OpenVMS advanced technical symposium – May 2007

Networking with OpenVMS

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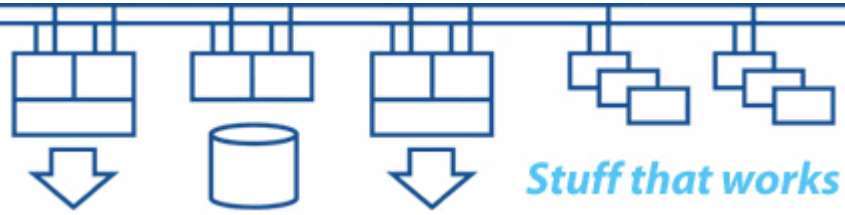

Overview

- Overview of networking and how networks work (switching, VLANs etc.)
- OpenVMS network protocols summary (SCS, TCPIP, DECnet, LAT, MOP etc.)
- DECnet-Plus and DECnet Phase IV overview
- TCPIP overview
- DECnet over IP overview
- Networking with multiple network interfaces for availability and performance
- Problem solving techniques and examples

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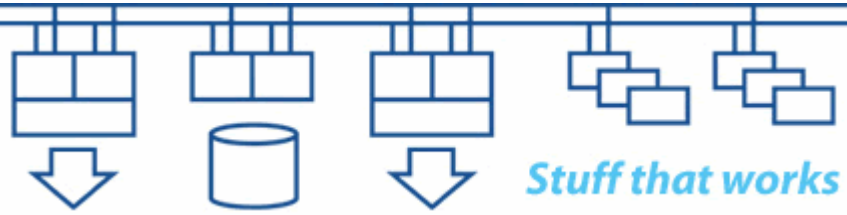
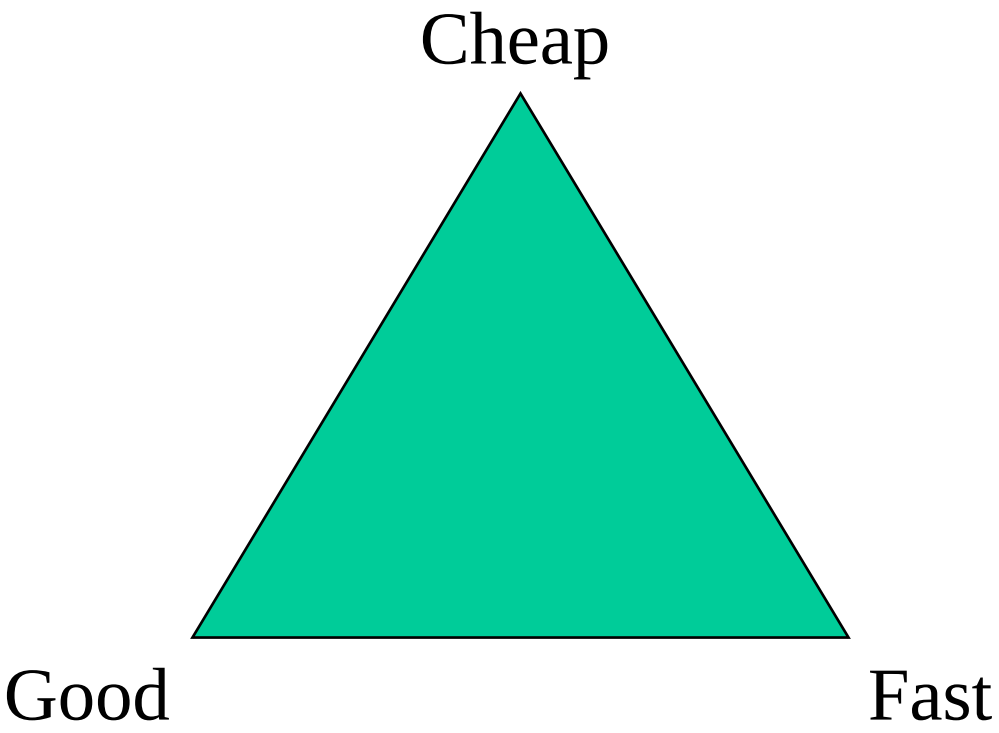


Compromises – pick any two!



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Cabling

- **Copper:**
  - **Co-axial (thick-wire, thin-wire)**
  - **Twisted pair (Category 5, 5E, Category 6 etc.)**
- **Fibre-optic:**
  - **Monomode (typically 9 micron)**
  - **Multimode (typically 50 or 62.5 micron)**

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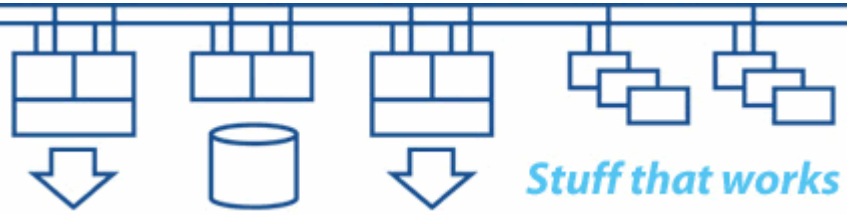

Ethernet

- 10 Mbit/sec
- 100 Mbit/sec (Fast ethernet)
- 1,000 Mbit/sec (Gigabit ethernet)
- 10,000 Mbit/sec (10Gigabit ethernet)
- Copper / fibre (different transmission characteristics)

- Wireless ethernet (802.11a/b/g etc.)
  - Note: WAP, GPRS, HSCSD, Bluetooth etc. are not wireless ethernet.

