Kexec: Soft-Reboot and Crash-Dump Analysis for Linux and Xen

Linux.Conf.Au, Sydney, Australia

http://www.vergenet.net/linux/kexec/

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A Tale in Three Parts

- Part I: Crash-Dump Analysis

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- Part I: Crash-Dump Analysis
- Part II: Kexec

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- Part I: Crash-Dump Analysis
- Part II: Kexec
- Part III: Port of Kexec to Xen

Part I

Crash-Dump Analysis

Crash-Dump Analysis

- User-Space Core-Dump
  - When an application crashes it is useful to analyse the state of the programme at the time of the crash
  - Operating systems provide a facility to dump the memory core of applications
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Crash-Dump Analysis

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  - Operating systems provide a facility to dump the memory core of applications
  - The core can be analysed using tools such as gdb
- Operating System Crash-Dump
  - When an operating system crashes it is also useful to analyse the state of the system at the time of the crash
  - The difficulty arises because it is the operating system that would naturally collect the memory dump, however it has crashed

Who is Interested In It?

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  - So a standardised solution is needed
- Kernel Developers
  - If end-users could collect crash dumps, it could be useful for kernel developers to isolate bugs.
  - The facility would need to be provided by distributions.
  - Crash-Dump size may be a problem when transferring between end-users and kernel-developers

Some Crash-Dump Solutions for Linux

- LKCD — Linux Kernel Crash Dump
  `http://lkcd.sourceforge.net/`
- netdump
  `http://www.redhat.com/support/wpapers/redhat/netdump/`
- diskdump
  `http://sourceforge.net/projects/lkdump/`
- Mini Kernel Dump
  `http://mkdump.sourceforge.net/`
- Kexec/Kdump

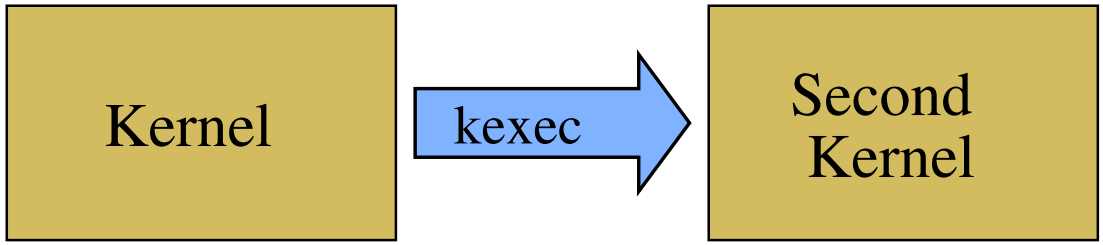
Full Disclosure: Mini Kernel Dump was developed in part by my employer, VA Linux Systems Japan K.K.

Part II

Kexec

Kexec

- Kexec is a feature of the Linux kernel that allows a new kernel to run in place of the running kernel



- It is named after exec(2), the system call which allows a process to replace a running process

Motivation for Kexec

- Allows rebooting to skip the BIOS and hardware initialisation
  - Some hardware has buggy BIOSes that do not allow reboot to occur reliably
  - Some hardware takes a really long time to reboot
  - Rebooting using kexec can be really fast
- Can be very useful for bootstrapping and rebooting in development environments.

Performing Kexec

- The new kernel is loaded into the running kernel from user-space using kexec-tool
  `# kexec -l /boot/vmlinuz`
- The new kernel can then be kexeced using the same tool
  `# kexec -e`
- Kexec is a method of warm or soft-booting machines

