KVM on s390: The good, the bad and the weird

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2016/08/25

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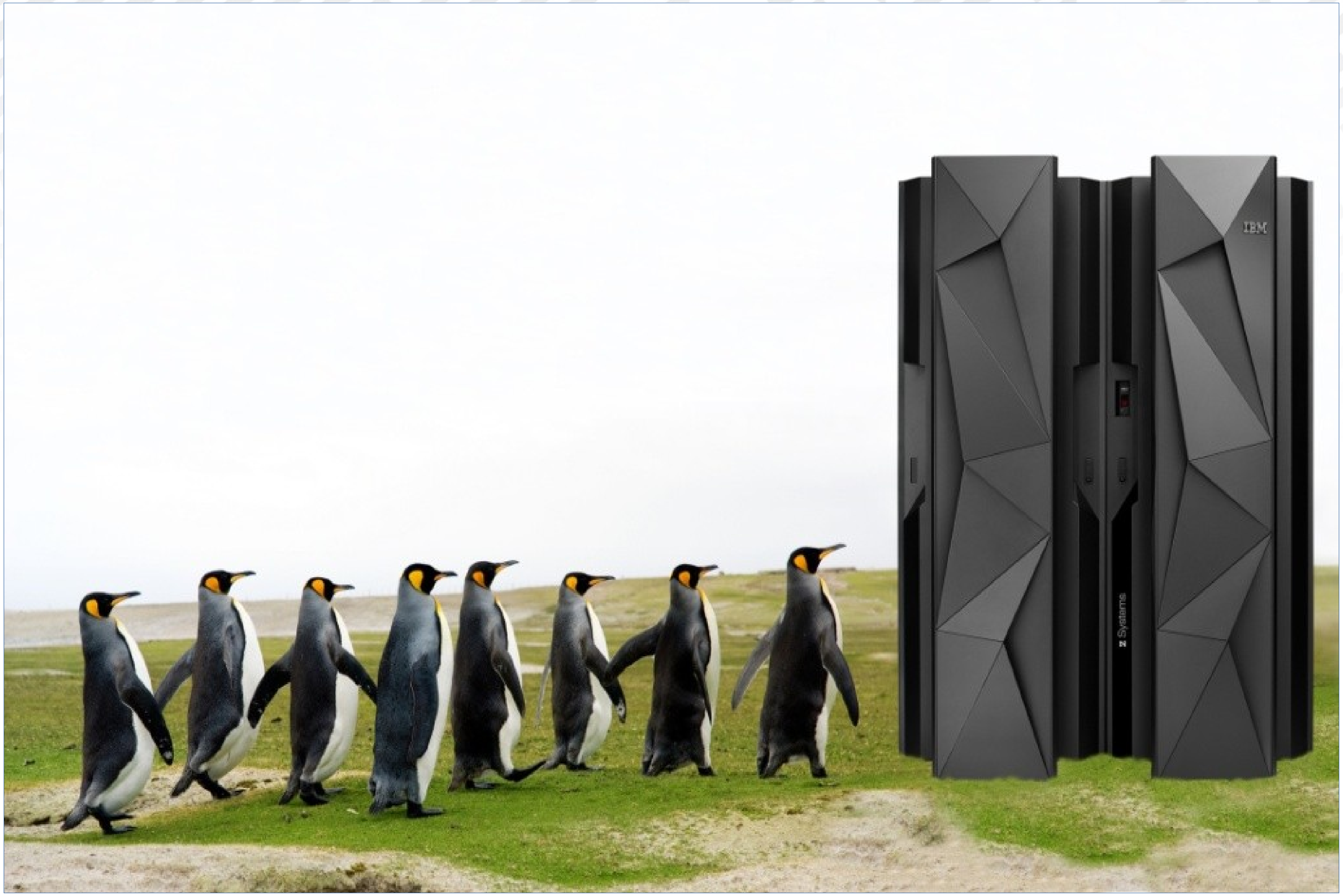
What's this about?



What's this about?

