# *Learnings from DECnet Transition*

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# *at we’ll talk about today...*

- Who I am
- Why I am here
- A short history of DECnet
- General Transition Principals
- Examples (good and bad) of our transition experiences
- The collected list of key learnings
- Open discussion

# ttle about me...

- I started in networking with Digital in 1977, working on DECnet Phase I
  - (previous to that I worked with *Real* complex systems!)
- I  been an engineer or technical leader network software space most of my Digital career
- I lead the team which designed Digital's first board level router
- As Phase V technical director, I helped to design key transition support
- I am now the systems architect for Pathworks TNG
- I am responsible for helping those customers who have complex or unique network design and operation issues

# [redacted]y am I here?

- In some respects, one could consider the learnings we have gained from transition to be a key competitive asset
  - Many network vendors have not yet had to face the problems of migrating a large customer base from one technology set to another, and will misunderstand or underestimate the complexity of the problem
- One could also argue that we should not discuss those transition experiences which did not go as expected
- But, as a networking company we strongly feel the need for the Internet to succeed, and feel that we have something to offer

# ttle about DECnet...

- DECnet is a proprietary peer to peer networking solution linking Digital systems togeather, and linking other systems to Digital systems
- A snapshot of it's history:

| | *Phase I* | *Phase II* | *Phase III* | *Phase IV* | *Phase V* |
|---|---|---|---|---|---|
| *Max nodes* | 2 | 32 | 255 | 64449 | 2E160 |
| *Area routing* | No | No | No | Yes | Yes |
| *Adaptive Rtg* | No | No | Limited | Yes | Yes |
| *Hidden Nodes* | No | No | No | Yes | Yes |
| *External Rtg* | No | No | No | No | Yes |
| *Cong. Control* | Limited | Limited | Limited | Yes | Yes |
| *Cong. Avoid* | No | No | No | No | Yes |
| *Naming* | None | None | Local | Local | Global |
| *Stds Support* | None | None | Some | Some | Lots |

# *ms (at least the way I’ll use them)*

- **Transition=Migration**
  - **Unless you are a lemming or a salmon**
- **Intermediate System=IS=Router**
  - **‘Rooter’ = ‘Router’ except in Australia and England**
- **End System=ES=non-routing Host**
- **Level 1 Routers know about the reachability of other ES and IS systems in their area**
- **Level 2 Routers know how to get to other areas, in addition to being Level 1 Routers**
- **Phase V=DECnet/OSI=Advantage Networks**
  - **I apologize in advance to the Digital Marketing People for my sins, and I will try to be better in the future**

# ttle more about DECnet...

- During the middle and late 80s, it was becoming apparent that several things needed to be changed with DECnet:
  - 16 bits of address was not enough
  - External routing needed to be added
  - Routing Vector routing needed to be replaced
  - We needed address OSI support for GOSIP and key customer bids
  - We needed to add dynamically established datalinks for our non-US. networks centered around X.25
  - We needed to replace the network management internal infrastructure
  - We needed to add support for distributed naming
  - We saw opportunities around dynamic address allocation
  - We needed to add new broadcast media types (FDDI, TR)

# ally* he gets to Transition...

- It was time for a new phase of DECnet!
- But we had to do this supporting the customers in with the following goals:
  - Every new Phase of DECnet fully supports the previous Phase
    - New Phase systems can coexist with previous Phase systems
    - New Phase systems can interoperate with previous Phase systems
    - The standard application APIs of the previous Phase are still supported
- With Phase V, there were some new wrinkles:
  - Networks were much larger, and critical to the business
  - The control of networks had moved away from MIS
  - Different people administered different types of nodes
  - The average experience level of people running networks had dropped
  - People had become ‘creative’ in the deployment of the product

