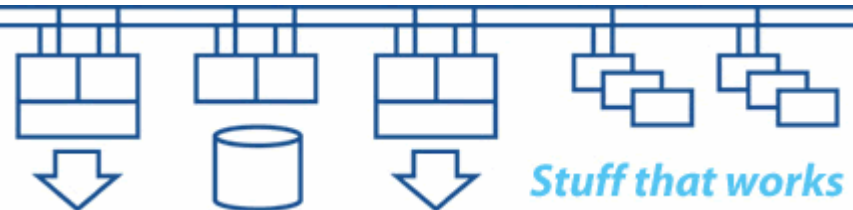


**OpenVMS advanced technical symposium – May 2007**

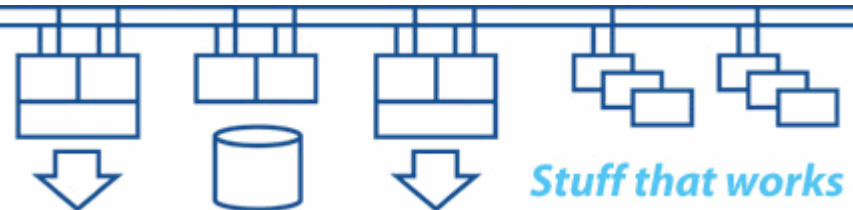
# **Networking with OpenVMS**

**Colin Butcher**

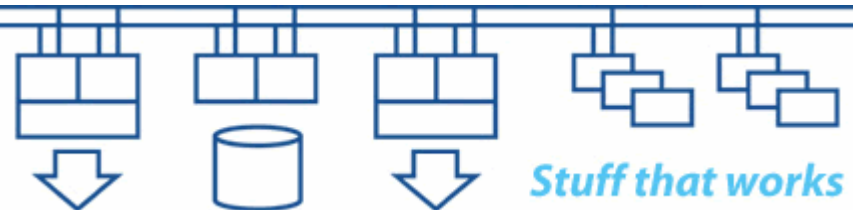
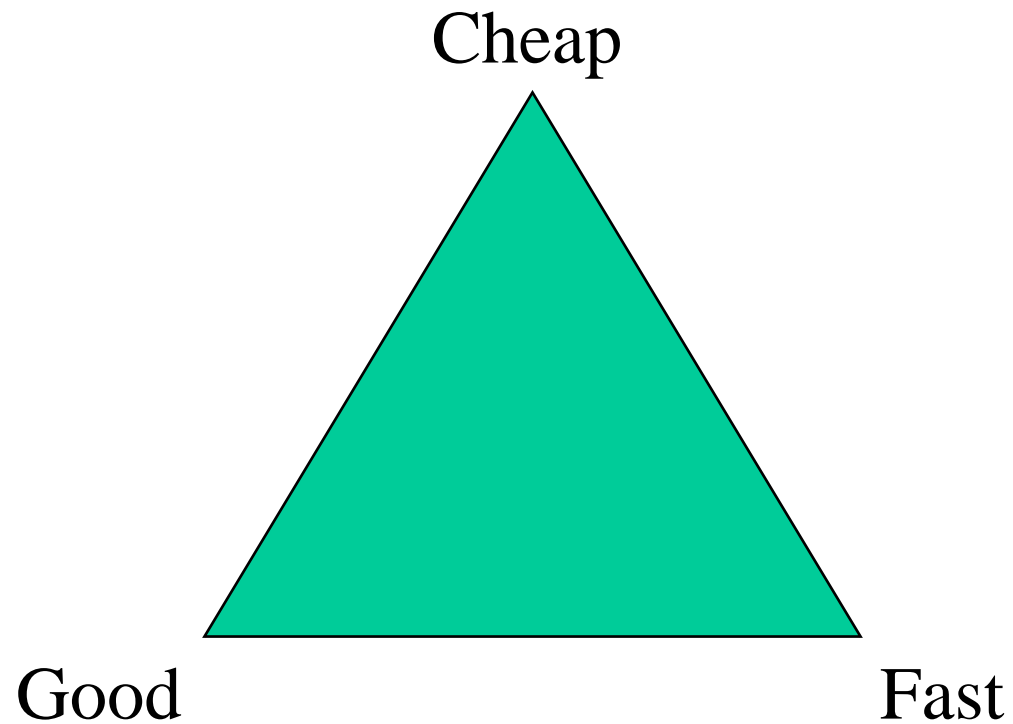
**Technical Director, XDelta Limited**



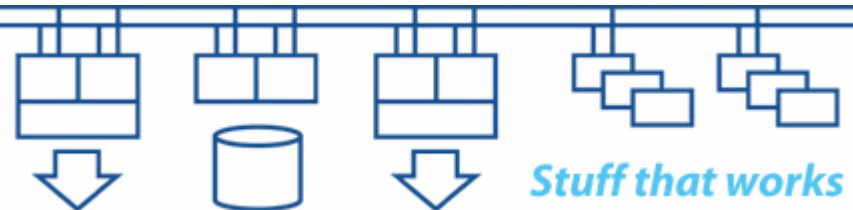
- **Overview of networking and how networks work (switching, VLANs etc.)**
- **OpenVMS network protocols summary (SCS, TCPIP, DECnet, LAT, MOP etc.)**
- **DECnet-Plus and DECnet Phase IV overview**
- **TCPIP overview**
- **DECnet over IP overview**
- **Networking with multiple network interfaces for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



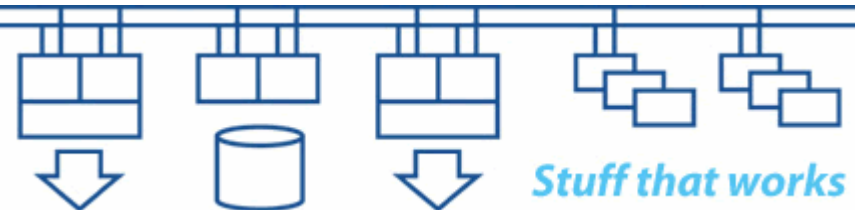
# Compromises – pick any two!