- s390 (aka z Systems®) was the second architecture to implement KVM
- First with a custom userspace (kuli), then with qemu
- KVM on s390 exploits some neat architecture features...
- ...but also had to deal with some decisions that sounded good at the time...
- ...and some rather odd things that are different from everybody else

Let's get started

SIE – Start Interpretive Execution

Let's get started

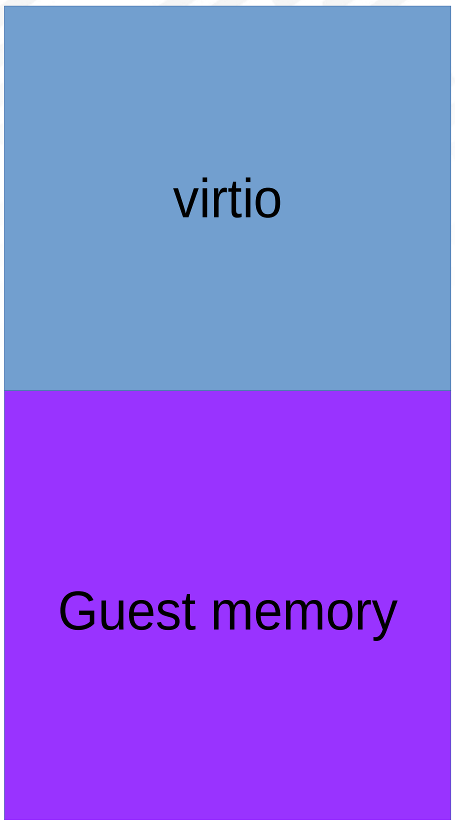
- SIE uses per-vcpu control blocks in host memory
  - ...this is nice for nested virtualization
- Satellite control blocks for some assists
- Intercept controls to enable manual interpretation
- Cool feature: ibc to fence back to a previous machine generation
- Intercept requests to get a vcpu out of the SIE
  - Headscratcher: We can request exit for stop, I/O and external – but not for machine checks
- Various SIE exits: instruction, program interrupt, idle...
- ...but mostly mapped to the same exit code in KVM

Let's get started

- (Nearly) everything used to be mapped to a single SIE exit reason
- Drawbacks: we need to fetch state, as we don't know what we need to handle the intercept
  - Instruction intercepts, wait states or program checks all need different status
- New 'specialist' exit codes (for handling of tsch, stsi, …)
- ...but a far cry from the variety of exit reasons on other architectures

