



## **Preliminary: Optical Scan Memory Card Testing**

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Version 0.3

This document summarizes the procedures that will be performed by the UConn VoTeR Center in pre-election testing of the Optical Scan memory cards. These procedures are being implemented by the VoTeR Center Faculty Staff in cooperation with Graduate Assistants Andy See, Seda Davtyan, Nicolas Nicolau, Sotiris Kentros, and Karpoor Sashidhar.

The memory card testing procedures are being refined as we perfect the testing procedures and improve testing capabilities. This document will be periodically revised to reflect the evolving procedures.

### **A. Memory Card Handling**

All memory card handling events will be recorded in a log book in duplicate (we are using permanently bound lab record books, with numbered pages with carbon copies). The purpose is to enforce a strict chain of custody policies. The memory cards will be stored in locked file cabinets in the lab. The events to be recorded in the log books are as follows.

- Memory card arrival at UConn via courier, express mail, etc.
- Memory card storage in a file cabinet
- Memory card removal from a file cabinet
- Memory card test start time
- Memory card test end time
- Other memory card handling events as/when needed

Each event will include at the information on:

- The purpose of handling the card
- What was done with the card (and the result, if relevant)
- Who participated in handling the card
- Timestamp
- Other information as needed

In the future, we intend to procure lockable and portable safes for storage and transportation of the cards.

## **B. Memory Card Test Procedure**

We now present the procedures that will be performed by us in (1) setting up and preparing for the testing of the memory cards, and (2) actual testing of the cards.

### ***B.1. Preparation for the Test***

The main activities involve programming control memory cards from the GEMS database and creating the images of the cards for comparison with the cards we will be receiving. In preparing for the test we will perform several procedures. The data on the cards includes the geometry of the ballot, and information on the ballot. Equally important, the cards contain an executable program involving counters corresponding to individual candidates, and the printing code for the built-in printer. We will identify the correspondence between the data in GEMS and physical cards, examine the executable code loaded into each memory card, load each unique memory card from GEMS, and dump the contents of the loaded memory cards into our own data repository. We will also prepare a program for comparing the data stored in our data repository with the data stored in the memory cards that will be shipped to us. We now detail these steps.

- *Identifying the correspondence between the GEMS database and physical cards:* The GEMS database contains the information on the ballot design for each voting district. The information to be provided by LHS documents the correspondence between the information in the GEMS database and the physical memory cards shipped to Connecticut. (This correspondence can in most cases be inferred from the names contained in the GEMS database, but to be sure we need the precise information from LHS.) This is a completely manual process.
- *Examining the executable code from GEMS:* GEMS contains an executable program for the Optical Scan that deals with the counters corresponding to individual candidates, and the printing of the results on the built-in printer. We will de-compile this code and inspect it for any irregularities. Since this code is loaded into each memory card, we will assume that good code is loaded into the cards in our control group. (In the future, we will develop a procedure to verify

that the code and data is loaded faithfully into memory cards.) This is a manual process (that we expect to partially automate in the future).

- *Loading the control group:* Using GEMS we will load each unique card from the GEMS database. This activity will commence with the receipt of the CD from LHS containing the GEMS database. It is understood that revisions to the GEMS database can be expected and that the process needs to be repeated for each revised memory card. This loading involves manual handling of the memory cards. It should take no more than 5 minutes per card, including the loading time itself.
- *Dumping the control cards:* We dump the contents of each unique district memory card into our repository and record the correspondence. Given that memory card readers are not available anywhere, we have constructed a memory card reader from an Optical Scan machine (this is a non-destructive and reversible procedure). Although it is possible to dump the contents of the memory card using an unaltered Optical Scan, it takes up to 10 minutes per card, involving several manual steps. Our approach takes under a minute per card.
- *Program to compare the contents of memory cards:* We are developing a program for comparing

At this point we are ready for testing the arriving cards.

Note: During our work with the Optical Scan machines and the memory cards we have performed reverse-engineering to understand what is contained in the loaded memory cards and how are the cards loaded. We have also requested, via LHS Associates, information from Premier on the format and structure of the data contained in the memory cards. However, since we believe we have sufficient understanding of the contents of the memory cards, we will be able to perform meaningful testing even if we do not receive this information from Premier.

## ***B.2. Testing Incoming Memory Cards***

Our goal is to check all memory cards we receive. We expect to receive over 300 memory cards – there are 2 memory cards that are shipped for each Optical Scan machine from LHS, out of which we expect to receive one cards for each pair of Optical Scan machines in each voting district. Given that this is going to be the first time that we perform the testing, the exact timing of the tests remains to be determined. However, depending we estimate that each card will take between 5 and 30 minutes, involving both manual and automated procedures.

For each card, we will log the information about the card received, dump the contents of the card into our repository, compare the dumped data with the images we have produced from the GEMS database, and note any discrepancies (discounting routine log events and timestamps indicating when the cards were programmed at LHS vs. when the images were taken by us). The results will be documented.

The specific activities are as follows.

- *Receiving memory cards:* Upon the receipt of a memory card from a district, the information about the card is logged, and the card is locked until it is tested. (The handling and logging procedures are described above).
- *Dumping of the card contents:* The contents of each memory card will be dumped, indexed, and stored in our repository.
- *Testing memory cards:* The test will involve an automated comparison of the data on the received memory cards with the data in the image of the corresponding control card. Where unexpected discrepancies are found, we will establish the possible reasons for these discrepancies. We anticipate to gradually increase the sophistication of the tests and analysis based on what we learn and discover.
- *What will we be testing for:* Any discrepancies (other than routine log events, sequence numbers, passwords, and timestamps) will constitute a problem. Such problems may be due to;
  - (a) bad cards,
  - (b) use of cards in bad machines,
  - (c) tampering with cards,
  - (d) tampering with machines.Depending on the nature of a problem, we will recommend that all other cards for the particular district are to be examined.

Note: A similar procedure is indicated for the post-election testing. Here, any discrepancies that are not due to routine use of the cards in the election will constitute a problem. In such cases we may recommend that the machines in that district are also examined.

- *Reporting:* In case of problem we will generate a report for you as soon as a problem is detected. We will generate a complete report once the testing is complete.

Note: We may need to retain the cards in case any problems arise during the election, or until the post-election audit, as necessary. Then we will return the cards (either to the

municipalities or LHS, to be determined).

Note: A similar procedure can be used for post-election card testing, if it is to be performed. Here we will be looking for any changes that are not consistent with the routine use of memory cards in an election.