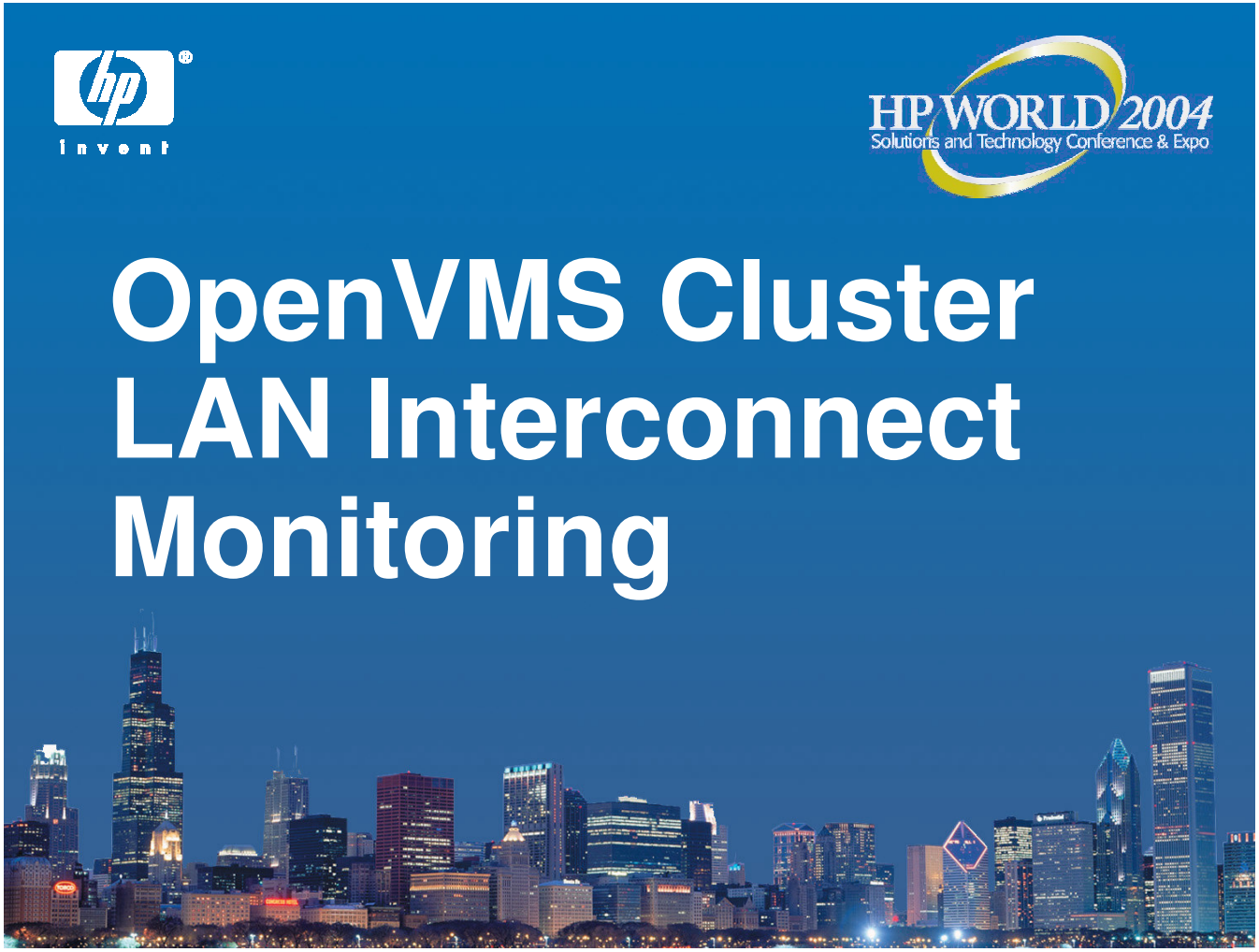

OpenVMS Cluster LAN Interconnect Monitoring

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Topics

- OpenVMS and LAN redundancy
  - How OpenVMS detects LAN failures
- LAVC$FAILURE_ANALYSIS facility
  - Theory of operation
  - Setup and use
  - Maintenance
- Available Freeware tools
  - EDIT_LAVC.COM
  - SIFT_LAVC.COM
  - LAVC$FAILURE_OFF.MAR

