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# Designing Switched WAN and Voice Solutions DSWVS

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## CCDP

# Designing Switched WAN and Voice Solutions DSWVS

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### Abstract:

This study guide will help you to prepare you for the Cisco Designing Switched WAN and Voice Solutions exam, 640-413, which is required for the Cisco Certified Design Professional – WAN Switching certification. Exam topics include network design, troubleshooting and management of ATM and Frame Relay networks.

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**Contents:**

Identify the Target ..... 4

Know the Competition ..... 4

The Four Design Steps Rules ..... 4

    Creating and Recognizing Opportunity ..... 5

    The Preliminary Design ..... 5

    Designing the Multi Platform Solution ..... 5

    Design Execution..... 6

Switched Voice and Wan Solutions..... 6

    IPX, BGP, IGX..... 6

    Cisco and Stratacom Solutions and Advanced Networking Features..... 7

        Advantages of Cisco Switched WAS and Voice Solutions ..... 7

        Data Network Connections ..... 9

    Protocol Support ..... 9

        Clocking ..... 9

    Using NMT for Data Networks..... 9

        Data Network Questions ..... 9

Voice Network Design .....10

    Line Coding .....10

        Clocking .....10

    Voice Compression Methods.....11

        ERL .....11

    ATM .....11

        Steps and Questions to Ask When Implementing an ATM Network .....12

    Frame Relay Design.....12

    Using the StrataSphere Network Modeler Tool .....15

        Data needed for the NMT .....16



**CCDP Designing Switched WAN and Voice Solutions DSWVS**

Designing with NMT .....16  
    Site Configuration .....16  
    Link Configuration .....17  
    Traffic Configuration .....17  
    Optimize the Design.....17  
    Adding Resilient Links .....17  
    Line Failure Results .....18  
    Simulate All .....18



## Identify the Target

It is key to know which customers will benefit the most from a Cisco Switched WAN and voice design. So listen to the customer, their current requirements, current setup and configurations. Make sure you consider future growth and the fault tolerance needs.

Record the hardware you need to identify:

- TDM – Time division Multiplexors have no migration to ATM. This is old school hardware. Your goal is to replace this hardware with faster Cisco gear and utilize a smaller number of leased lines to reduce overhead for the customer.
- TimePlex Synchrony
- Timplex LINK
- NET IDNX
- New Bridge 3600
- Netrix #1 ISS
- InfoTron NX
- GDC MEGAMUX/TMS
- Scitec Maxima

## Know the Competition

The competition will make an attempt to claim TDMs are more effective or that the Cisco solution is not the correct solution. Familiarize yourself with what the competition's products are and what they are bringing to the table. Talk to your customer to find out what are some of the claims that have been made.

- Fact - FastPacket is not true ATM.
- Fact - Cisco is active in the ATM Forum and also supports true ATM.
- Myths - TDM is more efficient than ATM.
- Fact - ATM makes very efficient use of bandwidth.
- Myth - Stratacom is a Frame Relay company for ISP's.
- Fact - Stratacom business is frame relay access to ATM.

## The Four Design Steps Rules

1. Create and Recognize Opportunities
2. Make up a Preliminary Design
3. Put together A Multi-Platform Solution
4. Execute the Design



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### **Creating and Recognizing Opportunity**

Acknowledge technology in use: E1 & T1 installations, TDM's, routers, SNA, voice, video, etc.

Know why the customer would want to accept your proposal and understand their budget constraints.

Seek customers with the following goals:

- Migrating TDM's to ATM or better technology
- Reducing cost on leased lines
- Seeking to scale to large network
- Improving fault tolerance and routing
- Reducing network congestion
- Seeking integration of data, voice and applications

Be prepared to explain to the customer why a switched WAN solution is best and how Cisco is a superior solution and product in comparison to competitors. Why?

Because Cisco is always better.

