



z/VM Live Guest Migration

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Agenda

- **Motivation**
- **Alternatives**
- **Early Steps**
- **Technology**
- **Conceptual Migration Process**
- **Technology Demonstration**
- **Challenges**
- **Summary**

Motivation

- **z/VM is extremely reliable**
 - ▶ Customers “complain” about having to IPL to/from Daylight Time
 - ▶ Still, z/VM is a single point of failure
 - ▶ More importantly, perhaps, it is a single point of service
 - Planned hardware and software outages predominate
- **VMware, Xen, pHyp, and other hypervisors have found value in guest migration**
 - ▶ Addressing a somewhat different set of problems than z/VM has
 - Reliability
 - Scalability limitations
 - ▶ A differentiating factor nevertheless
 - ▶ Caused us to reconsider its importance

Alternatives

- **Concurrent patch**
 - ▶ Firmware approach
 - ▶ Must be able to apply and remove patches
 - ▶ Number of combinations grows exponentially
 - Difficult to test
 - ▶ Could cause more problems than it solves
- **Application migration**
 - ▶ E.g., MetaCluster
 - ▶ Probably leaves virtual machine impotent
 - ▶ Knowledge at the wrong level
- **Multi-system virtualization**
 - ▶ “Single system image” including Live Guest Migration
 - ▶ Breadth of z/VM virtualization leads to large, complex challenge

Early Steps

- **IBM Research interest in problem of z/VM Live Guest Migration**
- **Started prototype work in 2004**
- **Speed Team created in summer 2006**
 - ▶ **Cross-site (Poughkeepsie, Endicott) team with Research assistance**
 - ▶ **Brought prototype forward to z/VM 5.3 base – Endicott**
 - ▶ **Designed Migration Diagnose – Endicott/Poughkeepsie**
 - ▶ **Developed Migration Diagnose – Endicott**
 - ▶ **Developed service machine (“moving van”) to orchestrate migration – Poughkeepsie**
 - **Based on CSE and ISFC**

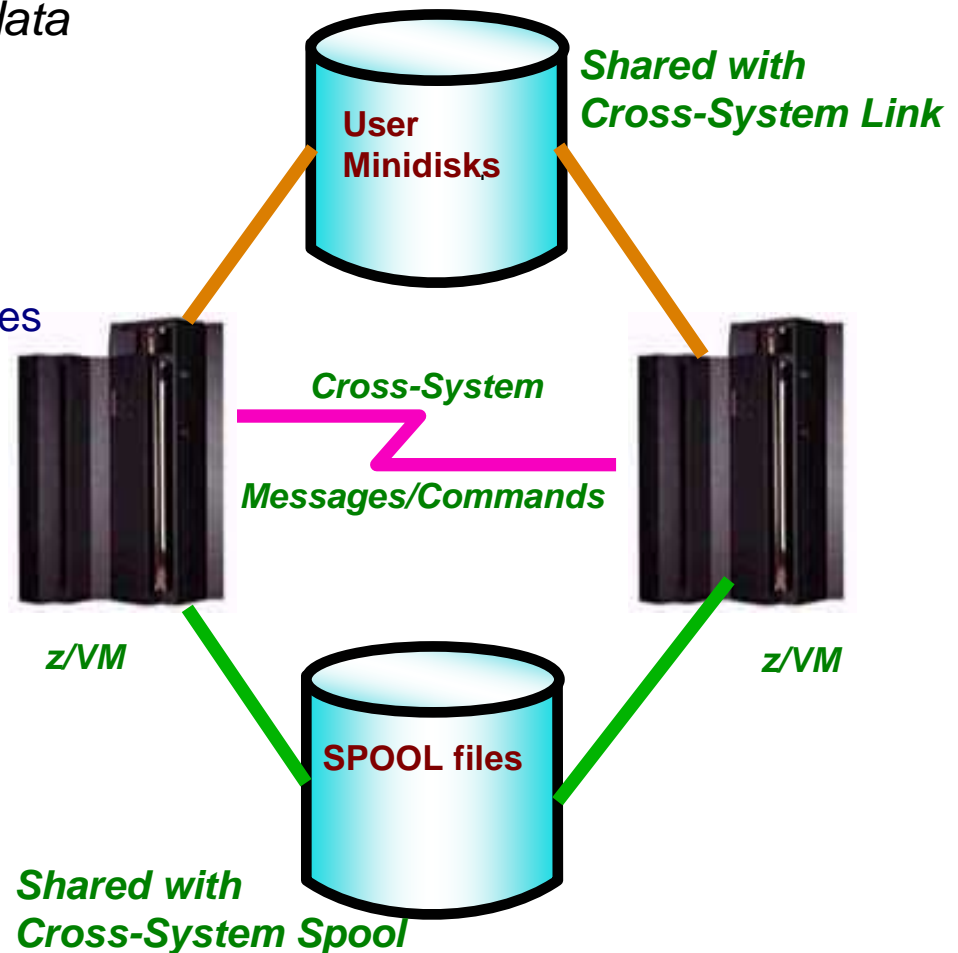
Technology

- **Cross-System Extensions (CSE)**
- **Inter-Systems Facility for Communications (ISFC)**
- **“TRACK” Diagnose**
- **Migration Diagnose**
- **Guest memory change tracking**

