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Visual NRM User's Manual: Tools for Applying the Network Rating Methodology

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VISUAL NRM USER'S MANUAL: TOOLS FOR APPLYING THE NETWORK RATING METHODOLOGY

1. INTRODUCTION

Visual NRM is a toolset and language for developing and evaluating a map of an argument that mission-critical information is adequately protected by a system in its larger operational environment. Visual NRM provides a graphical extension and automated support for applying DoD's Network Rating Methodology (NRM) [1]. This document presents a manual for using the Visual NRM toolset.

As shown in Fig. 1, an NRM security assurance argument composes assurance evidence from potentially many different sources and from four security disciplines: Physical, Technological, Operational, and Personnel. Visual NRM helps manage the complexity of this composition by mapping out the assurance evidence, tracing meaningful threads of reasoning, and highlighting significant results. The maps clearly specify how each piece of evidence contributes to the overall argument. The Visual NRM toolset supports traversing the hyperlinked argument and analyzing its security weaknesses.

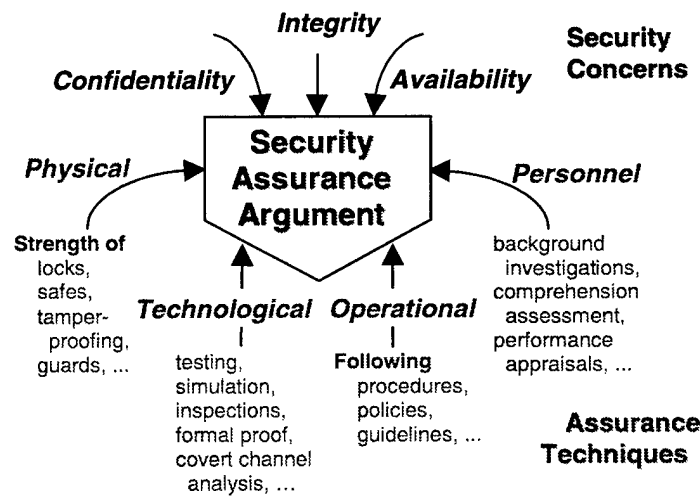


Fig. 1—NRM security assurance arguments

1.1. Security Analysis

Visual NRM supports a framework for analyzing the security of systems originally described in Ref. 2. Within this framework, claims are made about the security that a particular security discipline is required to provide. Assumptions document requirements that one discipline places on another. Each assumption from one security discipline should map to a claim (or set of claims) from another discipline that, in effect, validates the assumption. A gap in this mapping indicates a security vulnerability.

Fig. 2 illustrates this type of security analysis. The figure depicts the analysis of a system intended to provide a secure way to downgrade files from one network, approved to process information at level *High*, to another network, approved to process information at some lower level *Low*. The overall strategy is to require the Downgrade Officer (DO) to review individually each file requested for downgrade according to a set of Downgrade Procedures. As shown, the primary claim in the Technological Security domain is that a device, which we call the Downgrader, ensures that only the DO downgrades files.

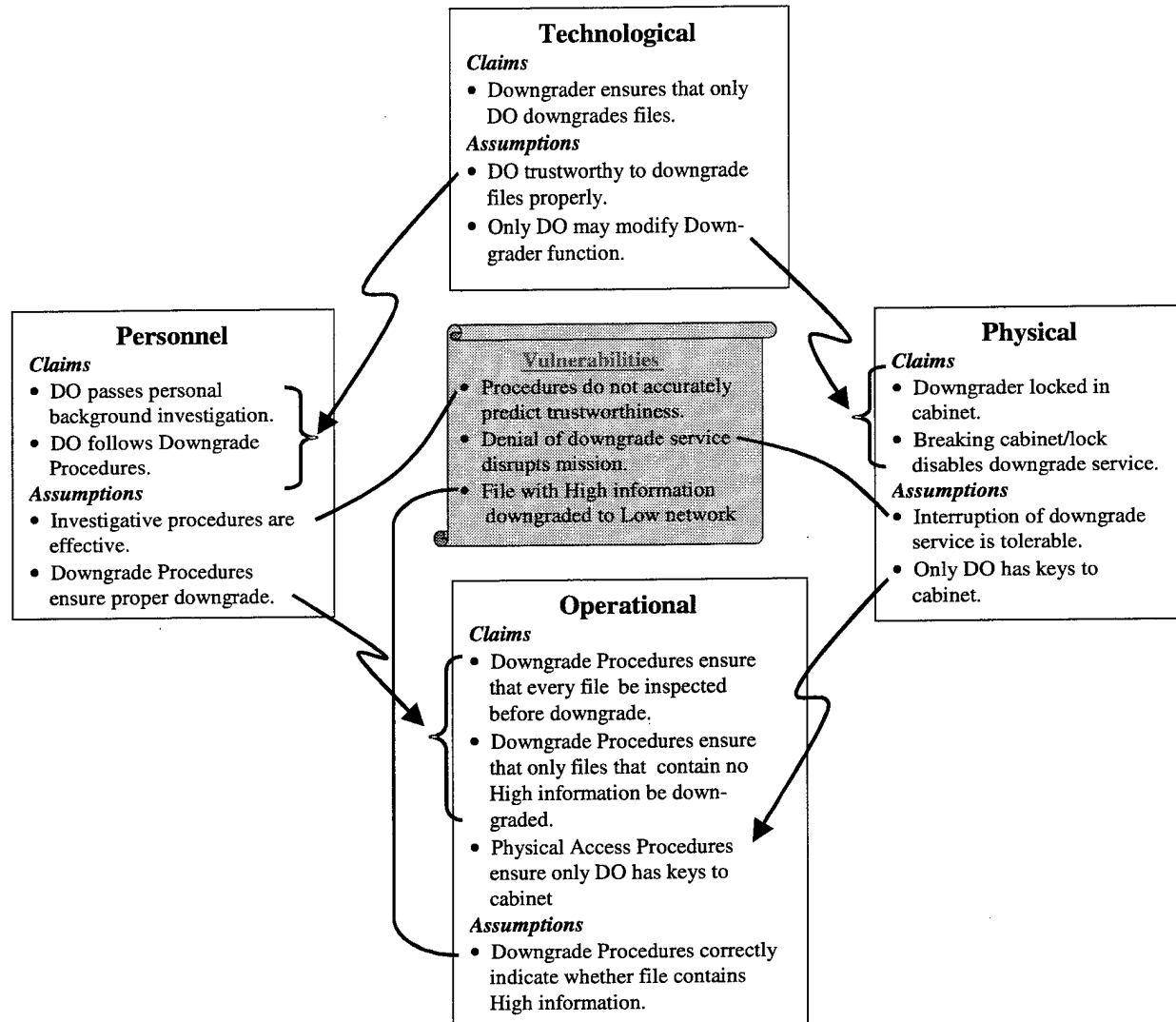


Fig. 2—Example security analysis

This technological claim assumes that the DO is trustworthy to downgrade files properly. As shown in the figure, this assumption is validated by two claims in the Personnel Security domain: that the DO passes a personal background investigation and that the DO is trained in Downgrade Procedures. This assumes, in turn, that the procedures used for background investigations accurately predict the trustworthiness of people investigated. In addition, the Downgrade Procedures, when correctly applied,

must ensure that information is downgraded properly. The first assumption is noted as a security vulnerability. Indeed, one could make claims about the effectiveness of the investigative procedures, as part of the Operational Security domain, but we have decided to place this assumption at the boundary of our security argument. The second assumption, on the other hand, is the subject of the Operational Security domain.

Two operational claims and one operational assumption validate the assumption that the Downgrade Procedures ensure proper downgrade. The claims require that the Downgrade Procedures have certain properties, i.e., that they ensure that every file be inspected before downgrade and that only those files that contain no High information be downgraded. An inherent difficulty of any downgrade process is determining the appropriate classification of an object. The assumption that the Downgrade Procedures correctly indicate whether a file contains High information is therefore a security vulnerability that we live with.

Another assumption of the Technological Security domain is that only users with role DO may modify the Downgrader function, including its physical configuration. Two claims in the Physical Security domain validate this assumption by requiring that the Downgrader be locked in a cabinet, which if broken disables the downgrade service. This assumes that the mission can tolerate an interruption of the downgrade service, a vulnerability for the argument described, and that only the DO has keys to the cabinet. As shown, this second assumption is validated by claims concerning Physical Access Procedures of the Operational Security domain.

Partitioning security requirements into the four security domains helps determine how to protect information in the most cost-effective manner. Since we cannot practically avoid risk altogether, the task becomes one of developing a partitioning that provides a good balance between affordability and risk reduction. One could, for instance, introduce guard inspections into the Downgrader example to reduce the risk of interrupted service due to physical attack. This would, of course, increase the personnel and operational costs associated with operating the Downgrader. The program manager would need to decide whether the reduction in risk is worth the corresponding increased cost for the operational environment.

Characterizing the assumptions associated with each domain and explicitly mapping assumptions to their validating claims, if any, further helps to outline the boundary of the security argument. Assumptions with no validation are at the edge of this boundary and map to real security vulnerabilities. These vulnerabilities must be assessed when deciding whether the residual risk is tolerable in the operational environment. The evaluator also needs to ensure the integrity of the assumption validation mapping itself. In the Downgrader example, the reader may have noticed the lack of any claims to ensure consistent application of the Physical Access Procedures. Conscientious application of the above approach helps to uncover such gaps, identifying security vulnerabilities that were not previously considered.

