BodySnatcher: Towards Reliable Volatile Memory Acquisition by Software

By

Bradley Schatz

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BodySnatcher: Towards reliable volatile memory acquisition by software

Bradley Schatz
Brisbane, AU
bradley.schatz@evimetry.com.au

Agenda

- Introduction
- Overview of software based acquisition proposal
- Description of implementation
- Experimental results
- Conclusions
- Demo

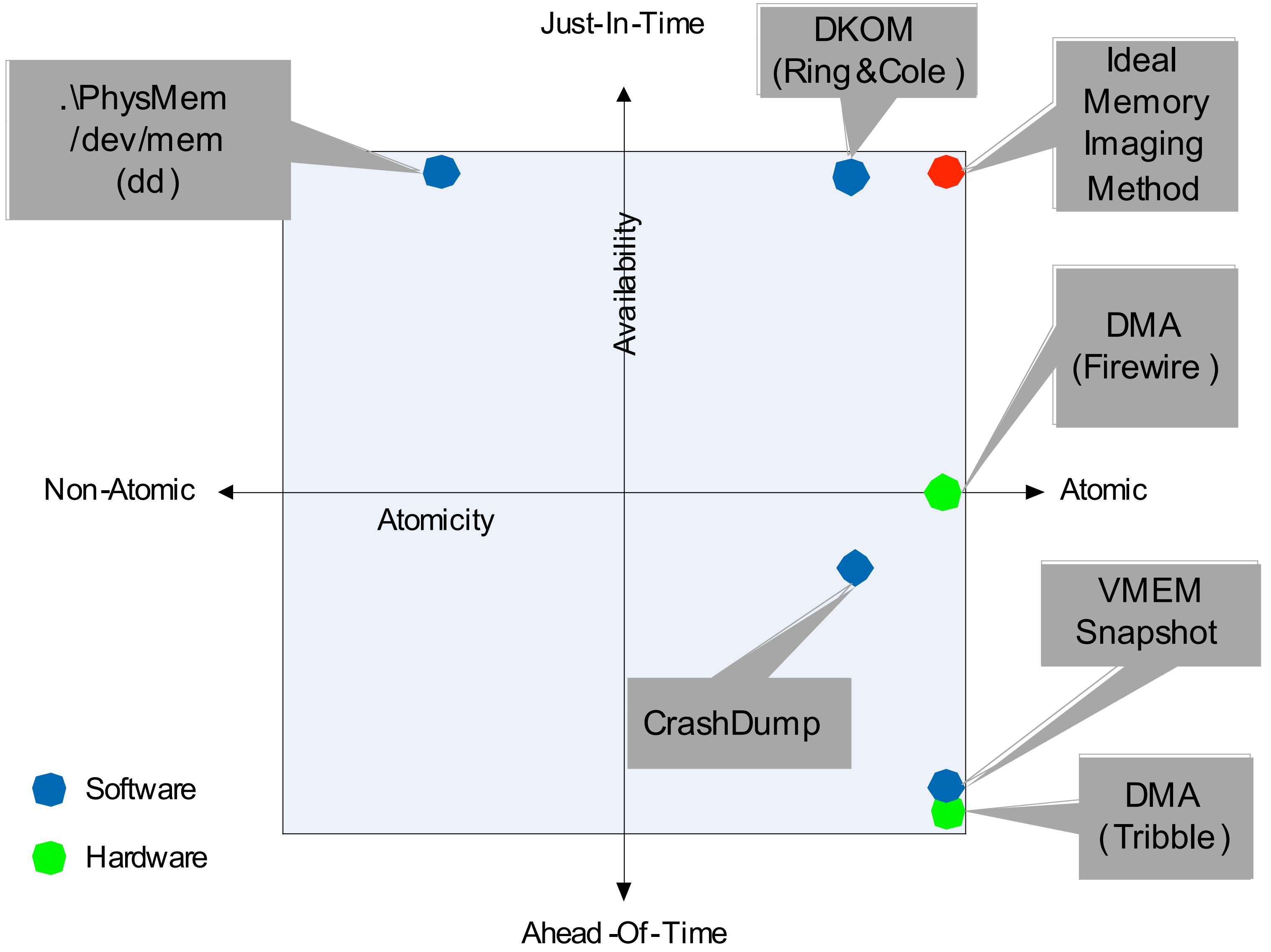
- RAM resident information
  - Passwords
  - Cryptographic keys
  - Network connections
  - Cleartext of encrypted data
  - …

- Erosion of trust in OS integrity
  - Was the computer operating correctly?