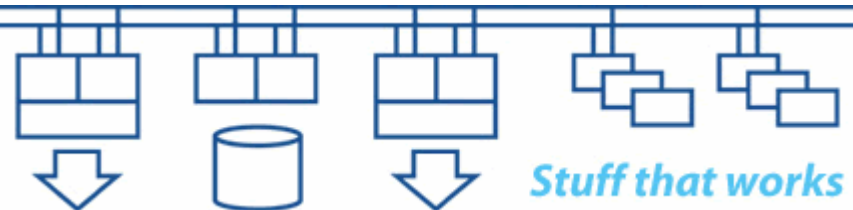
- **Copper:**
  - **Co-axial (thick-wire, thin-wire)**
  - **Twisted pair (Category 5, 5E, Category 6 etc.)**
- **Fibre-optic:**
  - **Monomode (typically 9 micron)**
  - **Multimode (typically 50 or 62.5 micron)**



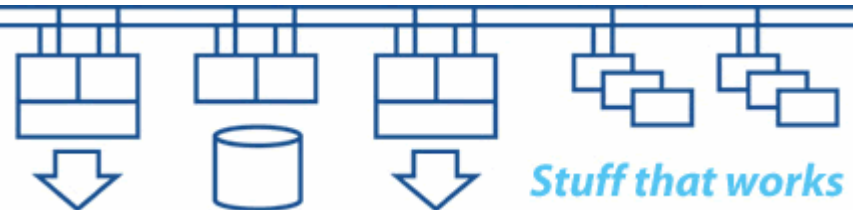
- **10 Mbit/sec**
- **100 Mbit/sec (Fast ethernet)**
- **1,000 Mbit/sec (Gigabit ethernet)**
- **10,000 Mbit/sec (10Gigabit ethernet)**
- **Copper / fibre (different transmission characteristics)**
  
- **Wireless ethernet (802.11a/b/g etc.)**
  - **Note: WAP, GPRS, HSCSD, Bluetooth etc. are not wireless ethernet.**



- **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)**



- **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***

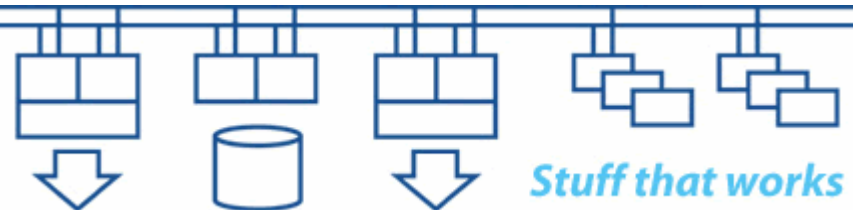


## Why segment a network?

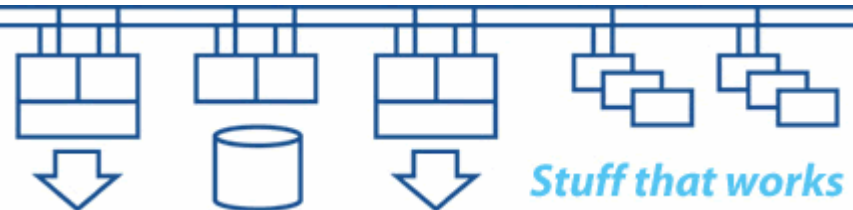
- **Performance**
- **Security**
- **Availability**

## How can you segment a network?

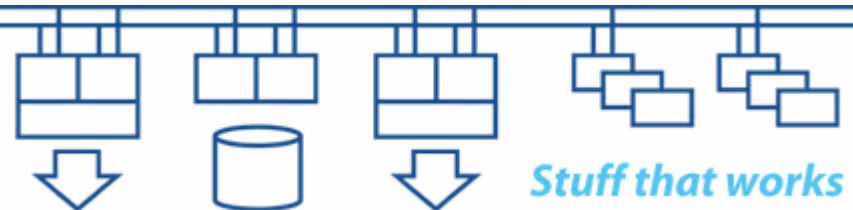
- **Repeaters**
- **Bridges**
- **Switches**
- **VLANs**
- **Routers**



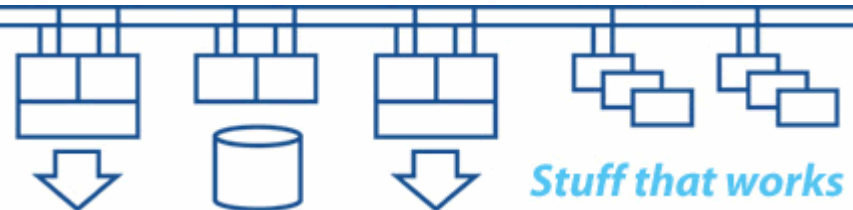
- **Layer 1 devices (“flat” network)**
  - **Provide electrical fault isolation**
  - **Simply re-time and re-transmit signal**
  - **No control of bandwidth**
  - **Beware of cumulative end to end delay exceeding maximum permissible frame timing – which leads to ‘folklore’ such as the “three repeater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