### **The Preliminary Design**

- This step covers various topics from making a high level map to sitting down with the customer, to creating a detailed map of the current network, to discussing the traffic types and connections.
- Get an accurate picture of the customer's current network, on that is not in detail at this point. Get a solid high-level map of the current network.
- Put together a new draft design for the customer.
- Based on the needs of the customer, make your equipment selections.
- Compile a spreadsheet with the product selections and cost.
- Respond to the customer's RFP.
- Present solutions to customer – include cost saving figures (including less staffing) and leased line reductions.
- If the customer is interested in the solution, have them sign the NON – Disclosure Agreement.
- Work with the customer and put together a detailed topology map. Include traffic types, voice and data connections, speeds and trunk types.
- Determine the performance and capacity required for the customer.
- Develop a mapping of the connected sites and the utilizations of the lines.

### **Designing the Multi Platform Solution**

- This is where you use the Network Modeling Tool (NMT).
- Based on the information gathered from the customer, use this data and input it into the NMT. Input links, sites, traffic types, distance between sites, as well and voice and data requirements.
- Design the appropriate solution.



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- Generate reports and a detailed topology map.
- Use the data from the NMT and feed it into the WANDL tool.
- Use the WANDL tool for large or enterprise customers.
- Verify your design.
- Take your solution and present to the Account Manager and the Cisco project manager to verify the design will work (with the amount of money involved it is ALWAYS good to get a second opinion).
- Get input and begin planning the implementation with the Account Manager and the Cisco project manager.
- Present your solution to the customer.
- Some customers require a Proof of Concept Lab – put together a demo.

### **Design Execution**

- Select the hardware, cables, cards, software and network management tools.
- Use the pricing agent and verify hardware availability
- Update your spreadsheet: add the nodes, cards, number of slots, versions of software, cables and cable types. Also include the configuration for each network connection.
- Make your final network topology changes and beautify it.
- Fill out the sales order. Again, consult the Account Manager and or Project Lead when doing this step.
- Turn in the implementation work to the Account Manager and or Project Lead.
- In this process it is important to get the input from the Project Manager to verify your design and help fill out the sales order.

## **Switched Voice and Wan Solutions**

### **IPX, BGP, IGX**

These use cell relay. The advantage to this is the ability of ATM to accommodate a large number of packet types. The goal is to move traffic over fewer trunk lines and use the lines with better throughput. With TDM's there is no migration path to ATM. Implementation of ATM in a TDM network would require an equipment upgrade. Bandwidth usage for ATM is dynamic and very flexible in comparison to TDM's. These features allow for a solution that is designed to handle delay sensitive data. These are delay sensitive applications that benefit from the enhanced throughput of WAN Switch Solutions:

- SNA
- DEC LAT
- Telnet
- Voice
- Video
- Conferencing



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The savings and throughput come from:

- Dynamic bandwidth allocation
- VAD Voice Activity Detection
- Voice compression
- Statistical multiplexing
- Repetitive pattern suppression
- Gigabit capacity

### **Cisco and Stratacom Solutions and Advanced Networking Features**

The technology Cisco uses to utilize 95% of a trunks capacity:

- **ForeSight (Stratacom)**
  - Rate congestion management
  - Monitors trunk usage, makes adjustments to throughput on a per connection basis
  - Closed loop Traffic Mgmt
- **OptiClass (service provisioning)**
  - Gives you the ability to set up to 16 Service Classes
  - Similar to Custom Queueing in routers
  - Gives a guarantee of service to each class
- **Statistical Multiplexing**
- **FairShare**
  - Used for VC queueing and traffic scheduling
  - Similar to Weighted fair queueing in routers
  - Fairly allocates bandwidth for equal access of bandwidth
- **AutoRoute**
  - Provides connection management
  - Seeks out the optimal paths and reroutes failed or full VC's
  - Automatically manages the bandwidth allocation and VC's
  - Routes and reroutes connections dynamically