Kexec Flow

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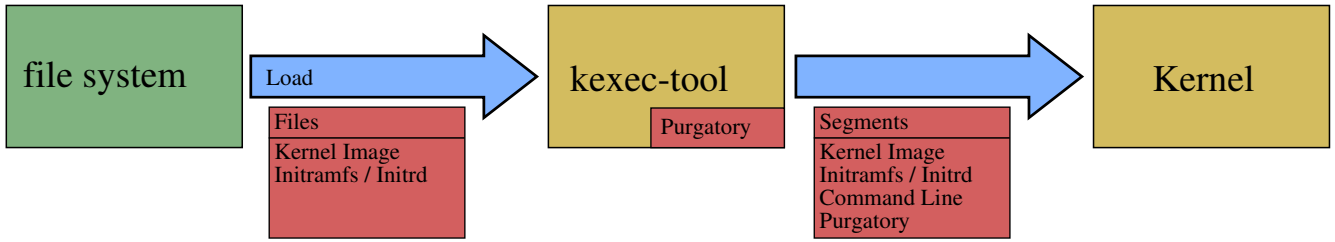

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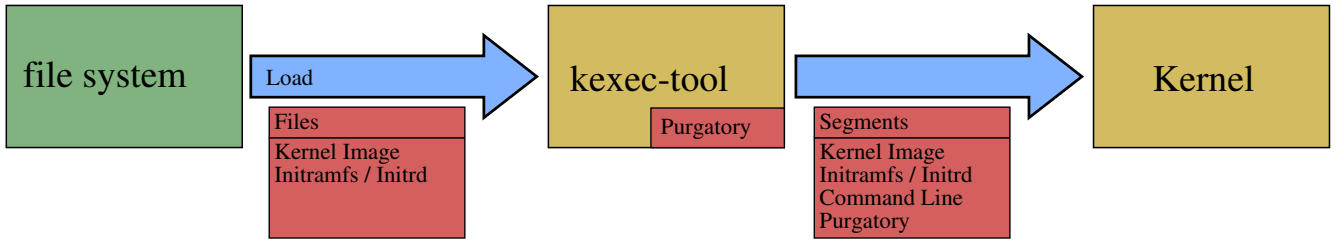

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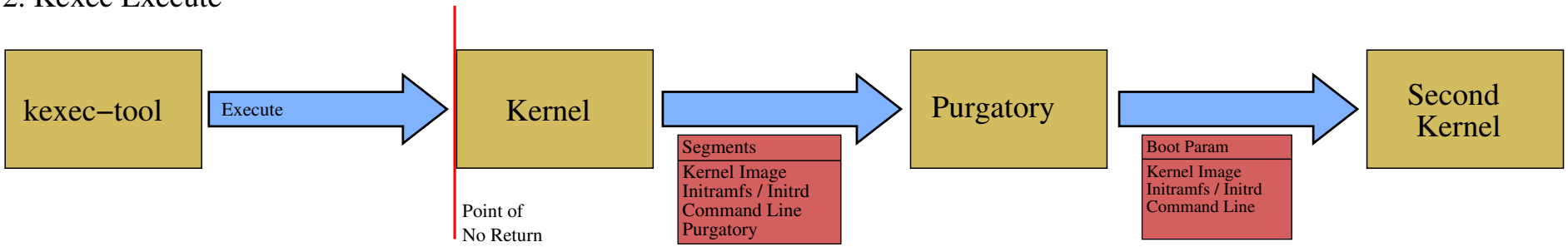
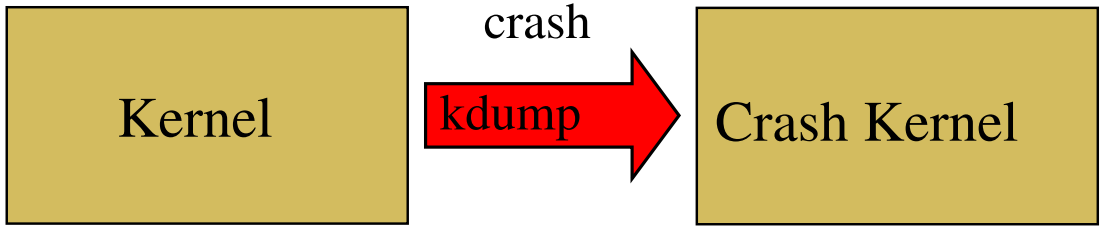


Kdump

- Kdump is an extension of kexec with allows a crash kernel to be executed in place of a running kernel if the running kernel panics



- Kdump and kexec use separate kernel images, which may be loaded independently of each other