Cross-System Extensions (CSE)

Virtual Machines may access their data from any z/VM image in a cluster

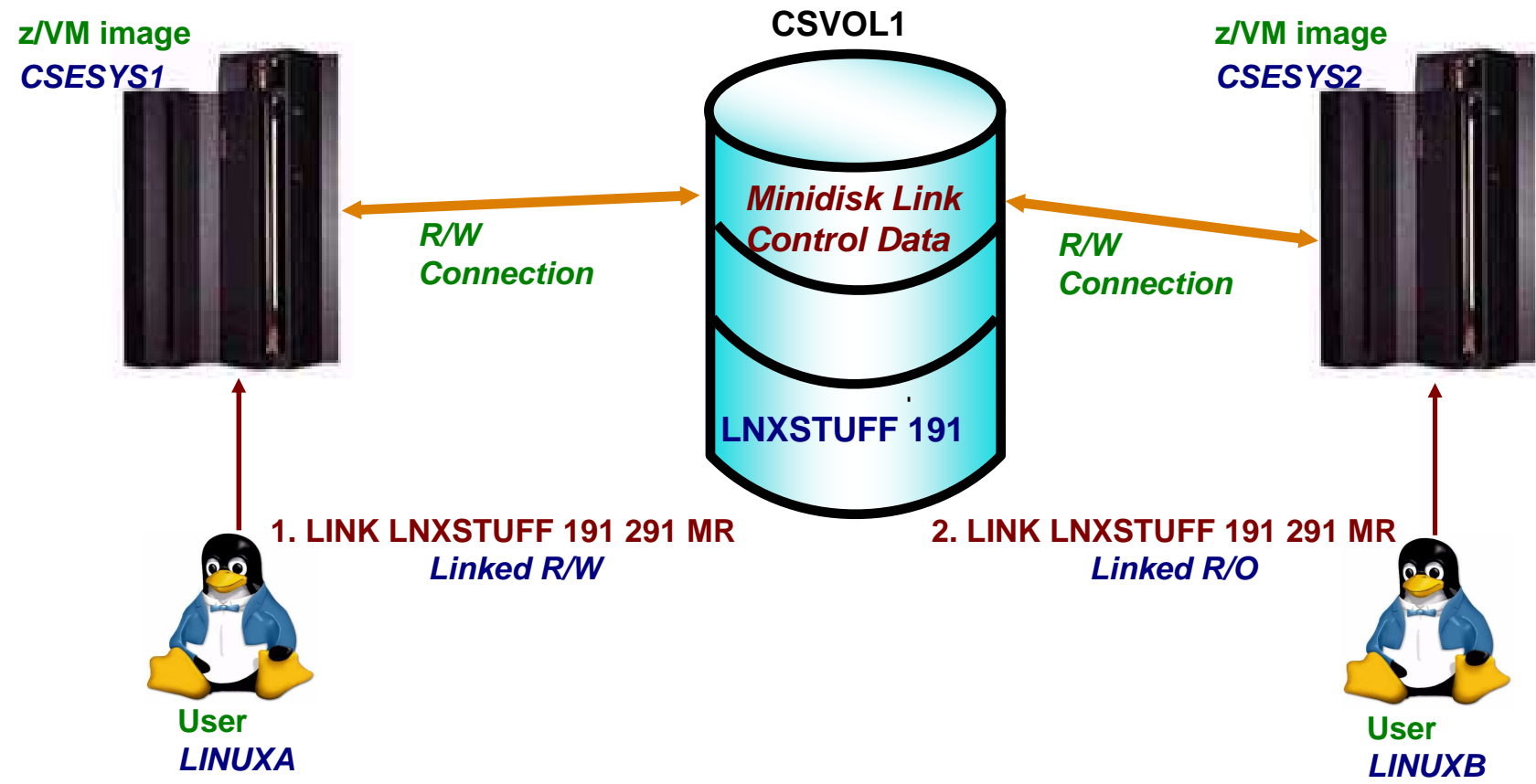
- Capability to share
 - Minidisks
 - Spool files
- Commands may be sent among images in the cluster
 - Messages
 - Query
 - Link
 - Spool File Commands