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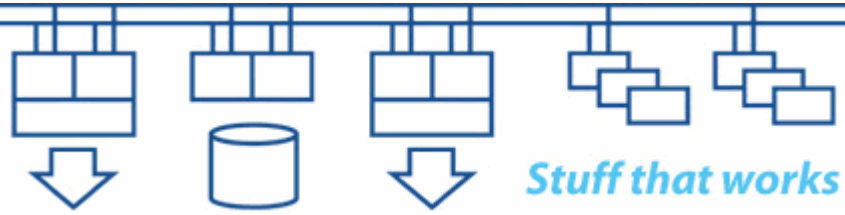

Common ethernet types

- 10base5 (thick-wire co-axial 500m)
- 10base2 (thin-wire co-axial 185m)
- 10baseT (2 pair in 4 pair cable, 100m, RJ45, Cat 3)
- 10baseF / FOIRL (fibre-optic, 2 core)
- 100baseT (2 pair in 4 pair cable, 100m, RJ45, Cat 5)
- 100baseF (fibre-optic, 2 core)
- 1000baseT (4 pair, 100m, RJ45, Cat 5E)
- 1000baseF (fibre-optic, 2 core)

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Ethernet addressing

- **Hardware MAC address**
- **Physical MAC address**
- **Broadcast address**
- **Multicast addresses**
- **Point to point addresses**
- **Ethernet packet format v IEEE802.3 packet format**

- ***TIP: SDA>SHOW LAN/FULL***

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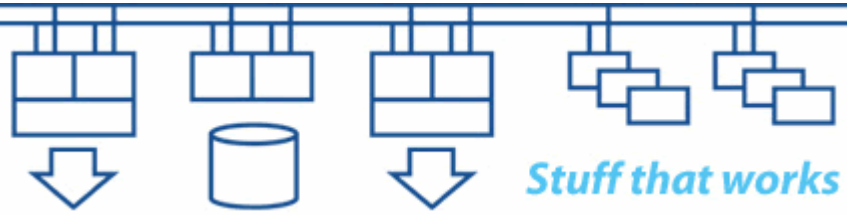

LAN - Segmentation

Why segment a network?

- Performance
- Security
- Availability

How can you segment a network?

- Repeaters
- Bridges
- Switches
- VLANs
- Routers

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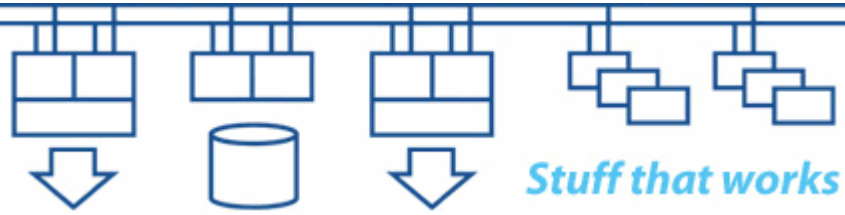

Repeaters

- **Layer 1 devices (“flat” network)**
- **Provide electrical fault isolation**
- **Simply re-time and re-transmit signal**
- **No control of bandwidth**
- **Beware of cumulative end to end delay exceeding maximum permissible frame timing – which leads to ‘folklore’ such as the “three repeater rule”**

- ***TIP:*** ***Beware of the generic term “hub”***

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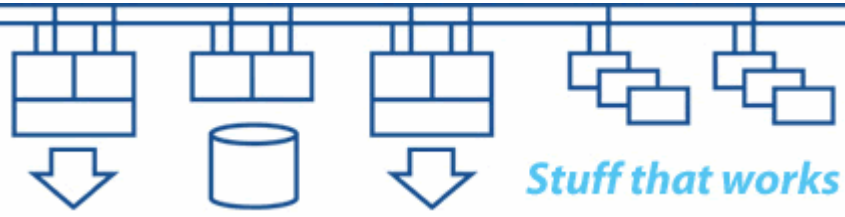

Bridges

- **Packet content based (Layer 2)**
- **Store and Forward**
- **Easy to use and configure**
- **Poor control of bandwidth (filtering)**
- **Spanning tree algorithm**
- **Provides an extended LAN**
- **Not all protocols can tolerate the inherent delays in working over an extended LAN**
- **Remote booting (MOP, BOOTP etc.) will absorb bandwidth**

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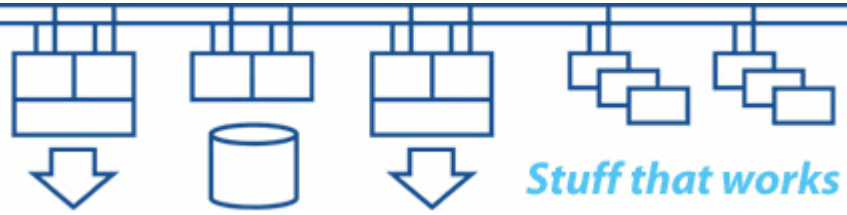

Switches

- Introduces parallelism
- Speed of chipsets (latency & bandwidth)
- Full duplex operation on a single device per port basis
- Traffic monitoring (mirror ports)
- Link aggregation
- Bandwidth control
- “Store and forward” versus “Cut through” switching
- Layer 2, Layer 3 etc. switching
  - Layer 3 generally refers to TCP/IP routing layer
  - Layer 4 generally refers to TCP/IP port numbers, eg: HTTP port 80 traffic)

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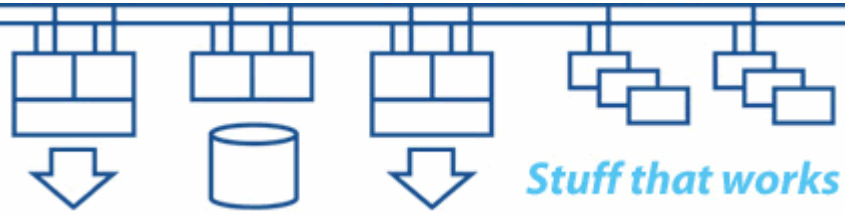