Kexec vs Kdump

- Kexec
  - Uses (all) system memory as any booting kernel would
  - The second kernel runs when triggered by kexec-tool
- Kdump
  - Runs the crash kernel in a reserved area of memory, so as to leave the panicked kernel's memory untouched for forensic analysis
  - The crash kernel runs when the running kernel panics

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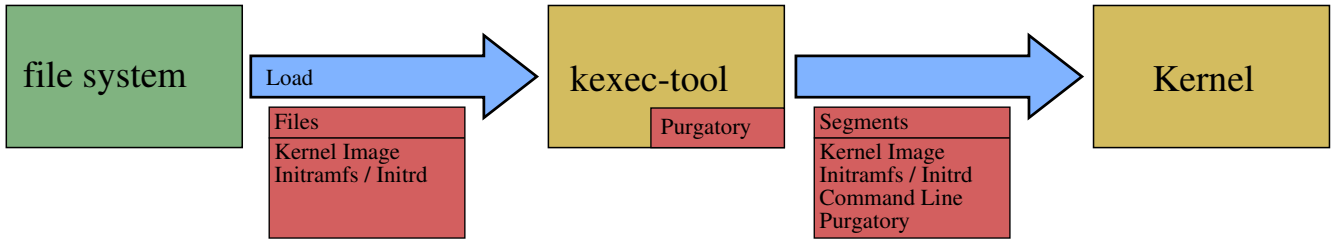

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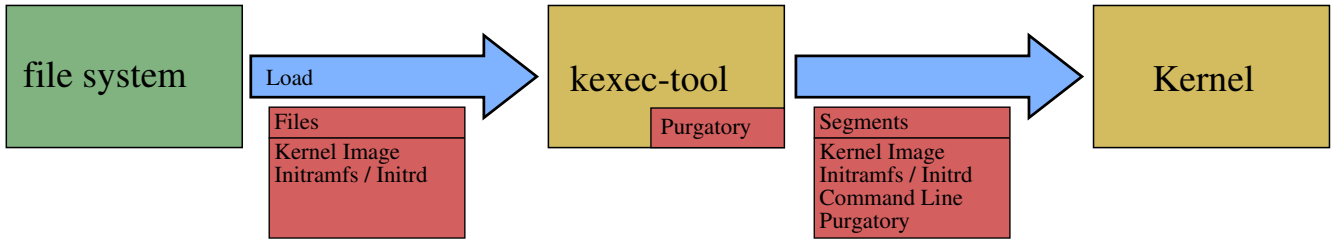

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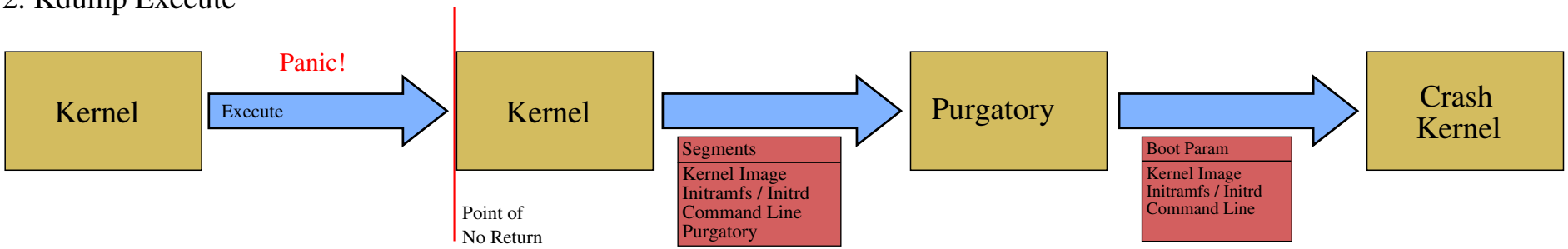