- **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**

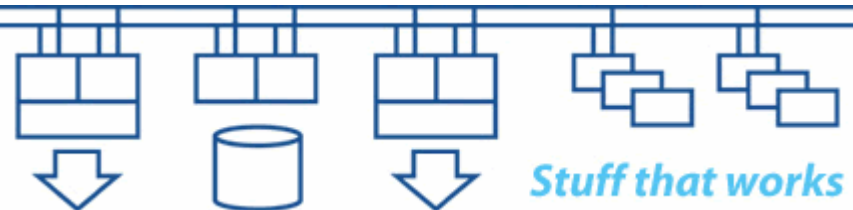


- **Introduces parallelism**
- **Speed of chipsets (latency & bandwidth)**
- **Full duplex operation on a single device per port basis**
- **Traffic monitoring (mirror ports)**
- **Link aggregation**
- **Bandwidth control**
- **“Store and forward” versus “Cut through” switching**
- **Layer 2, Layer 3 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)**

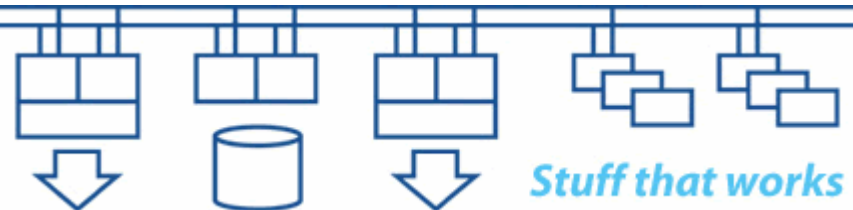


## Using VLANs to segment a network:

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

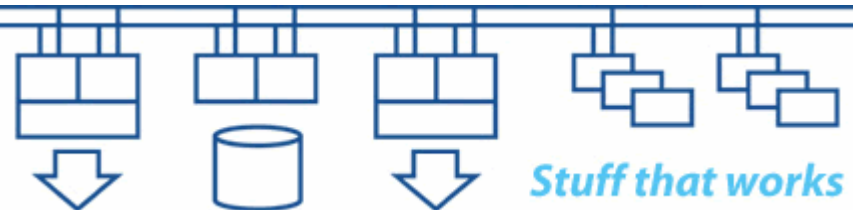


- **Shared bandwidth (“flat” network)**
- **Security issues (access control, data encryption)**
- **Roaming issues (multiple Access Points to switch ports and MAC address migration between ports)**
- **Wireless bridges**

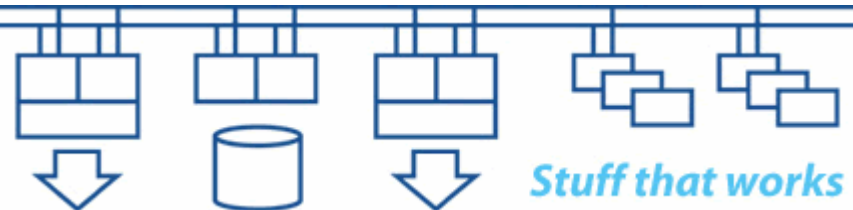


## **Routers are generally used to interconnect LANs over a WAN**

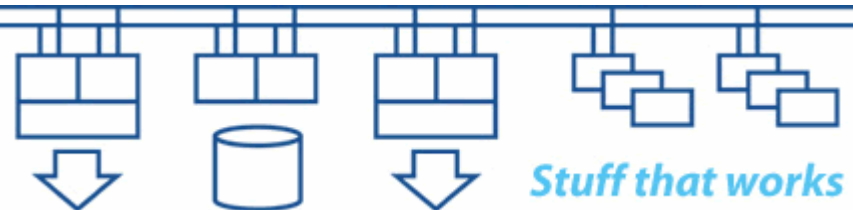
- **Separate devices or can be integrated into the core**
- **Need to design protocol addressing scheme and areas**
- **Good control over bandwidth**
- **Layer 3 devices – protocol address based**
- **IPV6 is common in big core routers**
- **Rare to find DECnet routing in modern routers – it's a TCP/IP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



- **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**

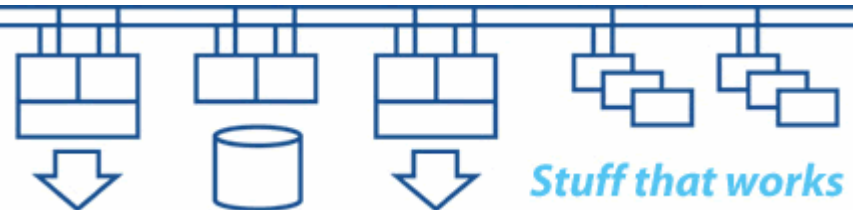


- **Availability is more important than performance**
- **Scale network so that desired overall system performance is based on minimum essential number of paths and maximum estimated traffic**
- **Take advantage of available bandwidth capacity to provide additional functionality when everything is working**
- **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**

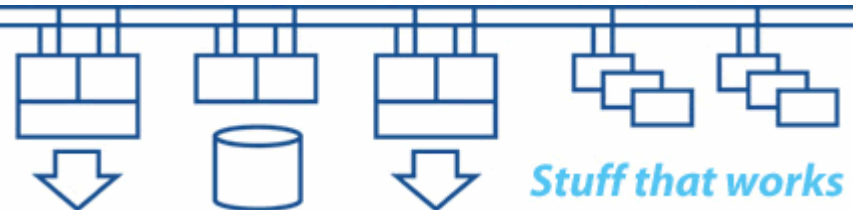


## Typical network protocols in use with OpenVMS systems:

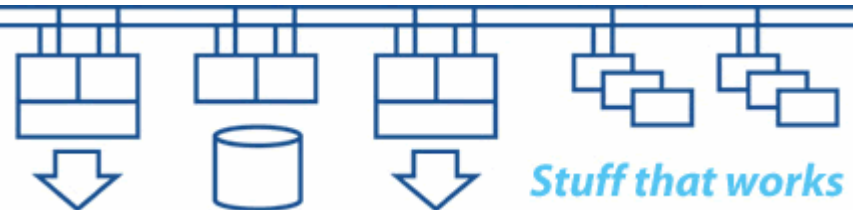
- **SCS (clustering)**
- **TCP/IP (and all it's components)**
- **DECnet-Plus (NSP,OSI and DECnet over IP) or DECnet Phase IV (NSP only)**
- **DECdns (not to be confused with TCP/IP's DNS/BIND)**
- **LAT (DECserver terminal access etc.)**
- **MOP + Remote Console (DECserver, LAVC boot etc.)**
- **DTSS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



