Compact Flash Card Failure Analysis and Recovery Efforts

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Presentation Overview

- Compact Flash Card basics
- Description of the CF card failures
- Partnership with SERT Data (data recovery company)
- Agreed upon data handling rules / signed NDA for security
- Data recovery efforts and steps taken so far
- Status update
- Action plan moving forward

Compact Flash (CF) Card Overview

- NAND Flash Memory mass storage device developed by SanDisk (early '90s)

- Capacity: 2MB to 512GB

- Dimensions: 43x36x3.3 mm (Type I) , 43x36x5 mm (Type II)

- Weight: 10 grams

- Speed: 30MB/sec to 120MB/sec depending on model (Ultra, Extreme and Extreme Pro)

- The CompactFlash interface is a 50-pin subset of the 68-pin PCMCIA connector

CF card w/ plastic case removed
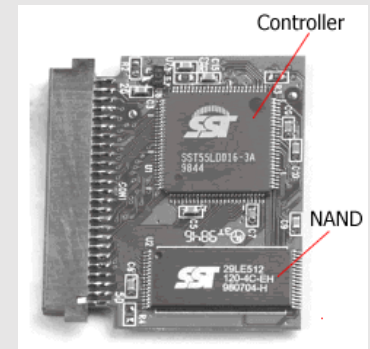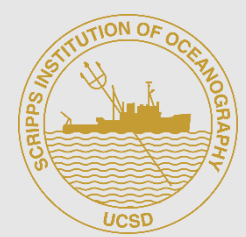
CF Card Failure Mode Description

- CF cards are no longer recognizable to a PC or Mac

- Good cards are initially tested for cold temp operations

- No apparent temperature correlation with failures

- Exact time of CF card failure during deployment is unknown

- All failed cards have been with a specific SanDisk Extreme 60MB/sec lot number BN130628013B

- Failures have occurred with cards formatted with FAT32 as well as free space.

# Partnership with SERT Data

www.sertdatarecovery.com

- HIPPA Compliant Data Recovery Company located in West Palm Beach, FL

- RAID arrays, Hard drives, Apple drives and Flash drives

- Flash drives include SSD, SD/MicroSD Smart Media and Compact Flash

Agreement Structure
Sert Data and SIO OBS group

- SERT Data signed NDA for securing control of recovered data on all failed CF cards that they receive from the SIO OBS group.

- SERT Data agreed to NOT copy any recovered data on their servers

- All recovered data is to be placed on hard drives that were sent to SERT Data by SIO OBS lab. All recovered data will be returned and SERT Data will NOT retain any data.
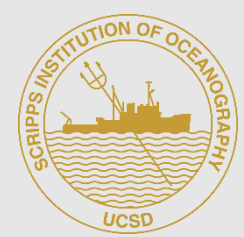
CF Data Recovery Effort

- **SERT Data determined that ALL failures were due to NAND memory controller chip failure**

- 9 failed SanDisk CF cards were sent to SERT Data along with supporting information for each card (i.e. expected file count and sizes)

- Examples of healthy SanDisk CF cards were sent to SERT Data – these cards included examples of the FAT32 file system with corresponding A2D files as well as examples of cards setup with free space.

- SanDisk card data recovery is the most challenging – not supported in their current utility due to proprietary read/write algorithm
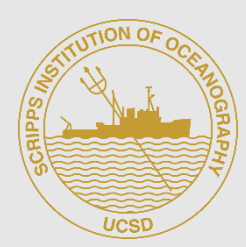
CF Data Recovery Effort

- SERT Data purchased new equipment dedicated to decoding SanDisk NAND flash read/write algorithms and deciphering new XOR and ECC *(SIO OBS group collaborated with SERT Data for acquisition of new instrument to help move the data recovery process forward)*

- The manufacturer of this new equipment has experience working with SanDisk form factors