Clearly, the above notation is too cumbersome to handle the complexity associated with real applications. Extending the Downgrader's argument to cover the gap identified above would result in additional claims and assumptions that would make the argument very difficult to understand and manage, even for this relatively simple example. Visual NRM provides a notation and tool support that significantly improves our ability to map out and evaluate the integrity of such arguments.

1.2. Visual NRM Maps

Although the notation used to construct Visual NRM maps draws on a number of sources [2-4], its primary basis is the Goal Structuring Notation originally developed at the Defence Research Agency (DRA) [5] for the elaboration of system safety arguments [6]. As shown in Fig. 3, distinct graphical primitives (shapes) of the notation represent key components of the argument map; a textual summary of

each component is shown inside each shape. The spine of an argument map hierarchically refines security *claims* about the system into subclaims and, eventually, into the *evidence* that a claim is satisfied. The flesh of an argument map describes supporting information about the refinement such as the general *strategy*, *assumptions* made, justifying *reasons*, and contextual *models*.

Longer, more detailed descriptions of the map components can be hyperlinked to the shapes, shown in the figure as dashed arrows. For example, architectural diagrams may be hyperlinked to model shapes; detailed assurance evidence, e.g., mathematical proofs and test suites, may be hyperlinked to evidence shapes. Security vulnerabilities can be tracked by hyperlinking assumptions made in one part of the argument to validating claims made in another part of the argument. Such assumptions become *dependencies* of the argument. Assumptions that are not so linked become vulnerabilities that must be considered when assessing residual risk.

1.3. Visual NRM Tool Architecture

The Visual NRM toolset was built to be easy to use, maintain, and extend. Its design supports ease-of-use by using graphical user interfaces that are familiar to a large portion of the potential user community. The design uses standard, widely accepted software components that support both the need for familiar interfaces and the need to maintain compatibility of Visual NRM with cutting edge technology. As well-supported software components evolve, Visual NRM can evolve in like manner with a minimal amount of effort. Finally, extensibility is important to the evolving Visual NRM design so that when users identify additional, value-added functions, the toolset can be extended easily with minimal changes to the existing implementation. The design supports extensibility primarily through the use of client-server and modular design techniques.

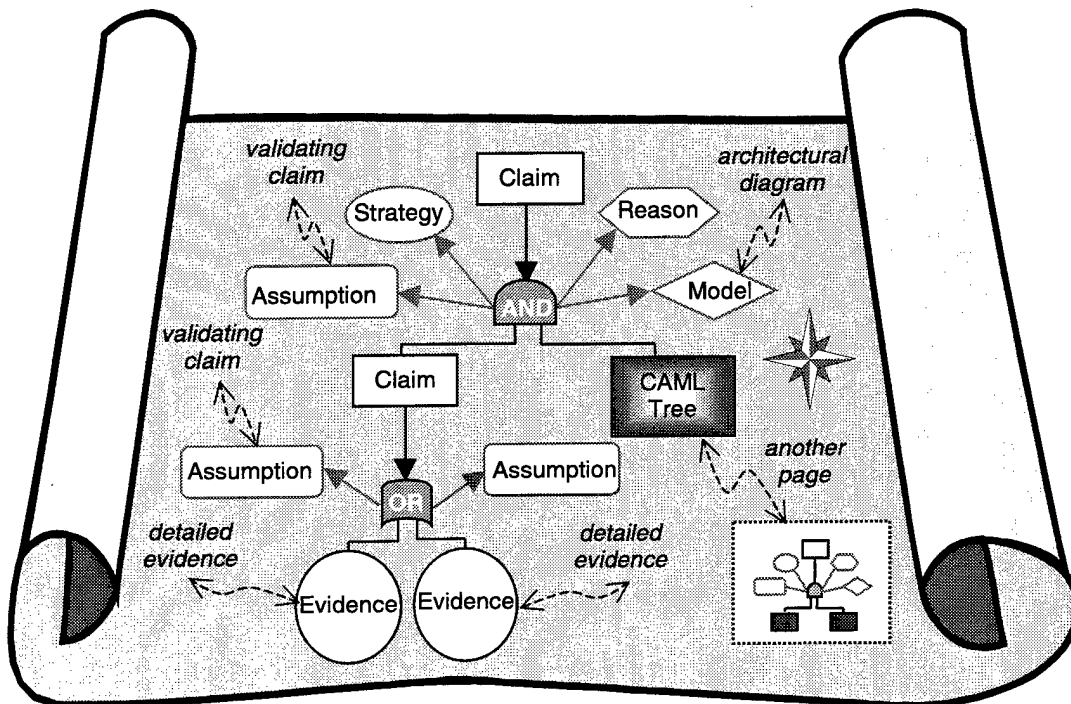


Fig. 3—Visual NRM assurance argument maps

Fig. 4 depicts the Visual NRM (VNRM) tool architecture. The VNRM Explorer provides a user-friendly front-end to the VNRM Database (VNDB) for tools in the VNRM Tool Library. The VNDB,

which is implemented in Microsoft Access, stores the artifacts of an assurance argument, including the Visual NRM map and its documentation, on a project-by-project basis. Users manage and access Visual NRM projects through the VNRM Explorer, an interface that has the familiar look and feel of the standard Microsoft Windows/NT Explorer. Tools in the library can update the VNDB only through the VNRM Explorer so as to preserve the consistency of the VNDB data and the tools' views of that data. The VNRM Explorer notifies any tools that have a need to know when data are updated.

Four tools that support creating and documenting Visual NRM argument maps currently reside in the VNRM Tool Library. VNRM Designer uses the Visio[®] extensible drawing package to create, analyze, and hyperlink Visual NRM maps. These maps can be integrated (as OLE links) into textual documents using the VNRM Documentor, which is implemented using Microsoft Word[®]. Both the Visio and Word environments were extended using Visual Basic (VB) to support Visual NRM-specific function. The VNRM Dictionary permits defining a standard terminology for consistent application across or within Visual NRM projects. Terms so defined are highlighted in the textual parts of the map and its documentation. Finally, VNRM Desktops provides a virtual desktops function to associate different segments of an assurance argument map for simultaneous elaboration or examination.

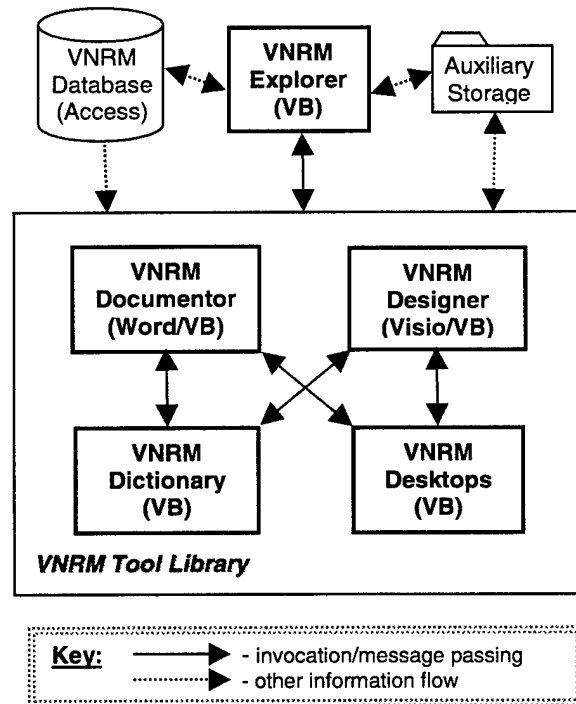


Fig. 4—Visual NRM tool architecture

1.4. Installing Visual NRM

1.4.1. System Requirements

Installing and running Visual NRM requires the following:

- Windows 98 or Windows NT 4.0 (Intel) operating system
- Pentium-class personal computer (PC)
- 32 megabytes of RAM or more

- 15 megabytes of free disk space
- Microsoft Word 97 installed
- Visio Professional 5.0 installed (Service Release C is needed and can be obtained at <http://www.visio.com/support/service/index.html>)
- WordToWeb2 is not required; however, without it, the HTML generation/viewing functions from the VNRM Documentor will not work

1.4.2. Instructions for Installation

1. If installing Visual NRM over a previous version, copy the Vndb.mdb file and the entire Projects directory to a backup location.
2. To start with a new Database and Projects directory, Delete the Projects directory and the Vndb.mdb files from the VNRM install directory prior to running the setup.
3. If using a downloaded installation file, extract the contents of the zip file downloaded, preferably into a temporary empty directory. After installing these files they can be deleted.
4. Execute the Setup.exe file located in the extracted directory. If installing from floppy disks, this file resides on the disk #1.
5. The setup application will run and display several information windows and ask for a destination path for the Visual NRM application. We suggest using C:\VNRM.
6. The setup must copy some custom files to the Visio Professional 5.0 Solutions directory. The setup attempts to locate this via a registry search. It will most likely find the correct path. However, if the Dialog asking for this path has a blank edit box, then use the Browse button to locate the Visio install directory on your computer or network. This is typically installed at C:\Program Files\Visio.
7. The setup must copy some custom files to the Microsoft Office/Word 97 Templates directory. The setup attempts to locate this via a registry search. It will most likely find the correct path. However, if the Dialog asking for this path has a blank edit box, use the Browse button to locate the Normal.dot file used by your Microsoft Office application on your computer or network. This is typically installed at C:\Program Files\Microsoft Office\Templates.
8. The setup will display an information window explaining the current install settings. Click the Next button to begin copying files; click the Back button to change the settings.
9. The setup program will next copy all the necessary files onto your system, set up environment variables for the application, setup a shortcut for the tool in your Start Menu / Programs folder and set up a shortcut on your desktop.
10. If the install was successful in locating Microsoft Word 97, it will load in order to run an installation template macro. If macro security is turned on in Word, a dialog box arises asking whether to Enable Macros, Disable Macros, or Cancel. Choose Enable Macros. The macros contained in this template simply move a macro called ReadyHTML to the Normal template. (Cautious users may perform this step manually by Disabling Macros, exiting Word, and, after the setup is complete, following the instructions, found in the Installation Troubleshooting section of this manual.) By Enabling Macros (or if macro security is disabled), a message box appears stating the macro has been copied. Click OK and the template document will close. Exit Word to return to the setup.
11. The setup requires Windows 98 users to reboot for proper setting of environmental variables. It is not necessary for Windows NT users to reboot prior to running the Visual NRM application.

