- For more details see

http://www.regjeringen.no/nb/dep/krd/prosjekter/e-valg-2011-prosjektet/tekniskdokumentasjon/tekniske-dokumenter-om-e-valglosningen.html?id=612114

E-voting in other countries



E-valg 2011 Process

- Openness
  - Project
  - Solution
  - Selection and requirements process
  - Source code
- Reference groups
  - Security reference group
  - Political reference group
  - Municipality reference group
  - User reference group
- External verification
  - DNV and others
  - Independent experts
    - Barry Schoenmaker and David Wagner
    - Melanie Volkamer and Olivier Spycher

E-VALG 2011 Debate

- Very little discussion so far
  - Complex topic
  - Information from KRD
    - Blog
  - Norwegians trust in the Norwegian government
- Media
  - Focus on principles
    - UN's Human rights
    - Illegal trial according to the Norwegian election law §1-1 claiming that all elections should be free and secret.
    - Family voting
    - Vote buying
    - Breach of tradition
  - **Little focus on technical solution**

Our efforts

- **End of 2009 established an independent security group**
  - **8-10 people in Bergen and Oslo**
  - **5 meetings with chief of security, Christian Bull**
  - **Developed a “concerns” list**
- **Aim**
  - **Analyse technical solution**
  - **Contribute with independent and constructive critique of the system.**

Threat discussion

- Voting applet
- Receipt
- Ballot box
- Transition from e-voting phase to p-voting phase
- Mixing
- Trust model
- Authentication
- Ballot
- Election results
- Central infrastructure
- Etc.

Some selected threats

- Authentication solution
- Insider threats
- Vote buying
- Malware
- Denial of service attacks

Authenticaton of voters and PKI solution

- **MinID (not eID as originally planned)**
- **A paradox is the fact that the authentication solution is proprietary**

Authenticaton of voters and PKI solution

- **Dilemma: How can the voters sign their vote without private keys?**
  - **Solution: Pre generate RSA signing keys for each voter…**

Insider threats

- **Authority knowledge**
  - **List correspondence between voters and receipts**
  - **Countermeasure: Physical destruction of hardware? Cooperation with Norsk Tipping, use similar method as for Flax lottery tickets.**

Insider vulnerabilities

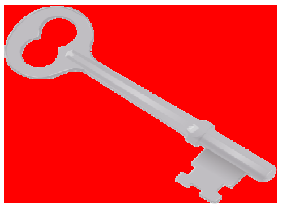
- **Information leakage**
  - **Officials can leak information about who voted in the electronic election and votes that where overwritten by a p-vote.**
  - **ISP and mobile companies can reveal info about who voted in the e-voting phase**
- **Ballot stuffing**
  - **Voting officials add votes for people who haven't voted**
    - **Countermeasure: Voting officials with conflicting interests?**

Insider threats

- Reconstruction of the decryption key
- Countermeasure: Private key split between different organisations.
  - Brønnøysund
  - DSB

Ballot box Key

+



Decryption Key

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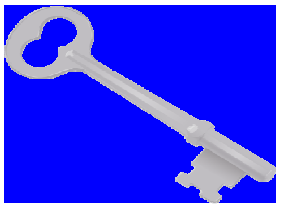

Receipt generator Key

Vote buying

- **Ways to prove how a voter voted**
  - **Voter shows SMS together with voting card**
  - **Prove encryption of ballot by revealing randomisation factor**
    - **Countermeasure: revoting and overwriting e-vote with a p-vote**
- **Vote buyers dilemma**
  - **Assurance of correct vote?**
  - **How to setup a vote buying market?**
  - **Penalties: 3 years for vote buyer, 6 months for vote seller**

Statistics from Estonia

	E-votes	% Multiple E-votes	% E-vote cancelled by p-vote
Parliamentary election - EU	58.699	1,55%	0,09%
Local election	104.413	2,27%	0,09%

Malware

- **Trojan changes vote**
  - **Countermeasure: Voter checks receipt**
  - **Discussion**
    - **How many people will have to check their receipts?**
    - **What if a voter falsely claims an incorrect receipt?**
    - **Receipt for each different candidate enough? (Does not consider ranking of candidates)**
    - **How to differ between vote changed due to malware and vote changed due to system errors?**

Malware

- **Trojan records vote**
  - **Countermeasures: None? Anti-Trojan software?**
- **Fake election client**
  - **Applet eliminates possibility of voting for some parties/candidates**
  - **Countermeasure: Signed applet(?)**

Denial of Service attacks

- Connection to central infrastructure
- Connection from receipt code server to voter

❖ Countermeasures:

Difficult? Internet voting period spread over time…

Understandability and usability

- **Explanations available at different levels**
- **Verifiability**
  - **Voters understands concept of receipts?**
- **How easy is it to vote?**
  - **Will grandma understand?**
- **Level of openness**
  - **Many public errors can be problematic…**

Summary

Remote-voting: Difficult to achieve true voter verifiability and coercion resistance.
Also complex and difficult to explain to the voters

- **Pros**
  - Accessibility
  - Voter turnout(?)
  - Cheaper(?)
  - Accuracy
  - Openness
- **Cons**
  - Single point of failure
  - Attacks might scale better
  - Will grandma understand it?
  - Private service providers
  - Less manual control?
  - Centralization

Questions?