- All the NAND chips have been read on one of the failed cards, XOR cipher has been determined and currently working to determine Error Checking and Correcting codes.
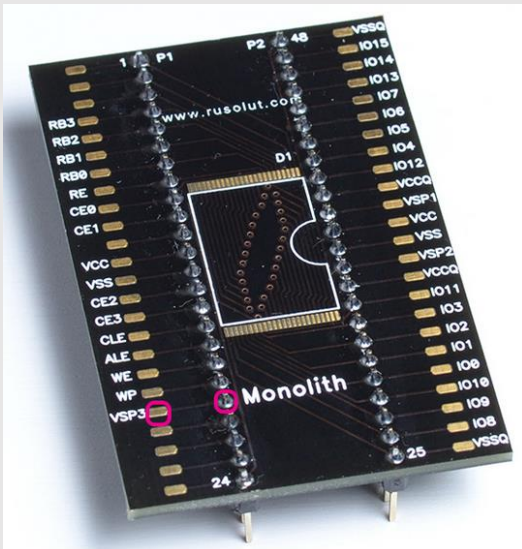
CF Card Data Recovery Efforts
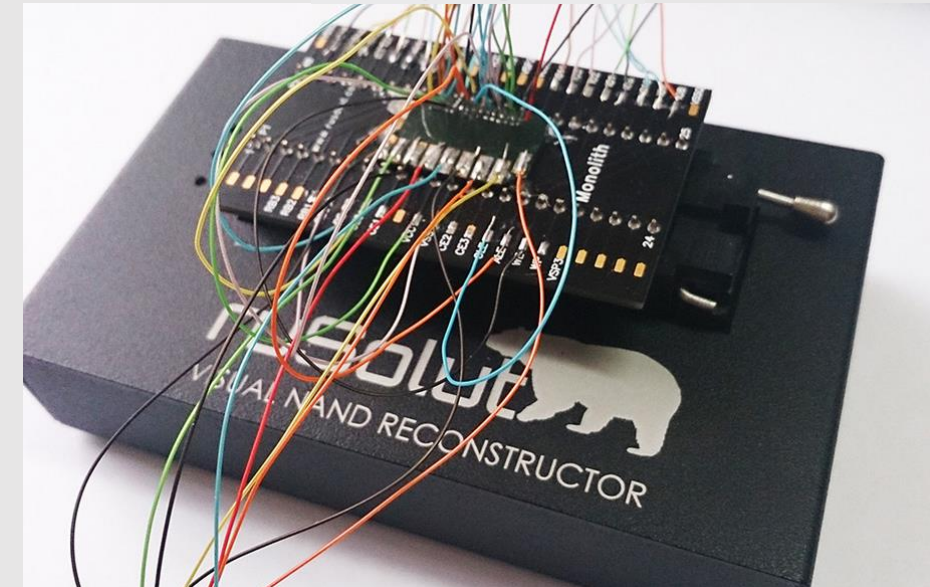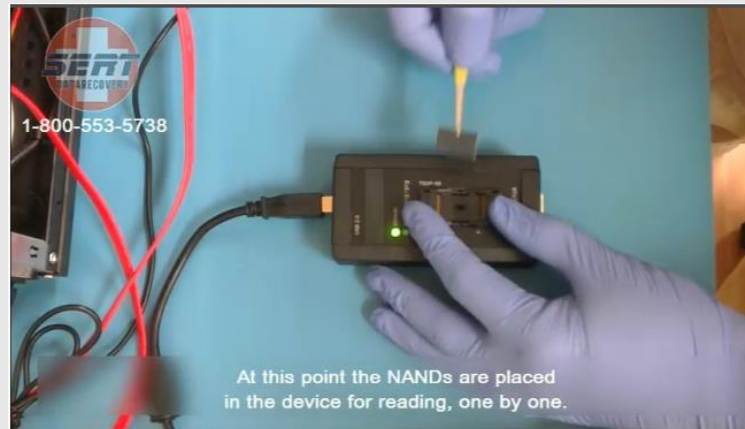# Visual NAND Reconstruction

1. Chip Off or NAND Flash recovery: Drives that become inaccessible and unresponsive require this kind of recovery. The NAND storage chips are carefully removed from the PCB board and placed in a special reader. The controller chip is what usually fails in these situations, and this is bypassed with a special recovery device.

Monolith Adapter

This universal adapter has special pads and pinout marking for sodering of monolithic devices, such as microSD, SD, UFD or any other chips with non-stanrdard package.