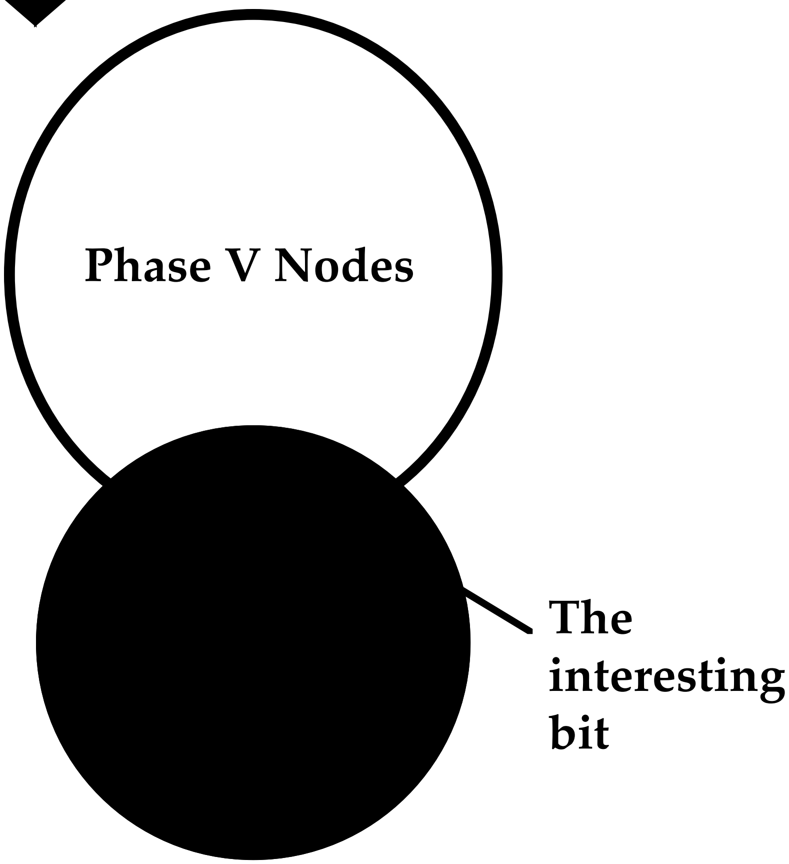
# impact of the new issues

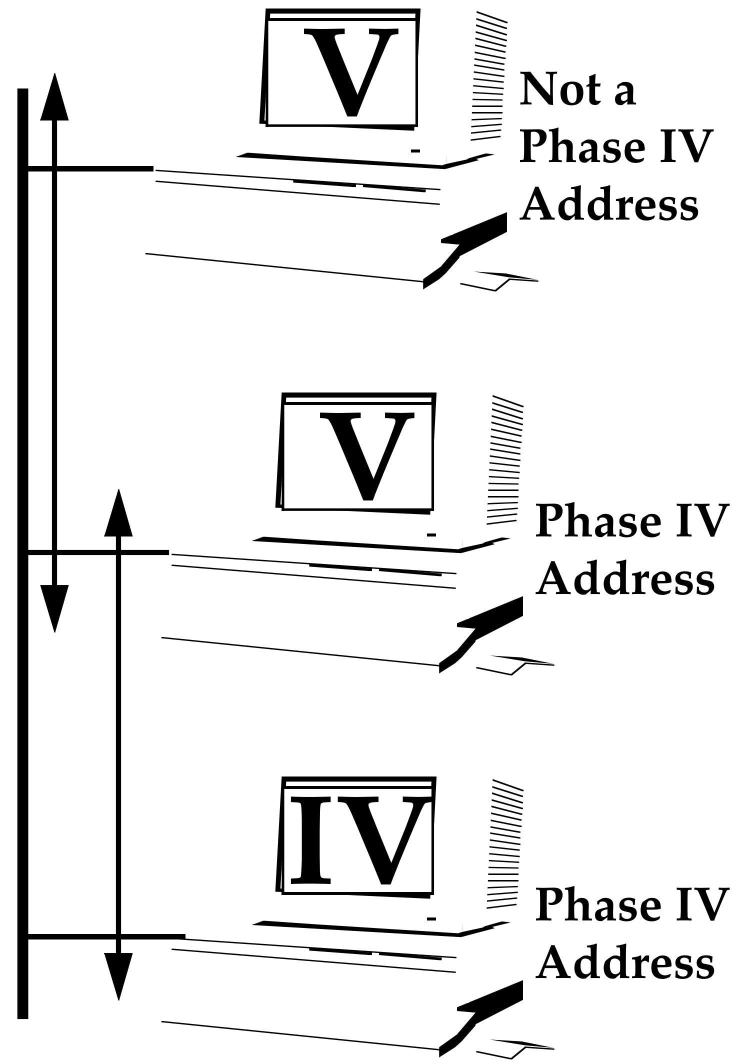
- **We figured out some things before we started to build the products**
  - **We would have to expect the transition to occur in stages, spanning perhaps as long as a few months or a quarter**
  - **We would have to support mixes of:**
    - **Phase IV and Phase V ES within an area**
    - **Phase IV and Phase V routers at both Level 1 and Level 2**
    - **Areas running Routing Vector and Areas running Link State**
  - **We would have to keep the installation and configuration process as simple as possible despite the new complexities such as NSAPs, IDPs, name space names, and so on.**
  - **We needed to automate key parts of the process**
    - **Address allocation and registration**
    - **Conversion of routing from RV to LS**
    - **Conversion of management scripts to the new UI**

# *Address Transition Process*

- **Early on in the design of Phase V, we decided that we would define a set of mapping rules which would map a section of the Phase V NSAP address space onto the existing Phase IV address space**
  - **This allowed customers to continue to use their existing Phase IV style addresses**
  - **This allowed applications which only understood the 16 bit address format to continue to operate without change**
  - **Along with "PMR" (or application level routing) supported a strategy developed in the Phase III to Phase IV time frame which allows existing Phase IV nodes to communicate beyond the 16 bit address space**

# *Address Transition Process*




**VAXmail example:**
**NODEA::NODEB::USER**

# Address Transition Issues

- **This technique has worked quite well for us, (over several Phases of DECnet) but there are some tradeoffs:**
  - **The IS nodes must understand the mapping rules in order to convert packets between the two address spaces**
    - **The rules must be consistent between the ES and the IS nodes**
  - **The 'Gateway' or 'Router' support needs to be built into the key applications**
    - **We had a general 'Passthrough Object' but do not recommend this technique as it breaks proxy security access**
  - **We used a one to one mapping between Phase IV areas and Phase V areas**
    - **This is easy to understand**
    - **There was one case where the customer wanted a one to many mapping between Phase IV areas and Phase V addresses**
- **Many customers dedicate hosts to act as dedicated gateways between the address domains**

# Applications Transition Process

- **A constraint which we operated under is that the host network software must be able to be updated independently from the applications**
  - **This requires that existing application interfaces must be preserved**
  - **This also was made possible by the fact that a well defined mapping between Phase IV addresses and Phase V addresses exists**
    - **This allows the Phase V session control layer to pass Phase IV style address structures up to the application**
- **In talks, handbooks, ... we discussed the fact that we would continue to support the ‘official’ Phase IV application APIs on Phase V systems**
- **We provided tools to convert the on-disk network application databases from Phase IV to Phase V so that any existing installed applications would continue to work when the new host software was installed**

# plications Transition Issues

- **In general this process has worked quite well**
- **Due primarily to the fact that we were addressing a much larger installed base than ever before (over 1 million systems) we discovered many ‘mission critical’ customer applications which were using a few ‘unsupported’ APIs**
  - **This forced us into reluctantly porting these interfaces to Phase V**
- **One thing which we overestimated was the speed at which the installation procedures for applications (Digital and 3rd party) would be updated to use the Phase V management**
  - **This left us in the strange state that if an application was already installed when the Phase V upgrade occurred, then it still ran. Unfortunately new or re-installs of the application could not occur.**
  - **We ended up providing a Phase IV management emulator**