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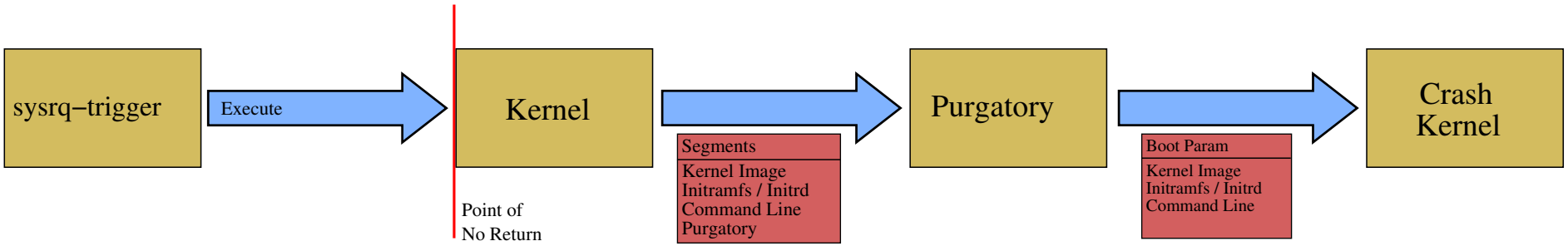
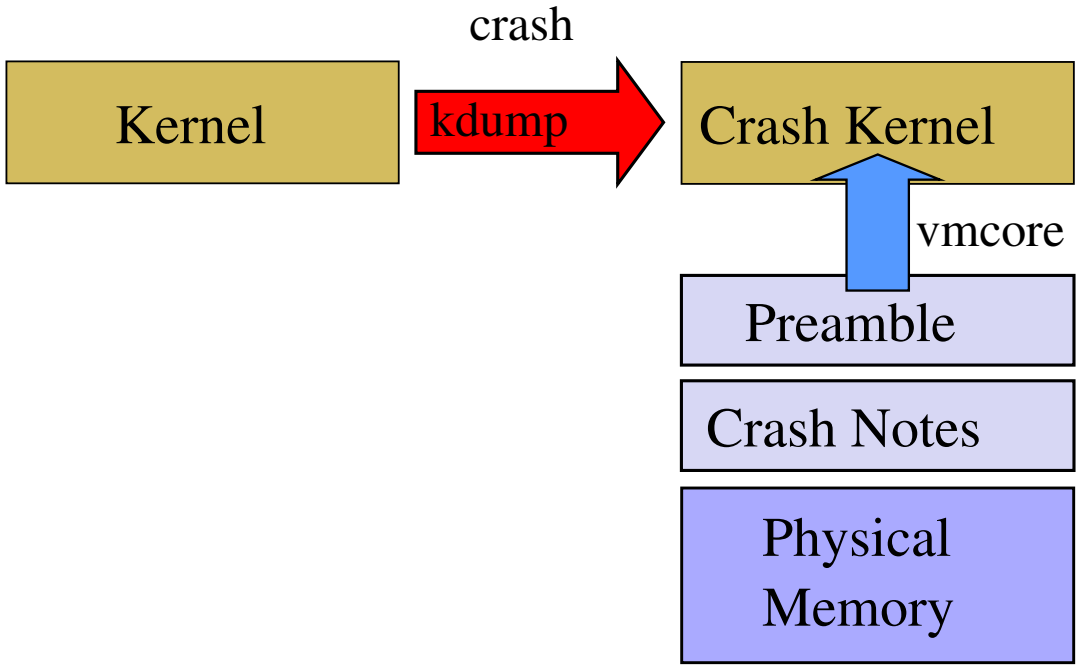


VMCore

- Visible as `/proc/vmcore`
  from within a crash kernel run by kdump
- Includes the entire physical memory,
  as visible to the panicked kernel



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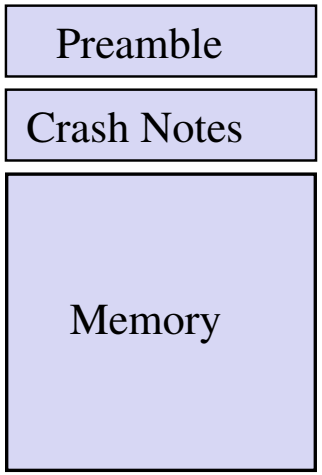