OpenVMS and LAN Redundancy

- PEDRIVER is the code supporting SCS communications over LANs
- Since OpenVMS version 5.4-3, use of multiple LAN adapters for SCS has been supported
  - Allows cluster to continue operating despite LAN adapter, bridge, or cable failures
- While hardware redundancy allows one to survive a failure,
  - Failures must be detected and promptly fixed, or a subsequent second failure could cause an outage

PEDRIVER 'Hello' Packets

- Sent approximately every 1.5 to 3 seconds
  - "Dithered" to avoid packet "trains" forming
- PEDRIVER expects to receive Hello packets regularly on each possible path

Network Troubleshooting

- Locating the offending component in a network failure can be difficult
- OpenVMS provides a tool to make failure detection and failed-component identification easier in a LAVC environment: it's called the LAVC$FAILURE_ANALYSIS facility

Template Program

- Template program is found in SYS$EXAMPLES: and called LAVC$FAILURE_ANALYSIS.MAR
- Written in Macro-32
  - but you don't need to know Macro to use it
- Documented in Appendix D of OpenVMS Cluster Systems Manual
  - Appendix E (subroutines the above program calls) and Appendix F (general info on troubleshooting LAVC LAN problems) are also very helpful

Using LAVC$FAILURE_ANALYSIS

- To use, the program must be:
  1. Edited to insert site-specific information
  2. Compiled (assembled on VAX)
  3. Linked, and
  4. Run at boot time on each node in the cluster

Maintaining LAVC$FAILURE_ANALYSIS

- Program must be re-edited whenever:
  - The LAN used as a Cluster Interconnect is reconfigured
  - A node's MAC address changes
    - e.g. Field Service replaces a LAN adapter without swapping MAC address ROMs
  - A node is added or removed (permanently) from the cluster

How Failure Analysis is Done

- OpenVMS is told what the network configuration should be
- From this info, OpenVMS infers which LAN adapters should be able to “hear” Hello packets from which other LAN adapters
- By checking for receipt of Hello packets, OpenVMS can tell if a path is working or not

How Failure Analysis is Done

- By analyzing Hello packet receipt patterns and correlating them with a mathematical graph of the network, OpenVMS can tell what nodes of the network are passing Hello packets and which appear to be blocking Hello packets
- OpenVMS determines a Primary Suspect (and, if there is ambiguity as to exactly what has failed, an Alternate Suspect), and reports these via OPCOM messages with a “%LAVC” prefix

Getting Failures Fixed

- Since notification is via OPCOM messages, someone or something needs to be scanning OPCOM output and taking action
- ConsoleWorks, Console Manager, CLIM, or RoboCentral can scan for %LAVC messages and take appropriate action (e-mail, pager, etc.)

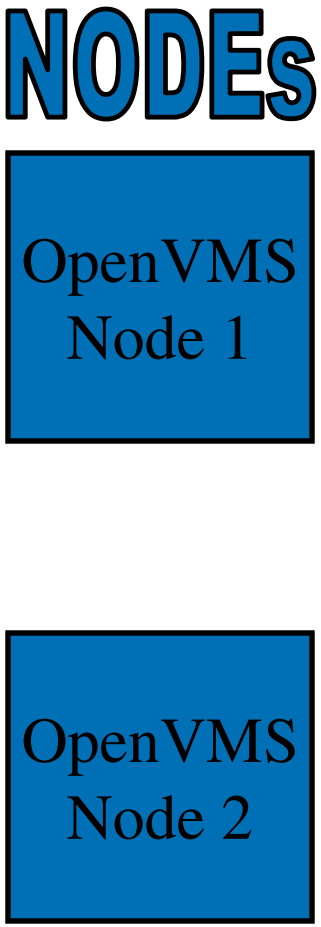
Gathering Info

- Data required:
  - Local Area Network configuration:
    - OpenVMS Nodes
    - LAN adapters in each node
    - Bridges
    - Hubs
    - Links between all of the above