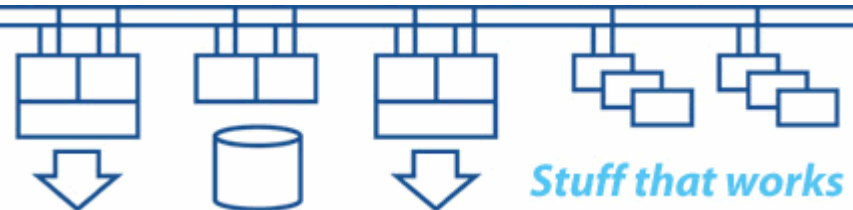
- **DECnet is a network protocol – a set of carefully constructed and written rules that define how computer systems can exchange data in a reliable and consistent manner.**
- **Underlying architecture has a name:  
eg: Digital Network Architecture Phase V**
- **Product is an implementation of that architecture:  
eg: DECnet/OSI V6.3 and DECnet-Plus V7.3-2 are both implementations of DNA Phase V**



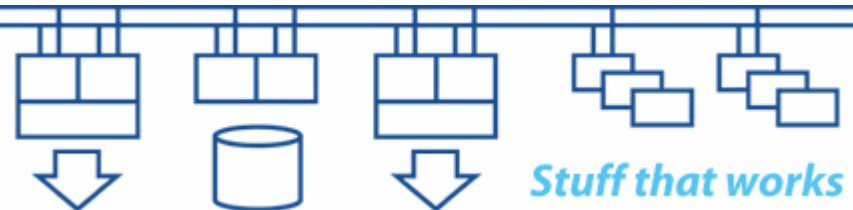
- **Phase IV (around VMS V4)**
- **Phase IV Plus (around VMS V5.2) – introduced:**
  - **End-Node Failover (Many circuits, only one active)**
  - **Path Splitting over multiple equal cost paths (Out of order packet cache)**
- **DECnet/VAX extensions for Phase IV**
  - **Provides NCL for router hardware 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**



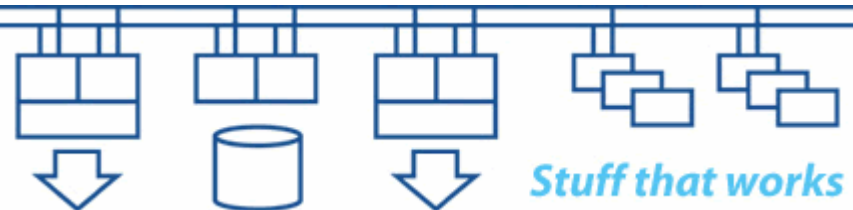
- **Originally UCX (Ultrix Connection) up to V4.2**
- **Third party TCPIP protocol stacks available (TCPware, Multinet etc.)**
- **Became TCPIP Services from V5.0 onwards. Based on port of Tru64 UNIX TCPIP kernel to OpenVMS.**
- **Need PWIP driver for DECnet over IP functionality**



- **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**

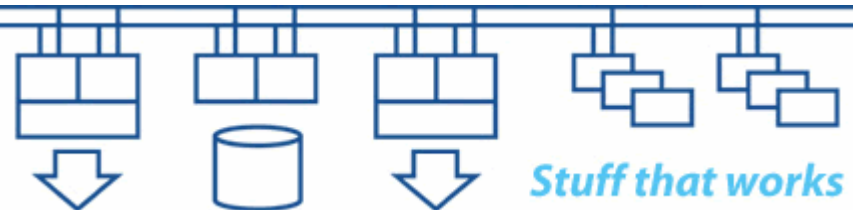


- **OpenVMS V7.1 introduced LANCP / LANACP for MOP loading without DECnet (needed to load cluster satellites)**
- **OpenVMS V7.3-2 introduced “LAN failover” for improved LAN availability (all protocols)**
- **TCP/IP V5.4 introduced “failsafe IP” for improved TCP/IP availability within a cluster**

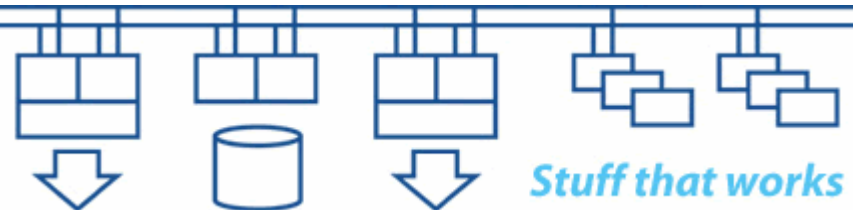


## **NCP entities:**

- **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)**

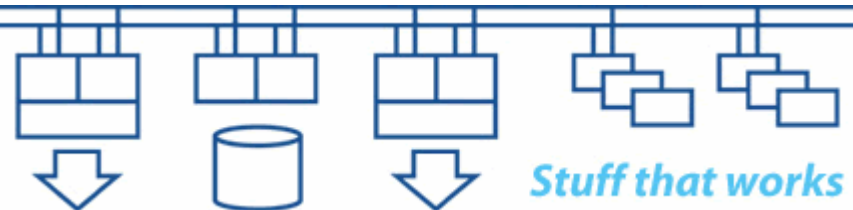


- **End Node**
- **Routing Nodes: Level 1 & Level 2 (Area) Routers**
- **MAC Address formed from Node address:**
  - **Area 1 - 63, Node: 1 - 1023**
  - **16 bit address = (Area x 1024) + Node number**
  - **SCSSYSTEMID = same 16 bit value**
  - **AA-00-04-00-nn-mm**
  - **nn-mm = byte reversed hexadecimal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