CSE Cross-System LINK

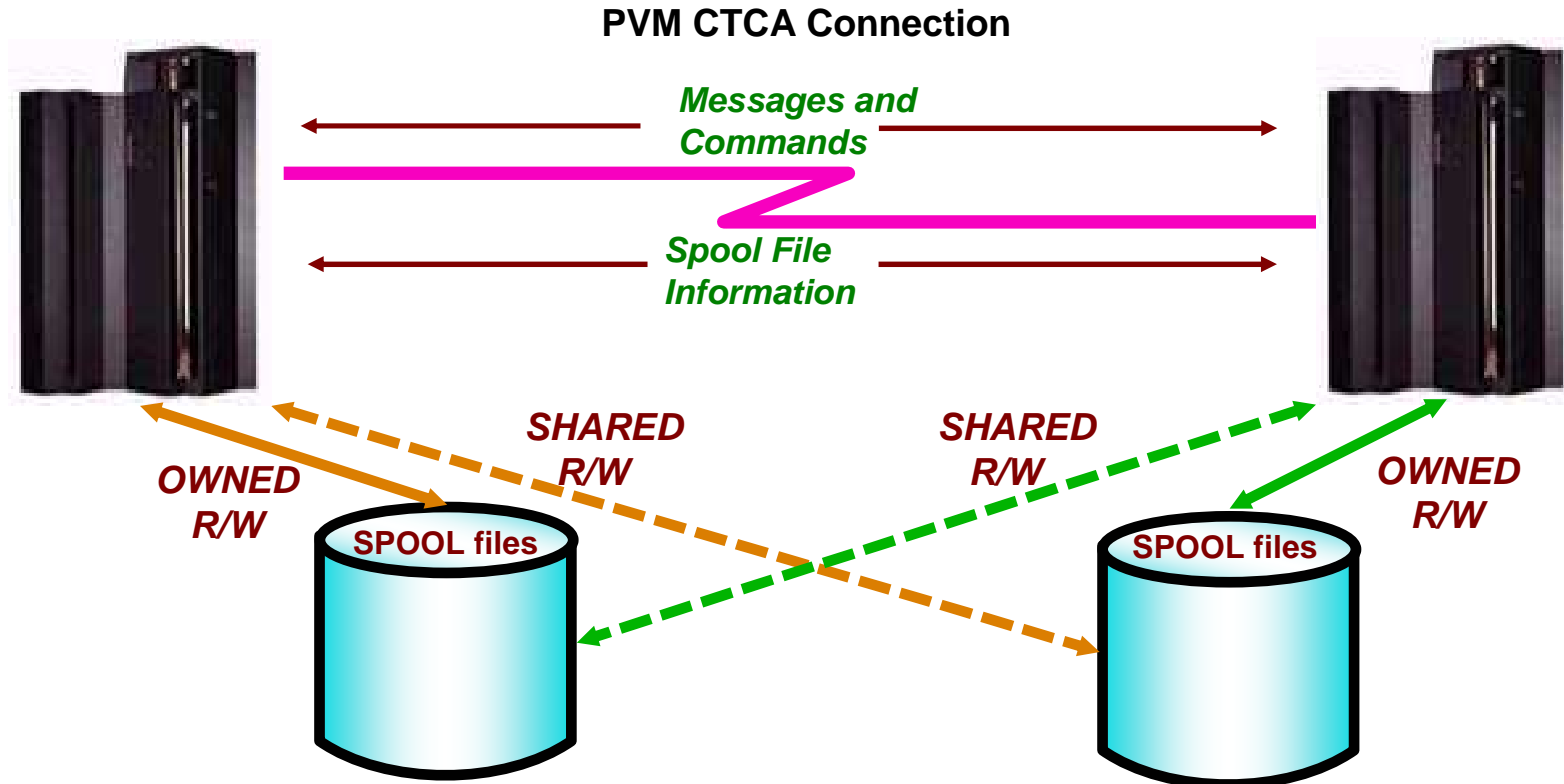
Shared Minidisk Volumes

- Link control information