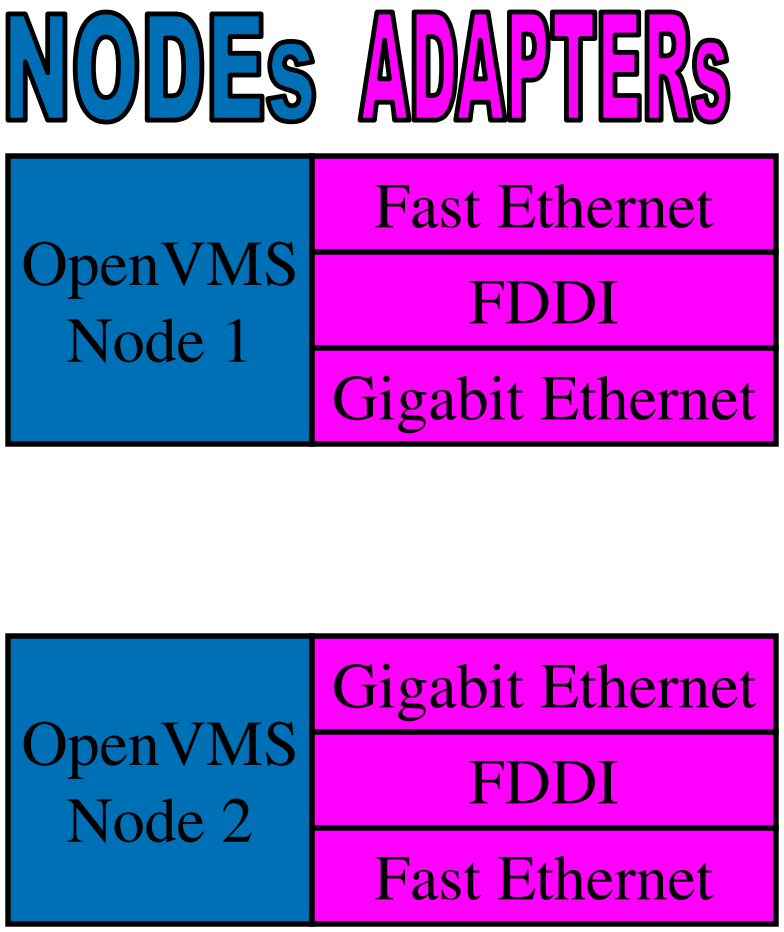
Network Information

- OpenVMS considers LAN building blocks as being divided into 4 classes:
  - **NODE:** The OpenVMS systems
  - **ADAPTER:** LAN host-bus adapters in each OpenVMS system
  - **COMPONENT:** Hubs, bridges, bridge-routers
  - **CLOUD:** Combinations of components that can't be diagnosed directly (more on this later)