### **Advantages of Cisco Switched WAS and Voice Solutions**

- No routing tables
- Multiple clocking sources
- Remote management and diagnostics
- Automatic rerouting without call disruptions
- Easy to operate
- Less staff requirements





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BGP Node THE BIG GUY  
15 Card Slots  
15,000 ports X 64kbps DS0  
Can use all of the Advanced Network Features  
20 GPS Capacity  
100 Full redundancy capable

AXIS Self  
16 Card Slot  
ATM Cell Bus 640Mbps

IGX Gigabit Switch  
Available in 8,16, 32 slot sizes  
1.2 Gbps Capacity  
Supports High Speed Data  
Uses advance call features like voice compression, Voice activity Detection, Echo cancellation  
Supports ATM, Frame Relay, and network trunking  
Like Big brother, BPX supports the advanced networking features.

Gather as much information as possible about the network in place and the expected future growth of the customer. Get a detailed topology map of the current network. Sit down with the customer and discuss the redundancy requirements.

Information to gather from the customer:

- Line cost per month
- Detailed topology of the network
- Detailed trunk group listing with separation of the voice and data channels
- Peak bandwidth use
- Average bandwidth use
- Routing and data protocols in use
- Fault tolerance requirements
- Clocking types and special clocking needs



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- Null modem use

### Data Network Connections

- **Bursty Data** - LAN protocol data – LAN and router data
- **Channelized DS0** – Voice or data multiplexors
- **Low Speed** – Asynchronous or synchronous connections – traffic source is point of sale terminals or data terminals
- **High Speed** – Synchronous links up to 1.3Mps – Traffic source FEPs or cluster controllers
- **Bundled Connections** – SuperRate connections are bundled 56k or 64k DS0's. Eight can be bundled up to 512k. Sometimes used when a DS1 is too much bandwidth. A SuperRate Channelized DS0's would work well here.
- **Channelized Data Pad (CDP) and Channelized Voice Modules** - can only use SuperRate connections
- **Dataphone Digital Service (DDS)** – 56K common carrier circuits

### Protocol Support

Cisco WAN Switches support a wide variety of protocols. The data passing through the switch is transparent to the switching process, so almost all data protocols are supported.

### Clocking

Cisco WAN Switches support four types of clocking methods.

- **Normal Clocking** – Supported by low speed cards. The receive and transmit clock are the same on the high-speed card and the end device.
- **Looped Clocking**- Supported by low speed cards. The end device is responsible for looping the receive clock and clocking the data.
- **Isochronous Clocking**- Used for devices that do not use a net synced clock.
- **Split Clocking** – End device timing in one direction and the high-speed card in another.

### Using NMT for Data Networks

When adjusting the COS class of service you can assign a rerouting priority to the lines. The values range from 0-15. 0 is the highest priority like in UNIX id's.

### Data Network Questions

- Are there applications with unique clocking requirements?
- Clocking methods in use?
- DDS tail circuits in use?
- Null modem functionality needed?



## Voice Network Design

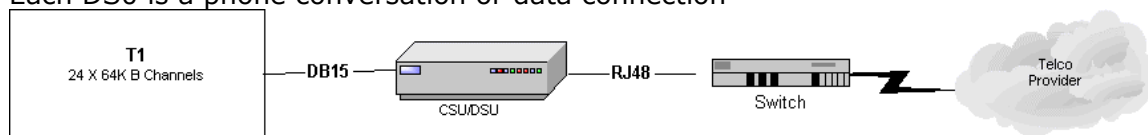
Preliminary steps – identify all the line types the customer is using and details about the features currently in use. Get a topology drawing from the customer. Collect this data:

- Trunk group listings and trunk costs
- Peak calling hours
- Call patterns now and in the future
- Whether the phones and PBX's are digital or analog
- The number of circuits in use
- Type of fax equipment, age and usage
- Gather noise, echo and dial features
- Percent of fax and modem traffic
- Whether any of the fax machines over 5 years old

Document where the data originates

- Routers, PBXs, FEPs, Bridges, CODECS, etc

**T1**- DS1=1.54 Mbps and contains 24 DS0's Digital Voice Channels  
Each DS0 is a phone conversation or data connection



**Companding** – the process of converting a signal from analog to digital A-law and mu-law types used. Mu-law is used in the US and in Japan.