Channels and paths and programs

Channels and paths and programs



diagnose 500

external interrupt

stsch

cc 3

chsc

cc 3

Channels and paths and programs

diagnose 500

I/O interrupt

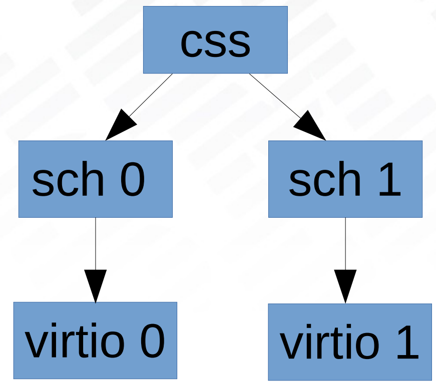
stsch

chsc

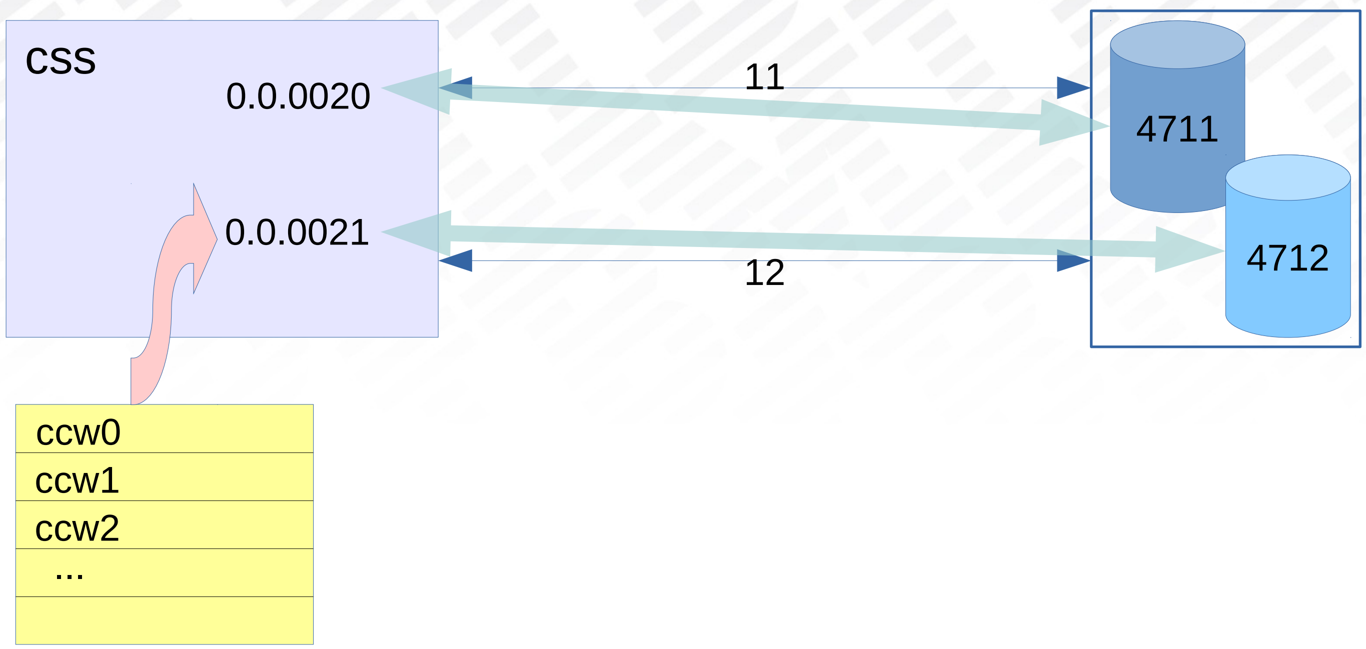
ssch

tsch

...



Channels and paths and programs



Channels and paths and programs

- stsch, msch, tsch – deal with device descriptions
- ssch, rsch, hsch, csch, xsch – deal with channel programs
- chsc – deal with a whole lot of things
- Neat features:
  - All I/O instructions are mandatory intercepts
  - Common set of architectural descriptions for all devices
  - All I/O devices can describe themselves

Channels and paths and programs

- virtio – the easy case
  - Fully virtual channel subsystem
  - Channel paths do nothing
- Passthrough (vfio) and emulation is more complicated
  - Need 'real' channel paths
  - Some refactoring to accommodate non-virtio devices
  - Vfio-ccw would be a talk in itself

It's PCI, but not as you know it

- PCI is a relative newcomer to the s390
- Only certain cards supported (RoCE, Flash, Compression)
- Needed to fit with existing paradigms
- No MMIO!
- Various instructions for reading/writing memory
- Integration into existing I/O infrastructure (adapter interrupts, channel-subsystem machine checks)
- ...and NO topology information!