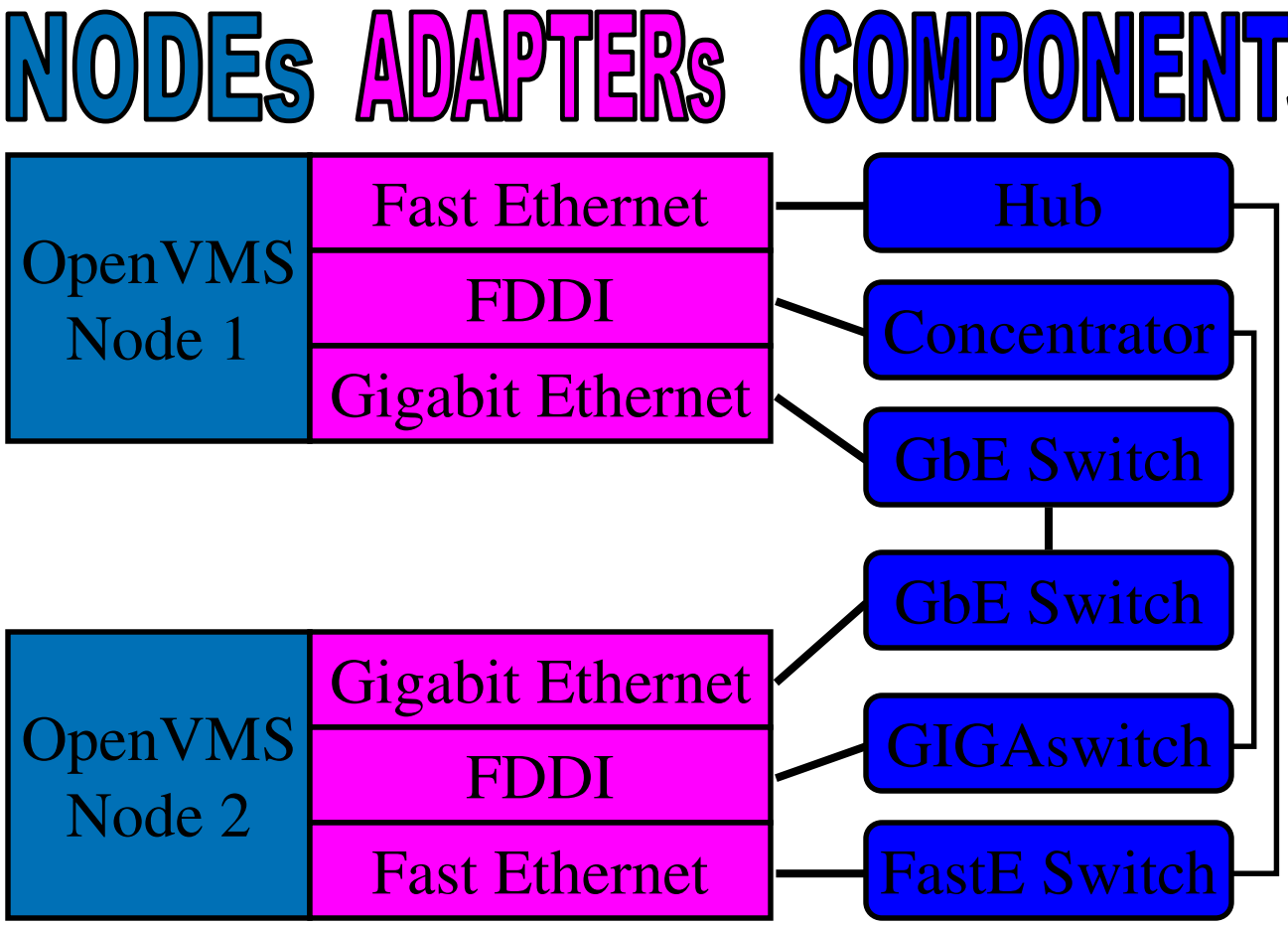
Network building blocks



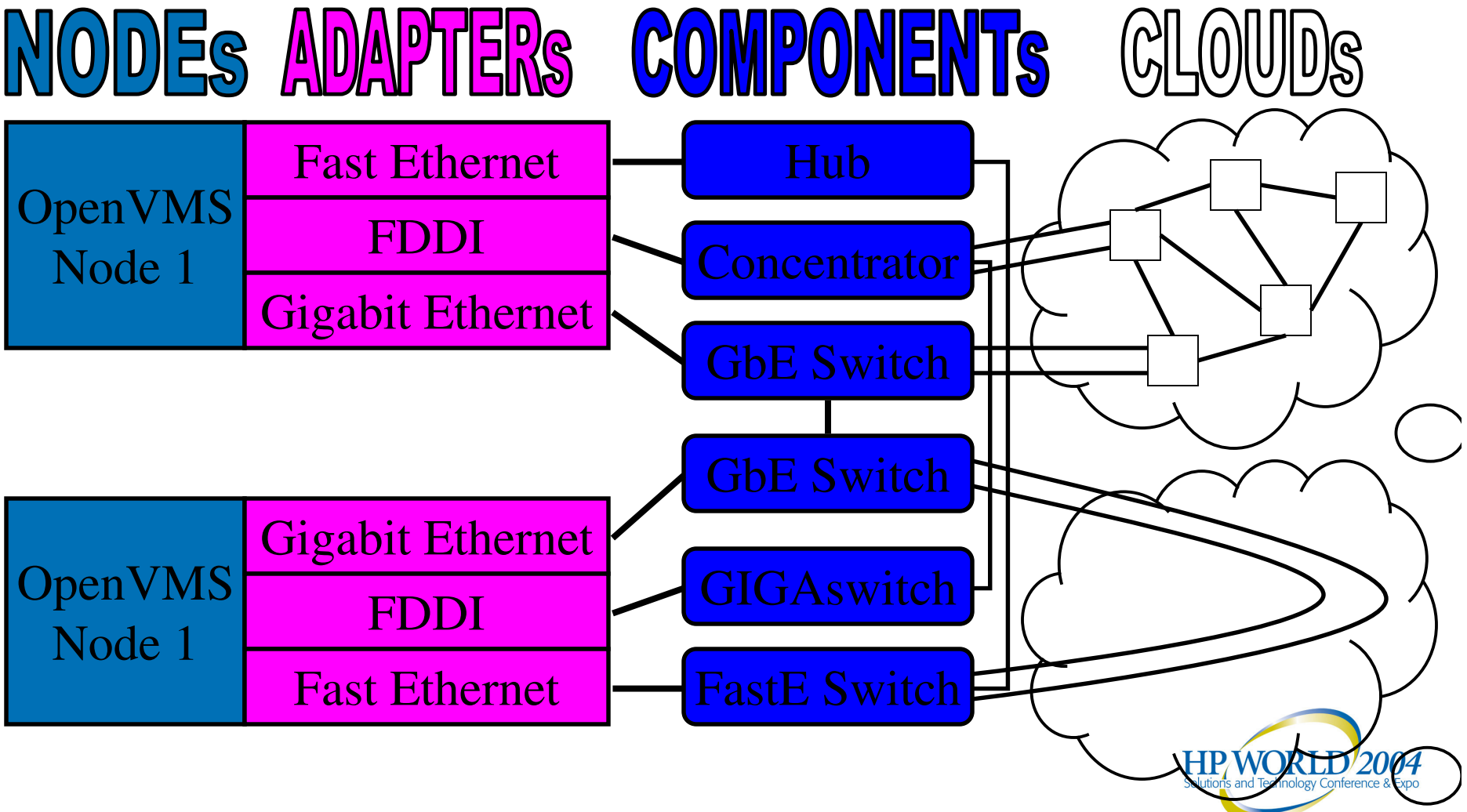
Network building blocks



Network building blocks



Network building blocks



Handling Network Loops

- The algorithm used for LAVC$FAILURE_ANALYSIS can't deal with loops in the network graph
  - Yet redundancy is often configured among LAN components
  - The bridges' Spanning Tree algorithm shuts off backup links unless and until a failure occurs
    - Hello packets don't get through these backup links, so OpenVMS can't track them
  - For these cases, you replace the redundant portion of the network with a "network cloud" that includes all of the redundant components
    - Then OpenVMS can determine if the network "cloud" as a whole is functioning or not

Handling Redundancy

- Multiple, completely separate LANs don't count as "loops" and OpenVMS can track each one separately and simultaneously

Gathering Info

- Data required (more detail):
  - Node names and descriptions
  - LAN adapter types and descriptions, and:
    - MAC address
      - e.g. 08-00-2B-xx-xx-xx, 00-F8-00-xx-xx-xx
    - plus DECnet-style MAC address for Phase IV
      - e.g. AA-00-04-00-yy-zz

Getting MAC address info

```
$! SHOWLAN.COM
$!
$       write sys$output "Node ",f$getsyi("nodename")
$       temp_file := showlan_temp.temp_file
$       call showlan/out='temp_file'
$       search 'temp_file' "(SCA)","Hardware Address"