for all systems is kept on the volume

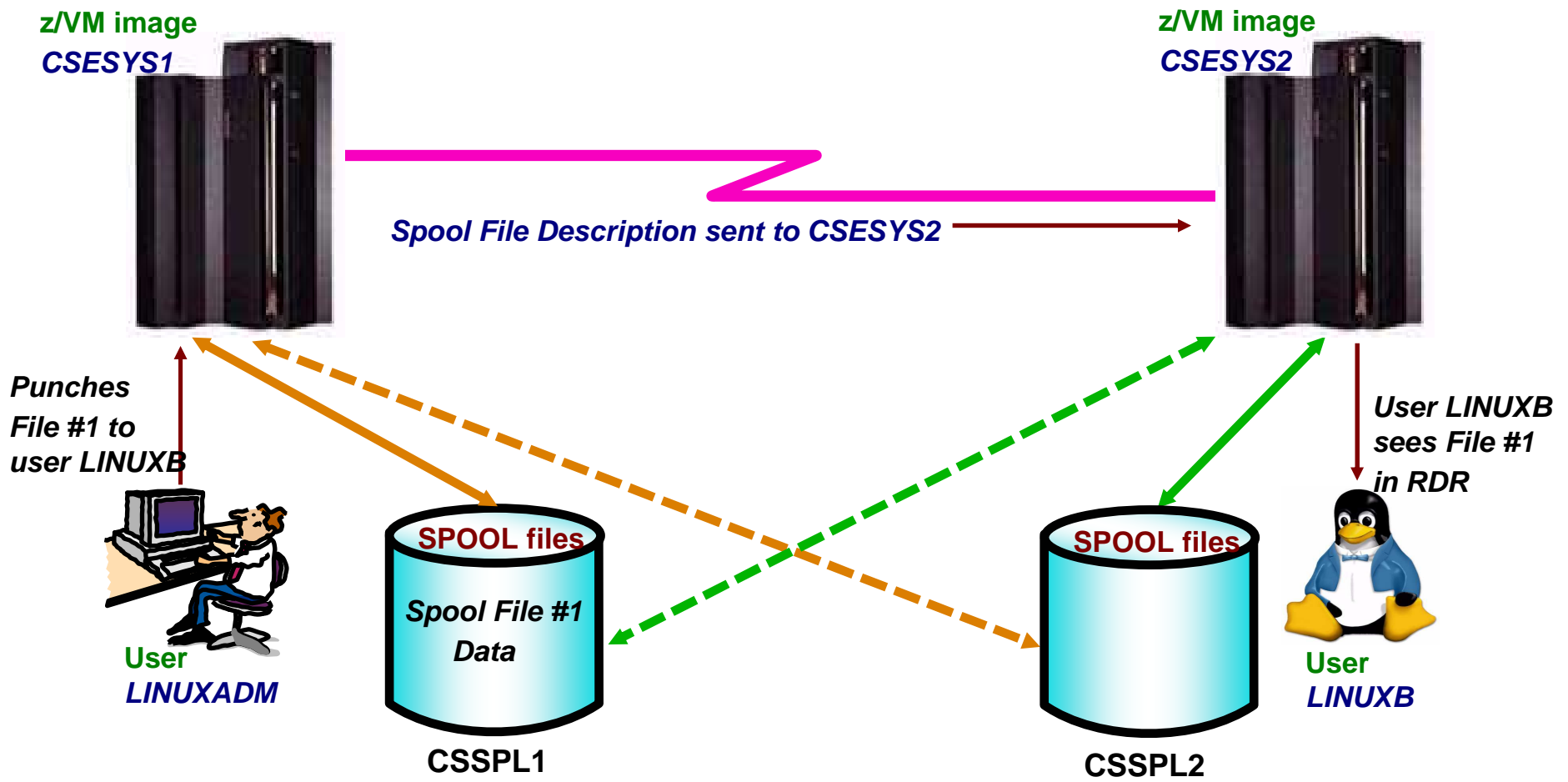


CSE Communication and Spool