Virtual LANs (VLANs)

Using VLANs to segment a network:

- Implemented within core switches
- Layer 2, Layer 3 etc.
- Port based VLANs
- Protocol based VLANs
- Connectivity between VLANs
- VLAN tagging of packets (802.1Q)

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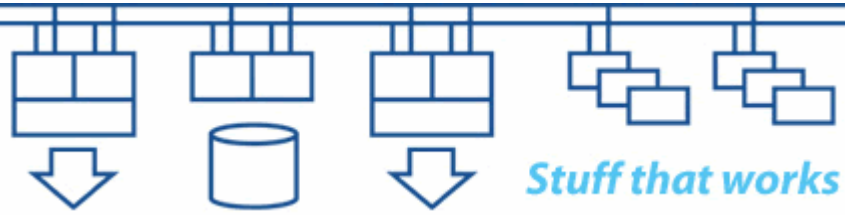

Wireless ethernet

- **Shared bandwidth (“flat” network)**
- **Security issues (access control, data encryption)**
- **Roaming issues (multiple Access Points to switch ports and MAC addres migration between ports)**
- **Wireless bridges**

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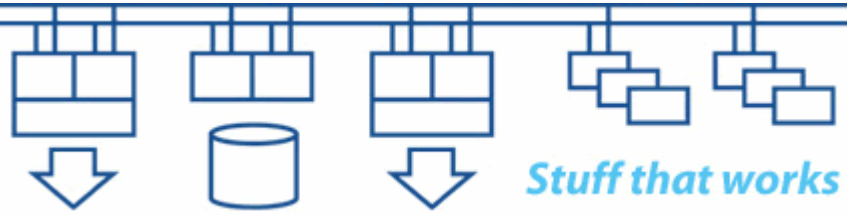

Routers

Routers are generally used to interconnect LANs over a WAN

- **Separate devices or can be integrated into the core**
- **Need to design protocol addressing scheme and areas**
- **Good control over bandwidth**
- **Layer 3 devices – protocol address based**
- **IPV6 is common in big core routers**
- **Rare to find DECnet routing in modern routers – it's a TCP/IP dominated world in the WAN**
- **Can set up OpenVMS systems as dedicated multiprotocol routers if you need both DECnet and TCP/IP routing**

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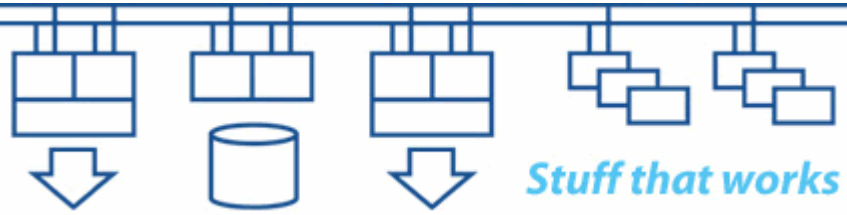

Performance

- **Latency - determines response times**
- **Bandwidth - determines throughput**
- **Parallelism - make use of multiple paths and devices**

- **Multiple adapters**
- **Multiple networks**
- **Split protocols across adapters**
- **Configure systems appropriately**

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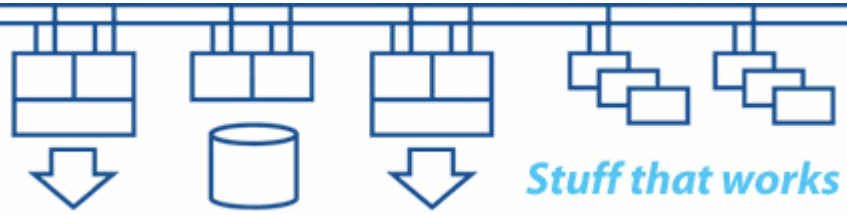

Availability

- Availability is more important than performance
- Scale network so that desired overall system performance is based on minimum essential number of paths and maximum estimated traffic
- Take advantage of available bandwidth capacity to provide additional functionality when everything is working
- Duplicate devices such as network printers and terminal servers on different paths
- Segment the network to provide gradual degradation rather than wholesale failure
- Network management is all about problem identification and rectification

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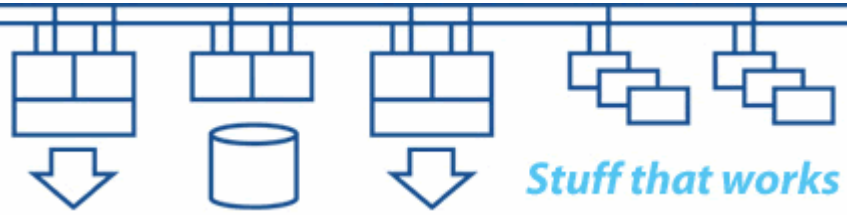

Common protocols

Typical network protocols in use with OpenVMS systems:

- **SCS (clustering)**
- **TCP/IP (and all it's components)**
- **DECnet-Plus (NSP,OSI and DECnet over IP) or DECnet Phase IV (NSP only)**
- **DECdns (not to be confused with TCP/IP's DNS/BIND)**
- **LAT (DECserver terminal access etc.)**
- **MOP + Remote Console (DECserver, LAVC boot etc.)**
- **DTSS (can be disabled)**
- **LAD + LAST (Infoserver etc.)**

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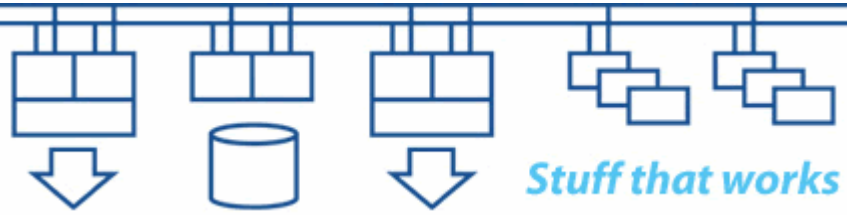