                /out='temp_file`-1
$       delete 'temp_file';*
$       search/window=(0,1) 'temp_file`-1 "(SCA)"
$       delete 'temp_file`-1;*
$       exit
$!
$ showlan: subroutine
$        analyze/system
show lan/full
exit
$       endsubroutine
```

Editing the Program

- Once the data is gathered, you edit the LAVC$FAILURE_ANALYSIS.MAR program
- There are 5 sections to edit, as follows:

Edit 1

- In Edit 1, you can give descriptive names to Nodes, Adapters, Components, and Clouds
- These names become names of macros which you'll create invocations of later in the code

Edit 1

```
;       Edit 1.
;
;               Define the hardware components needed to describe
;               the physical configuration.
;

        NEW_COMPONENT   SYSTEM          NODE
        NEW_COMPONENT   LAN_ADP         ADAPTER
        NEW_COMPONENT   DEMPR           COMPONENT
        NEW_COMPONENT   DELNI           COMPONENT
        NEW_COMPONENT   SEGMENT         COMPONENT
        NEW_COMPONENT   NET_CLOUD       CLOUD
```

Edit 2

- In Edit 2, you create “ASCII art” to document the LAVC LAN configuration
- This has no functional effect on the code, but helps you (and others who follow you) understand the information in the sections which follow
- In the drawing, you choose brief abbreviated names for each network building block (Node, Adapter, Component, or Cloud)
  - These abbreviated names are only used within the program, and do not appear externally