Challenges in Acquisition

- Fidelity
  - Atomicity
  - Integrity/Reliability
    - Historical Artifacts
    - Subversion
      - Hardware (Rutlowska)
      - Software DDefy (Bilby)
- Availability

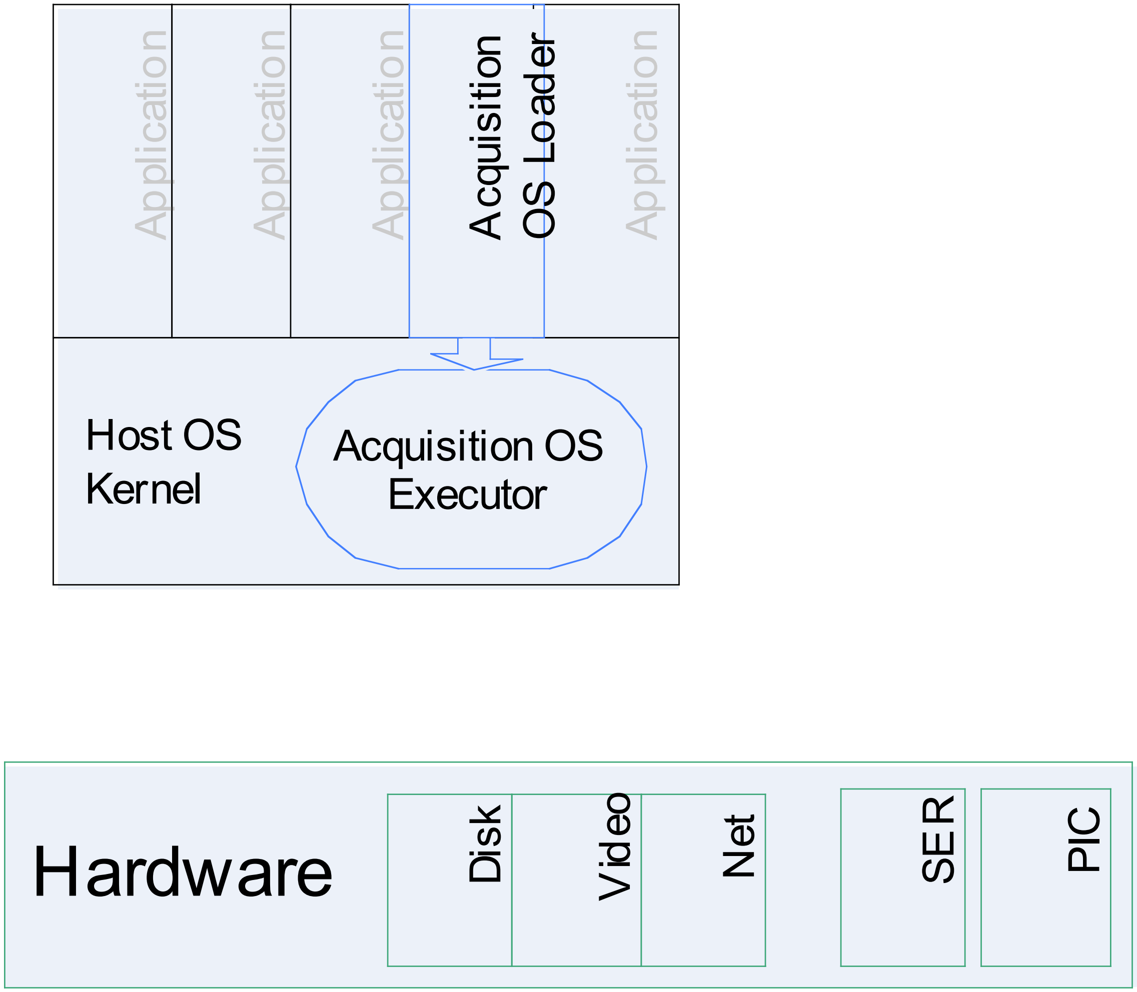
Existing Approaches