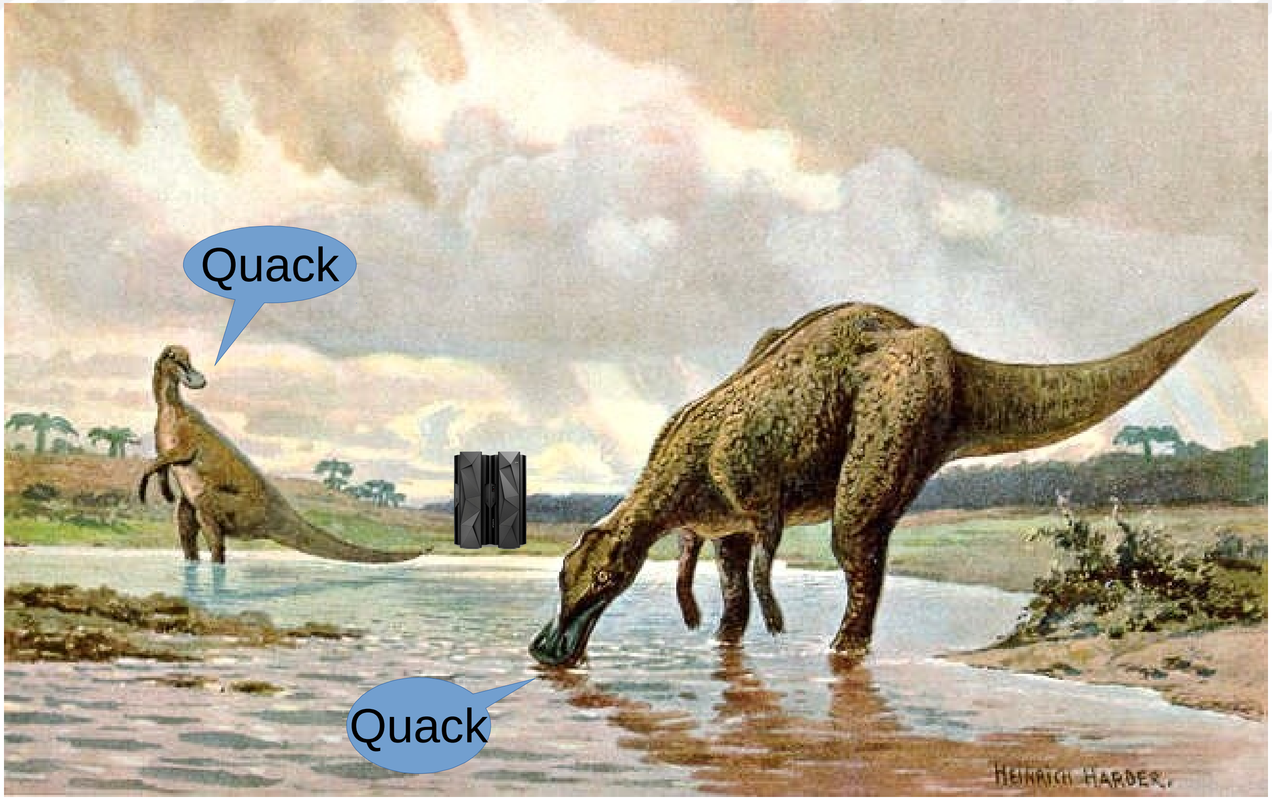
It's PCI, but not as you know it

You want	You use	You get
All PCI functions and their configuration	CLP List PCI Functions and CLP Query PCI Function	List of functions with FH, FID, UID, BARs and DMA values – NO bus/slot/function topology!
Read/write PCI config space	PCI LOAD and PCI STORE	Access to the config space – via privileged instructions!
MSI interrupts	Adapter interrupts and indicators	Message encoded with function index and indicator offset
Hot(un)plug notifications	Machine-check notified events	Information extracted via a channel-subsystem call – but it is still PCI-specific information

