

Prototype of an Electronic Voting Machine used in a survey in past federal elections in Mexico.

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Abstract— This document presents the results achieved in the design, development and manufacturing process to deliver 1,500 Electronic Voting Machines, used by the Federal Electoral Authority (IFE), to apply a survey to voters, in last President election's day in Mexico (July the 1st, 2012). Questions asked addressed IFE's performance and the convenience to use electronic voting machines in next federal election's day. Results were positive and more than majority of citizens surveyed, agreed to start using electronic voting devices in the future. Experience generated with this survey's deployment will complete the whole process of use, that will allow us to include required modifications for its successful use in future elections.

EVM: Electronic Voting Machine

IFE: Federal Electoral Authority

CINVESTAV: Centro de Investigación y de Estudios Avanzados

Official citizen: Responsible of the voting place

I. INTRODUCTION

This year 2012, it took place in Mexico, the federal electoral process to elect a new President and Congress Members of the nation. This federal election required more than 143,000 voting places, with a share of more than 50 million voters (with a population in the country of over 112 million people, with almost 80 million in voting age). All votes were cast and counted manually on paper ballots. More than 240 million ballots were printed in special paper with several security measures.

There are several phases of an election process, where technology can help:

- Once the citizen arrives, to authenticate voter's identity
- The voting process.
- Computing of votes.
- Results Transmission to the central site that gathers all voting places's results.

Our EVM covers the last three phases, leaving the first one (voter authentication) out of scope, due to complexity (for different reasons in our country) and control needed to avoid unauthorized people to vote or assure that authorized people vote only once. Authentication (using this EVM) keeps under

control of named citizens, responsible of voting places in election's day.

The EVM will avoid several problems experimented in a manually processed election, like:

- Ballot annulation due to voter mistakes issuing its selections.
- Official Citizen's mistakes, like: wrong vote annulations, ballot's casting mistakes and mistakes when filling the forms used to report results.

As general benefits that drive the use of this EVM, we can include:

1. Avoidance of printing millions of ballots (the EVM will print only the ballot equivalent of citizens that effectively vote).
2. Have visual and audible aids to reinforce voting directions to voters.
3. Keep the count electronically and compute results immediately when closing the election period.
4. Avoid the need to fill a form by citizens responsible of the voting place. The printed final report from the EVM is the evidence of results and any number of copies can be generated for Party representatives and authorities.

The Agency on charge of organizing the federal elections, IFE (Instituto Federal Electoral), simultaneously to the federal election 2012, invited voters, to answer a survey, using 1,500 Electronic Voting Machines (EVM) manufactured in CINVESTAV and distributed, controlled and managed by IFE in the whole country of México.

II. DESIGN

This EVM is the result of the trade-off among several factors, like phases of the process covered, size, weight, ease of use and cost.

A. Design

The main characteristics included in the design are:

- The voting process as stated in Mexico, taking into account its specific environment (geography, culture, size, energy and connectivity infrastructure).
- A printing evidence of each vote issued and the final printed report of results.
- EVM authentication and encrypted communication at result's transfer (to a central site), once the voting period ends and results are printed.
- Visual and vocal aids for directions to voter at voting step.
- Activation of EVM for voting purposes by Official citizen, once Voter is authenticated.

Next diagram illustrates the hardware building modules integrated in the EVM.

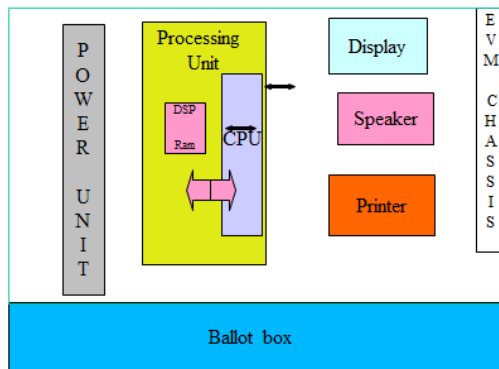


Figure 1. EVM Block Diagram

B. Software application

B.1 Use Cases

Once the EVM is installed and verified that it operates correctly, voting process starts and the Official citizens start authenticating voters, and for each one of them, the following actions is completed:

EVM Activation: The Official citizen activates the EVM to allow voter to make its selections.