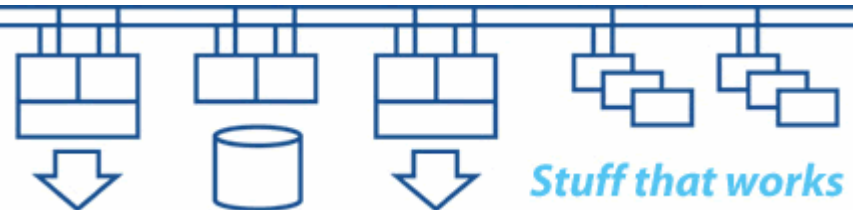


- **DECnet “hidden information”:**
  - **End Node to Routers (end node hello packets)**
  - **Routers to Routers (routing updates)**
  - **Routers to End Nodes (router hello packets)**
  
- **DECnet Phase IV bases the MAC address on the node number, so no need for routers on LAN except for determining 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.***

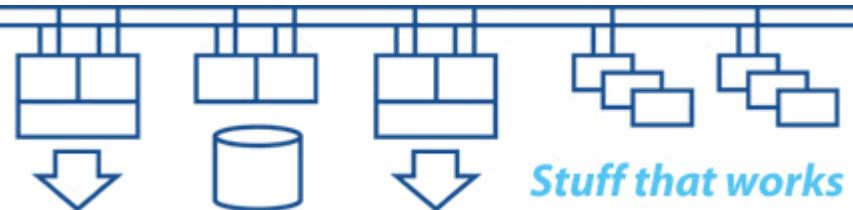


- **Areas are used to limit the size of routing tables and to reduce the “routing update” problem.**
- **DECnet addresses outside our area number need an area router if not on LAN.**
- **DECnet will use the highest numbered (by DECnet address) router node as the primary router by default.**
- **No need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

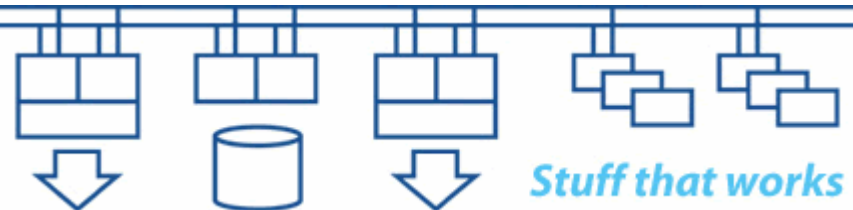


- **Number of nodes in a private network can exceed the address range (eg: Easynet)**
- **MOP loader needs fake node entries**
- **Sets MAC address on all LAN adapters based on DECnet node address, so cannot connect multiple LAN adapters to the same LAN (or extended LAN).**

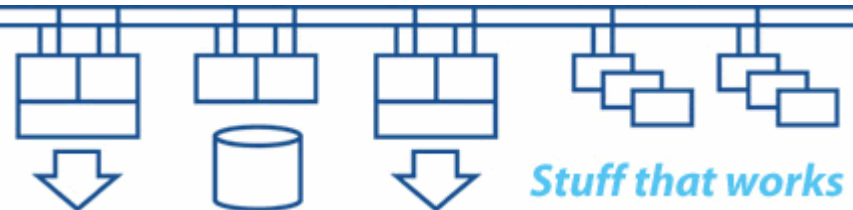
***TIP: Can route between parallel LANs, but cannot bridge between them due to the risk of duplicate MAC addresses.***



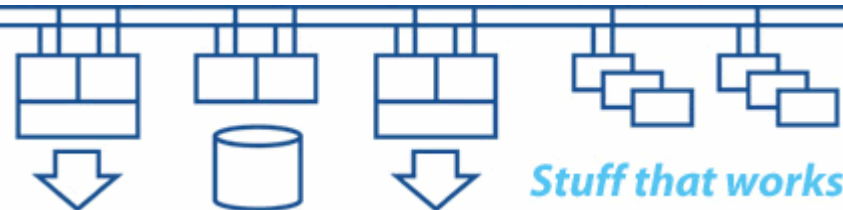
- **The obvious big difference - NCL in place of NCP**
- **Name Services**
- **DECnet over IP**
- **Permanent database is NCL script files (text)**
- **Time Synchronisation Service**
- **Routing algorithms (Phase V routers)**
- **Multiple path behaviour (multi-homed End System)**
- **Startup early in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