Up to 4 z/VM Images can share spool files



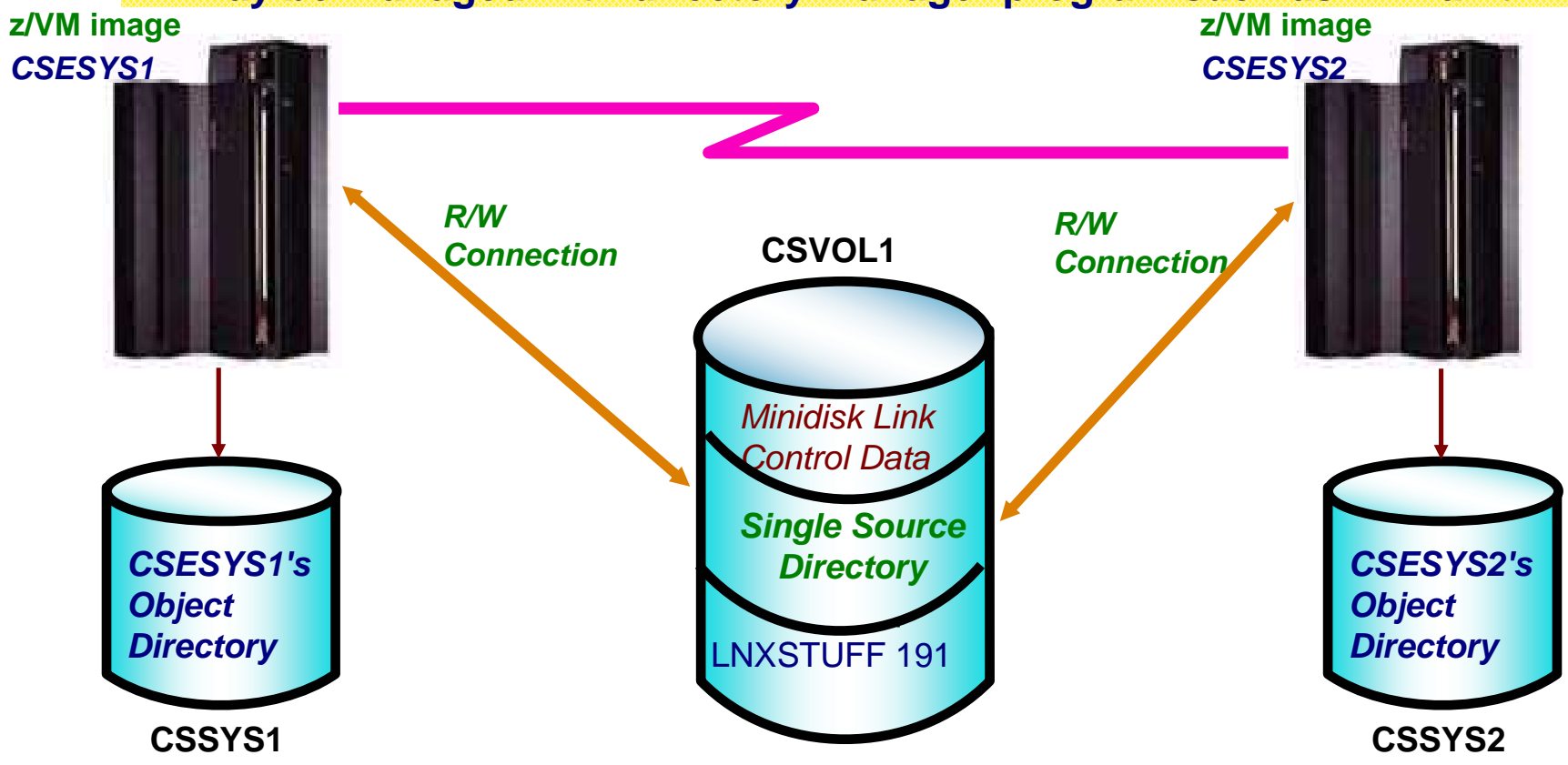
CSE Communication and Spool ...