Edit 2

```
;         Edit 2.
;
;                        Diagram of a multi-adapter LAV cluster.
;
;
;        Sa  -------+--------------+--------------+--------------+-------   Sa
;                   |              |              |              |
;                   |           MPR_A             |              |
;                   |         .----+----.         |              |
;                   |       1|        1|       1|              |
;                 BrA      ALPHA     BETA      DELTA           BrB
;                   |       2|        2|       2|              |
;                   |         `----+----'         |              |
;                   |           LNI_A             |              |
;                   |              |              |              |
;        Sb  -------+--------------+--------------+--------------+-------   Sb
```

Edit 3

- In Edit 3, you name and provide a text description for each system and its LAN adapter(s), and the MAC address of each adapter
  - The name and text description will appear in OPCOM messages indicating when failure or repair has occurred
  - The MAC address is used to identify the origin of Hello messages

Edit 3

- For DECnet Phase IV, which changes the MAC address on all circuits it knows about from the default hardware address to a special DECnet address when it starts up, you provide both:
  - The hardware MAC address (e.g. 08-00-2B-nn-nn-nn) and
  - The DECnet-style MAC address which is derived from the DECnet address of the node (AA-00-04-00-yy-xx)
- DECnet Phase V does not change the MAC address, so only the HW address is needed

Edit 3

```
;       Edit 3.
;
;               Label Node                  Description                          LAN HW Addr          DECnet Addr
;               ----- -----   ----------------------------------------   --------------------  ------------------

        SYSTEM   A,    ALPHA,  < - MicroVAX II; In the Computer room>
        LAN_ADP  A1,   ,       <XQA; ALPHA - MicroVAX II; Computer room>,   <08-00-2B-41-41-01>,  <AA-00-04-00-01-04>
        LAN_ADP  A2,   ,       <XQB; ALPHA - MicroVAX II; Computer room>,   <08-00-2B-41-41-02>

        SYSTEM   B,    BETA,   < - MicroVAX 3500; In the Computer room>
        LAN_ADP  B1,    ,      <XQA; BETA - MicroVAX 3500; Computer room>,  <08-00-2B-42-42-01>,  <AA-00-04-00-02-04>
        LAN_ADP  B2,    ,      <XQB; BETA - MicroVAX 3500; Computer room>,  <08-00-2B-42-42-02>

        SYSTEM   D,    DELTA,  < - VAXstation II; In Dan's office>
        LAN_ADP  D1,    ,      <XQA; DELTA - VAXstation II; Dan's office>,  <08-00-2B-44-44-01>,  <AA-00-04-00-04-04>
        LAN_ADP  D2,    ,      <XQB; DELTA - VAXstation II; Dan's office>,  <08-00-2B-44-44-02>
```

Edit 4

- In Edit 4, you name and provide a text description for each Component and each Cloud
  - The name and text description will appear in OPCOM messages indicating when failure or repair has occurred

Edit 4

```
;       Edit 4.
;
;               Label each of the other network components.
;

        DEMPR   MPR_A, , <Connected to segment A; In the Computer room>
        DELNI   LNI_A, , <Connected to segment B; In the Computer room>

        SEGMENT Sa,  , <Ethernet segment A>
        SEGMENT Sb,  , <Ethernet segment B>

        NET_CLOUD       BRIDGES, , <Bridging between ethernet segments A and B>
```

Edit 5

- In Edit 5, you indicate which network building blocks have connections to each other
- This is a list of pairs of devices, indicating they are connected

Edit 5

```
;          Edit 5.
;
;                    Describe the network connections.
;

           CONNECTION          Sa,       MPR_A
           CONNECTION                    MPR_A,     A1
           CONNECTION                               A1,        A
           CONNECTION                    MPR_A,     B1
           CONNECTION                               B1,        B

           CONNECTION          Sa,       D1
           CONNECTION                    D1,        D

           CONNECTION          Sa,       BRIDGES
           CONNECTION          Sb,       BRIDGES

           CONNECTION          Sb,       LNI_A
           CONNECTION                    LNI_A,     A2
           CONNECTION                               A2, A
           CONNECTION                    LNI_A,     B2
           CONNECTION                               B2, B

           CONNECTION          Sb,       D2
           CONNECTION                    D2,        D
```

EDIT_LAVC.COM Tool

A DCL command procedure is available to gather all the information and create an example LAVC$FAILURE_ANALYSIS.MAR program customized for a given cluster. See:

- This tool is in the V6 Freeware for OpenVMS under directory [KP_CLUSTERTOOLS]. Grab EDIT_LAVC.COM and EDIT_LAVC_DOC.TXT from the Freeware CD itself or from the HP OpenVMS website at: http://h71000.www7.hp.com/freeware/freeware60/kp_clustertools/
- These are also available at http://encompasserve.org/~parris/

Copy EDIT_LAVC.COM to a directory on a cluster-common disk, accessible from all nodes.