Reader

Universal socket to read NAND memory of any existing and future package

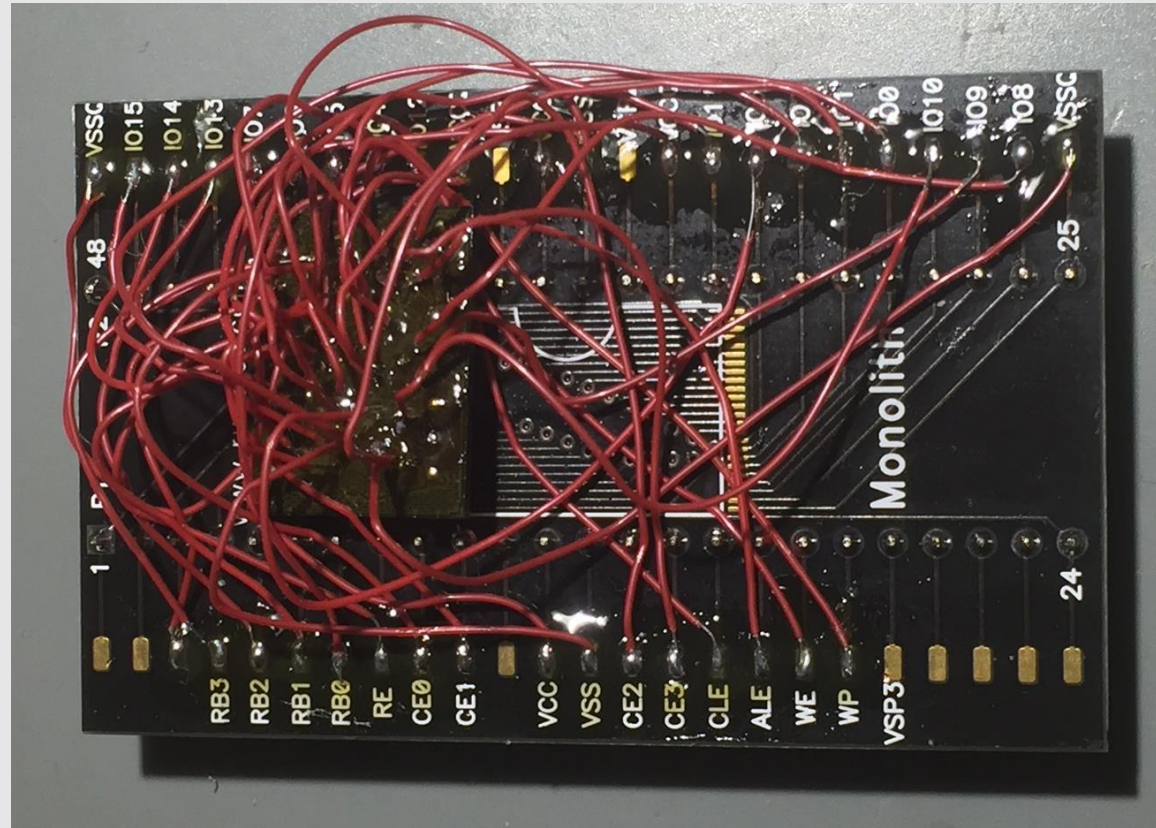At this point the NANDs are placed in the device for reading, one by one.

CF Card Data Recovery Efforts
Visual NAND Reconstruction

NAND Flash Chip (LGA-52 footprint) from CF Card
wired to monolith adapter to check if the chip was 16 bit