12. Once the setup is complete, remove the extracted zip files from your system to reclaim that space. Keep a copy of the zip file or floppy disks, in case re-installation is necessary.

1.4.3. Starting Visual NRM

To start Visual NRM, execute the VisualNRM shortcut created in the Programs Folder of the Start Menu, double-click the VisualNRM shortcut created on the desktop, or execute the file <target dir>\Bin\VnrmExplorer.exe. The Desktops and Dictionary tools are available from within the VnrmExplorer or Designer (Visio) environments. The Dictionary tool is also available from within the Documentor (Word) environment. A special menu and toolbar within Visio and Word provides the Visual NRM specific functionality.

1.4.4. Installation Troubleshooting

- The installation should properly register a Visual Basic user control that our software relies on. If you experience errors relating to communication between the VNRM Explorer tool and the Designer (Visio) or Documentor (Word) tools, you may need to manually register this file. To do this, run FastOcx.exe in the <target dir>\Bin folder. Right-click the IpcComm.ocx file in the <target dir>\NrmLib directory to register it. Choose Register from the resulting pop-up menu.
- The Installation Routine should have created the necessary Environment Variables (VndbPath and WordToWebPath). If necessary, this can be done manually:

For Windows 98, add or modify the following two lines in your C:\autoexec.bat file:

- set VndbPath= <target location of the VNRM installation, for example "C:\VNRM">
- set WordToWebPath= <target location of the WordToWeb2 installation, for example "c:\Program Files \WordToWeb2">

For NT, set these environmental variables in the usual way. (Control Panel / System / Environment Tab)

- The installation copies a template file for Visual NRM Drawings to the Visio Solutions directory. This can be done manually by copying <target dir>\VnrmDesigner\VnrmDesignerDrawing.vst to the Visio Solutions directory.
- If step 10 of the Instructions for Installation was not successful, either because the Word application could not be located or macros were disabled, you must manually execute it. Double-click the NRMstr.dot in the directory where you installed Visual NRM, e.g., C:\Vnrm. If prompted whether to Enable Macros, Disable Macros, or Cancel, choose Enable Macros. The macros contained in this template simply move a macro called ReadyHTML to the Normal template. Click OK to the status box and the template document will close. Exit Word.

1.4.5. Uninstalling Visual NRM

To remove Visual NRM from the system, use the Add/Remove Programs utility within Control Panel. Choose the Install/Uninstall tab and select Visual NRM from the list of applications. Click the Add/Remove button. At the Confirm File Deletion prompt, click Yes to proceed. UninstallShield will be loaded. If prompted, do not delete any shared files that were copied to your machine during the installation.

1.5. Structure and Terminology of This Manual

The rest of this document provides both tutorial and reference documentation for Visual NRM. Section 2 is a tutorial that touches on core functions for each of the Visual NRM tools to give the user a hands-on overview of Visual NRM capabilities. The remaining sections provide reference information for beginning or experienced Visual NRM users. Henceforth, we conform to the following terminology and notational standards:

- The term *click* refers to a click of the left button of the mouse. When a right-click is needed, we specifically say *right-click*. *Double-click* means clicking the left mouse button twice in rapid succession. We also combine the Alt and Ctrl keys with mouse clicks and other keystrokes. For example, *Alt-double click* means to double click the left mouse button while holding down the Alt key.
- The term *dragging*, as in dragging an object, means holding down on the left mouse button on the object and moving it to a different position. Release the button only when you have completed the repositioning.
- We use the Helvetica font to denote text that is to be entered or viewed by the user at a Visual NRM tool interface.
- For menu selection, the phrase select menu item A|B|C, for example, means to select menu A, then select submenu B of A, and, finally, to select menu item C from submenu B.

2. TUTORIAL

In this tutorial you will construct a small portion of a security assurance argument map for a simple information downgrader. 6 contains the argument map used in this tutorial.

2.1. Start Visual NRM

Start Visual NRM by double-clicking the VnrmExplorer.exe program in the VNRM home directory Bin folder. There should also be a menu item Programs|Visual NRM under your start menu. We suggest putting a shortcut icon on your desktop for easy access. Regardless of the method of invocation, VNRM Explorer is the first interface you see and is the center of Visual NRM processing activity.

- Start Visual NRM.

2.2. Establish a Visual NRM Project

You should now have the VNRM Explorer interface in front of you, which will look similar to that shown in Fig. 5. The interface is split into two primary parts. The left-side window contains the primary objects that constitute a Visual NRM argument map, organized as a TreeView hierarchy. The right-side window contains descriptions of certain elements when they are selected in the left-hand window. The model of organization is the conventional Windows/NT Explorer, with which most PC users should be familiar. Most operations on VNRM objects are available from either the menu items at the top, or the toolbar right below it. Click on the View|Large Icons menu item to see the toolbar icons in more detail. Dragging any corner of the VNRM Explorer interface expands the size of the window. Dragging the bar between the left and right windows in the interface re-apportions the space allotted the two windows.

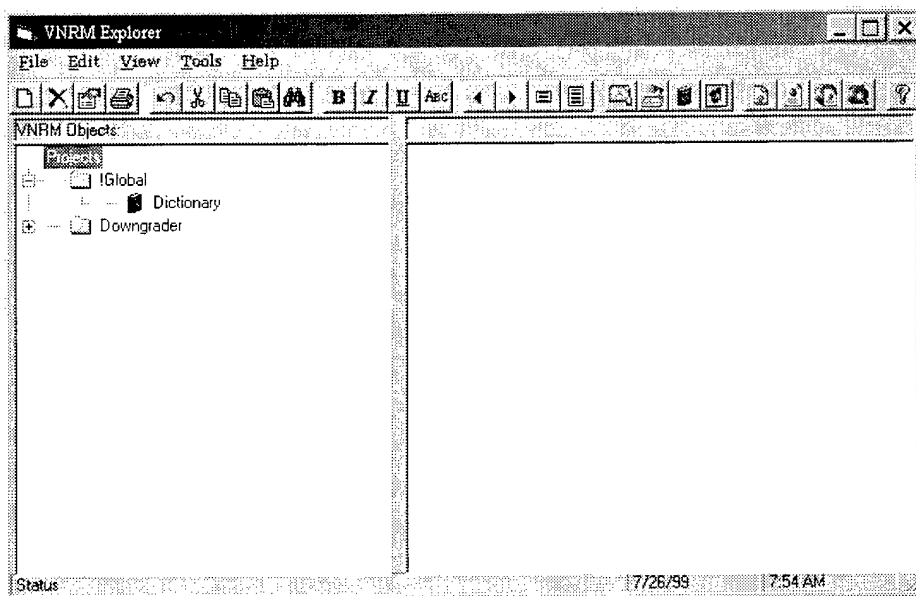


Fig. 5–VNRM Explorer interface

To create a new project:

- ❑ Click on the **Projects** keyword on the left-hand side. This should highlight, in a different color, the word **Projects**, as shown in Fig. 5.
- ❑ Click **File|New** to bring up the Project Identification dialog. Click the different tabs to see the types of information that can be associated with a project. This information will be filled in later since it is only used in the VNRM Documentor. You could have also invoked the **New** command by pressing **Ctrl-N** from the VNRM Explorer interface. This is indicated to the right of the **File|New** menu item. Such indications inform the user when Control, e.g., **Ctrl-N**, or Function Keys, e.g., **F1**, can be used instead of clicking on menu items.
- ❑ Go to the **Product** tab and change the name of the project to **Tutorial** by replacing the default, – **New Project**, with **Tutorial**.
- ❑ Click the **X** button.

Visual NRM projects, including the project that you just created, are shown at the top-level of the TreeView hierarchy.

- ❑ Click on the **Tutorial** project. The label above the right-side window reads description.
- ❑ Click in the window below the label and enter a description of the project, perhaps the description **A simple information downgrader**.

Certain nodes of the TreeView can be associated with descriptions, such as this, simply as comments to the user regarding the intended purpose of the object. The system does not rely on these descriptions for correct operation and, thus, they can be omitted if desired.

To expand the Tutorial project:

- ❑ Click on the plus sign to the left of the **Tutorial** folder TreeView icon. Three branches of the **Tutorial** project will appear, one for each of the tools – **VNRM Designer**, **VNRM Dictionary**, and **VNRM Documentor**.

- Click on the **Designer** branch. We are going to create a new Designer document. We could do this by clicking the **File|New** menu item as before. Instead, however, use the toolbar. Hold the cursor over the first toolbar icon, the one shaped like a piece of paper. You'll notice a little box pop-up with the word **New** in it. This tells the user the function that is invoked as a result of clicking that toolbar item. The names correspond to the names used in the menu bar.
- Click the **New** toolbar icon. A Document Identification dialog box will appear. Again, this information is only used in the VNRM Documentor.
- Change the document title to **Information Downgrader**.
- Click the **X** button.