Proposed Approach

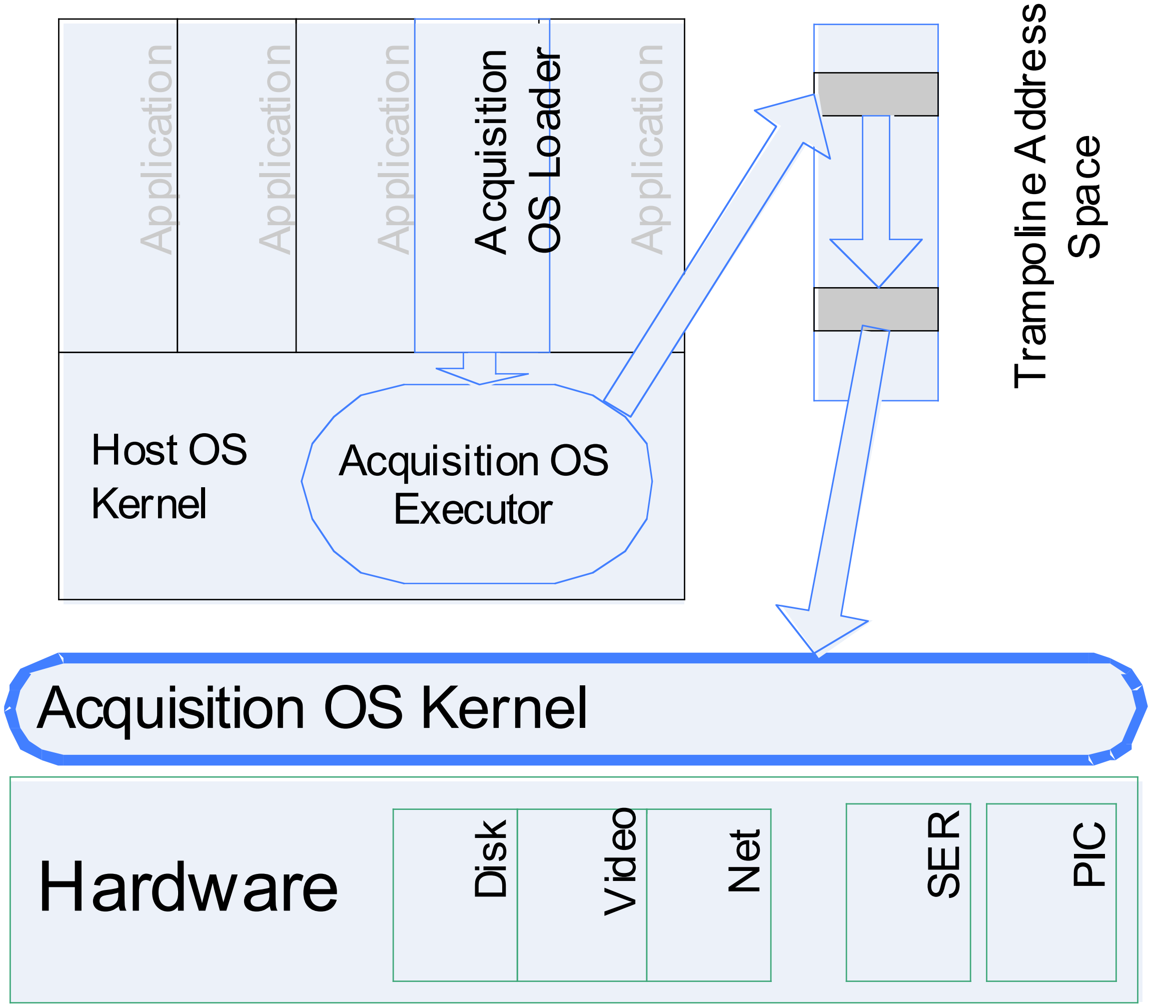
- Problem:
  - Software memory imaging
    - High Availability
    - Atomicity
    - Resistance to subversion
- Proposed Solution:
  - Halt un-trusted OS
  - Capture using pristine OS