Note: There are 4 LGA-52 NAND Flash chips on each of the CF cards

CF Card Data Recovery Efforts

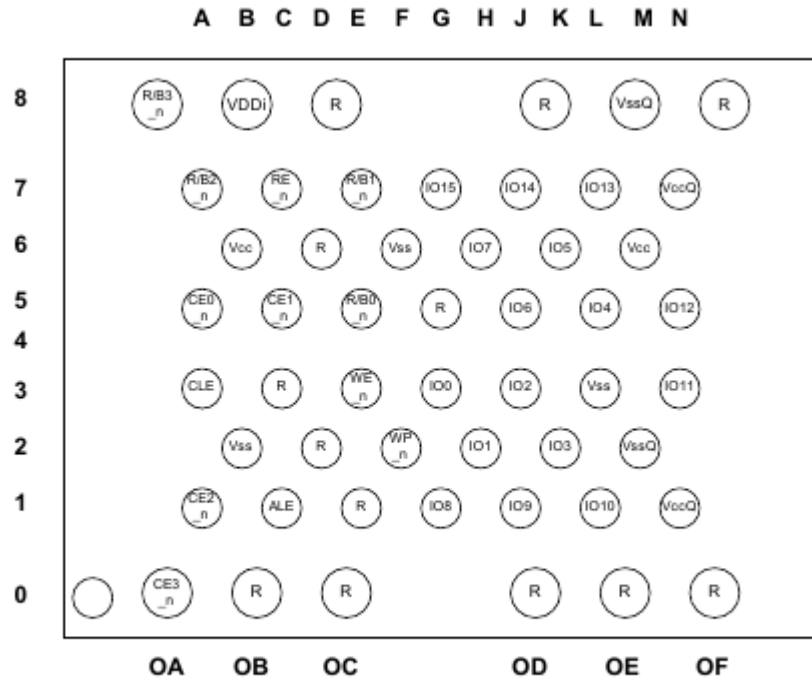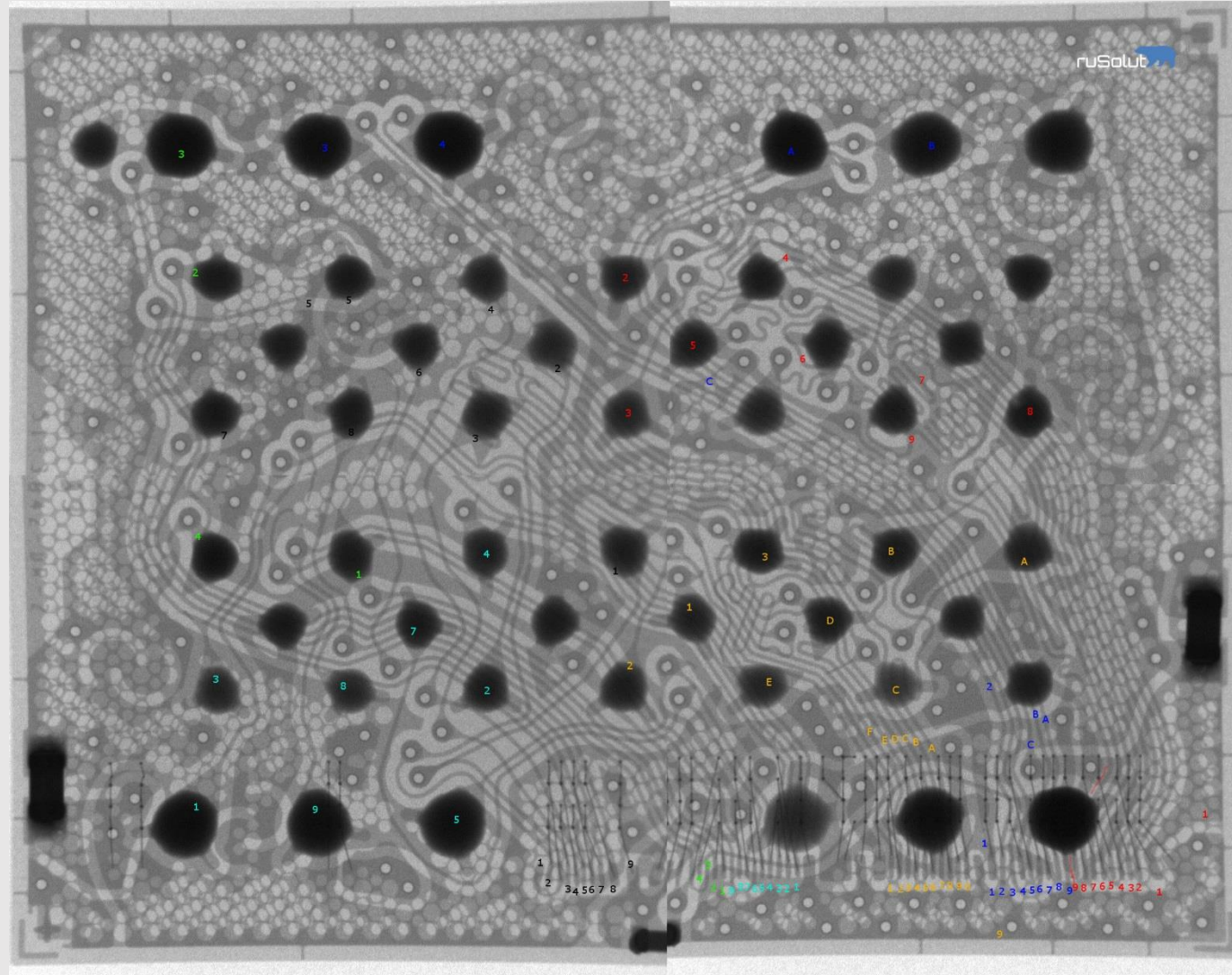LGA-52 footprint for NAND Flash IC on Compact Flash Card

Figure 5   LGA pinout for 16-bit data access

LGA 52 NAND

CF Card Data Recovery Efforts

X-ray image of SanDisk NAND Flash Chip

CF Card Data Recovery Summary

- Ongoing effort and partnership with SERT Data and their developers

- SERT Data's opinion is that the Controller IC failures are due to manufacturer defects

- We may consider using non SanDisk cards in the future to avoid the proprietary encoding scheme used. This would simplify future data recovery efforts that may be necessary.

- We are no longer using SanDisk CF cards from LOT# BN130928013B

Thank You!

Questions?