The VNRM Designer will appear with a blank document available for editing. Notice that the VNRM Explorer continues executing, and must remain executing, while VNRM Designer executes. Close VNRM Explorer only when all other Visual NRM tools have been properly exited.

2.3. Define the Downgrader Problem

You should have VNRM Designer (Visio) open with a blank drawing page, which will look similar to that shown in Fig. 6. The page will have **Information Downgrader: Page-1** in the window title bar. We will construct on this page the first-level refinement of the downgrade problem.

2.3.1. Name the Page

To change the name of the page from its default **Page-1**:

- Click **File|Page Setup**.
- Click the **Page Properties** tab of the dialog box
- Change the name to **The Problem**.
- Click **OK**.
- Click the **Designer|SaveAll** menu item.

As you are using VNRM Designer, remember to save your work often by using the **SaveAll** menu item (in the **Designer** menu) or toolbar icon.

2.3.2. Add Shapes to the Page

The first-level refinement is shown in Appendix A, Fig. A1. To draw this refinement, use the shapes on the stencil in the upper left-hand corner of the VNRM Designer interface.

To create the Objective shape:

- Drag the Objective shape to the blank drawing page. Notice that the shape has small green squares around it, indicating that it is selected. If you click the middle of the shape, the squares turn gray. If you click it again, they turn back to green. Since selecting a shape will be important for future operations, this distinction is important. Green boxes means the shape is selected; gray boxes, or no boxes, means the shape is not selected.
- Reposition the shape, if necessary, by dragging it to the new position.
- Double-click the shape. A larger version of the shape will appear.
- Select the larger shape.
- Enter the text shown in the objective shape of Fig. A1. The text will automatically format itself; do not enter any carriage returns or other formatting manually.

- ❑ Click the **X** at the top right-hand corner.

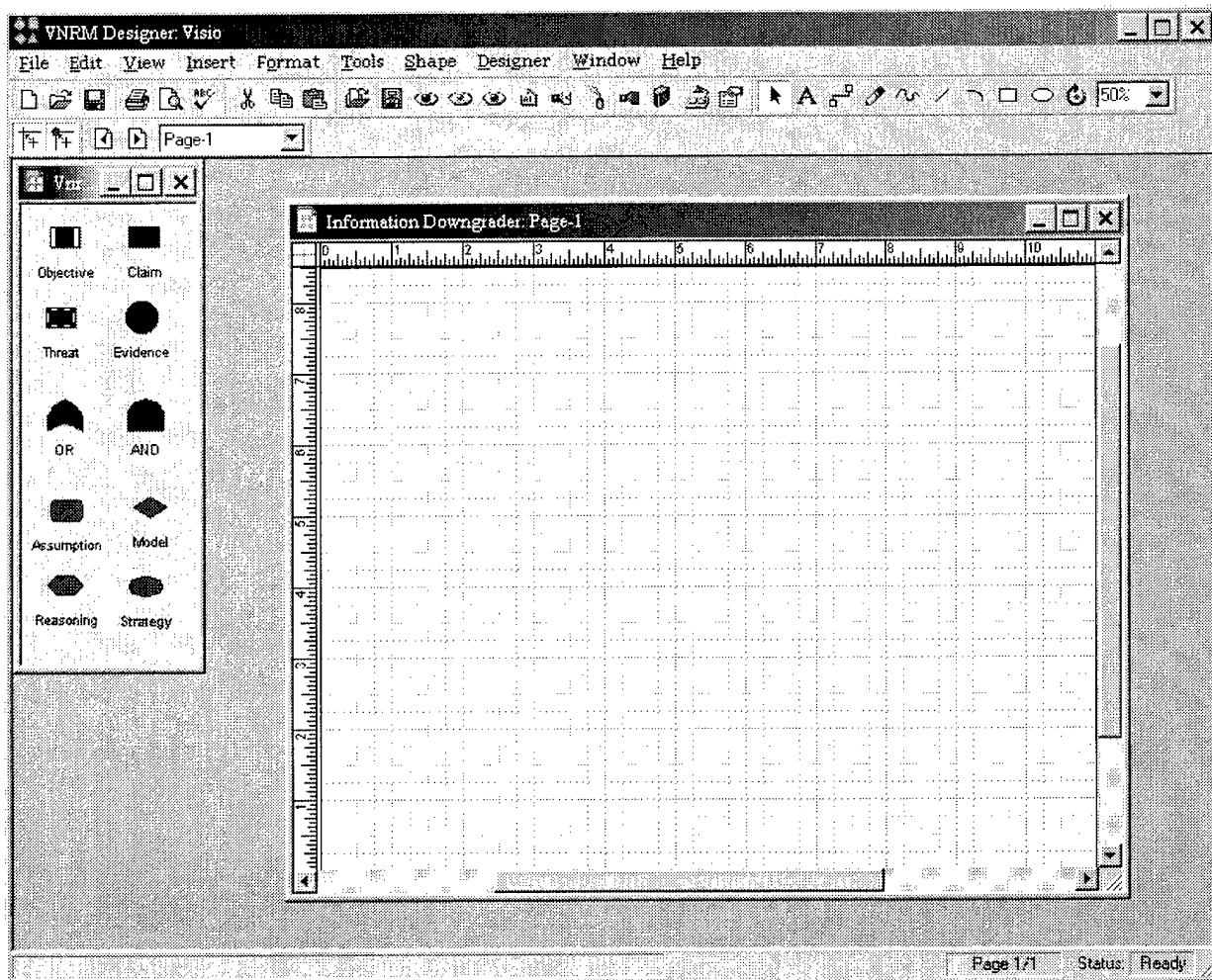


Fig. 6–VNR Designer interface

Dictionary terms are highlighted as the word downgrade is in the objective shape of Fig. A1. To define a term in the project's dictionary:

- ❑ Start up the VNR Dictionary by clicking the Designer|Dictionary menu item. The tool that appears looks similar to that shown in Fig. 7, with a list-box on top of a text-box. The Dictionary can also be invoked by clicking the little blue book icon on the toolbar. You'll notice the Dictionary label if you hover over the icon, as in the VNR Explorer. Many of the Designer menu items are available on the toolbar
- ❑ Click the diamond shape to the left of the upper list-box.
- ❑ Click Add.
- ❑ Type downgrade into the list-box.
- ❑ Hit return. This action eventually highlights the word downgrade in the objective shape. There may be a brief lag time since the Add checks the database to ensure that the term is not already defined.

- ❑ Enter the definition of **downgrade** in the text-box, e.g., moving information from one classification level to a lower classification level.
- ❑ Click the downgrade term in the list-box to accept the definition.

Returning to VNRM Designer:

- ❑ Add the other shapes that appear in Fig. A1 to the drawing page (i.e., a Model, a Strategy, a Reasoning, an AND gate, and four Claim shapes), just as you did for the Objective shape. Do not worry that the claim shapes are not shaded. Shading indicates that they are links to a refinement on a different page, which we will set up later.
- ❑ Add the text and dictionary terms indicated, defining terms as you see fit. Appendix A contains our definitions.

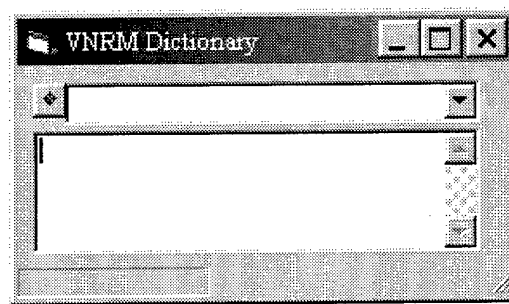


Fig. 7–VNRM Dictionary interface

2.3.3. Connect and Label Shapes

When the text for all the shapes in Fig. A1 have been entered, the shapes can be connected. The Connector Tool is invoked by clicking the Connector Tool icon on the (Standard) toolbar, i.e., the toolbar icon that shows a line connecting two squares, between the toolbar icons displaying a big letter A and a pencil.

To connect and label the shapes:

- ❑ Click Connector Tool toolbar icon; notice that the cursor on the drawing page has a little crooked arrow beside it, an indication that the Connector Tool is operational. The small blue X's on each shape are the start and end points for a connector. Each connector is unidirectional.
- ❑ Put the cursor beside a blue X on the source shape; a black box should appear around the blue X.
- ❑ Drag an arrow to a blue X on the destination shape.
- ❑ If necessary, to change the blue X to which a connector is attached, hold the cursor directly over the connection point until a four-pronged arrow appears, and click drag the connection to the new connection.
- ❑ Finish connecting the shapes as shown in Fig. A1. Don't worry about the Claim shapes to which the Shape Links are linked; we deal with these in a later section.
- ❑ To get out of the Connection mode, click the Pointer Tool icon. The Pointing mode is the typical mode you want to be in when not connecting shapes, thus the reason for laying out all the shapes on a page before connecting them together.

- ❑ Label the shapes using the **Designer|Label Shapes** menu item or **Label Shapes** toolbar icon. This operation labels the shapes in the documents of the currently active project in a breadth- or depth-first manner, depending on the option set in the **Designer|Options** dialog (the default is breadth-first labeling). **Label Shapes** also labels any connectors whose labels could not be resolved when first drawn.

2.3.4. *Format Shapes on Page and Pages in Window*

You can now position the shapes and connections on the page to your liking. Visio has an alignment tool that is particularly helpful for lining shapes up on the page.