Voter selections: The voter makes its choices according to election candidates. Once it is done, EVM deactivates immediately and will be activated for next voter by the Official citizen.

Once the election period ends the EVM status is changed by the Official citizen, to print results.

Results transfer: Once all forms are printed, the EVM is moved/transported to the Federal District where results transfer takes place, in the presence of authorities and Parties representatives.

Next figures summarize those steps.

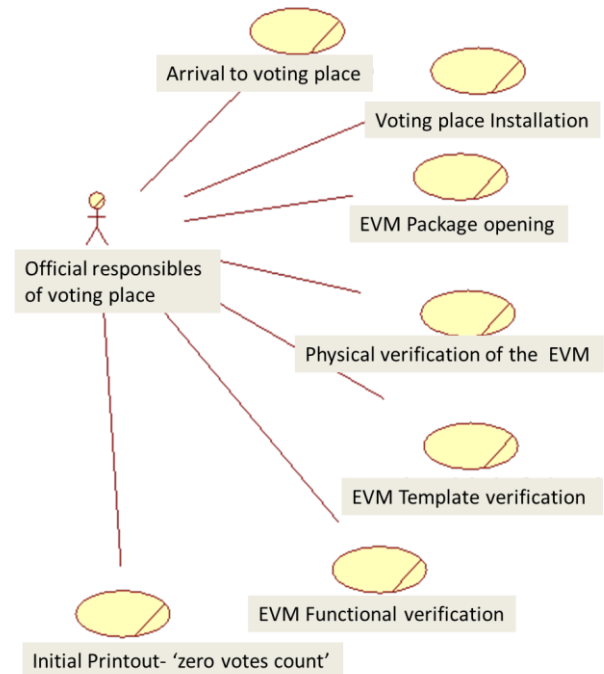


Figure 2. EVM installation, available and ready to vote.

Once the EVM is activated, voter can make its selections as depicted in Use Case diagram on figure 3.

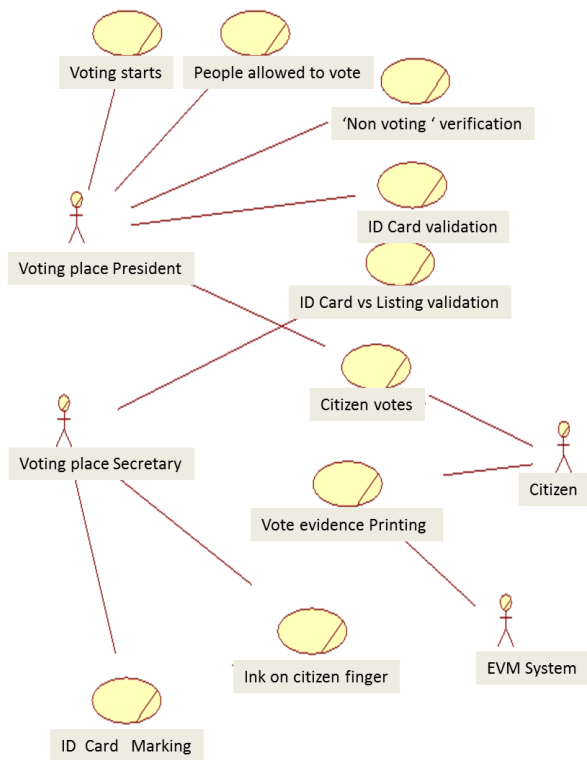


Figure 3. Voting phase

Once voter ends its selection, a printed evidence is kept inside the EVM in case of auditing is requested.

Once election period ends, the EVM is transported to the Federal District of that region, where results are transferred to the central site, as depicted in figure 4.