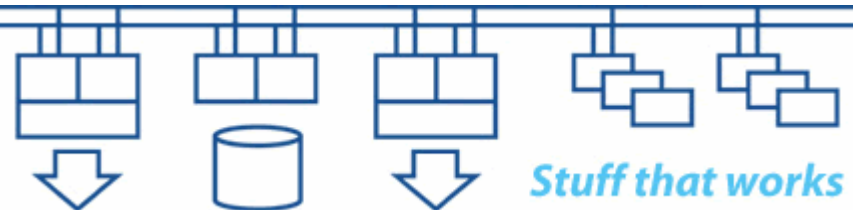
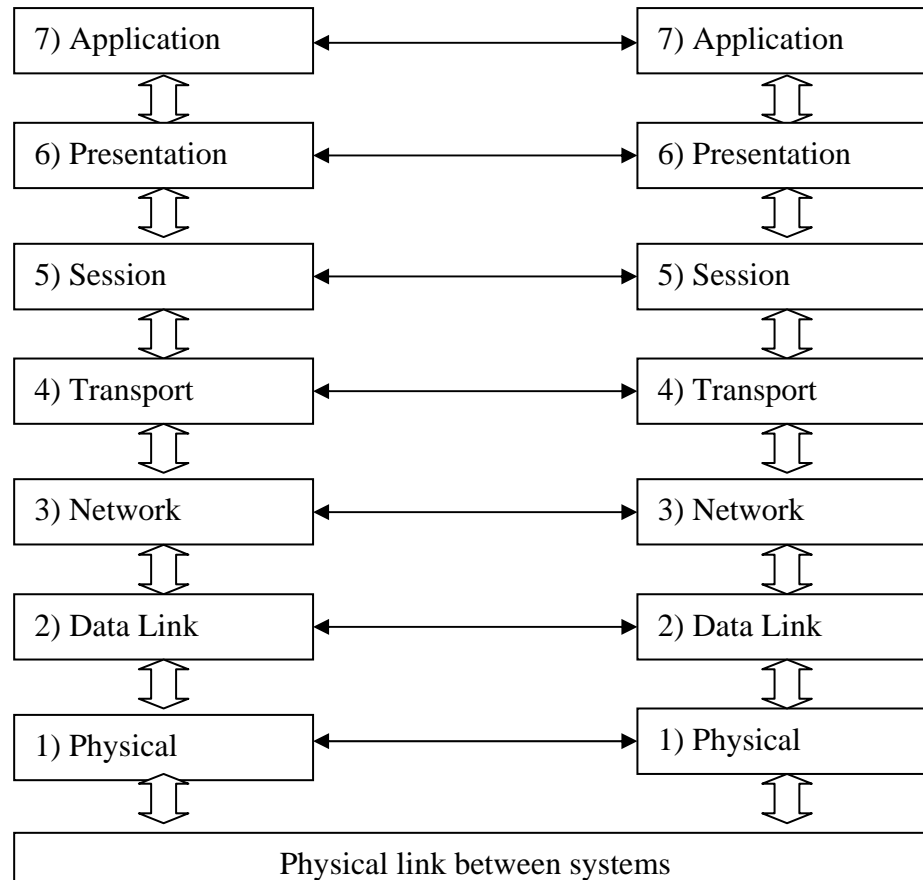


- **Clearly shows OSI layers in the “entity hierarchy”**
- **Very powerful, far more so than NCP**
- **NCL scripts form the equivalent of the Phase IV permanent databases.**
- **DECNET\_REGISTER to maintain known nodes list**
- **DECwindows interface (NET\$MGMT) with ability to display the equivalent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

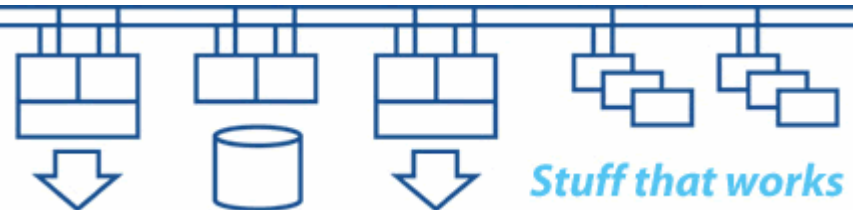


<b>7</b>	<b>Application</b>	<b>Provides for distributed processing and access, contains application programs and supporting protocols (eg FTAM).</b>
<b>6</b>	<b>Presentation</b>	<b>Coordinates conversion of data and data formats to meet the needs of the individual applications.</b>
<b>5</b>	<b>Session</b>	<b>Organises and structures the interactions between pairs of communicating applications.</b>
<b>4</b>	<b>Transport</b>	<b>Provides reliable transparent transfer of data between end systems with error recover and flow control.</b>
<b>3</b>	<b>Network</b>	<b>Permits communication between network entities.</b>
<b>2</b>	<b>Data link</b>	<b>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).</b>
<b>1</b>	<b>Physical</b>	<b>Connects systems to the physical communications media.</b>



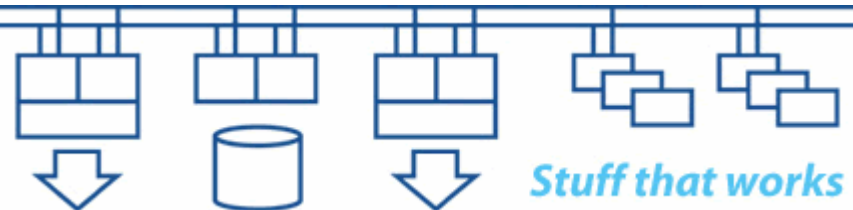


- **session control**
  - applications and ports
- **transports**
  - NSP and OSI (plus OSI templates)
- **routing**
- **routing circuits**
- **csma-cd station (ethernet and FDDI)**
- **<datatype> links (HDLC, DDCMP etc.)**
  - <datatype> link logical station
- **modem connect lines**