### Line Coding

- AMI - Alternate Mark Inclusion
- B8ZS – Bipolar 8 Zero Substitution
- HDB3 – High Density Bipolar 3
- CMI – Coded Mark Inversion

**Line Framing** – Used on T1 lines

- D4 – Super Frame
- ESF –Extended Super Frame

### **Clocking**

Needed for proper WAN operation

- **Network Master Method** – Like the Master domain model in an NT network, each node uses a Master clock. Usually a BPX.



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- **Master/Slave Method** – Like a Multiple Master model in an NT network, nodes are grouped in a hierarchy. Used in the US.
- **Packetization Method** – From the receive clock, each node's clock is based on the data stream.
- **Plesiochronous Method** – GPS method – Node get their clocking data from GPS. Used in Europe.

### Voice Compression Methods

- **PCM** – Pulse Code Modulation
- **VAD** – Voice Activity Detection
- **SAD** – Silence Activity Detector
- **DSI** – Digital Speech Interpolation
- **ADPCM** – Adaptive Differential Pulse Code Modulation

### ERL

- **Echo** – Caused by the transition from 4 line to 2 line cable. Normally it is not a problem as long as there is not a lot of delay.
- **Echo Return Loss** – ERL - Measured in decibels and is used to measure how much of the signal was lost. This is a good thing as long as there is not a lot of delay. Average loss is 10-20 dB. This amount is acceptable.
  - The median is about 20dB loss to 20 ms of delay.
  - The Cisco switchgear adds 30 to 100 milliseconds of delay. This can cause the echo to become very noticeable and irritating.
  - Echo cancellers can filter out the echo. If a WAN switch is added, the existing echo cancellers may need to be tuned to pick up the extra 30-100 ms delay.
  - Over an IPX/IGX there is a noticeable increase in delay. Echo cancellers may need to be ordered with the CDP or CVM cards.

### ATM

**ATM (Asynchronous Transfer Mode)** – like Frame Relay and X.25, it uses PVC's and SVC's to establish connectivity. Used for high-speed data, video and voice. It uses cells to transport information in 53 byte cells. ATM Features:

- 5 bytes for header, 48 for data
- QOS (Quality of Service) is effective for managing ATM
- Flexible multiplexing and switching technology
- Low latency due to small cells and high speed media
- Supports high performance applications
- Uses SNAP encapsulation to multiplex several protocols
- SVCs are disconnected once transmission is complete
- Operates primarily at the Data Link Layer of the OSI model



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AAL 1/3,4/5	Data Link Layer
ATM Layer	Data Link
ATM Physical	Physical

**AAL (ATM Adaptation Layer)** – operates at the Data Link Layer, and its primary function is to hide what it is doing to the frames from the higher OSI Layers. Abstraction is right.

**ATM Layer** – establishes connections and passes cells through the ATM network.

**ATM Physical** – manages the physical transmission of the cells. Does the bit to cell conversion.

### Steps and Questions to Ask When Implementing an ATM Network

- Get a high-level topology map.
- Do any of the ATM circuits connect to any frame relay networks?
- Get a list of all the sites using ATM
- Which application and services running on ATM (MPOA, routing protocols)?
- Are there plans for new growth or sites?
- What are the fault tolerance requirements?