CSE Single Source Directory

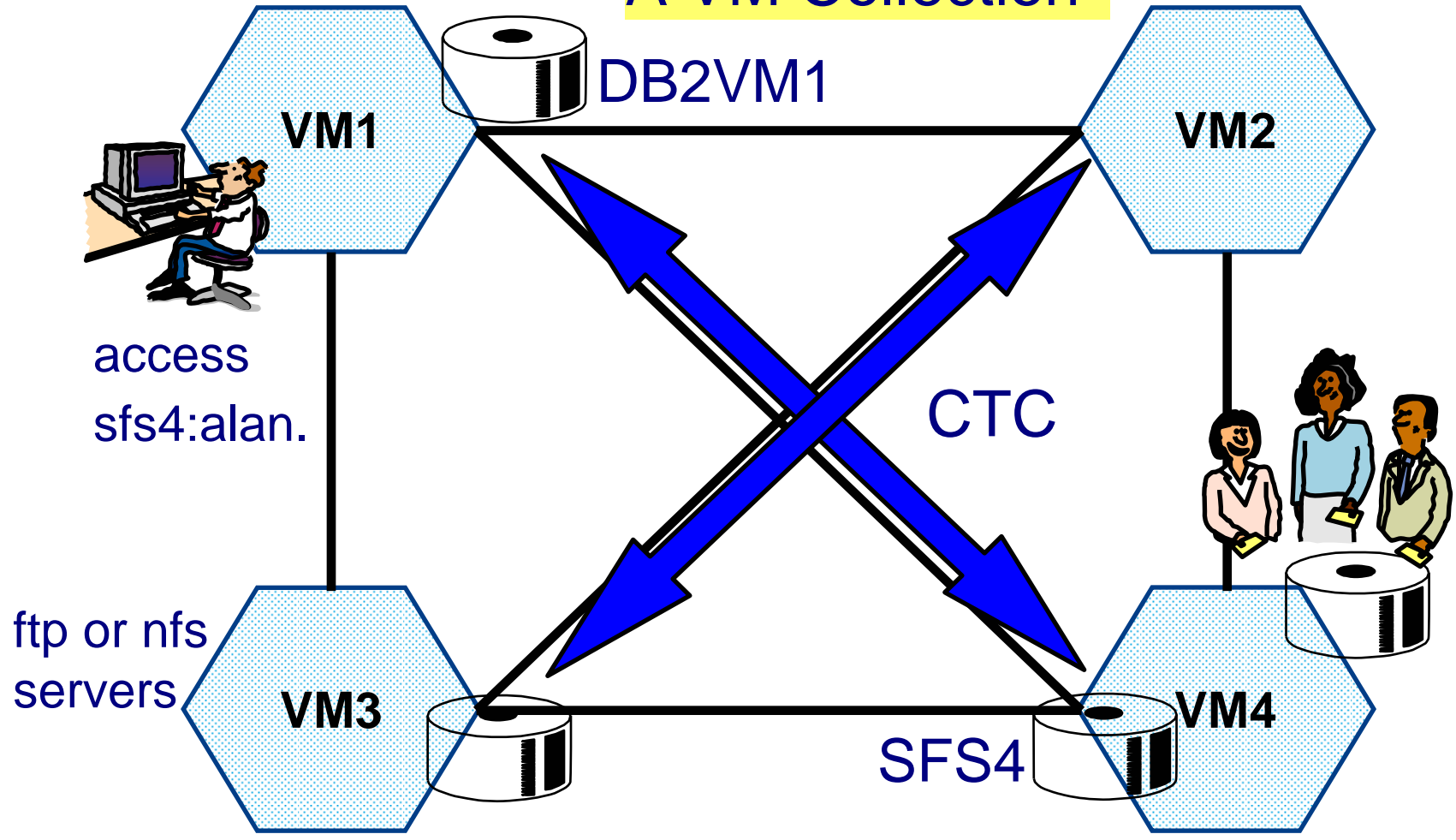
All systems use the same source directory

- Each system has its own object directory
- May be managed with directory manager program such as DirMaint



Inter-System Facility for Communications

A VM Collection



“TRACK” Diagnose

- **TRACK tool originally from Princeton (Serge Goldstein) now maintained by Nationwide (Jim Vincent)**
- **z/VM 5.2 storage management changes provided motivation to dispense with TRACK’s use of LOCK, DISPLAY HOST, and Diagnose 4 (Examine Real Storage)**
 - ▶ **Proposed Diagnose interface to enable authorized guest to gain access to target’s base address space or System Execution Space as a data space**
 - **Natural use by exploiting Access Register mode**
 - ▶ **Code written but serialization issues never resolved => not released**
 - ▶ **Turned out to be useful for guest migration (with extension to allow read-only or read/write access to target’s address space)**