To align all of the shape links in a straight row:

- ❑ Select all of the shape links. Multiple shapes can be selected by de-selecting all shapes on the page and then shift-clicking each shape to be included.
- ❑ Click **Tools|Align Shapes**.
- ❑ Choose the type of alignment desired; the first **Up-Down** alignment works nicely for this particular example.
- ❑ Click **Tools|Distribute Shapes**.
- ❑ Choose the first **Left/Right** distribution; this distributes the shapes evenly across the page.
- ❑ Click **OK**.

The look of the diagram can also be improved by adjusting the height of the horizontal bend for the connectors between the **AND/OR** gates and the shapes to which they point. To do this:

- ❑ Click on the connector between the **AND** gate and the second claim (**C1m2**).
- ❑ Put the cursor over the green x.
- ❑ Drag the bend to a new, more appropriate height.
- ❑ Through alignment and connector bend repositioning, make your refinement as nice looking as in Fig. A1.

To get rid of the excess drawing space on the page, making it more convenient for editing:

- ❑ Click **File|Page Setup**.
- ❑ Under the **Page Size** tab click the **Size Page to Fit Drawing** button.
- ❑ Click **OK**.

To view the whole page:

- ❑ Click the **View|Whole Page** menu item.
- ❑ Re-size the window as desired by dragging any corner of the active window.
- ❑ To save these settings as default, right-click on a blank portion of the page and click **Save Window Settings**.

Henceforth, whenever you open this page, the position and size of the page's window will be the same as when you performed the last **Save Window Settings**.

2.3.5. *Build a Contextual Model*

We are now going to create an architectural diagram to which the model shape Fig. A1 will be hyperlinked. This is the purpose of the small square shape, henceforth called the **Hyperlink shape**, on the right corner of the **Model shape**.

To add the **Hyperlink shape**:

- ❑ Select the model shape.
- ❑ Invoke the Add Hyperlink menu item (in the Designer menu) or toolbar icon. This places an unshaded Hyperlink shape on the Model shape, indicating that it has not yet been instantiated.
- ❑ To instantiate the Hyperlink, double-click the Hyperlink shape. This raises a dialog box with three sections: the first identifies the file path or URL for the link; the second identifies a named location within the file or URL to jump to; and the third is an optional description that will appear when the cursor hovers over the hyperlink shape. The first section is predefined to be the pathname of the currently active document; leave that section alone.
- ❑ Enter the string **Downgrader Diagram** in the second and third sections. You will create this diagram subsequently.
- ❑ Click OK. This shades the hyperlink indicating that it is instantiated.
- ❑ If you entered the hyperlink information incorrectly, right-click the Hyperlink shape and click the **Hyperlink|Edit Hyperlink** menu item.

To create the page that you have just linked:

- ❑ Click the **Insert|Page** menu item.
- ❑ Click the **Page Properties** tab in the resulting dialog box.
- ❑ Enter **Downgrader Diagram** in the Name text box.
- ❑ Click the **Open Page in New Window** checkbox.
- ❑ Re-size the window by dragging any corner to the desired size.
- ❑ Reposition the window, if necessary, so that both of the pages, **The Problem** and **Downgrader Diagram**, are visible.

To create the diagram that illustrates the Downgrader's external environment using two other stencils available in the Visio Professional package (Appendix A, Fig. A2):

- ❑ Select the window that you just created.
- ❑ Click **File|Stencils|Network Diagram|Basic Network Shapes 3D**. All of the shapes you see in Fig. A2 (**Workstation, Server, Printer, Computer, Laptop, Room, Bus Network, and Ring Network**) are available from this stencil except the **Man Holding Folder**, which is available from **File|Stencils|Visio Extras|Clipart**. A **Workstation** shape was used to represent the Downgrader. If the 3-dimensional version of the stencil is not available, use equivalent shapes from the two-dimensional stencil called simply **Basic Network Shapes**.
- ❑ Drag and drop the shapes onto the page.
- ❑ Connect the shapes as shown in the diagram using the **Connector Tool**, as before.
- ❑ Label the shapes as shown in the diagram. Names of shapes can be edited by simply double-clicking the shape. There is a handle for moving the labels to the desired position. The formatting of lines and text can be adjusted using the functions available under the **Format** menu item.

2.4. Refine the Argument Map

Now we will expand the refinement begun on the page called **The Problem** in the document called **Information Downgrader**. We will add a separate document for refining each of the subclaims on this page.

2.4.1. Add a New Document

To add a new document:

- Click the **File|New|VnrmDesignerDrawing** menu item to create a new document. This action raises a dialog box requesting the project to which the new document is to be added.
- Double-click the **Tutorial** project.
- Change the name of the page to **DO Downgrade** by clicking **File|Page Setup** and selecting the **Page Properties** tab as before.

In the current version of Visual NRM, the document name has to be changed from the VNRM Explorer interface. To do this:

- Open the **Designer** branch of the **Tutorial Project** from VNRM Explorer.
- Double-click the name of the document just created.
- Type the new name **Technology Security** and hit the enter key.
- Go back to VNRM Designer to the page just created. The name of the window of this page will eventually be updated to **Technology Security: DO Downgrade** to reflect the renaming.

2.4.2. Expand Refinement to New Document

To expand the refinement to the new page:

- Select the window containing the **The Problem** page in VNRM Designer.
- Right-click the first **Claim** shape that you created earlier, which should now be labeled **Clm1**, and click **Convert to Claim Link**. This shades the interior of the shape, which is now referred to as a **Claim Link**.
- Double-click this new shape. A **Claim** shape will appear to which the **Shape Link** is linked. Notice that the same text appears in both shapes. In fact, the user can not edit the **Claim Link** text directly; VNRM Designer maintains their consistency automatically.
- Select the newly created **Claim** shape.
- Click the **Edit|Cut** menu item.
- Select the window containing the **DO Downgrade** page.
- Click **File|Paste** to paste the **Claim** shape that you just cut. This creates a link between designer documents that can be traversed by alt-double clicking the **Claim** shape and its corresponding **Claim Link**.
- We now want to create the structure shown in Fig. A3, on the **DO Downgrade** page. Do this in a manner similar to the construction of the structure on the **The Problem** page in section 2.3. The **Dependency** shape is added as an **Assumption** shape and only becomes a **Dependency** when it is validated by **Clm2**. For now, do not worry about the red **Validation** shapes.
- Click **Designer|Label Shapes**. This operation will label the shapes for all documents in the current project.
- Click **Designer|Save All**.
- Follow the instructions in Sections 2.4.1 and 2.4.2 for each of the other sub-Claims on the **The Problem** page. The names of the documents and pages to create for each refinement are shown in Table 1.

Table 1—Refinement Elaboration Information

| Root Shape Label | Document Name | Page Name | Fig. Number |
|------------------|----------------------|----------------------|-------------|
| Clm1 | Technology Security | DO Downgrader | Fig. A3 |
| Clm2 | Physical Security | Physical Access | Fig. A4 |
| Clm3 | Personnel Security | DO Trustworthy | Fig. A5 |
| Clm4 | Operational Security | Downgrade Procedures | Fig. A6 |

2.4.3. Create Validation Links

It is important to assess each assumption in the argument map to determine whether claims or evidence elsewhere in the argument can validate it, since assumptions that are not validated represent a potential security vulnerability. Let's look first at Assumption Asm1 on the **DO Downgrade** page. Claim Clm2 on the **Physical Access** page, which states that only the DO may modify Downgrader function, assures that the Downgrader is not tampered with by unauthorized individuals.

To indicate this validation, let's create a validation link between Clm2 and Asm1:

- Deselect all shapes by clicking the **Deselect All** menu item (from the Designer menu) or toolbar icon.
- Select only Asm1 and Clm2.
- Click the **Validate Assumption** menu item or toolbar icon. If these were the only two shapes selected, the validation link should correctly show that Clm2 validates Asm1.
- If necessary, remove shapes included in the Validation stack that are not needed by right-clicking the Validation shape and clicking **Remove Validation**.
- If necessary, remove the whole validation stack by right-clicking the validating/validated shape and clicking **Remove Validation Stack**.
- Re-label the shapes by clicking **Designer|Label Shapes**. This converts the Assumption shape into a Dependency shape, indicating the assumption has been validated.

2.4.4. Construct a Virtual Desktop

At times, it is convenient to have collections of pages that are developed, analyzed, and/or presented as a group. We call such groupings virtual desktops. The VNRM Desktops interface consists of three parts: a desktop viewer in the main body with a list box underneath. To the left of the list box is a pull-down menu with **Add** and **Delete** commands. We now create a simple desktop using the VNRM Desktops tool:

- From VNRM Designer invoke VNRM Desktops by clicking the **Designer|Desktops** menu item or the **Desktops** toolbar icon. An interface similar to that shown in Fig. 8 should appear.
- Close all but the **The Problem** and **Downgrader Diagram** pages of the **Information Downgrader** document. If this document is not currently loaded, load it by right-clicking the document in VNRM Explorer and clicking **Designer**. Once you have **The Problem** page showing, double-click the hyperlink shape in the **Downgrader Diagram Model** shape to open the **Downgrader Diagram** page.
- Position and size these pages as you like.
- Click the pull-down menu on the VNRM Desktops tool.

- ❑ Click **Add**.
- ❑ Type in the list box the name of the desktop, e.g., `DowngradeProblem`.
- ❑ Hit the carriage return. A miniature version of the desktop is shown in the desktop viewer.