(CBR) – Constant bit rate - (rt-VBR) – Realtime variable bit rate – support realtime applications (video and voice)

nrt-VBR – non realtime variable bit rate – are used for other applications that do not require strict variation

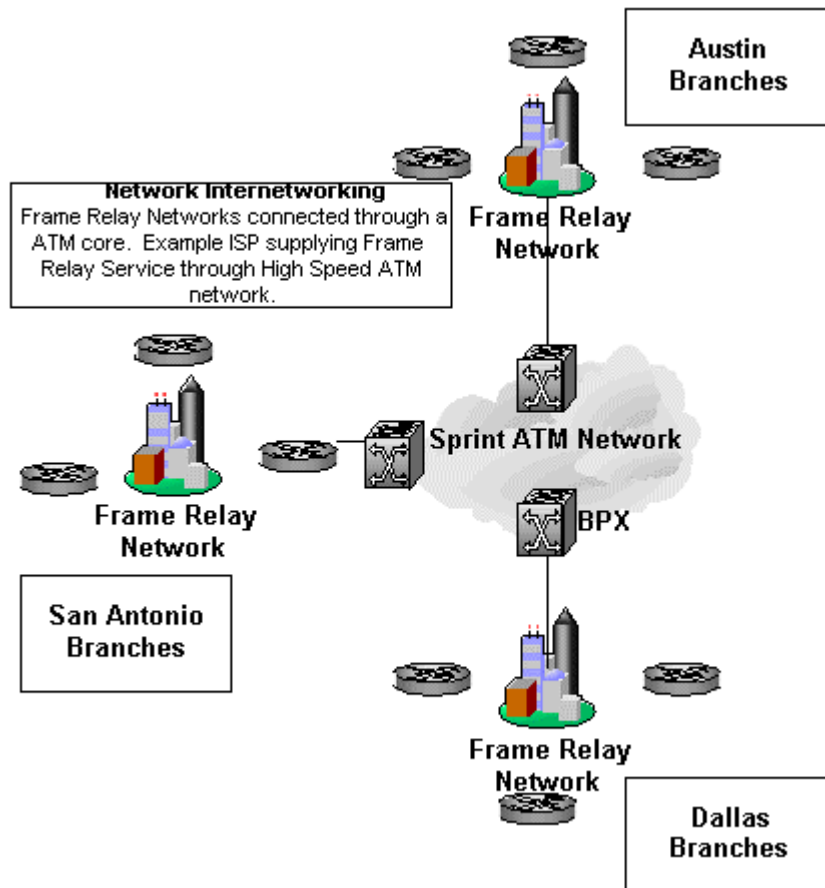
### Frame Relay Design

There are some misconceptions about frame relay networks. It is important that frame relay uses Virtual Circuits. Although this more complex, it offers some flexibility in the topology of the network.

- **Frame Relay interfaces** - Frame relay requires the use of a CSU/DSU. Like X.25, frame relay uses SVC's and PVC's. PVC's are used for frequent and long connection times. SVC's are for sporadic, infrequent traffic.
- **Frame Relay Bandwidth** - Max throughput is up to T3 speed. Frame relay is a layer 2 protocol. It uses the upper layer for error correction. It is faster than X.25. Cisco switches support frame relay to 2Mbps.
- **Network Internetworking** - Frame Relay Networks connected through an ATM core. The source and destination ports on the nodes are Frame Relay. The BPX Node performs the internetworking function here.



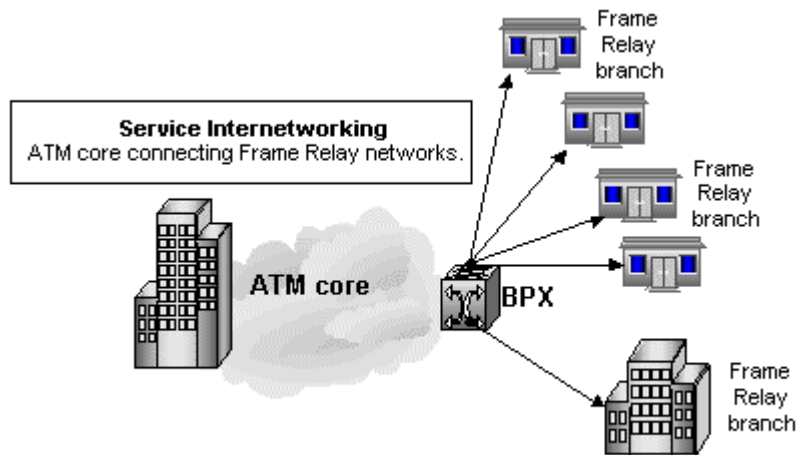
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- **Service Internetworking** – Similar to the above and used when ATM connects to a Frame Relay network. The switch performs the service internetworking. The translation is transparent to the frame network. This is useful when a core network is upgraded to ATM and the branches are Frame Relay.