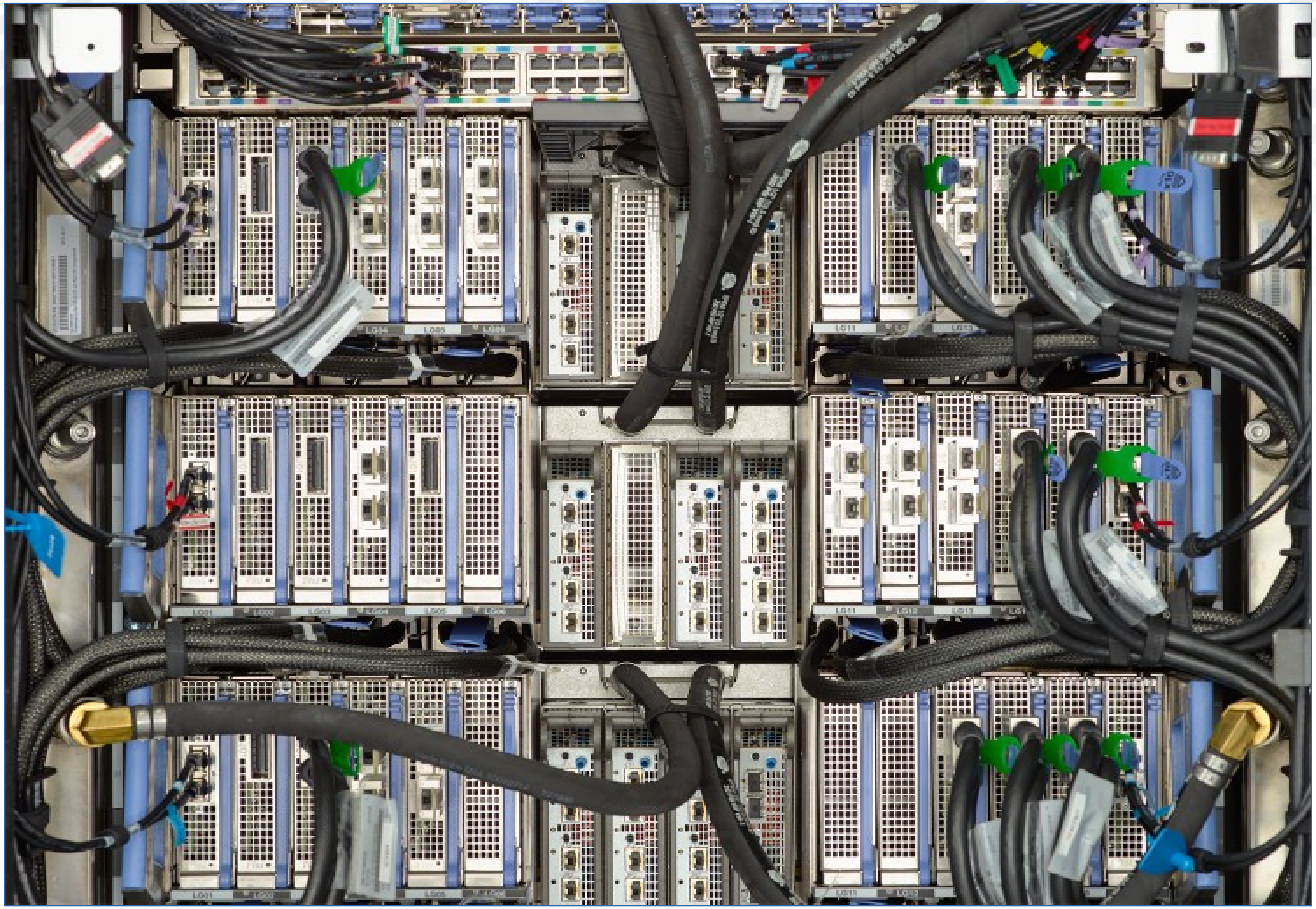
It's PCI, but not as you know it

- Linux guest side integration worked quite well, but...
- ...host side modelling in qemu was not that easy
- Challenge: Reconcile qemu's topology-based modelling with zPCI's information
- Solution: Build a 'fake' topology, add satellite zpci devices to store s390-specific information (fid, uid)

It's PCI, but not as you know it



The changing ways of SIGP



The changing ways of SIGP

- SIGP – Signal Processor
- First implementation: partly in the kernel, partly in userspace
  - This did not play well with keeping cpu state in qemu...
  - ...and was racy between SIGPs
- Moved to userspace, guarded by a capability
  - Privileged program exceptions still handled in the kernel
  - Exception: 'fast' SIGPs which also need access to kernel state
  - But we have to keep the old code around...
- Neat architecture feature: SIGP interpretation
  - For a subset of SIGP calls, we can let the SIE handle it
  - Exitless signalling of other vCPUs → win