- If there is no disk accessible from all cluster nodes, instead pick a username and copy EDIT_LAVC.COM to the default directory for that username on each node in the cluster.

Using the EDIT_LAVC.COM Tool

To create a customized version of LAVC$FAILURE_ANALYSIS.MAR and deposit it into your default directory, do:

$ @EDIT_LAVC

To examine the resulting program:

$ EDIT / READ LAVC$FAILURE_ANALYSIS.MAR

- Look for the sections entitled “Edit 1” through “Edit 5”

To compile/assemble and link the resulting program:

$ @EDIT_LAVC BUILD

To enable viewing of any OPCOM messages generated:

$ REPLY / ENABLE=CLUSTER

OPCOM Messages Generated

- On a failure, LAVC$FAILURE_ANALYSIS identifies at least one Primary Suspect:
  - **%LAVC-W-PSUSPECT,** *<device_description>*
- If there is more than one device whose failure might produce the same symptoms, LAVC$FAILURE_ANALYSIS can also identify one or more Alternate Suspects:
  - **%LAVC-I-ASUSPECT,** *<device_description>*
- When the repair of a Suspect device (either Primary or Alternate) is detected, this is reported:
  - **%LAVC-S-WORKING,** *<device_description>*

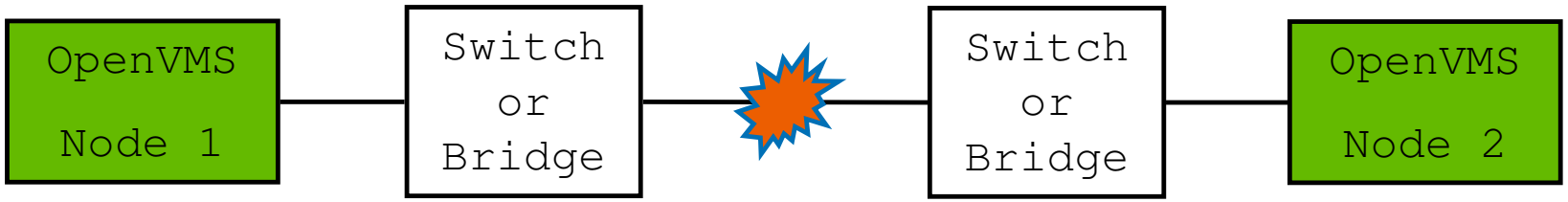
Customization with EDIT_LAVC.COM

- EDIT_LAVC.COM tries to make up reasonable default descriptions for nodes, adapters, and network segments. You can override these with logical names. For example:

```
$!
$! Create LAVC$FAILURE_ANALYSIS.MAR file customized for XYZ cluster
$!
$ DEFINE EDIT_LAVC_DESC_CLUSTER "XYZ"
$ DEFINE EDIT_LAVC_DESC_NODE_ABC ", Alphaserver ES45 in XYZ cluster"
$ DEFINE EDIT_LAVC_DESC_NODE_ABC_ADAPTER_EWA “Device EWA, Node ABC, DEGPA“
$ DEFINE EDIT_LAVC_DESC_NODE_ABC_ADAPTER_EWB “Device EWB, Node ABC, DE500"
$ DEFINE EDIT_LAVC_DESC_NODE_ABC_ADAPTER_FWA “Device FWA, Node ABC, DEFPA (left)"
$ DEFINE EDIT_LAVC_DESC_NODE_ABC_ADAPTER_FWB “Device FWB, Node ABC, DEFPA (right)“
...
$ DEFINE EDIT_LAVC_DESC_VLAN_1 "Cisco VLAN 123 (Fast Ethernet); XYZ cluster"
$ DEFINE EDIT_LAVC_DESC_VLAN_2 "GIGAswitch A (FDDI); XYZ cluster"
$ DEFINE EDIT_LAVC_DESC_VLAN_3 "Cisco VLAN 456 (Gigabit Ethernet); XYZ cluster"
$ DEFINE EDIT_LAVC_DESC_VLAN_4 "GIGAswitch B (FDDI); XYZ cluster"
$ @EDIT_LAVC
```