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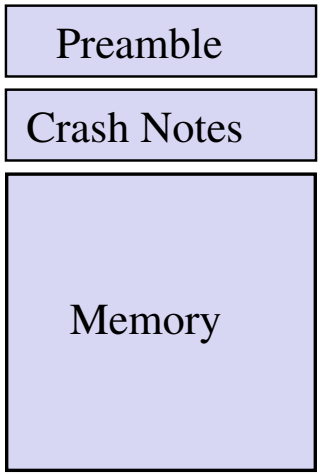

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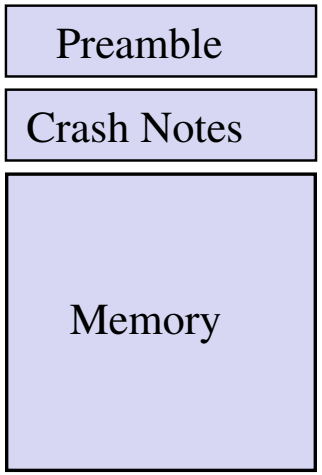

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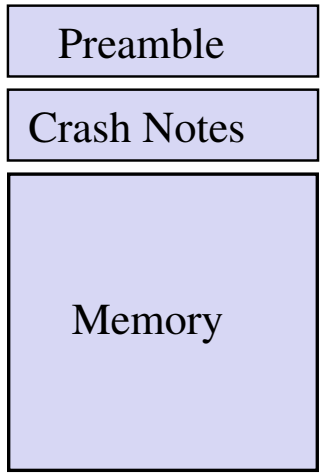

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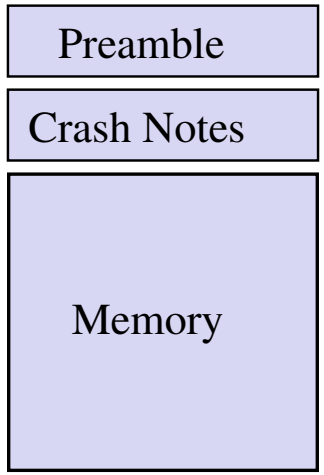
- Core files may be analysed using tools such as gdb



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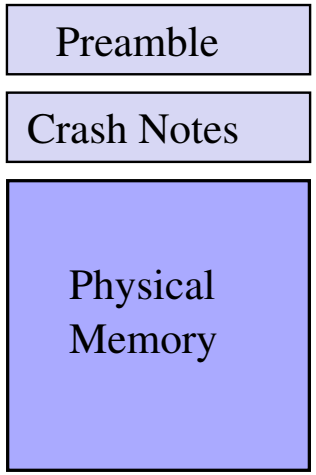

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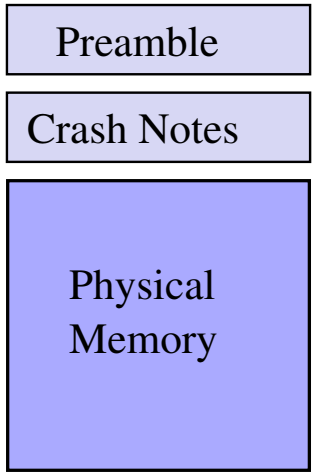

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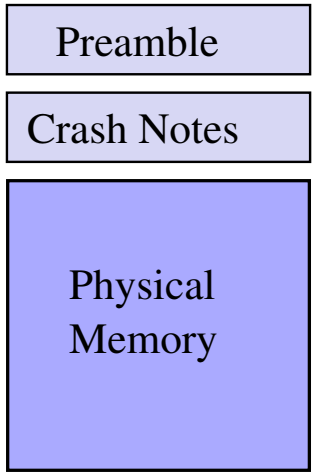

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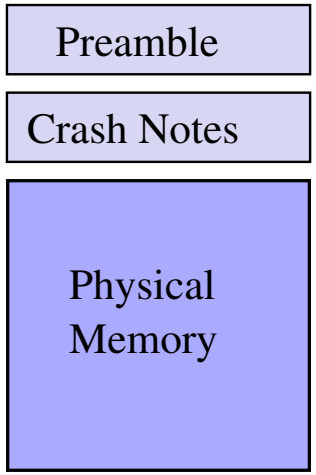