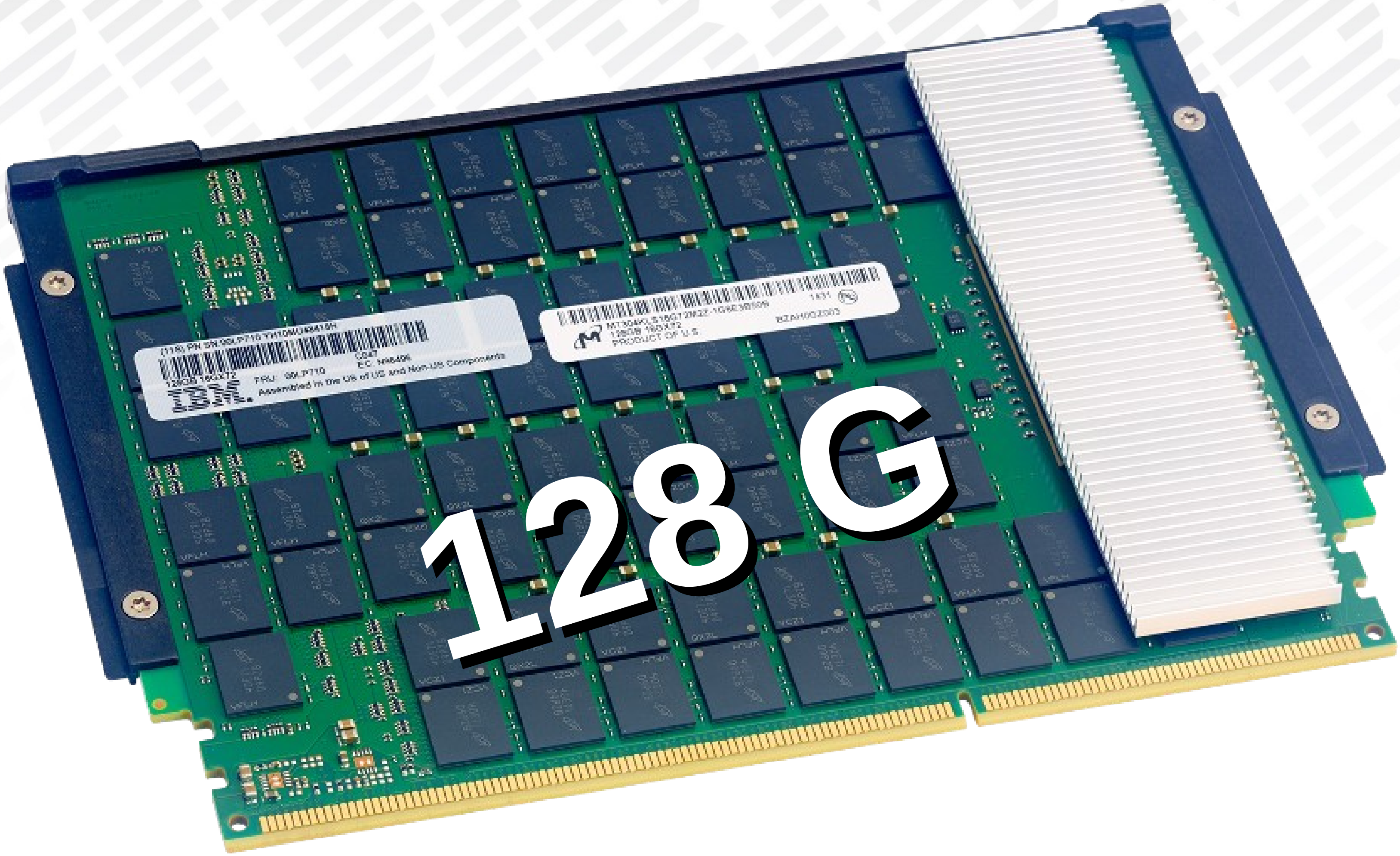
The call that wants to be a processor

- SCLP – service-call logical processor
- Takes on many tasks performed by a PC's BIOS/UEFI
- ...but it is a well-specified interface
- In practice, we emulate it as a simple call
  - Send a control block (SCCB), get an (external) interrupt on completion
- Supported features vary with the machine generation

The call that wants to be a processor

- Provide information about the machine
  - Number of cpus, amount of memory, …
  - ...and a list of facilities that is not completely distinct from cpu facilities
- Allow to dynamically change the machine's current configuration
  - Activate standby cpus, deactivate PCI functions, ...
- Implement a console
  - VT-220 compatible or line mode
- All of this is best implemented in userspace
- qemu models this as a device hierarchy

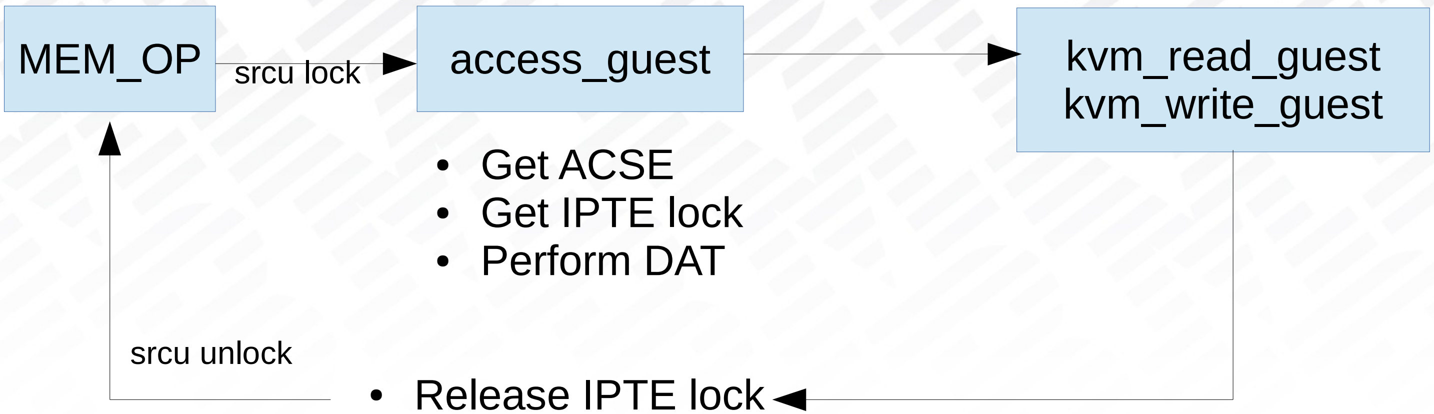
Let's talk about memory



Let's talk about memory

- We need host kernel support to read/write memory in a correct way
- Reasons:
  - IPTE lock (for DAT)
    - To synchronize against page table changes by the SIE
    - Contained in SIE control block
  - Possible storage key operations
- Solution: introduce an IOCTL (KVM_S390_MEM_OP)

Let's talk about memory



Note:

- Program checks may happen
- Key protection currently not implemented

Check arch/s390/kvm/gaccess.c for the gory details

Thank you!