Correlating Error Messages Between Nodes

- %LAVC OPCOM messages from each node show the failure *from the viewpoint of that specific node*
  - You can often get a better feel for the actual underlying failure by comparing the failure messages as reported from each node



SIFT_LAVC.COM Tool

- A DCL command procedure is available to gather all %LAVC messages from OPERATOR.LOG files and sort them in timestamp order to allow easier correlation of the events from the viewpoint of each node. See:

  SIFT_LAVC.COM from the [KP_CLUSTERTOOLS] directory of the OpenVMS V6 Freeware or from:
  http://encompasserve.org/~parris/sift_lavc.com

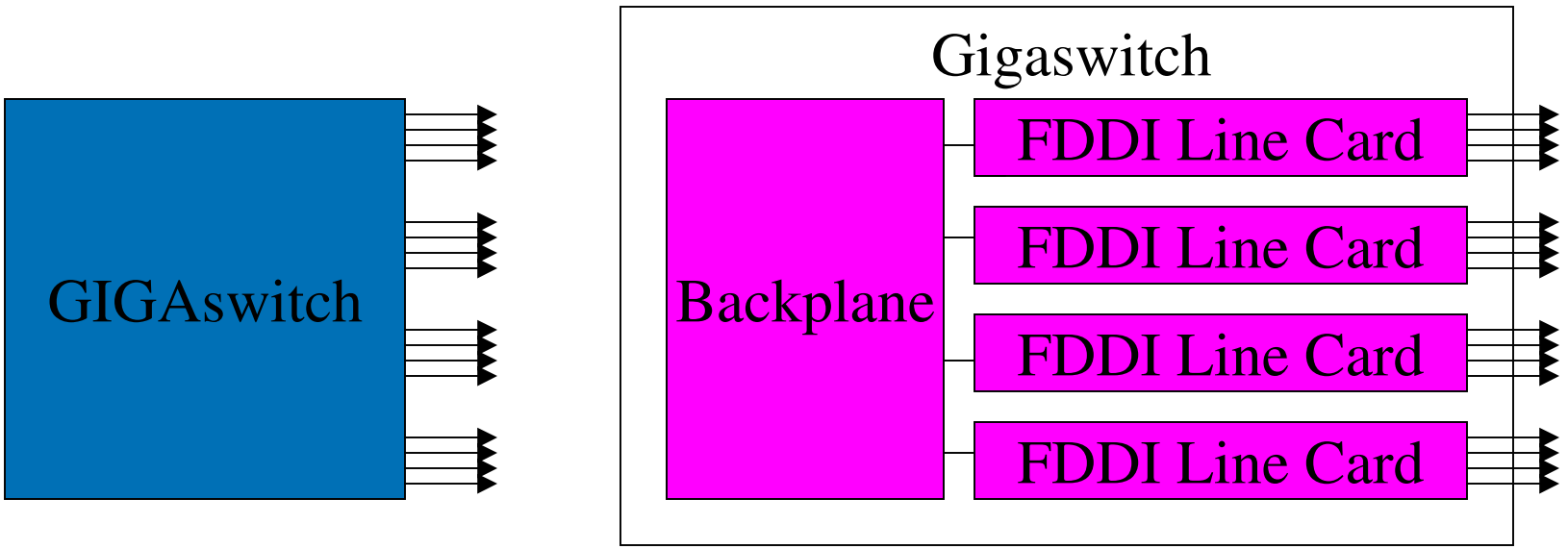
- To summarize %LAVC messages from the current (highest-numbered) version of OPERATOR.LOG files on all nodes, do:

```
$ @SIFT_LAVC
```

Level of Detail

- There is a trade-off between level of detail in diagnostic info and the amount of work required to initially set up and to maintain the program over time
  - More detail means more work to setup, and more maintenance work, but can provide more-specific diagnostic info when failures occur

Level of Detail Example



Disabling LAVC$FAILURE_ANALYSIS

To turn off LAVC Failure Analysis, use the LAVC$FAILURE_OFF.MAR program found in the [KP_CLUSTERTOOLS] directory of the OpenVMS V6 Freeware or at:
http://encompasserve.org/~parris/lavc$failure_off.mar

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