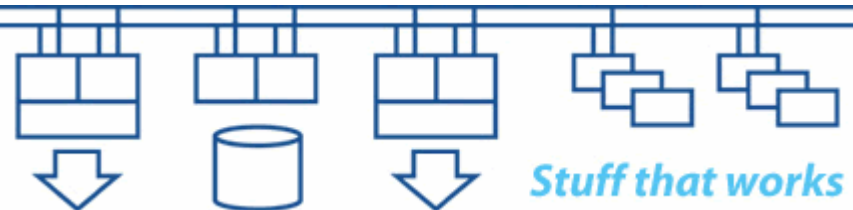


## Which Name Service to use?

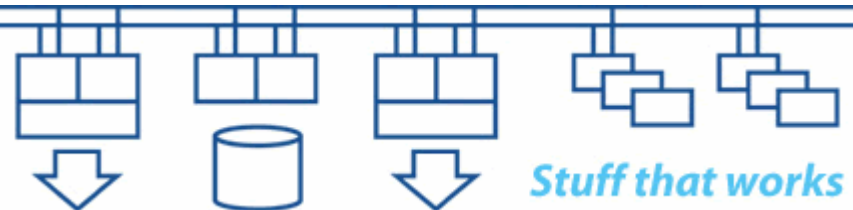
- **Local**
  - **DECdns**
  - **Domain (DNS/BIND) – the TCP/IP name resolver**
- 
- **NameServer replication**
  - **Layered Product Requirements for DECdns use (DECdfs, RSM etc.)**
  - **DECNET\_REGISTER**



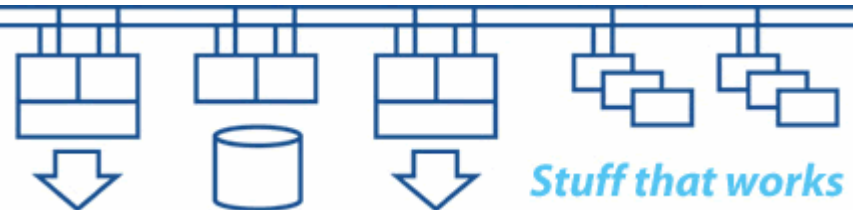
- **Phase IV compatible addressing**
  - **The AA-00-04-00-xx-xx address**
  - **Multiple CSMA-CD adapters**
- **Synonyms and FullNames**
- **Address Towers**
  - **Transport selection (NSP or TP4)**
  - **Session Control version selection (SC2 or SC3)**



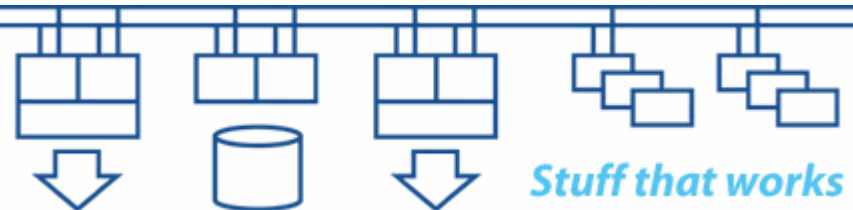
- **Why have Routers at all?**
- **Prior to DECnet-Plus V7.1 all Phase V routing is done by separate dedicated routers (Intermediate Systems). Good for big networks. Expensive for small networks.**
- **Multi-Homed End Systems can reduce routing requirements**



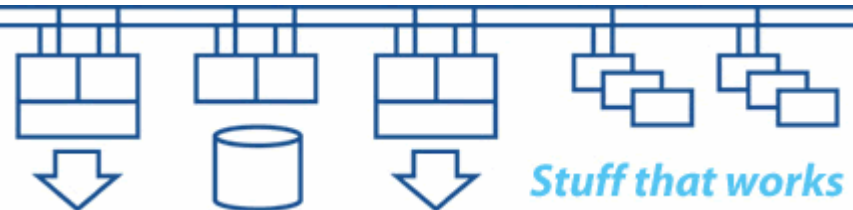
- **Can disable DTSS by defining the NET\$DISABLE\_DTSS logical name in SYLOGICALS.COM.**
- **DTSS server can receive time from NTP (example provided)**
- **New procedures for changing DST zone rules (Alpha only), also see AUTO\_DLIGHT\_SAV system parameter**
- **Phase IV migration improvements (databases,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



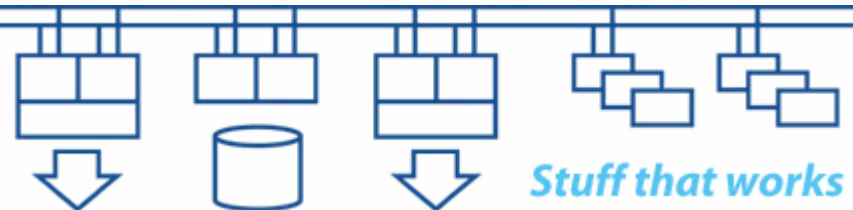
- **Preserves DECnet APIs for existing applications**
- **Performance and availability are determined by underlying IP network infrastructure**
- **DECnet uses TCPIP as a pseudo-transport layer**
- **Need to have RFC1006 and RFC1869 (aka RFC1006-Plus) OSI transport templates - ports 102 and 399**
- **Streams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