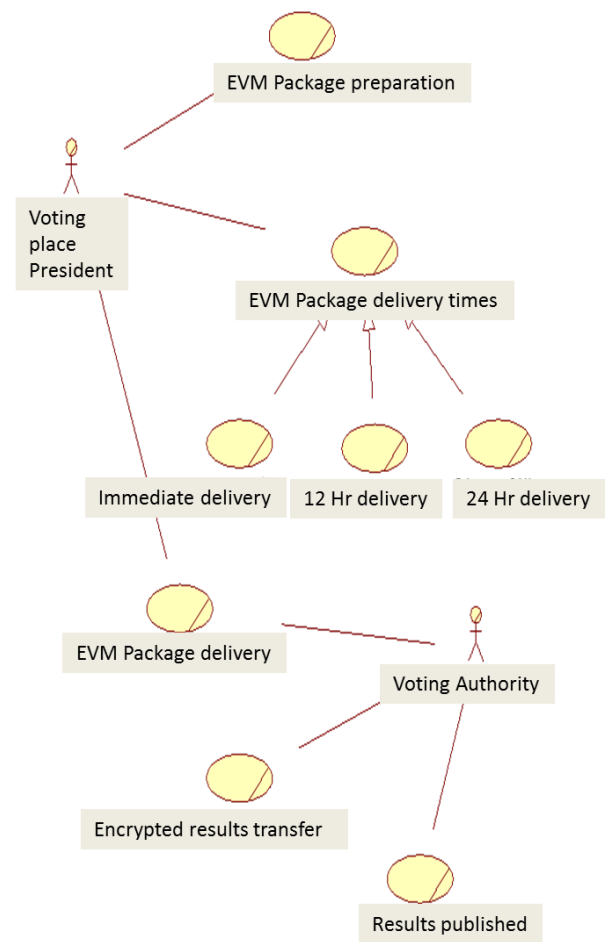


Figure 4. EVM final delivery and transfer of results

Software was developed to allow an Administrator to reconfigure the voting template according to specific election or survey. It can support any type of election provided that maximum number of selections that can be made are 30 (number of push buttons related with a template).

III. MANUFACTURING AND DEPLOYMENT

Once defined and agreed the voting process and functionality within the EVM, next action was to define its components and the corresponding manufacturing process to fit with the trade-off mentioned above. All elements are important but there are three of them, that highly contribute to certainty and reliability:

Computer board: Processing Board was designed internally with the appropriate tool kits to develop the software application, including a DSP to process the designed vocal aids

Printer: The printer provides the evidence of each vote and the final report delivered to all participants.

Remote activation module: It eases the use of the EVM, allowing its activation for each authenticated voter (by the Official citizen).

With this approach, equipment is less prone to be hacked, printed ballots are the evidence of process correctness and EVM voting activation is verified in place, according to voter authentication.

Other important components are:

- The voice announcements programmed to help voter make its candidate selections.
- The transfer module that authenticate the EVM and encrypts data to assure integrity.
- Voting template with up to thirty selections (push buttons).

A. Manufacturing

The project was developed and finished in a very short period of time (five months), taking into account all design decisions and manufacturing processes specifications (to meet requirements).

We integrated eight key providers to be able to receive components and modules on time to supply them to the manufacturing chain in a synchronized way. Within this process we settled four main quality control points (enumerated below) to optimize production time, while assuring the right operation of each EVM once it was packed.

- 1) **Raw material testing:** All components and modules (processing board, printer, leds, etc.) when arriving, were tested before entering the assembly chain.
- 2) **EVM physical or mechanical assembly:** Once assembled, the EVM was verified in terms of fixation, connection, etc.
- 3) **Software testing:** In the software loading step, a complete functional verification was made, to assure that all components behave according to the election or survey configured.
- 4) **Final inspection and identity verification:** Now, with a newborn EVM, inventory was updated (with unique identifier for authentication purposes) and destination was assigned (one of the 300 federal districts in which the country is divided).

B. Deployment

Production delivery schedule was defined according to transportation dates programmed to send trucks to the 300 existing Federal Districts in the country.

IFE was responsible to deliver the packed EVMs to their final destinations and local authorities were on charge to deliver specific EVMs to vote locations selected to apply the planned survey.

C. Results

Next figure shows the manufactured EVM, installed in a voting place, used on July the 1st for surveying purposes.



Figure 5. Electronic Voting Machine

On July the 1st 2012, EVMs were installed and thousands of surveys received and counted. Results will be released for publishing soon by IFE, but regarding convenience to use EVMs in federal elections, answers were quite positive.

IV. CONCLUSIONS

At CINVESTAV, working closely with IFE, we were capable to design and manufacture 1,500 Electronic Voting Machines in a record time of five months.

Delivered equipments were deployed and put in operation in the whole country on time to apply the planned survey in federal election's day.

At CINVESTAV, we have the capacity to develop and supply new versions of EVMs according to country's requirements considering the corresponding legislation changes for next federal elections in 2015 or local state elections.

V. REFERENCES

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