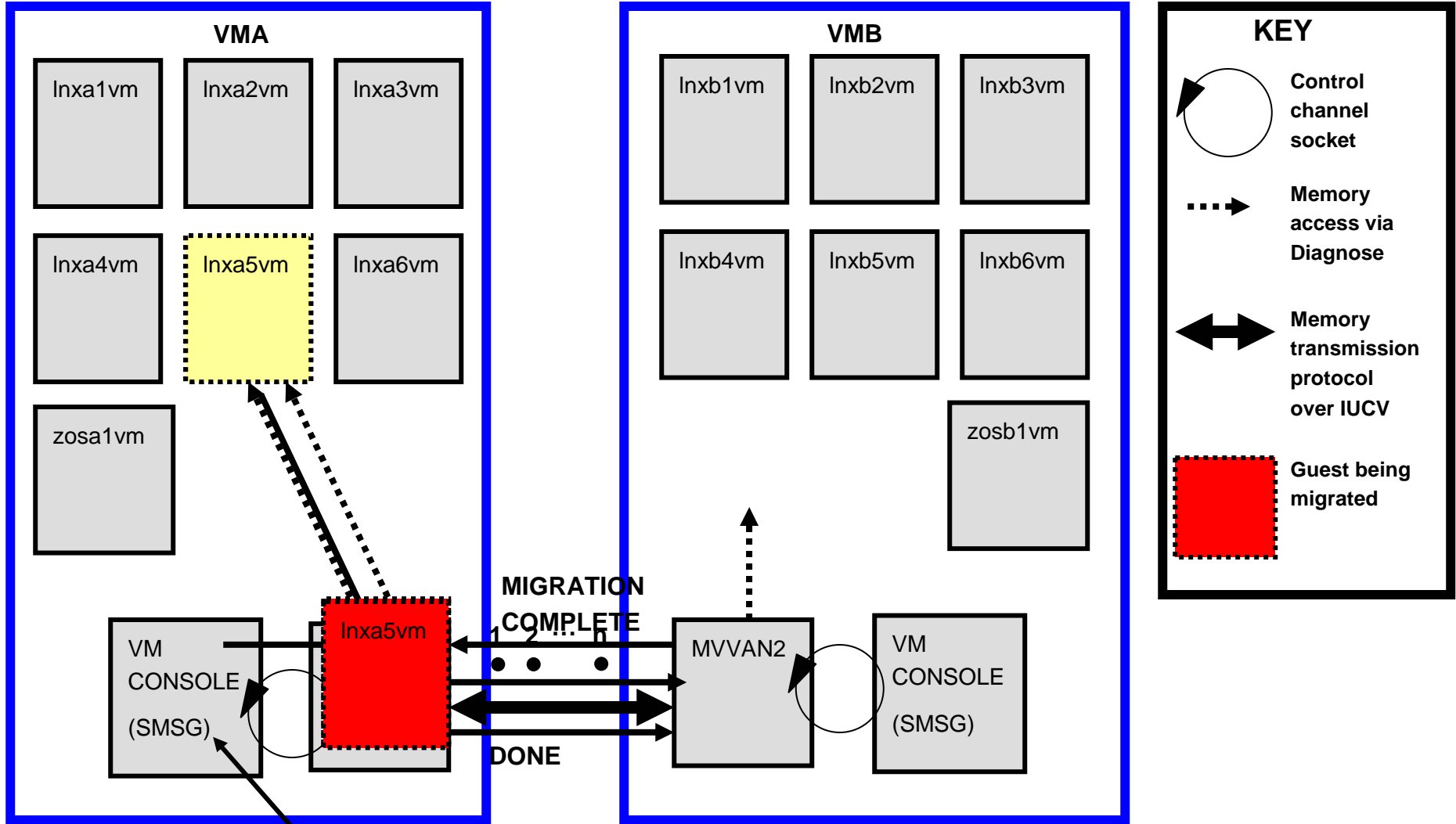
Migration Diagnose

- **Migrator interface to CP functions**
 - ▶ **Begin migration (outward or inward)**
 - ▶ **Get guest configuration**
 - ▶ **Set guest configuration**
 - ▶ **Retrieve migration change bits**
 - ▶ **Stun guest**
 - ▶ **Get guest state**
 - ▶ **Restore guest state**
 - ▶ **Abort migration**

Guest Memory Change Tracking

- **Initiated by Migration Diagnose “Begin outward migration” function**
 - ▶ **Causes target guest key operations to be intercepted**
 - ▶ **Keeps shadow copy of page change state for migration**
- **First invocation of “Retrieve migration change bits” returns a “1” bit for each non-zero target guest page and resets all migration change bits**
- **Subsequent invocations clear migration change bits and return a “1” bit for each page changed since last invocation**