Proof of Concept Load

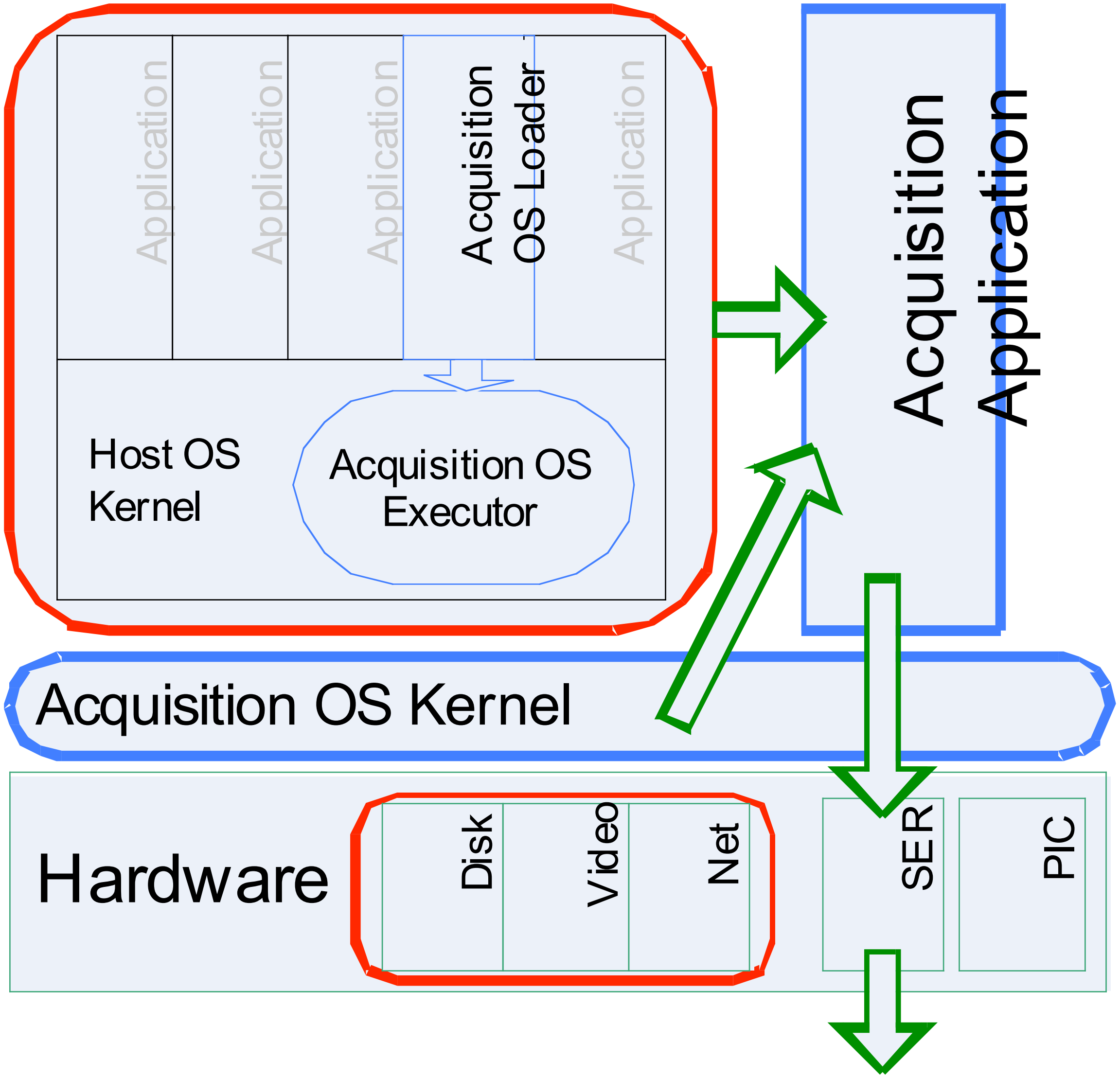


Proof of Concept

Create VSpaces & Snatch Control



Proof of Concept Acquisition



Proof of Concept BodySnatcher vs. ??Linux

	x86 Linux	**coLinux**	**BodySnatcher**
Hardware			
Devices	Real Hardware	***Virtual Hardware***	***Minimal set of Real Hardware***
Initialization	BIOS, Linux Kernel	BIOS, NT Kernel, Drivers	***Re-initialize PIC,*** ***Serial port,*** ***Rest unchanged***
OS Boot	BIOS, Real Mode Loader, Real Mode Kernel	***User-space Loader,*** ***Kernel-space Driver,*** ***Trampoline address space***	User-space Loader, Kernel-space Driver, Trampoline address space
Memory			
Physical Range	BIOS identified RAM	Windows allocated subset	Windows allocated subset
Virtual Scheme	Regular Virtual Memory	***Virtualised Virtual Memory***	Virtualised Virtual Memory
Physical Access	*/dev/mem*	None	***De-virtualised /dev/mem***

Experiment

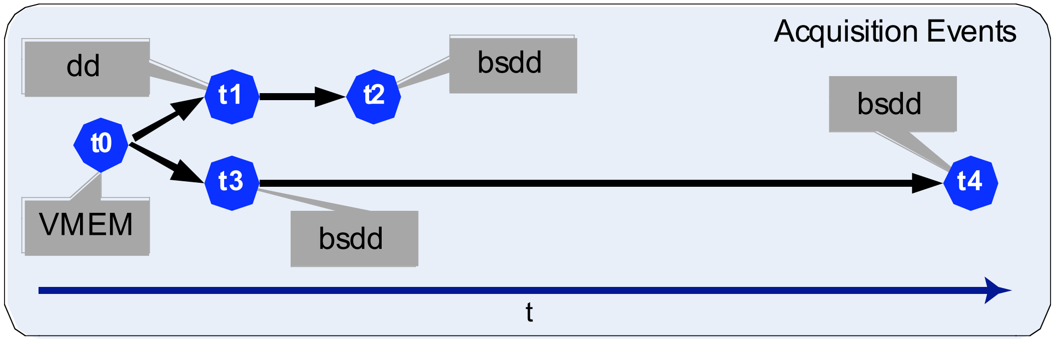
- Setup
  - VMware 6
  - Win2k SP4 Host OS
  - 32M Acquisition memory sandbox
  - 2.6MB kernel, 1MB initrd
- Method
  - Running guest
  - Image { VMEM | dd | bodysnatcher }
  - Verify image integrity – ptfinder (Schuster)
  - Compare differing pages between images