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### FRF – Frame Relay Facts

#### Frame Relay

- Cost Effective
- **Fast**
- Uses VC's for connections
- Full Mesh Possible through VC's
- Low Latency
- Full mesh inexpensive can be done with VC's through the frame provider

#### Point to Point

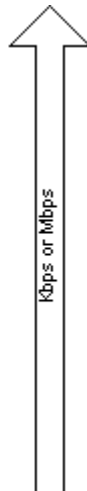
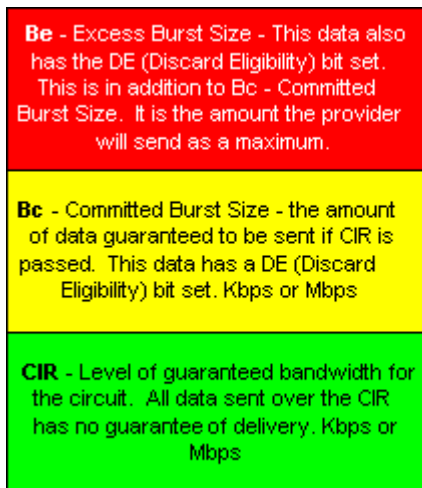
- More expensive
- Full Mesh expensive
- Bandwidth can be wasted
- Picks up latency through other sites if all sites are not full mesh

- **MIR** – Minimum Information Rate – Foresight Parameter- is the minimum amount of data that will be passed, even if the network is congested.
- **CIR** – Committed Information Rate - Level of guaranteed bandwidth for the circuit. All data sent over the CIR has no guarantee of delivery. Measured in Kbps or Mbps
- **Bc – Committed Burst Size** – The amount of data guaranteed to be sent if CIR is exceeded. This data has a DE (Discard Eligibility) bit set. Measured in Kbps or Mbps



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- **Be – Excess Burst Size** – This data also has the DE (Discard Eligibility) bit set. This is in addition to Bc – Committed Burst Size. It is the amount the provider will send as a maximum.
- **PIR – Peak Information Rate** – Foresight Parameter - Peak bandwidth available with no congestion on the network.
- Frame Relay Standard Maximum
- This is the (Be) Excess Burst Size – This data also has the DE (Discard Eligibility) bit set. This is in addition to Bc – Committed Burst Size. It is the amount the provider will send as a maximum.
- ForeSight PIR standard  
Use this calculation.  
 $PIR = MIR \times (1 + Be/Bc)$



The reason for the different rate is because of the bursty nature of LAN protocols.

### Using the StrataSphere Network Modeler Tool

This tool runs on a Sun SPARCstation. There also is a demo available on the web but you will have to contact a Cisco SE to get access to the site and a password. The tool is used to input customer data. The StrataSphere NMT is very useful. In brief, the tool is used to input customer data, set up a design, test fault tolerance of the network, produce graphical topology maps, and generate reports. The tool can also provide cost and part numbers. It can also provide a schema for the cards, nodes





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and ports usage. This is a brief synopsis of navigation and the process. For detailed information on this product, perform a hands-on lab.