DECnet Naming Conventions

- **DECnet is a network protocol – a set of carefully constructed and written rules that define how computer systems can exchange data in a reliable and consistent manner.**

- **Underlying architecture has a name:**
  eg: Digital Network Architecture Phase V

- **Product is an implementation of that architecture:**
  eg: DECnet/OSI V6.3 and DECnet-Plus V7.3-2 are both implementations of DNA Phase V

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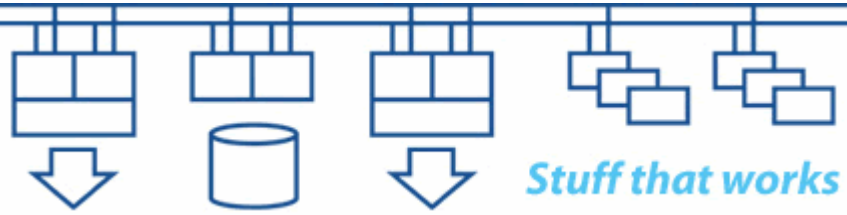

DECnet History

- **Phase IV (around VMS V4)**
- **Phase IV Plus (around VMS V5.2) – introduced:**
  - **End-Node Failover (Many circuits, only one active)**
  - **Path Splitting over multiple equal cost paths (Out of order packet cache)**
- **DECnet/VAX extensions for Phase IV**
  - **Provides NCL for router hardware setup on Phase IV**
- **DECnet/OSI (Phase V)**
  - **Multi-homed End System (Many circuits, all active)**
- **DECnet-Plus (Phase V)**
  - **Re-introduced Host-Based Routing**

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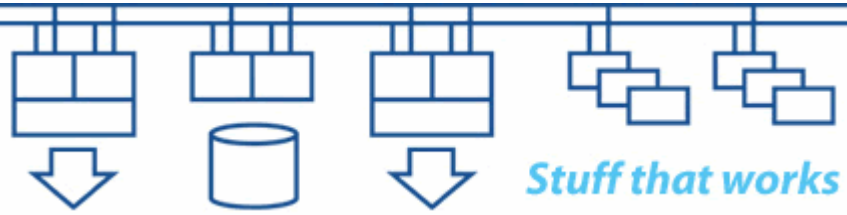

TCP/IP History

- **Originally UCX (Ultrix Connection) up to V4.2**
- **Third party TCPIP protocol stacks available (TCPware, Multinet etc.)**
- **Became TCPIP Services from V5.0 onwards. Based on port of Tru64 UNIX TCPIP kernel to OpenVMS.**
- **Need PWIP driver for DECnet over IP functionality**

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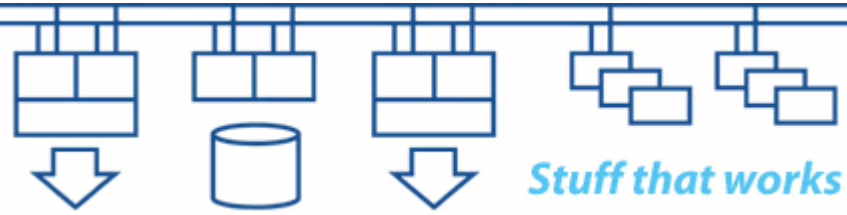

OpenVMS networking features (1)

- **VAX VMS V4.x introduced SCS for LAVC**
- **Infoserver introduced LAD / LAST for serving remote disc containers. Also used by RSM. Available in OpenVMS V8.2-1 onwards for Integrity to provide network upgrade.**
- **Pathworks (Advanced Server) introduced DECnet for PC operating systems and LANmanager functionality for OpenVMS systems. Replaced by CIFS (based on SAMBA)**
- **Galaxy introduced SMCI pseudo-LAN interconnect**

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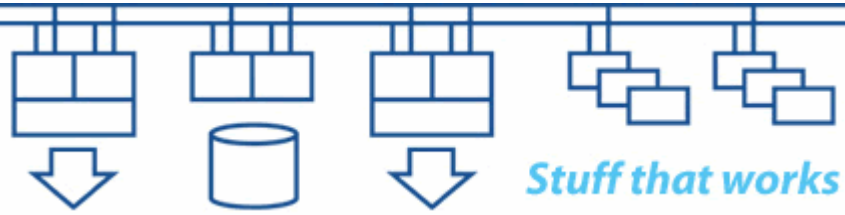

OpenVMS networking features (2)

- **OpenVMS V7.1 introduced LANCP / LANACP for MOP loading without DECnet (needed to load cluster satellites)**
- **OpenVMS V7.3-2 introduced “LAN failover” for improved LAN availability (all protocols)**
- **TCP/IP V5.4 introduced “failsafe IP” for improved TCP/IP availability within a cluster**

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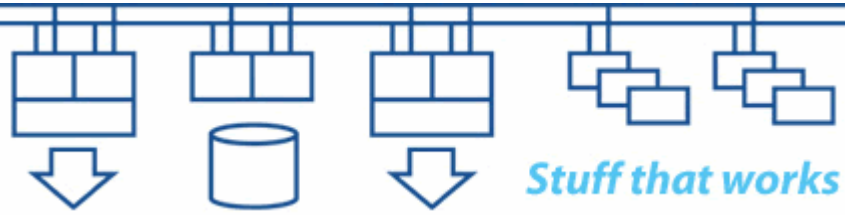

NCP entities:

- **Executor (representation of the local node)**
- **Circuit (representation of logical connection path)**
- **Line (representation of hardware)**
- **Node (representation of other “executors”)**
- **Object (representation of an application port)**
- **Link (representation of a path between objects)**