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- VMcore can be used to save this state to disk or a remote host
- The resulting image than then be analysed off-line using tools like crash
  `http://people.redhat.com/anderson/crash_whitepaper/`

Part III

Port of Kexec to Xen

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- And as a further bonus, provides a method of soft-booting

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- Additional hooks were added to load and unload kernels into the hypervisor

Xen Kexec Flow

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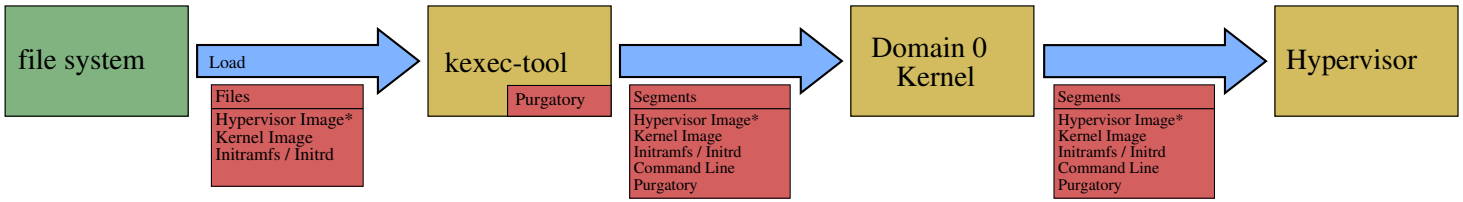

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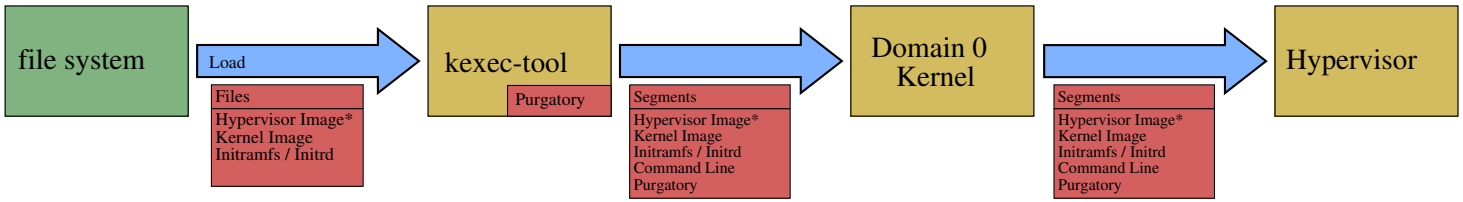

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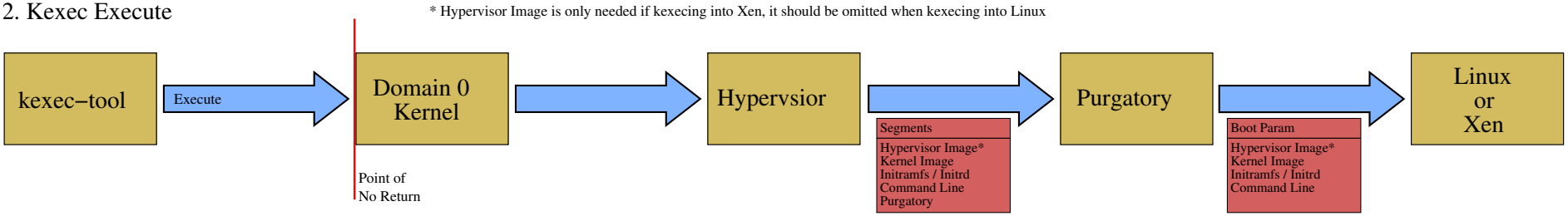