**Data needed for the NMT**

- Geography (site locations)
- Line costs
- Line speed needs
- Fault tolerance requirements
- Outage plan and requirements

**NMT Tool Menus    Sub Menus**

Configure	Write	Links	Voice Traffic	Data Traffic	Bursty Traffic
Execute	Fail Analysis				
Optimize					
Route					
Fail Analysis	Simulate All	Alt Route	Results		
Display	Links	Parts list	Maps		

**Key Keys**

<b>ESC</b> Key	Saves Entries and returns to the previous screen
<b>UP Arrow</b> Key	Scrolls through entries
<b>DOWN</b> Arrow Key	Scrolls down or moves to the next line for a new entry
<b>Delete</b> Key	The name says it all: Deletes entries
<b>Enter</b> Key	Makes selection
<b>Tab</b> Key	Moves through entries
<b>F5</b> Key	Moves to second screens

**Designing with NMT**

**Site Configuration**

- From the NMT Design Window, click the CONFIGURE Menu and press **Enter**
- Select Sites and press **Enter**
- A Sites table will appear
- Press **DOWN** arrow to navigate to the Site field
- Type the name, and you have created a new site
- Enter Site Values Type, Size, Power, IGX, Back Card, Front Card, Reluctant Link Card



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- Press **DOWN** Arrow to enter another site
- Press the **ESC** Key to save your work, and return to the CONFIGURE Menu
- Save your work by selecting Write in the CONFIGURE menu

### Link Configuration

- In the CONFIGURE menu, select LINKS press **Enter**
- Use the **DOWN** Arrow Key and select a site. Use the **Tab** Key and make the site value changes
- Press F5 to move to the second link menu values. Press the **ESC** Key to save your changes
- Press the **ESC** Key to return to the CONFIGURE menu

### Traffic Configuration

- You must make selections for NMT to assist you in your data modeling. You must tell the NMT what type of traffic you are making configurations for
- In the CONFIGURE menu, select VOICE TRAFFIC and press **Enter**
- Use the **DOWN** Arrow Key and select a site. Use the **Tab** Key and make the site value changes
- Use the **Tab** Key and make the site value changes
- Use the same basic steps to configure Data and Bursty Traffic
- When completed, and you exit the CONFIGURATION Menu, NMT will check your work. You will see CHECKING CURRENT CONFIGURATION warnings
- Go to WARNINGS AND ERRORS section in the DISPLAY menu. NMT will make changes to your design as needed. Check the warning browser to inspect the changes

### Optimize the Design

When you select OPTIMIZE from the EXECUTE menu. NMT performs a series of calculations.

1. NMT creates a topology optimized for the lowest cost possible
2. NMT builds the network model
3. NMT routes the new topology connections
4. NMT will create reports for review

From the display menu you can view link data, view a parts list, and create graphics from the MAPS menu.

### Adding Resilient Links

- You must run an OPTIMIZE or a ROUTE before running SIMULATE ALL or FAIL ANALYSIS.



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- Go to the CONFIGURE Menu and select LINKS. Use the **Tab** Key and move over to the Keep field. The default is 0 for a link. Changing this value to 1 tells NMT to create redundant links.
- The **ESC** Key exits the CONFIGURE MENU. From the EXECUTE menu, select ROUTE. Each value that you changed to 1 will now have new routes created. The **ESC** Key exits this menu.

### Line Failure Results

- To view results created from a line failure follow these steps.
- From the EXECUTE MENU select FAIL ANALYSIS. Select FAIL LINE and select the line you wish to fail. Make the Y or N selection for the link.
- Select ALT ROUTE and press the **Enter** Key to save changes. Select RESULTS from the FAIL ANALYSIS menu.
- This will display link loads and any connections that were not rerouted.
- Any links that are down from the last fail analysis will appear in red.

### Simulate All

- This step performs a failure analysis for every link in your designed network.
- After doing a route refresh, go to the SIMULATE ALL from the FAIL ANALYSIS menu.
- Choose a file name to save your results.
- Press the **ESC** Key to get the execute menu
- From the REPORT menu, select VIEW to see your results.

Special thanks to  
[Julian Laredo](#)  
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