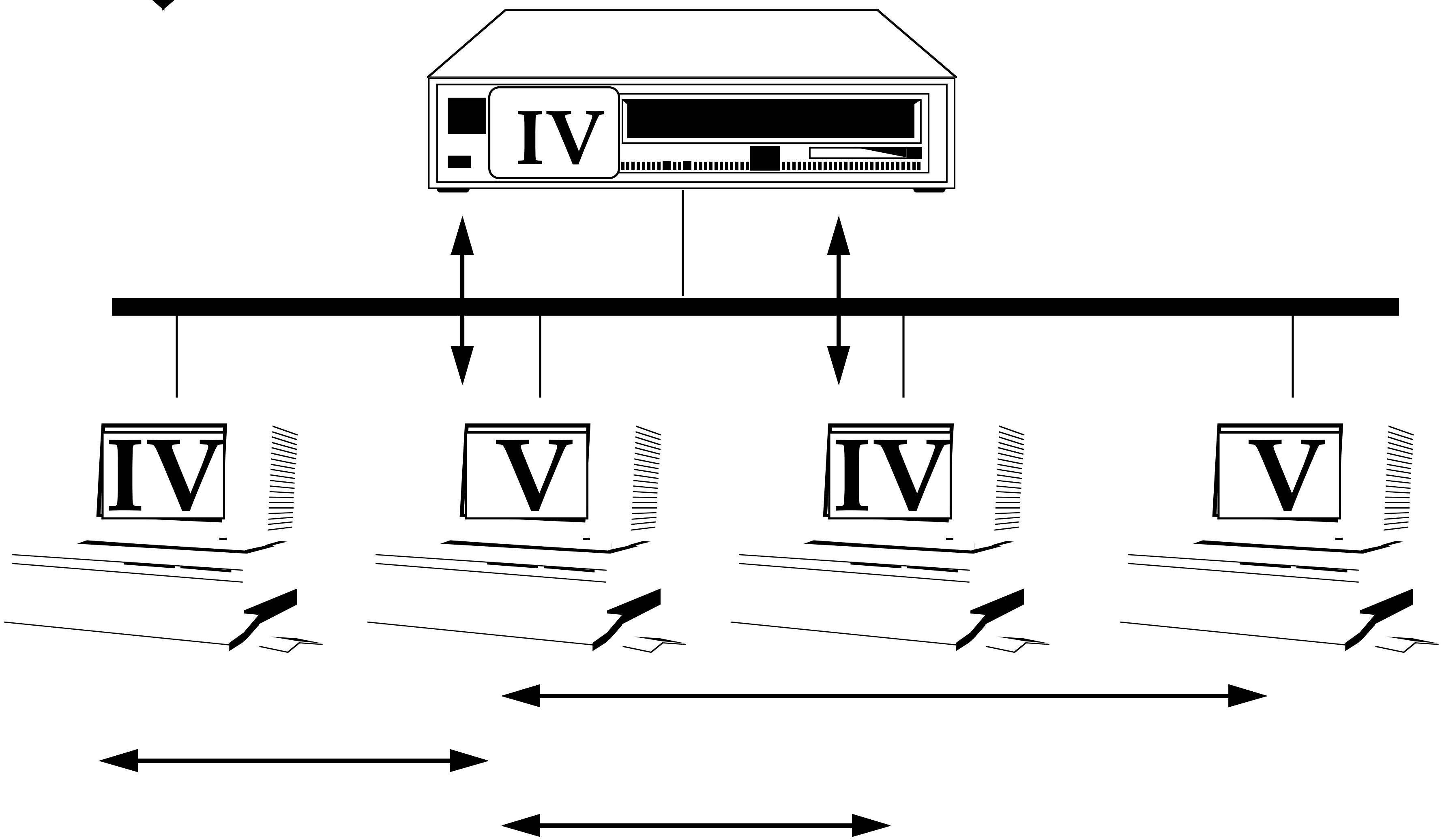
# ES Transition Process

- **Since the people responsible for the upgrade of the host software are different than those responsible for the router upgrade, we decided that Phase V software must be installable on a node, even if that node were to run in a Phase IV routing area**
  - **Therefore, Phase V ES nodes contain both the Phase IV and Phase V code paths**
- **Also, in order to reduce the complexity of the software upgrade, the design dictated that if the ES heard an IS hello, it could assume that the IS knew how to convert between Phase IV and Phase V addresses**
  - **This implies an underlying assumption that Digital could work with the major 3rd party routing vendors to get them to support Phase V conversion in a timely manner**

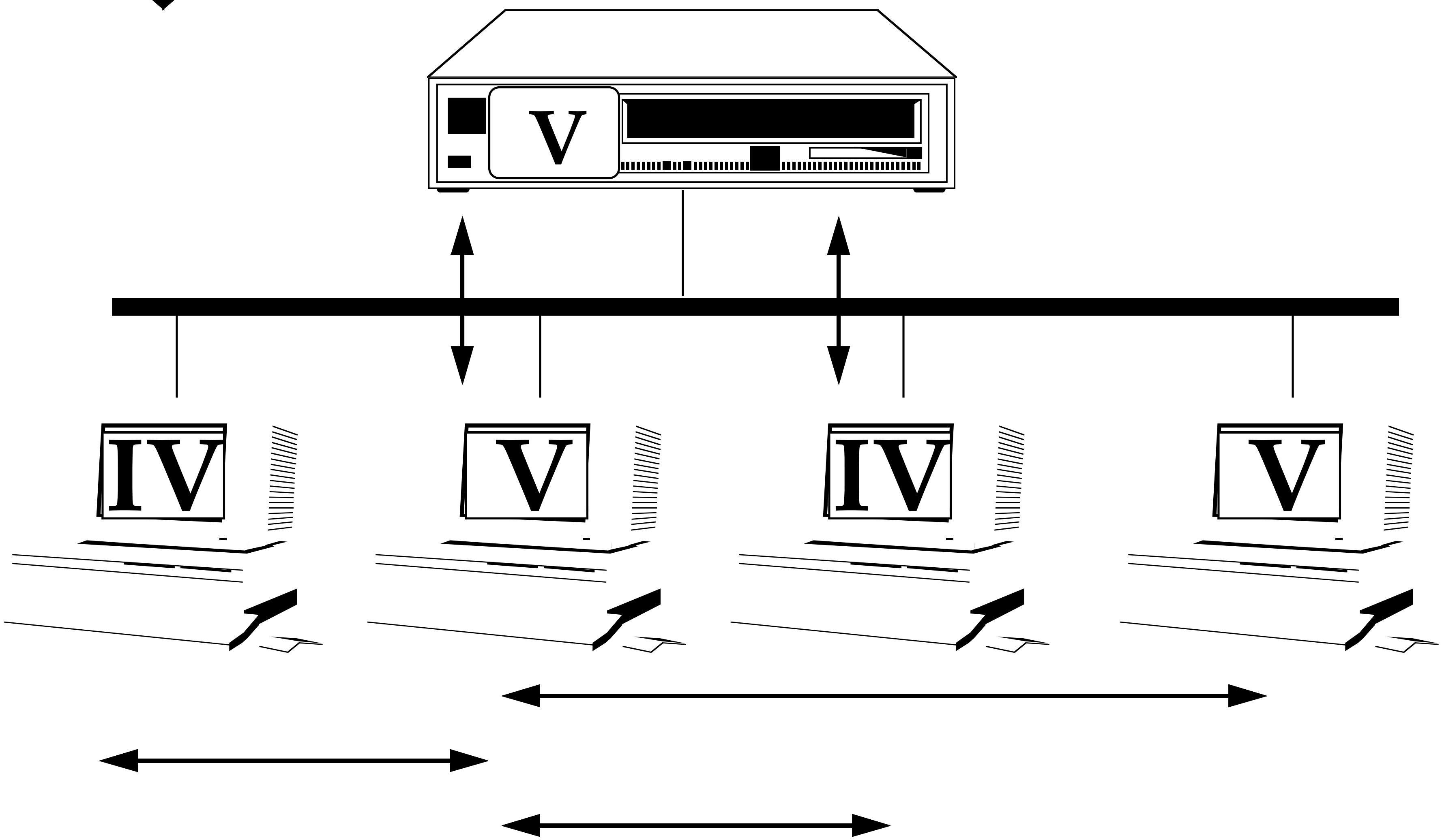
# ES Transition Process

- Update the ES software regardless of the type of area
- There is no reason to bring down an area to upgrade all the ES at the same time
- There is no reason to upgrade all the ES in an area, mixed configurations are fine
- The ES systems cache the type of the next hop for any particular destination.
  - The ES will format the packet in Phase IV or Phase V format depending upon the type of the next hop
  - Packet conversions can and do happen anywhere in the path between the source and destination
  - If a reverse path cache entry, or a redirect causes the cache entry to be updated during a conversation the format can change midstream

# ES Transition Process



# ES Transition Process



# Transition Issues

- **Separating the ES transition from the IS transition turned out to be very important**
- **This is especially true since we were significantly off on our estimates of how rapidly we would be able to move the installed customer base to Phase V**
  - **There are a vast number of commercial legacy applications built on specific versions of a Phase IV operating system which won't upgrade**
  - **The drop in the world economies has pushed the tendency for customers to retain existing investments for a longer period of time**
  - **The rate of technology change arriving at the customers has caused them to be overwhelmed**
  - **"If it works, leave it alone!"**

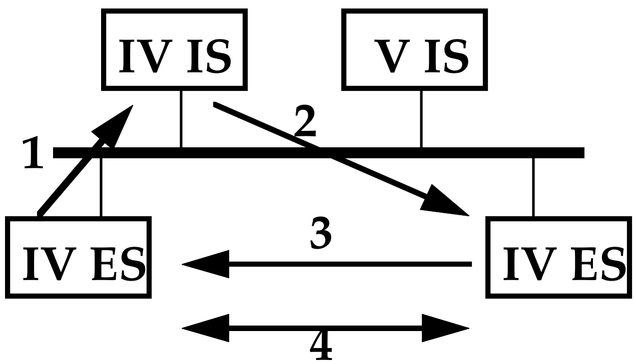
# *Transition Issues*

- **We were only partially successful in getting the other DECnet router vendors to support Phase V conversion**
  - **Some don't support it at all**
  - **Everybody does it different**
- **As a result, we are adding some ES switches to disable the assumption that an IS knows how to convert packets**
  - **This has tradeoffs, but seems to work well in most SIN routing networks**
- **We have buttons or knobs to allow modification or disabling for almost all functions in Phase V**
  - **Most customers never play with them (think of all those interesting jumper blocks inside your PC!)**
  - **Some of the functions are there just to support some very bizarre uses of similar functions under Phase IV (more later)**
    - **Like nodes which are only *sort* of there for security reasons**