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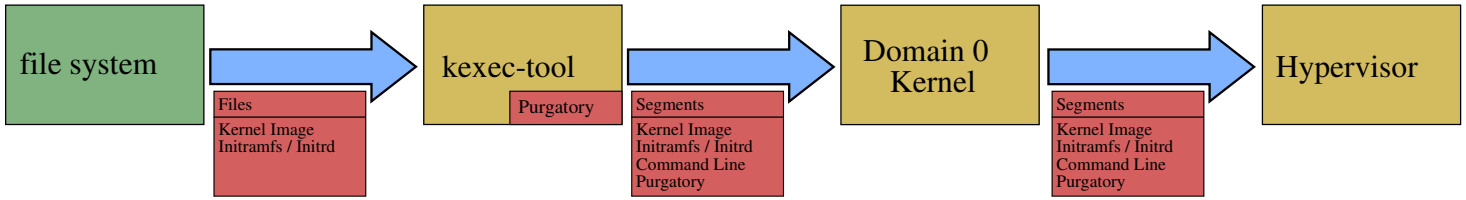

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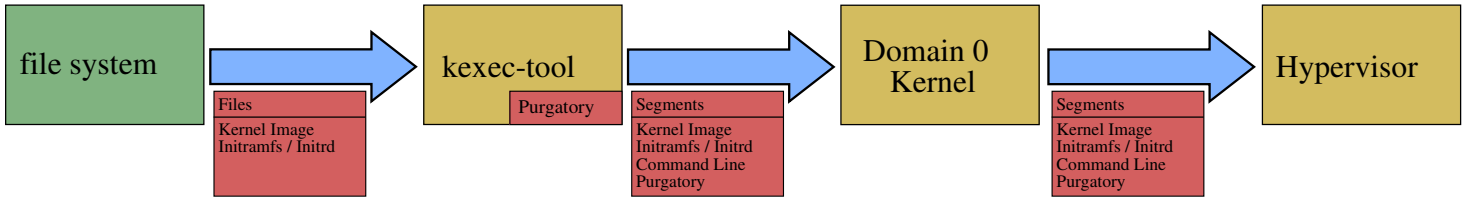

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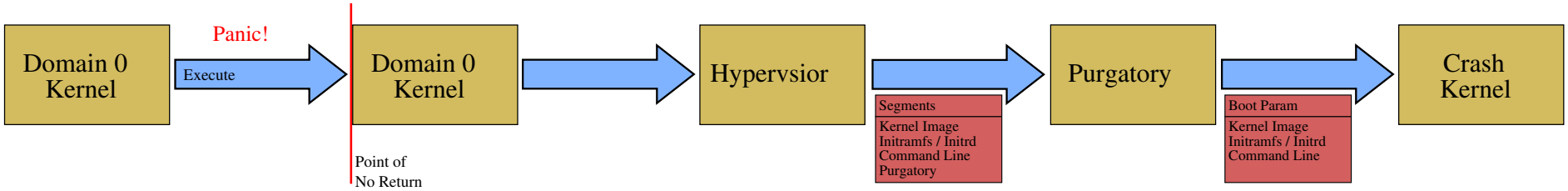

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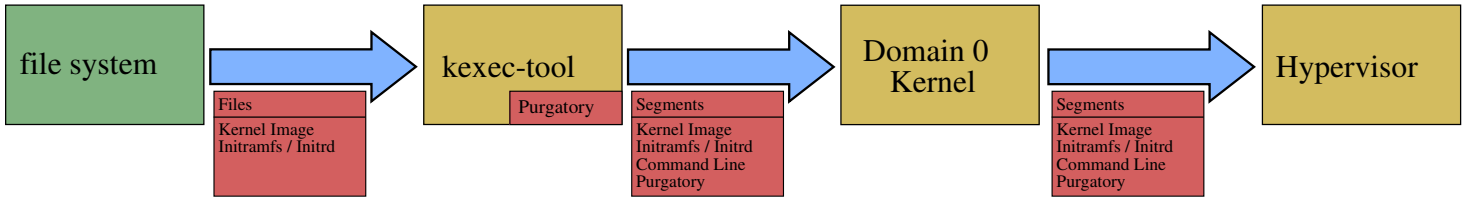