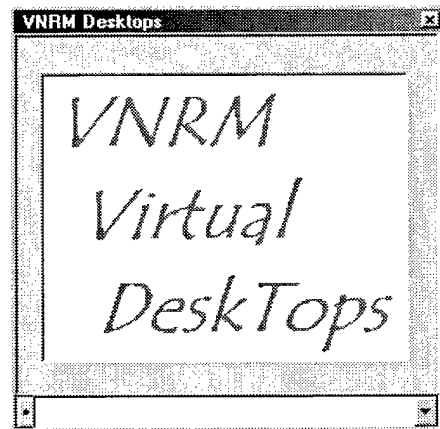


Fig. 8–VNRM Desktops interface

VNRM Desktops allows desktops that include pages from different documents. To construct a multi-document desktop:

- ❑ Close the `Downgrader Diagram` page.
- ❑ Open the pages associated with each of the first three claims on `The Problem` page by alt-double clicking the link shapes for each.
- ❑ Arrange the pages as desired.
- ❑ Invoke the **Add** operation in VNRM Desktops as before.
- ❑ Type a name for the new desktop, e.g., `DORestrictedDowngrade`.
- ❑ Hit the carriage return. This desktop reflects the part of the argument describing how the downgrade function is limited to only `DO` application. But note that the `DO Trustworthy` page does not really belong to this grouping.
- ❑ To delete `DO Trustworthy` from the desktop, click the miniature version of the page in the desktop viewer.
- ❑ Click the miniature version again.
- ❑ Select the **Remove from Desktop** menu item.

2.4.5. Exit VNRM Designer

At this point, you have invoked several tools, possibly including VNRM Designer, VNRM Dictionary, VNRM Desktops, and, of course, VNRM Explorer. All of these tools are executing independently, so they need to be shut down separately. However, when exiting Visual NRM altogether, always exit VNRM Explorer last, since it is the means through which Visual NRM updates the VNDB. For now, just exit the other three tools:

- ❑ Exit VNRM Dictionary by clicking the **X** in the upper right-hand corner of the window.
- ❑ Exit VNRM Desktops by clicking the **X** in the upper right-hand corner of the window.

- ❑ Exit VNRM Designer either by clicking the **X** or the **File|Exit** menu item. This may ask you whether you want to save each document. You should generally save any documents to which you have made any changes, since the database is updated incrementally as you make modifications. If you really do not want your changes saved, you may, but you will have to re-synchronize the database the next time you open the project (section 4.1.12). You do not need to save the *Vnrm.vsd* when it asks, although it does not hurt to do so. Finally, Visual NRM was developed on the Windows 98 platform. Unfortunately, for users of Windows NT, there is an error in Windows NT that causes Visio to break on exit. This does not cause a problem as long as you have saved your Designer documents previously.

2.5. Document the Argument Map

So far, you have constructed the graphical components of the Downgrader Argument Map. You are now going to create the Microsoft Word document that will serve as the framework for describing the argument map in a form suitable to the evaluators of the argument.

2.5.1. Add the Documentor Document

The Documentor permits the graphical components to be imported and placed in the manner desired by the developer to meet the needs of the evaluation. To use the hierarchical structure of the map, the Documentor requires that the developer identify the root page of each Designer document, i.e., the page that forms the top of the hierarchy for the document of which it is a part. To do this:

- ❑ Select the VNRM Explorer interface.
- ❑ Open the **Tutorial** project, if not already open, to display the three branches of the project.
- ❑ Open the **Designer** branch, if not already open, to display the five documents that we constructed.
- ❑ Open the **Information Downgrader** document by clicking on the plus sign to the left of that branch. You'll see two branches, one for the **Downgrader Diagram Visio** drawing and one for the **The Problem** page. The **The Problem** page is the root of the **Information Downgrader** document.
- ❑ Right-click **The Problem** page
- ❑ Click the **Set Root Page** menu item. You'll notice that **The Problem** is bolded, indicating its status as root page.
- ❑ In a similar manner, for each of the other four documents, open the document and set the (only existing) page as root.
- ❑ Close the **Designer** branch by clicking the minus sign to the left of the branch.

Now you can add a new Documentor document, much like we did to create the Designer document previously:

- ❑ Click the **Documentor** branch
- ❑ Click the **New** toolbar icon. A Document Identification dialog box will appear, as before.

To fill out the fields of the dialog:

- ❑ Entitle the document **Information Downgrader Assurance Argument Map**.
- ❑ You are the author, so use your identification in the author-related fields.
- ❑ Use your own organization's format for referencing documents in the Reference Number field, e.g., at NRL we often use references of the form **NRL Technical Memorandum 5540-xxx:apm**.

- ❑ Fill in any other fields that you desire. Any information that you do not fill out will not be completed when the Documentor document template is instantiated. This is not a problem, since those fields can either be completed manually or deleted altogether. However, fields that are completed manually are not entered in the VNDB.
- ❑ Click the **X** in the upper right corner. VNRN Documentor will appear, similar to that shown in Fig. 9, with the uninstantiated Documentor template open for editing. Fields of the template document appear in the document as a description of the field delimited by square brackets. Again, notice that VNRN Explorer continues executing, and must remain executing, while VNRN Documentor executes.

To instantiate the Documentor template:

- ❑ Click the **Identify Project** menu item (of the **Documentor** menu) or toolbar icon. Notice that not all fields are instantiated, because we skipped filling out certain project properties when we originally created the project.
- ❑ Go back to VNRN Explorer.
- ❑ Select the **Tutorial** project.
- ❑ Click the **File|Properties|Identify Project** menu item or the **Identify Project** toolbar icon.
- ❑ Fill in the properties
- ❑ Return to VNRN Documentor.
- ❑ Invoke **Documentor|Identify Project** to instantiate fields in the rest of the template.
- ❑ If certain fields are not applicable to your project, simply delete them. This may require deleting rows from the **Point of Contact** table, e.g., by selecting the row and clicking **Table|Delete Row**.

2.5.2. Import the Argument Map

To import the argument map that you created in VNRN Designer:

- ❑ Click the **Import VNRN Map** menu item (under the **Documentor** menu) or toolbar icon. This invokes a dialog box similar to that shown in Fig. 10).
- ❑ Make sure the **Insert Documents as Chapters** and the **Manual DB Field Update** options are selected (as shown).
- ❑ Select the documents for inclusion in the following order: **Information Downgrader**, **Technology Security**, **Physical Security**, **Personnel Security**, and **Operational Security**. Do this by clicking on each document and clicking the **Select** button, in sequence. If you make a mistake, you can remove the document from the list of **Selected Documents** by clicking the **Remove** button.
- ❑ Click the **Submit** button. The importation process, which takes a few minutes to complete, is finished when the dialog box disappears.