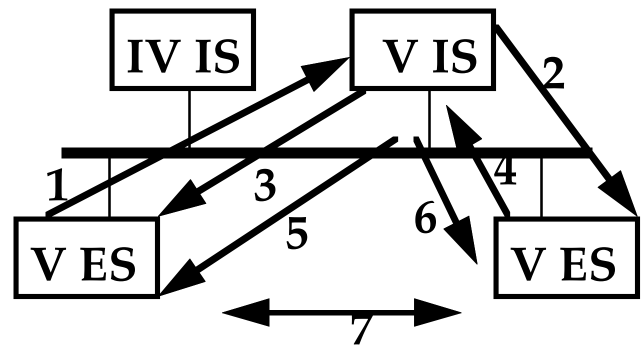
# Transition Issues

- **One more point about designing ES nodes which are multi-lingual**
  - **You must carefully think through all the mixed mode cases because it is in these boundary cases where your brain pops**
  - **This is one case where the customer benefit is very clear, but it is also costly to design and build this level of integration, it may not be worth it in all cases**
  - **Asymmetrical behavior in a mixed configuration is an example of what to be careful about.**

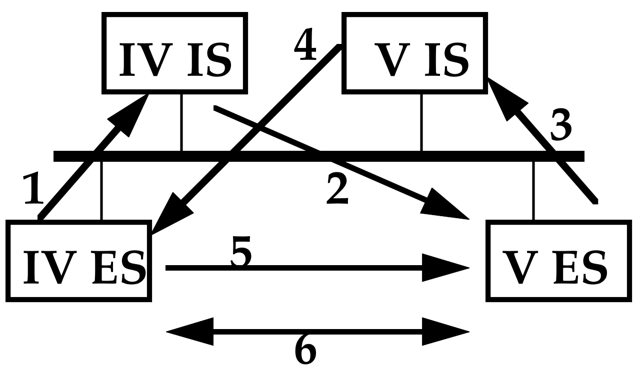
# Example of Asymmetric Behavior



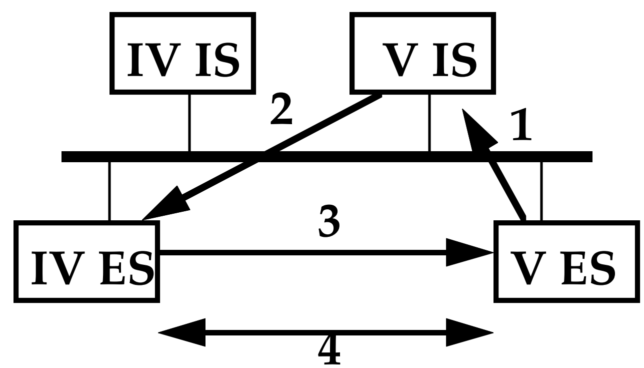

1. Phase IV only




2. Phase V only




3. Mixed, Phase IV starts

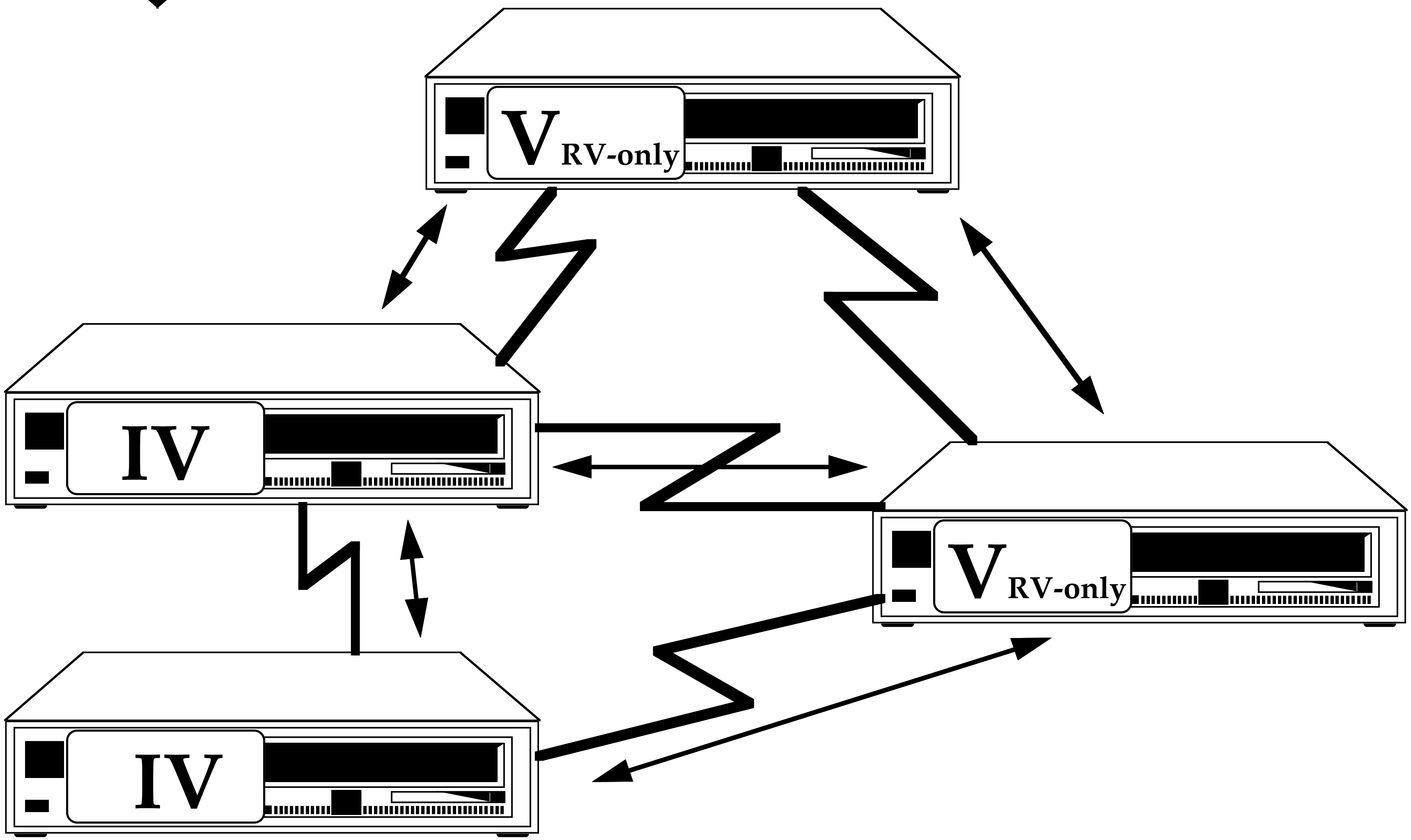



3. Mixed, Phase V starts

# Transition Process

- Since each area or group of areas may administered by a different authority, areas must be convertible to Phase V independently of each other
- In addition, we required that Phase V routers be able to support both Phase IV and Phase V ES nodes within any area
  - This requires Phase V routers to support both Phase IV and Phase V ES-IS protocols and processing concurrently
- We also required the ability to upgrade the router software one node at a time, while the area was up
  - The IS software has a management switch which can be set to RV only, RV but LS-ready, or LS only
  - Install the IS software set to RV only, the Phase V IS will behave the same as a Phase IV IS
  - There is no reason to bring the entire area down to upgrade all IS at the same time