- VMware imaging
  - Snapshot VMware virtual machine, copy .vmem file
- Garner dd imaging
  - Mount USB storage in VM, image to USB
- BodySnatcher Imaging
  - telnet → named pipe TCP proxy → VMware Virtual Serial Port → linux serial console
  - In BodySnatcher terminal session
  - dd if=/dev/mem bs=4096 | gzip -9 | uuencode

Results 1

128M Acquisition – Win2KSP4 – light load

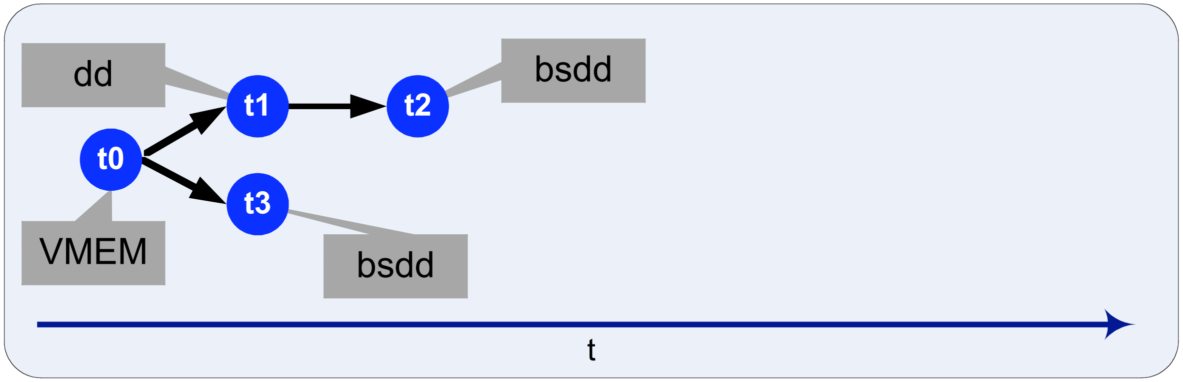
	Compared Images	Linear Pages Same	Linear Pages Different	Linear – %
t0 ⑧ t1	VMEM/dd	18,536	14,231	43
t0 ⑧ t3	VMEM/bsdd (2)	21,307	11,461	35
t1 ⑧ t2	Dd/bsdd (1)	18,905	13,862	42
t0 ⑧ t2	VMEM/bsdd (1)	15,348	17,420	55
t3 ⑧ t4	Bsdd (2)/bsdd (3)	32,473	295	0.9



Results 2

512M Acquisition – Win2KSP4 – heavy load

	Compared Images	Linear Pages Same	Linear Pages Different	Linear – %
t0⑧t1	VMEM/dd	70,886	60,185	46
t0⑧t3	VMEM/bsdd	120,045	11,026	8.4
t1⑧t2	dd/bsdd(2)	73,115	57,956	44



Conclusions

- Fidelity
  - Integrity –
    - Lower impact on unallocated memory than Garner’s dd
    - Higher impact on unallocated memory than DMA
  - Atomicity - Host OS ceases to run, leaving in atomic state
- Availability
  - runs without advance preparation (vs. DMA, Crashdump)
- Reliability
  - (Arguably) Less vulnerable to subversion (vs. dd, CrashDump)

Conclusions Limitations

- Complex
- Currently runs on particular VMware configuration (Win2K, legacy PIC)
- Currently no support for APIC, SMP, x64, PAE
- Output channel slow (Serial)

- Still considerable changes to host memory in load stage
- Still prone to subversion
- Requires Admin access or exploitable kernel vulnerability to run

Future Work BodySnatcher

- Engineering
  - Remove virtualised virtual memory
  - Real hardware
  - USB Output Channel
  - Driver signing
  - Port to other OS
  - Harden against subversion
  - Non-contiguous BodySnatcher sandbox allocation
- Research
  - Resumption of Host OS
  - Clearer picture of memory changes

Thank you!

bradley.schatz@evimetry.com.au