Conceptual Migration Process

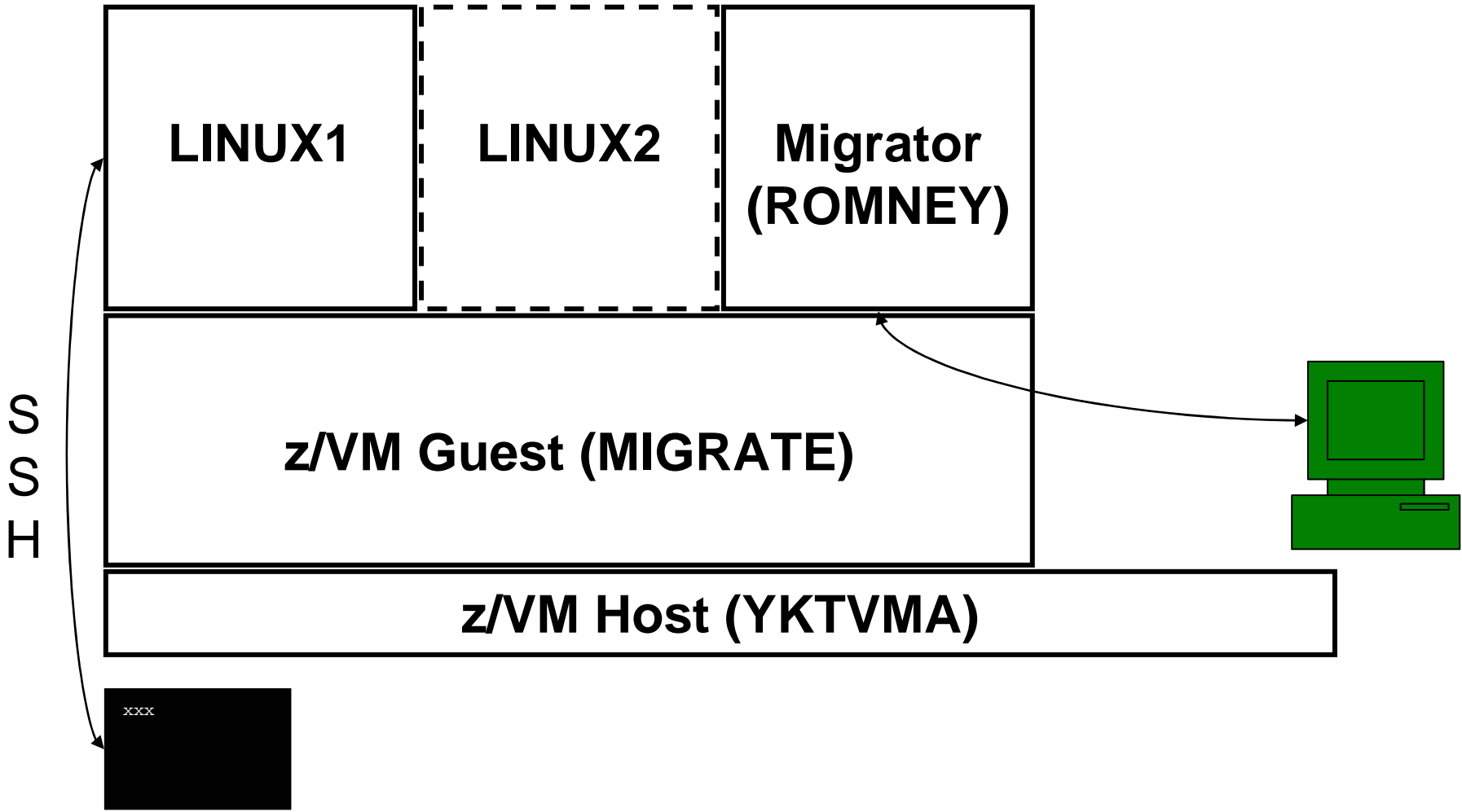


SMMSG MVVAN1 MIGRATE LNXA5VM MVVAN2

Technology Demonstration

- **Configuration**
- **Caveats**
- **Problems**
- **Demo**

Technology Demonstration - Configuration



Technology Demonstration - Caveats

- **This is a proof-of-concept**
 - ▶ Same system still presents most challenges
 - ▶ Simpler to set up, control, and demonstrate
 - ▶ Guests are only 128MB
 - ▶ Not speed team moving van – REXX program orchestrates migration using functions that invoke Track and Migration Diagnoses
- **Using a different user identifier is merely a convenience**
 - ▶ Facilitates testing
 - ▶ Does not affect other aspects of migration
- **Invocation via SMSG or as a CP command is well understood**
 - ▶ Some additional considerations (e.g., serialization of requests) will have to be made

Technology Demonstration - Problems

- **Brief but inconvenient pause (PING) after migration completes and network interface reset**

Technology Demonstration

Challenges

- **Release-to-release compatibility**
- **Existing CSE and ISFC customer environments**
- **Processor architecture and features**
 - ▶ E.g., System z9 to z990
- **CSE and ISFC duplication**
 - ▶ Collection definition
 - ▶ Communication
- **Distance**
 - ▶ Shared I/O subsystem
- **User name space**
- **Migration eligibility**
 - ▶ Some current restrictions will disappear
 - ▶ Others will need to be removed

Summary

- **Multi-system virtualization on System z is feasible**
 - ▶ **Need to define objectives**
 - ▶ **Requires staged delivery plan**
- **We have a guest migration prototype**
 - ▶ **Work needed to make the function production-ready**

The image shows a close-up, low-angle view of a server rack. The perspective is looking up at the server units, which are dark grey or black. The IBM logo is prominently displayed in the center, rendered in a white, stylized font with horizontal stripes. Below the logo, the text '@server' is visible in a smaller, white font. The background features various server components, including a rectangular window or indicator light at the top, and several horizontal slots or handles on the left side. The lighting is dramatic, with strong highlights and deep shadows, emphasizing the metallic textures and geometric lines of the server hardware.

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@server