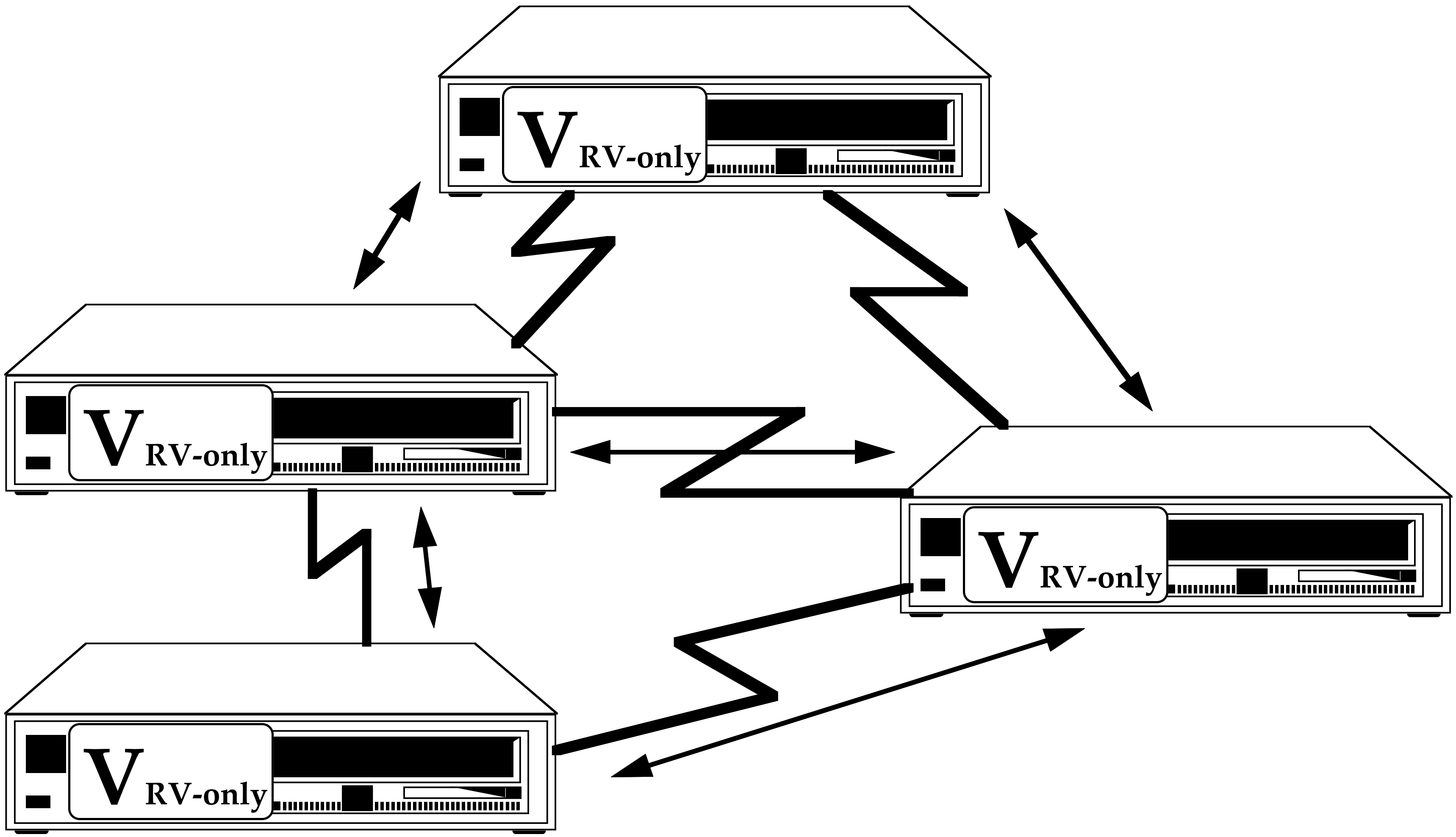
# IS Transition Process



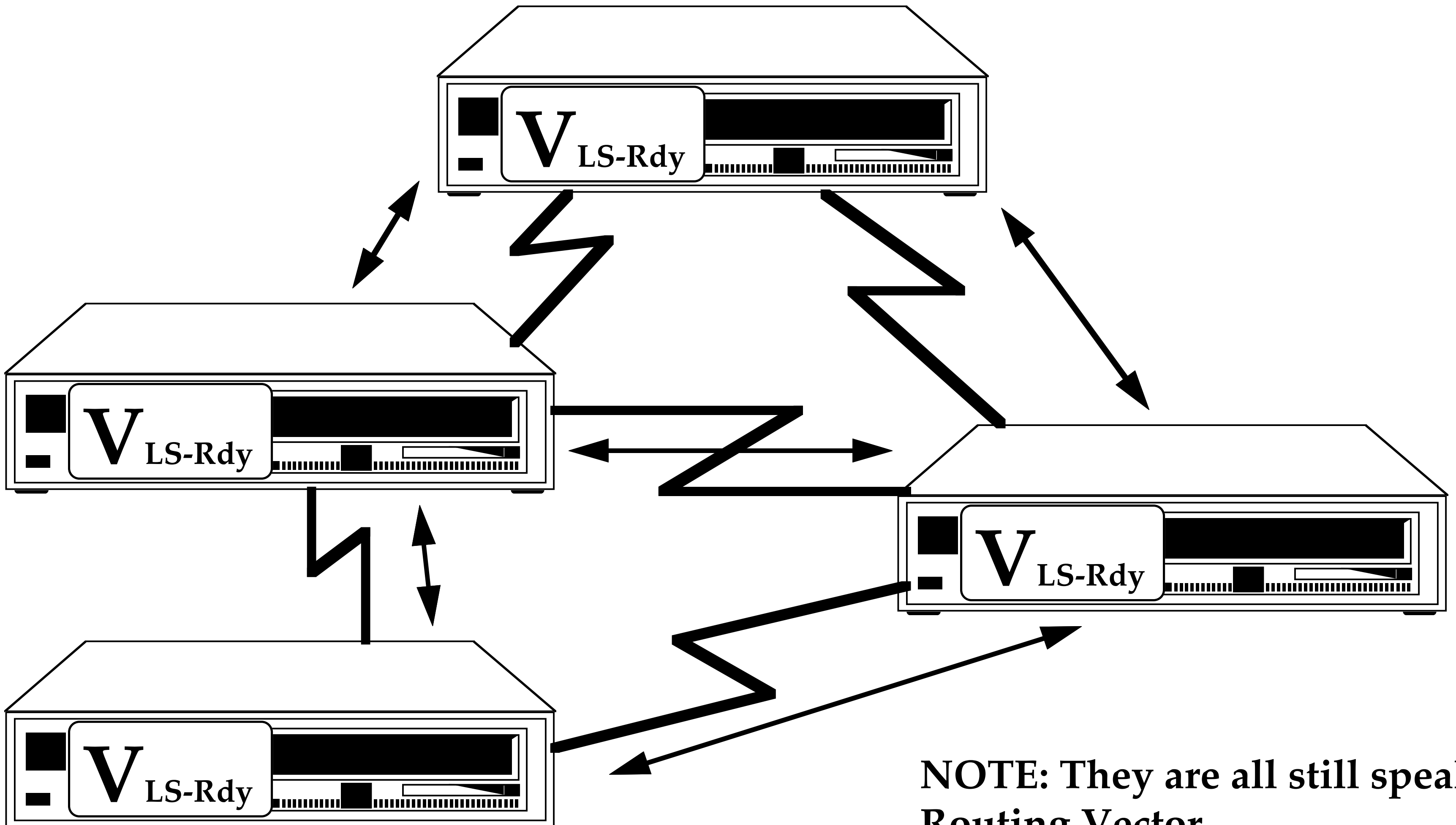
# IS Transition Process

- **Once all the IS software within an area had been upgraded (set to RV-only), then the conversion to Link State routing can occur**
  - Via network management, all the routers were set to "RV but LS-ready"
  - After this was complete, a single router in the area was set to "LS-only"
  - The flooded Link State packet from that router would cause all other routers to switch to running Link State
  - If a mistake occurred, that single router could be set back to "RV but LS-ready" which would cause all the routers in the area to switch back to running Routing Vector
- **This automatic transition of the routing protocol was considered an important feature to simplify the introduction of the new protocol and reduce the area down time**