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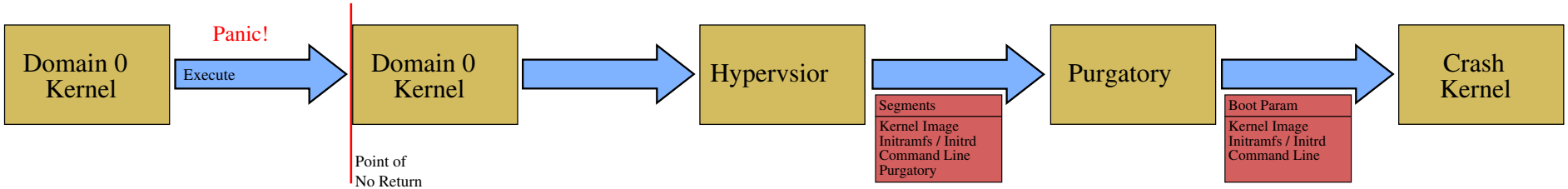

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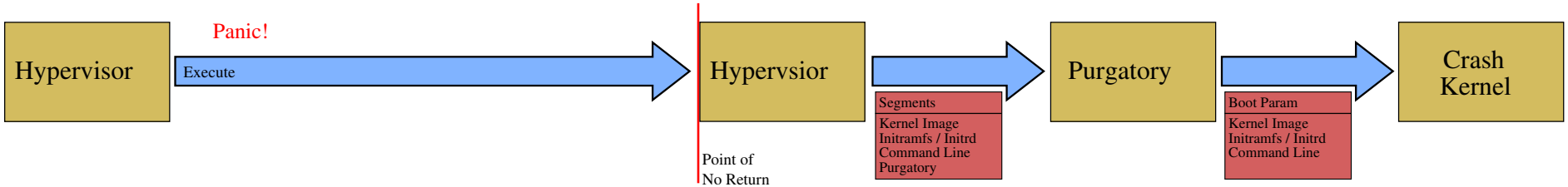
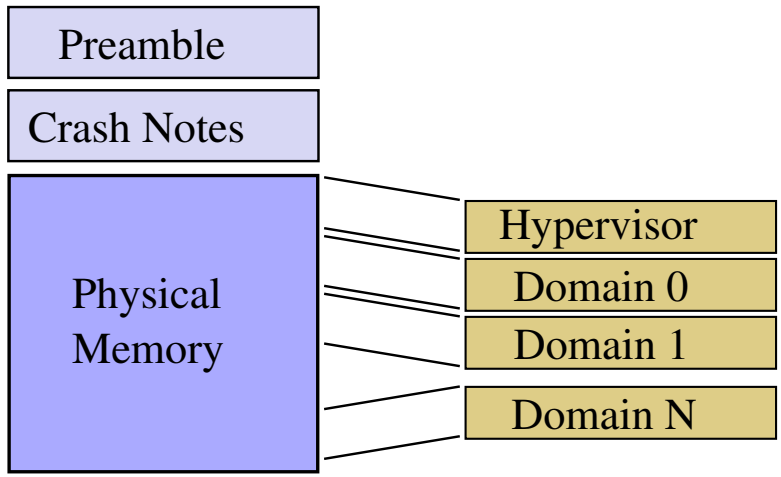


VMCore Files for Xen

- The same as Linux's (for now)
- memory includes the hypervisor, domain 0 and domain U
- Kazuo Moriwaka is working on dumpread, which allows the memory of the hypervisor, or any of the domains to be extracted from the vmcore
- Itsuro Oda is working on xencrash, a fork of crash for handling xen crash-dumps.



Note that domain memory is not linear

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- In practice this has not been a problem for the i386 and x86_64 implementations, but it does manifest in ia64

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- N.B: This is probably broken if cpus are hotpluged, regardless of Xen

Status of the Xen Port

- Working with the port, all combinations of Xen/Linux→Xen/Linux transitions possible
- Without the port, only Linux→Xen/Linux transitions are possible
- Status

x86_32	included in Xen 3.0.4
x86_64	included in Xen 3.0.4
ia64	work in progress

Questions?