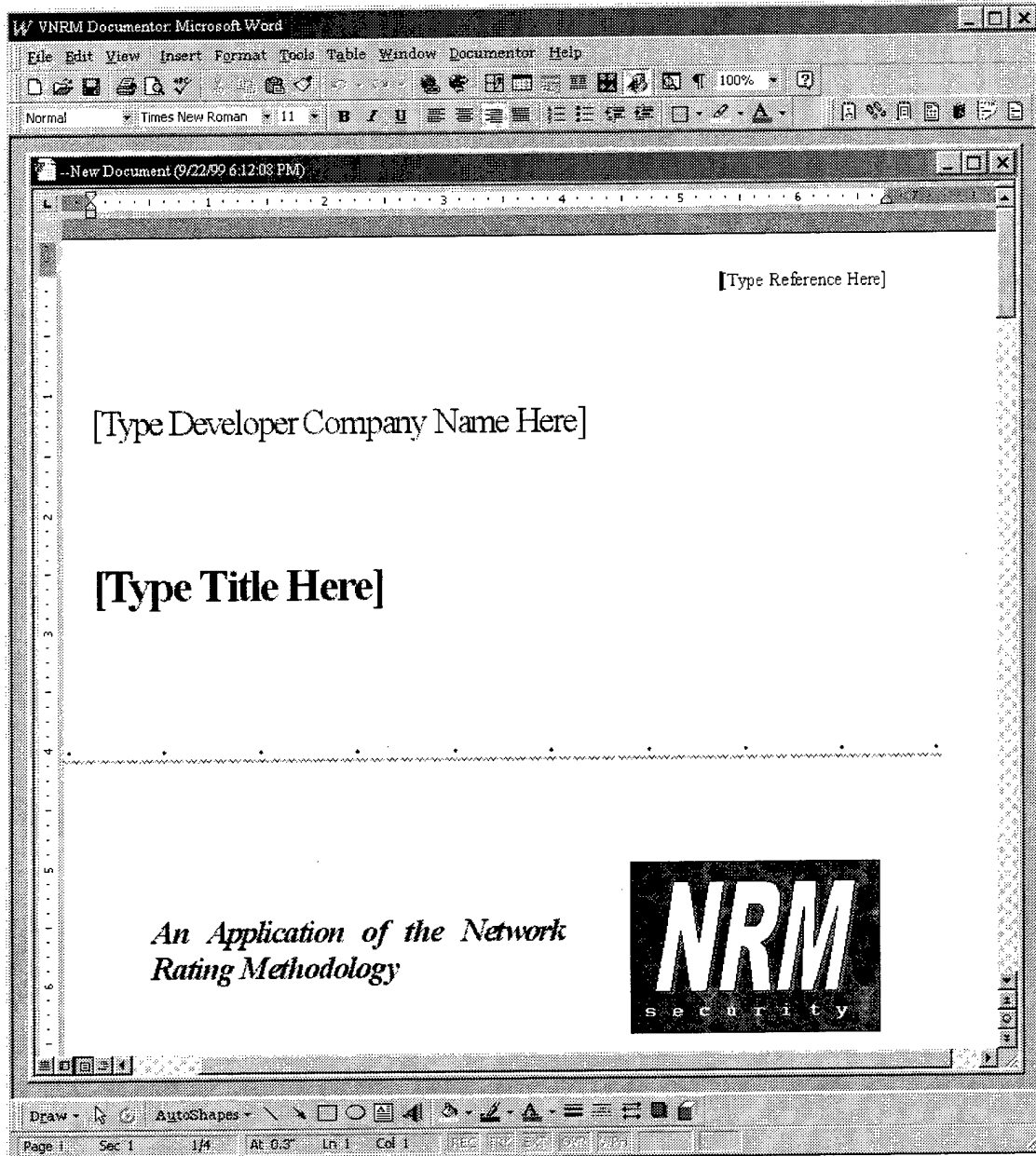


Fig. 9—VNRM Documentor interface

The Documentor is using the hierarchical structure of the Designer diagrams as the section structure for the Word document. Each page of the Designer document is placed in its own section, with the hyperlink information translated to figure and page number cross-references. The Designer diagrams and hyperlink tables are imported as OLE links so that they can be updated as the Designer documents change in VNRM Designer. Choosing the Manual DB Field Update option forces the user to update diagrams manually by clicking Documentor!Update Fields Now menu item. Although automatic update may seem better, the overhead costs associated with Word regularly checking the need for an update is prohibitive for larger projects. The tables must always be updated manually using the Documentor!Update Tables menu item.

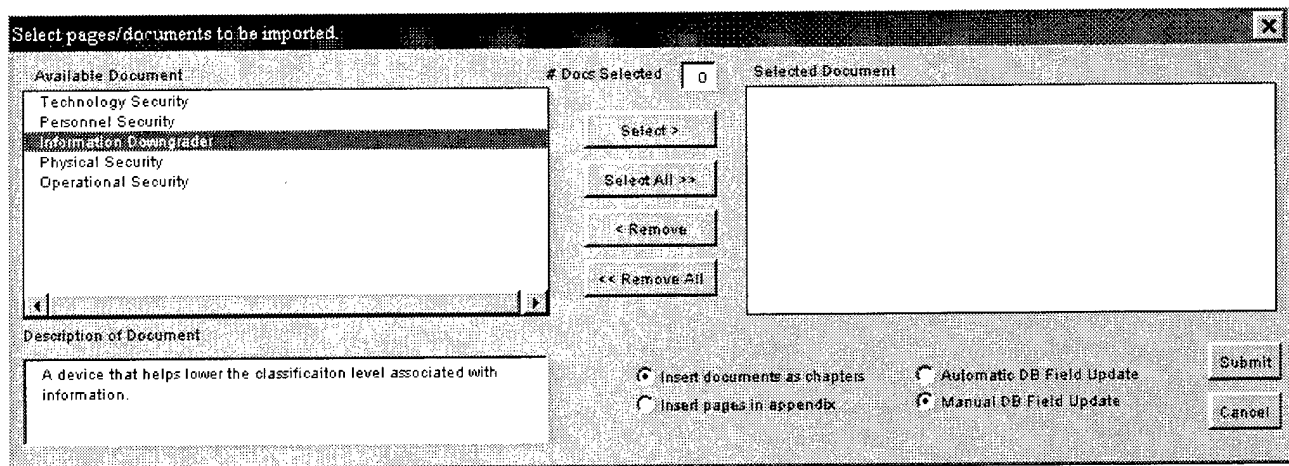


Fig. 10—Dialog box for importing an argument map

2.5.3. Insert the Dictionary

To import and extend the project dictionary that you created in VNRM Designer:

- Click the **Update Dictionary Table** menu item (under the **Documentor** menu) or toolbar icon. This inserts a table of the dictionary entries as a separate chapter at the end of the document.
- Open up the VNRM Dictionary tool by clicking the **Documentor|Dictionary** menu item.
- Click the diamond shape to the left of the upper list-box.
- Click **Add**.
- Type **trustworthy** into the list-box.
- Hit the return.
- Enter the definition of **trustworthy** in the text-box, e.g., **dependable execution of responsibility**.
- Click the **trustworthy** term in the list-box to accept the definition.
- Click **X** in the upper right corner.
- To reflect the changes to the dictionary in the Word document, invoke the **Update Dictionary Table** function in VNRM Documentor again. Note that you should not change the definitions in the Word table directly, since these changes do not update the database and will be lost the next time **Update Dictionary Table** is invoked. Changes to shapes that contain the new term will not be updated until the project documents are opened using VNRM Designer.

3. VNRM EXPLORER

The VNRM Explorer provides a utility to help manage, build, and review Visual NRM assurance argument maps. Its interface, shown in Fig. 11, is split into two primary windows. The window on the left presents the project management hierarchy in the TreeView form familiar to users of Microsoft's Windows/NT Explorer. The window on the right presents additional information about the node of the hierarchy chosen, and highlighted, on the left. Fig. 11 also shows the definition of the term downgrade in

the Downgrader project dictionary. But we are getting ahead of ourselves. Let's first describe the structure of the project management hierarchy.

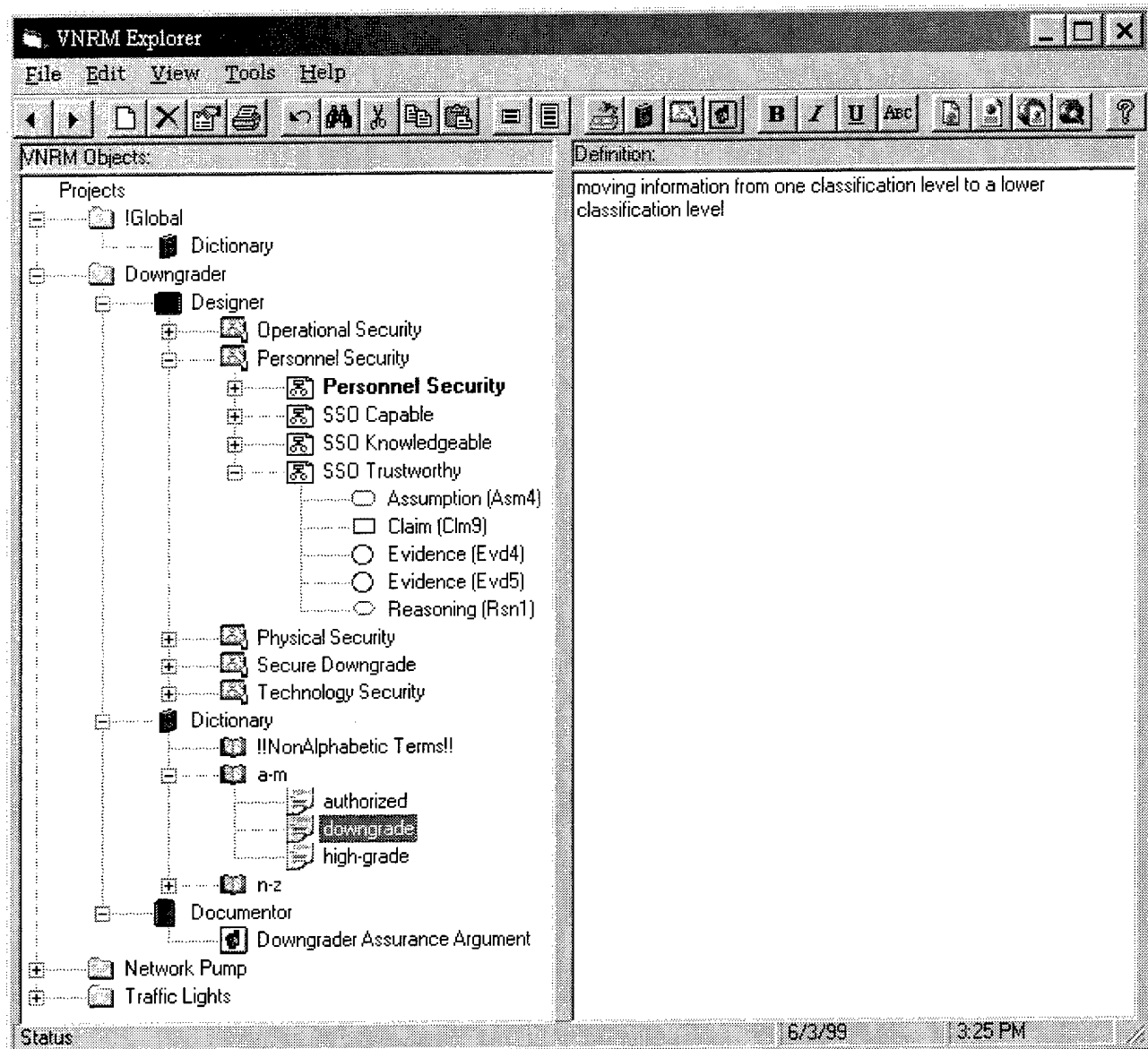


Fig. 11–VNRM Explorer interface

The top-level of the VNRM hierarchy, **Projects**, is split into a Global Dictionary and a list of projects currently under construction. Fig. 11 shows three projects – **Downgrader**, **Network Pump**, and **Traffic Lights** – of which only **Downgrader** is opened for viewing. The Global dictionary defines terms that must be used consistently across all projects. Although the Visual NRM toolset does not ensure their consistent application, it does ensure that users are aware of when globally defined terms conflict with terms defined local to a project. All terms are highlighted when used in VNRM argument maps, indicating that their special meaning is defined in either the global or a project-local dictionary.