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DECnet Phase IV - Terms

- **End Node**
- **Routing Nodes: Level 1 & Level 2 (Area) Routers**
- **MAC Address formed from Node address:**
  - **Area 1 - 63, Node: 1 - 1023**
  - **16 bit address = (Area x 1024) + Node number**
  - **SCSSYSTEMID = same 16 bit value**
  - **AA-00-04-00-nn-mm**
  - **nn-mm = byte reversed hexadecimal 16 bit address**

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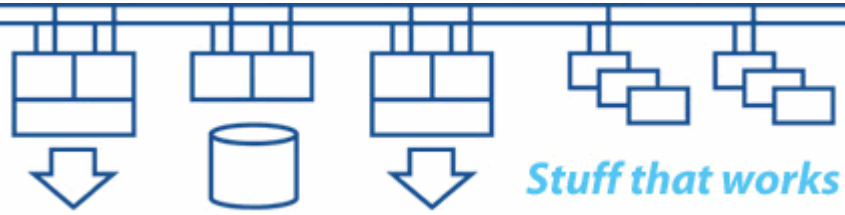

DECnet Phase IV – who's where?

- **DECnet "hidden information":**
  - **End Node to Routers (end node hello packets)**
  - **Routers to Routers (routing updates)**
  - **Routers to End Nodes (router hello packets)**

- **DECnet Phase IV bases the MAC address on the node number, so no need for routers on LAN except for determining adjacencies.**

TIP: ***Router on LAN will give fast "node unreachable" rather than slow "timeout" when attempting to connect to a node that is not on the LAN.***

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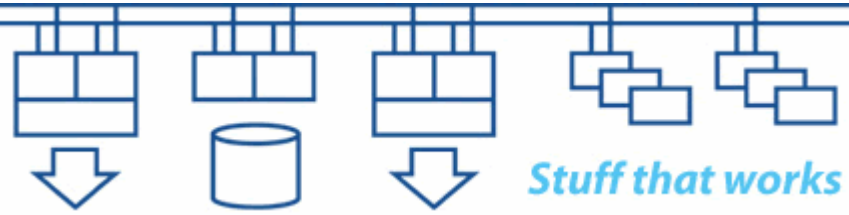

DECnet Phase IV - Routing

- **Areas are used to limit the size of routing tables and to reduce the “routing update” problem.**
- **DECnet addresses outside our area number need an area router if not on LAN.**
- **DECnet will use the highest numbered (by DECnet address) router node as the primary router by default.**
- **No need to change node address if node is moved within the LAN, or if all within the same DECnet area.**

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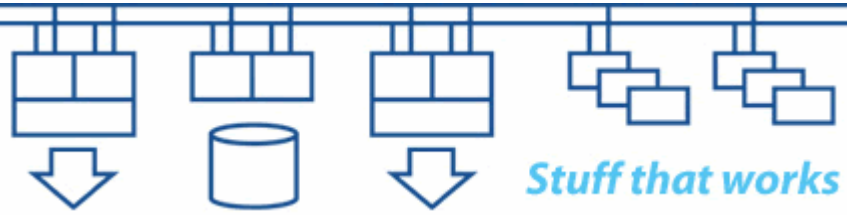

DECnet Phase IV - Limitations

- **Number of nodes in a private network can exceed the address range (eg: Easynet)**
- **MOP loader needs fake node entries**
- **Sets MAC address on all LAN adapters based on DECnet node address, so cannot connect multiple LAN adapters to the same LAN (or extended LAN).**

TIP: ***Can route between parallel LANs, but cannot bridge between them due to the risk of duplicate MAC addresses.***

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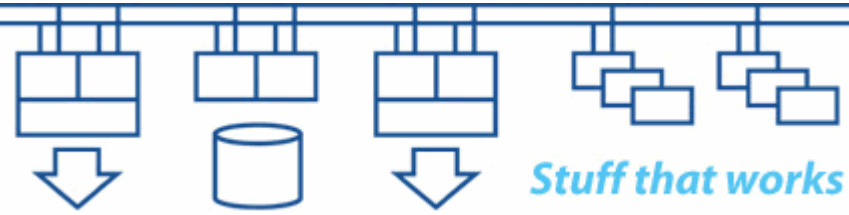

DECnet Phase IV to Phase V

- **The obvious big difference - NCL in place of NCP**
- **Name Services**
- **DECnet over IP**
- **Permanent database is NCL script files (text)**
- **Time Synchronisation Service**
- **Routing algorithms (Phase V routers)**
- **Multiple path behaviour (multi-homed End System)**
- **Startup early in boot sequence**
- **Phase IV compatible addressing on first adapter only (by default)**

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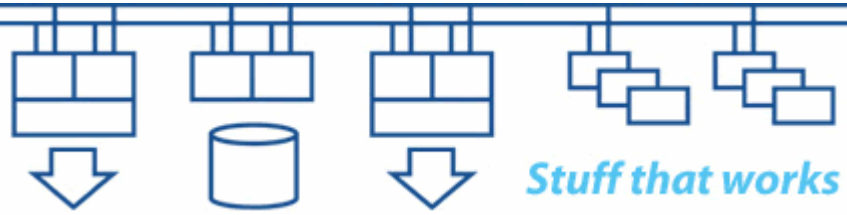

NCL in place of NCP

- **Clearly shows OSI layers in the “entity hierarchy”**
- **Very powerful, far more so than NCP**
- **NCL scripts form the equivalent of the Phase IV permanent databases.**
- **DECNET_REGISTER to maintain known nodes list**
- **DECwindows interface (NET$MGMT) with ability to display the equivalent NCL commands**
- **NCL SHOW … WITH … syntax**