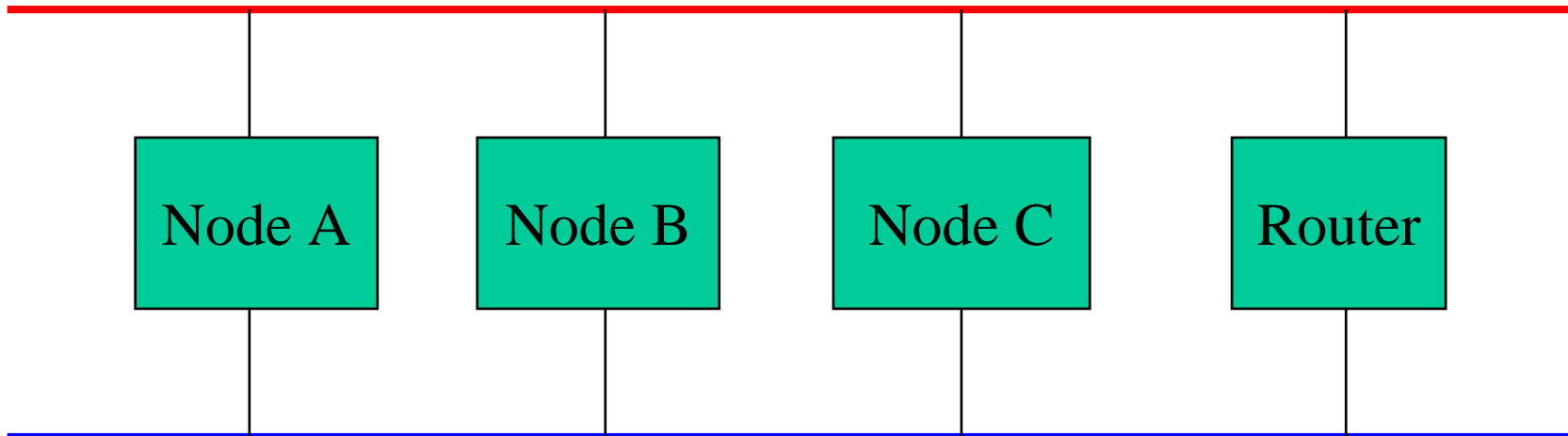


- **Need to have DNS/BIND name service in list for access to local name resolver:**
  - @NET\$CONFIGURE ADVANCED
  - Naming services: “LOCAL,DOMAIN”
  - use 127.0.0.1 as address of name resolver!
- **Can enable DECnet over IP “on the fly”:**
  - change the naming (remove from LOCAL or DECdns naming database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

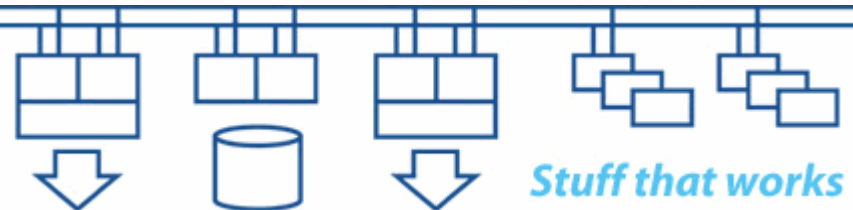


- **Don't be scared of Phase V - it works, generally at least as well as or better than Phase IV**
- **NCL is a much better tool than NCP**
- **Keep it simple - use Local naming, Phase IV compatible addressing and the NSP transport**
- **DECnet over IP lets you use applications with the DECnet APIs over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

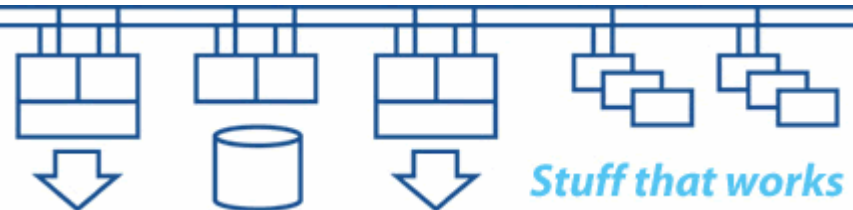




- **Phase IV – different costs, all L1 routers**
- **Phase IV Plus – same costs, all L1 routers**
- **Phase IV Plus – same costs, end node failover**
- **DECnet/OSI – both active, Multi-homed End Systems**
- **DECnet-Plus – both active, Multi-homed ES or IS**

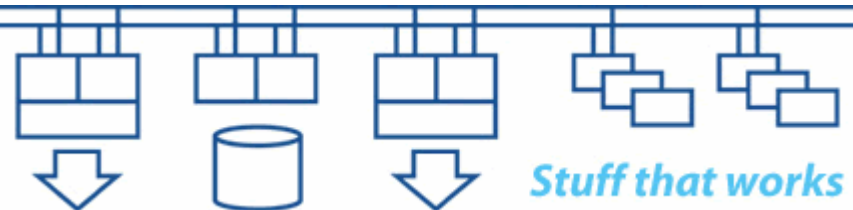


- **LAN failover (LLdriver)**
- **DECnet Phase IV and V - load balancing**
- **TCP/IP - Failsafe IP**
- **SCS – stopping and starting per adapter with SCACP or LAVC\$START\_BUS / LAVC\$STOP\_BUS**
  
- **MOP and LANCP (network booting)**
- **LAD / LAST (InfoServer)**
- **LAT (DECservers)**

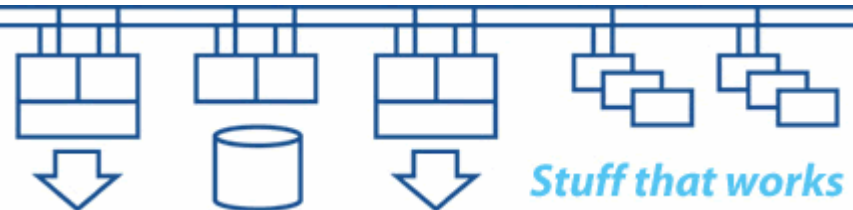


## Relative time is more useful than absolute time

- **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**



	Before	Now	After
Environment			
System			
Component			



# Thank you for your participation

## Q & A