# *The IS Transition Process - The software is upgraded..*

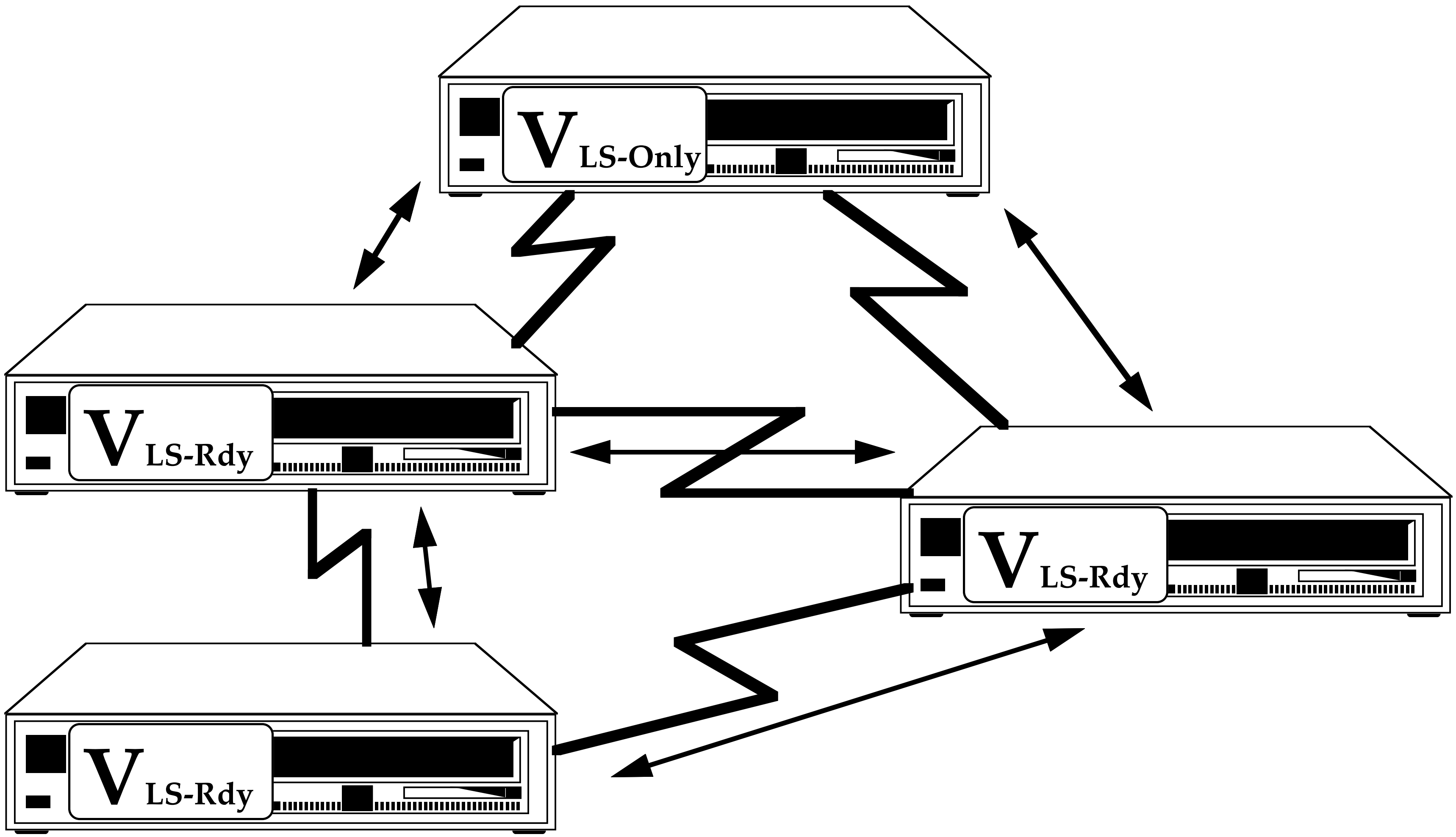


# The IS Transition Process -
# The routers are armed...

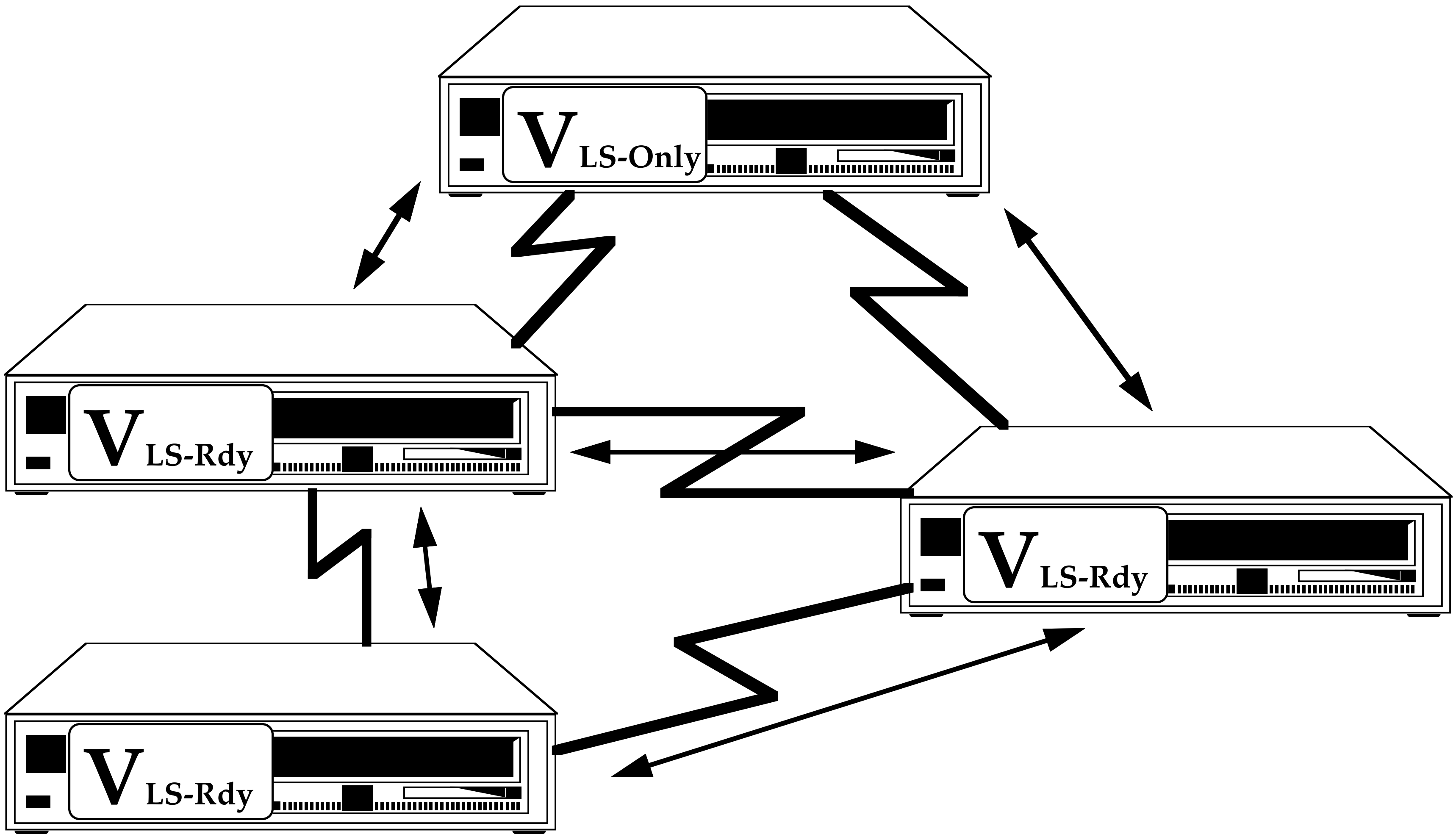



**NOTE: They are all still speaking Routing Vector**

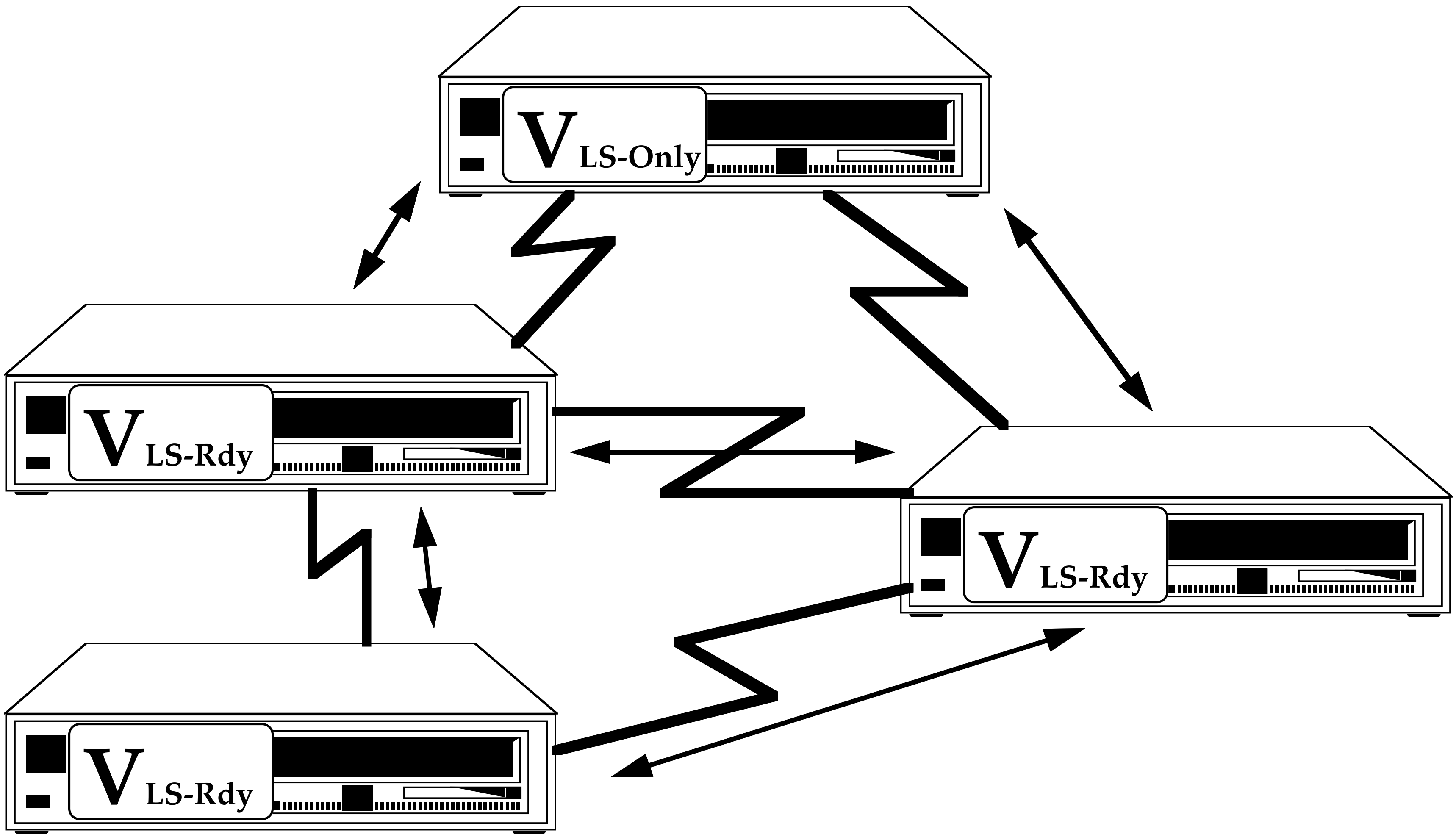
# *The IS Transition Process - Flip the first node...*



# e IS Transition Process -
# ...and the rest follow...



# *The IS Transition Process -*
# *...until they are all done!*



# ne Notes about this

- **After the network is running Link State, the management switches are set to "LS-Only" one system at a time to prevent an accidental reversion back to Routing Vector**
- **I've presented this along the original Digital migration strategy which involves integrated routing support for Phase IV and Phase V**
  - **BUT, the same technique could be used to deploy and enable a SIN style incremental support or protocol converters between protocol types**

# *Other Shoe Drops...*

- *None* **of the customers were willing to use this technique!**
  - **In fact, we were surprised that they were horrified by the whole idea**
- **The reason is easy to see in hind sight:**
  - **We were focusing on a good idea, namely keeping the transition as simple as possible for the routing administrator**
  - **We didn't fully internalize the operational issues involved for the routing administrator**
    - **The administrators are measured on their ability to keep the network running to certain levels of stability and up-time**
    - **While the technique promised to minimize the amount of time within the area, the possible benefits were more than offset by the risk that the automated conversion might get stuck**
    - **The administrators also would not trust a solution which only gets exercised once in each network**
- **Most customers have ended up rebooting the area manually overnight with operators at each routing site**