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OSI 7 layer model

7	**Application**	**Provides for distributed processing and access, contains application programs and supporting protocols (eg FTAM).**
6	**Presentation**	**Coordinates conversion of data and data formats to meet the needs of the individual applications.**
5	**Session**	**Organises and structures the interactions between pairs of communicating applications.**
4	**Transport**	**Provides reliable transparent transfer of data between end systems with error recover and flow control.**
3	**Network**	**Permits communication between network entities.**
2	**Data link**	**Specifies the technique for moving data along network links between defined points on the network, and how to detect and correct errors in the Physical layer (layer 1).**
1	**Physical**	**Connects systems to the physical communications media.**

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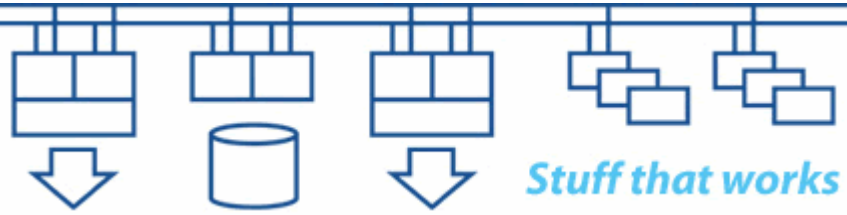
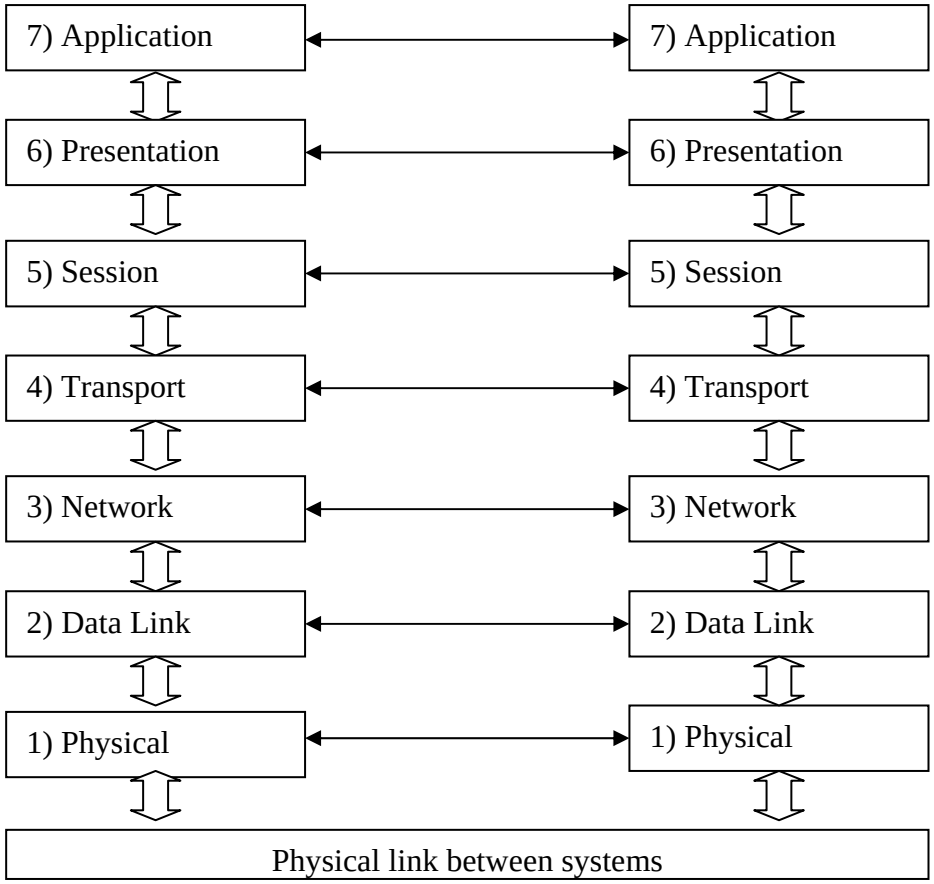


Data flow between the layers



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NCL Entities

- session control
  - applications and ports
- transports
  - NSP and OSI (plus OSI templates)
- routing
- routing circuits
- csma-cd station (ethernet and FDDI)
- <datatype> links (HDLC, DDCMP etc.)
  - <datatype> link logical station
- modem connect lines

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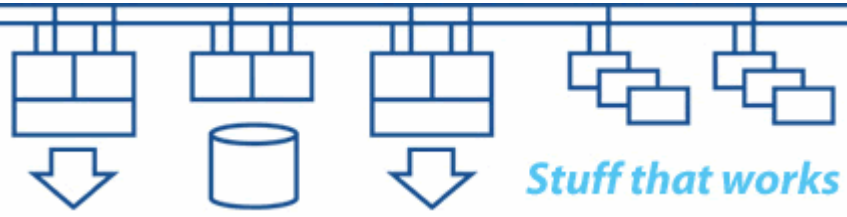

Which Name Service to use?

- **Local**
- **DECdns**
- **Domain (DNS/BIND) – the TCP/IP name resolver**

- **NameServer replication**
- **Layered Product Requirements for DECdns use (DECdfs, RSM etc.)**
- **DECNET_REGISTER**

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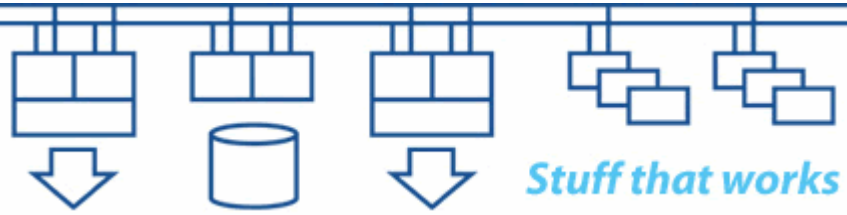

DECnet Addressing

- **Phase IV compatible addressing**
  - **The AA-00-04-00-xx-xx address**
  - **Multiple CSMA-CD adapters**

- **Synonyms and FullNames**
- **Address Towers**
  - **Transport selection (NSP or TP4)**
  - **Session Control version selection (SC2 or SC3)**

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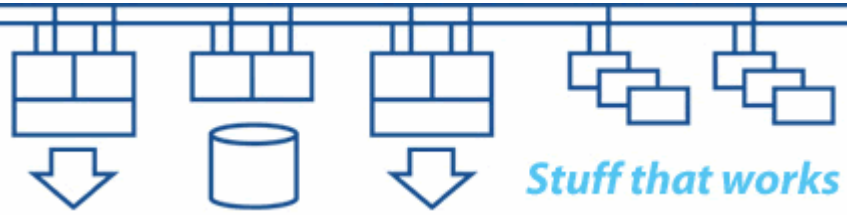

Routing

- **Why have Routers at all?**
- **Prior to DECnet-Plus V7.1 all Phase V routing is done by separate dedicated routers (Intermediate Systems). Good for big networks. Expensive for small networks.**
- **Multi-Homed End Systems can reduce routing requirements**

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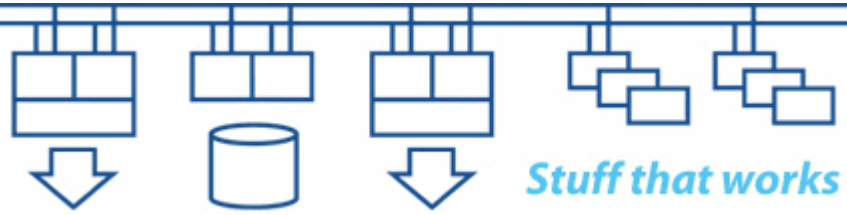

OpenVMS / DECnet-Plus V7.3-2 onwards

- **Can disable DTSS by defining the NET$DISABLE_DTSS logical name in SYLOGICALS.COM.**
- **DTSS server can receive time from NTP (example provided)**
- **New procedures for changing DST zone rules (Alpha only), also see AUTO_DLIGHT_SAV system parameter**
- **Phase IV migration improvements (databases, FDDI)**
- **Improved NCL help**
- **Reduced NCL output on boot by default (NET$STARTUP_QUIET_NCL logical)**

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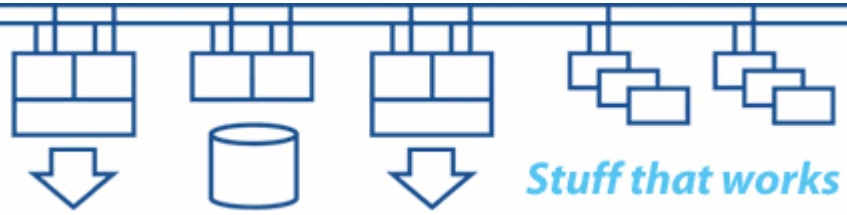

DECnet over IP (1 of 2)

- **Preserves DECnet APIs for existing applications**
- **Performance and availability are determined by underlying IP network infrastructure**
- **DECnet uses TCPIP as a pseudo-transport layer**
- **Need to have RFC1006 and RFC1869 (aka RFC1006-Plus) OSI transport templates - ports 102 and 399**
- **Streams interface**
- **Need to have PWIP driver enabled**

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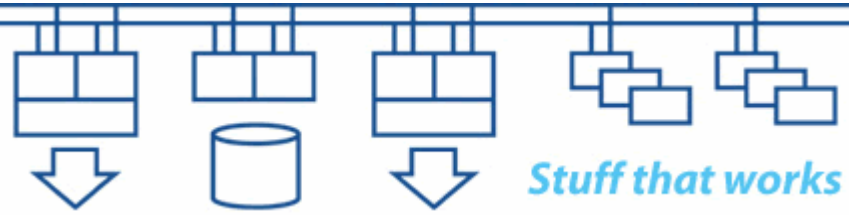

DECnet over IP (2 of 2)

- **Need to have DNS/BIND name service in list for access to local name resolver:**
  - **@NET$CONFIGURE ADVANCED**
  - **Naming services: "LOCAL,DOMAIN"**
  - **use 127.0.0.1 as address of name resolver!**
- **Can enable DECnet over IP "on the fly":**
  - **change the naming (remove from LOCAL or DECdns naming database with DECNET_REGISTER and add to HOSTS database or DNS/BIND server)**
  - **NCL> FLUSH SESSION CONTROL NAMING CACHE ENTRY "*"**

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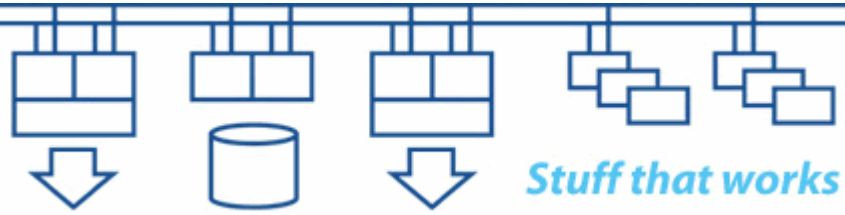

Phase V summary

- **Don’t be scared of Phase V - it works, generally at least as well as or better than Phase IV**
- **NCL is a much better tool than NCP**
- **Keep it simple - use Local naming, Phase IV compatible addressing and the NSP transport**
- **DECnet over IP lets you use applications with the DECnet APIs over a TCP/IP only infrastructure**
- **Multi-Homed End Systems get you load balancing for the price of an end-node licence**