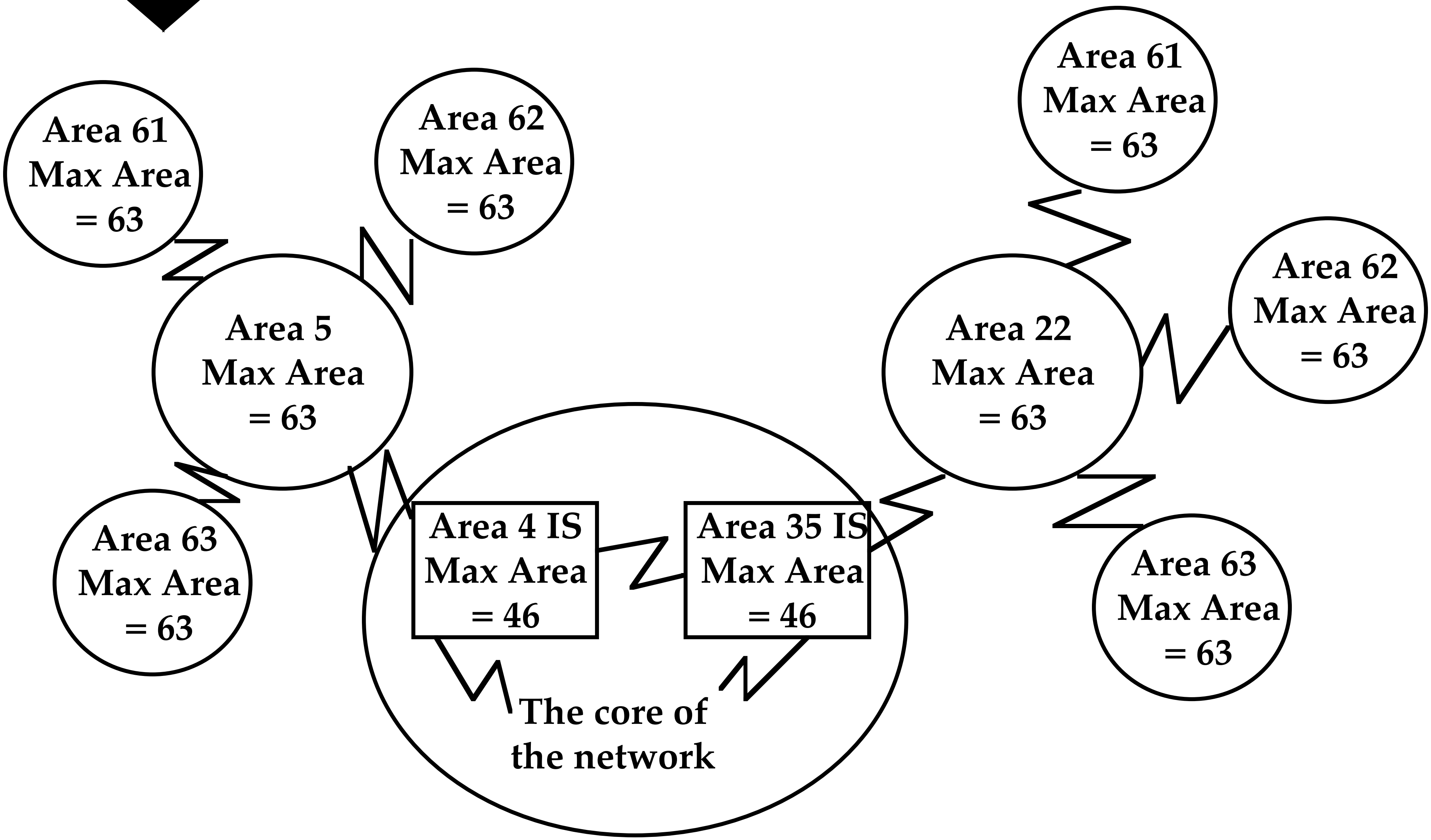
# Transition Issues

- **Allowing various mixed configurations has been very important**
- **We have a significant number of networks which have**
  - **a mixture of Phase IV and Phase V areas within the network**
  - **a mixture of Phase IV and Phase V software within Phase IV areas**
  - **a mixture of end systems in each type of area**
- **Unlike ES transition, the routing administrators prefer a tighter control over the transition, manual reconfiguration is preferred for changes to the routing core of the network**
- **We have had to propagate and support network management parameters in Phase V which were specific to Phase IV in order to support specific un-anticipated configurations based on those parameters**

# cial Considerations

- **Techniques which cause multiple nodes to have the same address have been a nightmare for transition**
  - There are nodes hidden behind “Max Address” filters within areas
  - There are entire areas hidden behind “Max Area” filters
  - We even have one customer who has significantly more nodes hidden than are visible, including several countries which only have hidden nodes
- **Hidden nodes create all sorts of problems due to duplicate addresses, duplicate names, and partitioned networks**
- **These parameters were designed to control the propogation of routing information, not to control the network diameter or support duplicate addresses**

# Example of Hiding Areas



# Learnings

- Take everything I've said with a grain of salt, each protocol stack is different, but much of the DECnet learnings may apply
- Separate the Transition into several independent, more focused transitions
  - Applications Transition
  - End System Transition
  - Level 1 Router Transition
  - Level 2 Router Transition
- Avoid the use of routing parameters for address duplication. In general, avoid the 'unnatural' use of routing control parameters - you'll be sorry if you do!!

# *Learnings*

- **Mapping the old address space as a subset of the new**
  - **This idea has worked out well for us several times now**
  - **This idea helps to support existing applications over new stacks**
  - **This idea works very well with “Passthrough” applications**
- **Preserving the existing application APIs**
  - **This is important to preserve the installed application base**
  - **The larger the installed base, the more likely non-standard APIs were used in mission critical applications**
  - **Expect applications to move to new APIs slowly**
  - **Don’t forget about the installation and configuration part of apps**

# Learnings

- **Having End Systems support both the new and old stacks at the same time**
  - This is an important feature to support the controlled deployment of the new protocol within existing networks
  - Some End Systems will never upgrade, but will exist for a long time due to legacy applications and issues other than networking
  - Be careful to evaluate the actual way in which the user has used the system, it is likely different than was designed or expected
  - Take special care with mixed protocol cases and asymmetry
  - This tactic is complicated to design and build but holds great value for the end user
  - Remember that in general, the end users want the transition to happen transparently, with as little user interaction as possible

# Learnings

- **Having Intermediate Systems support both the new and old protocols at the same time**
  - This is an important feature to support the controlled deployment of the new protocol within existing networks
  - Allows the customer to upgrade the software on the IS even if they are staying with the old protocol
  - Be careful to evaluate the actual way in which the user has used the system, it is likely different than was designed or expected
  - This solution avoids a big-bang day where major sections of the routing network must be taken down for a massive upgrade
  - This tactic is complicated to design and build but holds great value for the routing administrator
  - Remember that in general, the routing administrators want the transition to happen under their direct control, with support for completely backing out to the previous state if something goes wrong

# Learnings

- **Within the development group we formed a team focusing specifically on transition issues**
  - **Members represented the tech office, management, marketing, the customer test group, educational services, the service organization, and the EASYnet.**
  - **The group partnered with several key customers and worked with the customers to develop transition plans for their networks**
    - **We got a better understanding of operational issues**
    - **They got free transition help**
  - **This team was responsible for recommending modifications to the architecture or products, the development of marketing and training materials, and transition literature**

***Thanks for listening...***
***....any questions?***