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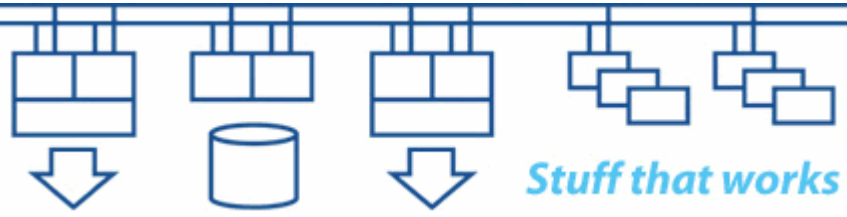
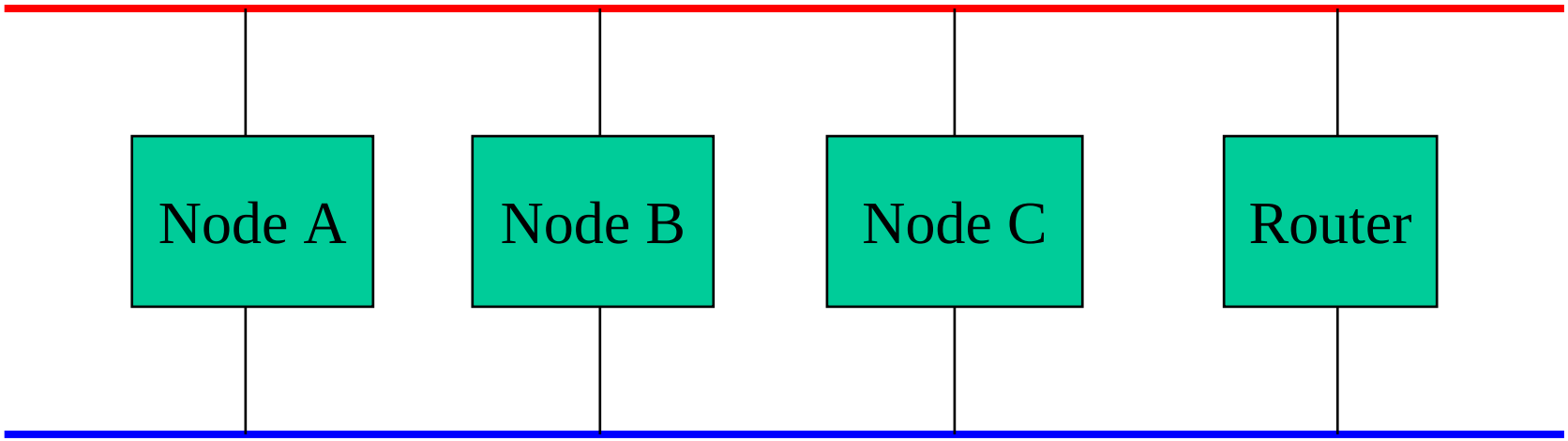


Dual LAN behaviour



- **Phase IV – different costs, all L1 routers**
- **Phase IV Plus – same costs, all L1 routers**
- **Phase IV Plus – same costs, end node failover**
- **DECnet/OSI – both active, Multi-homed End Systems**
- **DECnet-Plus – both active, Multi-homed ES or IS**

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Multiple LAN interface behaviours

- **LAN failover (LLdriver)**
- **DECnet Phase IV and V - load balancing**
- **TCP/IP - Failsafe IP**
- **SCS – stopping and starting per adapter with SCACP or LAVC$START_BUS / LAVC$STOP_BUS**

- **MOP and LANCP (network booting)**
- **LAD / LAST (InfoServer)**
- **LAT (DECservers)**

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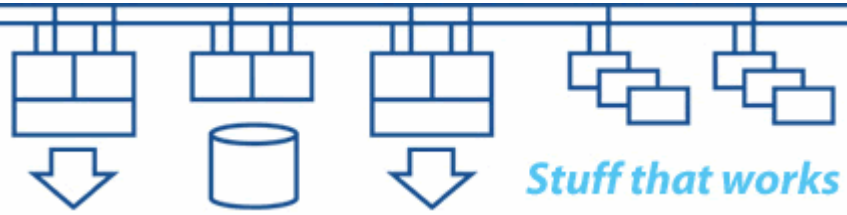

Relative time is more useful than absolute time

- Need to be able to order events across the network based on timestamps
- UTC Timestamp format
  - Time value
  - Inaccuracy component
- External reference clocks
- NTP
- DTSS

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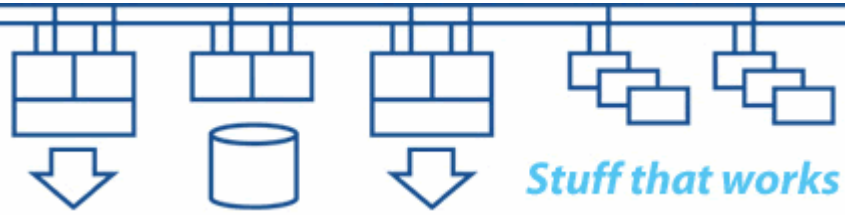

Problem solving concepts

	Before	Now	After
Environment			
System			
Component			

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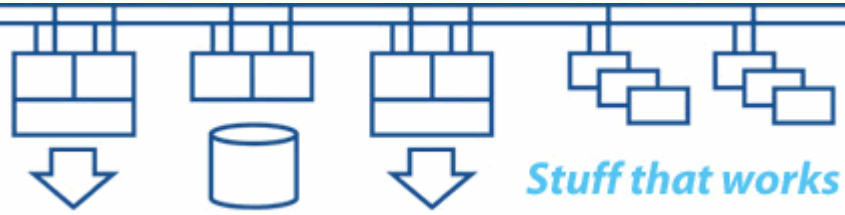

Thank you for your participation

Q & A

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