Each project in the hierarchy has three branches – **Designer**, **Dictionary**, and **Documentor** – which organizes the development artifacts associated with each tool. The **Dictionary** branch contains the set of terms defined local to the project. When more than 10 terms are defined, a classification is automatically created to help more easily locate terms of interest. Fig. 11 shows the partitioning of the **Downgrader** project's dictionary into a-m, n-z, and one for terms starting with nonalphabetic characters. The **Documentor** branch simply lists the set of textual (Microsoft Word) reports that have been produced to describe the VNRM maps produced. We next describe the **Designer** branch, which is where most of the work of producing VNRM maps takes place. VNRM Desktops does not currently have its own branch, but can be accessed from the Tools menu to be discussed later.

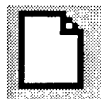
The **Designer** branch contains the primary development artifacts associated with the graphical elements of Visual NRM maps. Designer documents, at the top-level, contain a set of pages, at the next level, which, in turn, each contain a set of shapes. As shown in Fig. 11, the **Downgrader** project is split into five documents, **Secure Downgrade** and one for each of the NRM security disciplines. The **Personnel Security** document is split into four pages. The page of the same name is the root claim tree, indicated by its bold formatting. This page forms the top level of the claim tree hierarchy in the document; all other pages in the document describe subtrees of the top level. Finally, Fig. 11 shows the shapes and corresponding shape labels that appear on the **DO Trustworthy** page. Clicking these shapes show their contained text on the right. Designer documents, pages, and shapes correspond to Visio documents, pages, and shapes, as will become apparent in section 4 on the VNRM Designer.

The VNRM Explorer maintains many of the Windows/NT conventions for adding, deleting, and renaming nodes within the TreeView hierarchy. Nodes can be added using the insert and delete keys. Nodes that permit modification can be renamed in-line by double-clicking the node, typing the new name, and hitting return. Certain nodes of the VNRM Explorer hierarchy cannot be added, deleted, or renamed within the Explorer, even though one might think they should be. In particular, the page and shape nodes of the **Designer** branch for a project can only be modified within VNRM Designer.

The rest of this section describes the functions provided by the VNRM Explorer. The functions are largely organized according to the menu item in which they can be invoked. Each function description includes, as appropriate, preconditions of use, results of execution, additional means of invocation, and future enhancements. If the function can be invoked via the toolbar, the toolbar icon representing the function is displayed. Since Visual NRM is an evolving prototype, certain functions may not yet be implemented. We describe these future enhancements to provide a more complete picture of where Visual NRM is going.

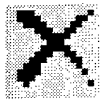
3.1. File Menu

3.1.1. New



The **New** menu item creates a new VNRM project, Designer document, Dictionary term, or Documentor document. The type of object created depends on which node of the TreeView is highlighted at the time. Select **Projects** or a specific project when adding a new project; do likewise to add the other types of objects. In the case of a Designer or Documentor document, **New** brings up the **Properties** dialog for identifying various attributes of the object (section 3.1.3) and then invokes Designer (section 3.4.1) or Documentor (section 3.4.4), as appropriate. In all cases, **New** creates the new entry in the TreeView and gives it a default name. The name can be changed by double clicking the item and editing it in-line. **New** can also be invoked by depressing **Ctrl-N** or the **Insert** key, or by right-clicking an object of the type you wish to insert.

3.1.2. Delete



The **Delete** menu item deletes a VNRM project, Designer document, Dictionary term, or Documentor document. **Delete** removes the node currently highlighted in the TreeView hierarchy, provided it is one of the four types list above. Since there is no undo for the **Delete** operation, it asks for confirmation before it actually deletes an object. **Delete** can also be invoked by depressing **Ctrl-D** or the **Delete** key, or by right-clicking an object of the type you wish to insert.

3.1.3. Properties



The **Properties** menu item allows the user to assign various attributes to VNRM projects and documents. **Properties** bring up a dialog box in which the user assigns values to the attributes of the project or document selected in the TreeView. These attributes identify these objects and are used to automatically fill-in parameters of a (MS Word) template used to create Documentor documents. The **Properties** dialog also arises when a new document is created so that proper initial values can be attributed.

3.1.4. Set Root Page

The **Set Root Page** menu item identifies the root page of a Designer document. The root page is needed in the Documentor as a starting point for importing the pages of a Designer document as a distinct chapter of an MS Word document. VNRM Explorer indicates the current root page of a document by formatting its name in bold font. **Set Root Page** can also be invoked by depressing **Ctrl-R** or by right-clicking on the page to be set.

3.1.5. Print



The **Print** menu item is currently not implemented. We plan to permit the user to print portions of VNRM maps directly from the VNRM Explorer. Currently, the user needs to open up VNRM Designer or VNRM Documentor to print the maps.

3.1.6. Exit

The **Exit** menu item terminates the VNRM Explorer session. **Exit** can also be invoked by depressing **Ctrl-E** or clicking on the **X** in the upper right-hand corner of the VNRM Explorer interface.

3.2. Edit Menu

3.2.1. Undo



The **Undo** menu item undoes the last **Cut** (section 3.2.2) or **Paste** (section 3.2.4) operation performed. If **Cut** or **Paste** was not previously invoked, **Undo** has no effect. **Undo** can also be invoked by depressing **Ctrl-Z**.

3.2.2. Cut



The **Cut** menu item cuts highlighted text from a dictionary definition that is displayed on the right window in the VNRM Explorer. The text that is deleted is stored in the system clipboard so that a subsequent **Paste** (section 3.2.4) inserts the cut text at the current cursor position. If a dictionary entry is not displayed with text highlighted, **Cut** has no effect. We plan to enhance the **Cut** function to apply to shape text accessible from VNRM Explorer. **Cut** can also be invoked by depressing **Ctrl-X**.

3.2.3. Copy



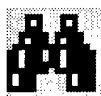
The **Copy** menu item stores in the system clipboard the highlighted text from a dictionary definition that is displayed on the right-hand window in the VNRM Explorer. The stored text is available to a subsequent **Paste** (section 3.2.4), which inserts the stored text at the current cursor position. If a dictionary entry is not displayed with text highlighted, **Copy** has no effect. We plan to enhance the **Copy** function to apply to shape text accessible from VNRM Explorer. **Copy** can also be invoked by depressing **Ctrl-C**.

3.2.4. Paste



The **Paste** menu item inserts text at the current cursor position of the dictionary definition that is displayed on the right-hand window in the VNRM Explorer. The text inserted is that stored in the system clipboard at the time of the **Paste**, as a result of a previous **Cut** (section 3.2.2) or **Copy** (section 3.2.3) operation. If a dictionary entry is not displayed with the cursor positioned, **Paste** has no effect. We plan to enhance the **Paste** function to apply to shape text accessible from VNRM Explorer. **Paste** can also be invoked by depressing **Ctrl-V**.

3.2.5. Find



The **Find** menu item is not currently implemented. We plan to permit the user to find strings that occur in the definition of terms in dictionaries or in shape text. This function will be useful for ensuring that terms are used consistently or for applying a format to particular string.

3.2.6. Format Menu

3.2.6.1. Bold, Italics, Underline, Small Caps



The **Format** menu items are not currently implemented. We plan to provide functions to format (embolden, italicize, underline, or small capitalize, respectively) highlighted text from a dictionary definition. If a dictionary entry is not displayed with text highlighted, the operations will have no effect. These format commands will also be invocable by depressing **Ctrl-B**, **Ctrl-I**, **Ctrl-U**, or **Ctrl-S**, respectively.

3.3. View Menu

3.3.1. Toolbar/Status Bar

The **Toolbar** and **Status Bar** menu items determine whether the **Toolbar** and **Status Bar** in the VNRM Explorer are visible or not. The default is that both bars are visible. The bars are visible only when their corresponding menu items are checked. Clicking one of the menu items when unchecked makes that bar visible and checks the menu item. Clicking a checked menu item makes that bar invisible and unchecks the menu item. We plan to enhance the status bar to include more useful information regarding the status of particular operations. The visibility of the **Toolbar** and **Status Bar** can also be toggled using the function key **F9** and **Ctrl-F9**, respectively.

3.3.2. Small/Large Icons

The **Small Icons** and **Large Icons** menu items determine the size of the toolbar and **TreeView** cons and corresponding text. **Large icons** are useful for demonstrations to other individuals. **Small icons** are useful for reducing the amount of space that the VNRM Explorer takes up on the screen. **Small icons** are the default. The check indicates which size is chosen. The user can toggle between small and large icons

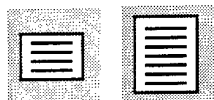
by clicking on the menu item that is currently not checked. Clicking a checked menu item has no effect. **Small Icons** can also be invoked by depressing the F11 function key; **Large Icons** can be invoked by depressing Ctrl-F11.

3.3.3. Go Back Leaf Node/Go Forward Leaf Node



The **Go Back Leaf Node** and **Go Forward Leaf Node** allows the user to re-visit previously selected leaf nodes in the VNRM Explorer TreeView, similar to the **Back** and **Forward** functions of most WWW browsers. If no earlier leaf nodes are visited, **Go Back Leaf Node** has no effect; similarly, if no later nodes are visited, **Go Forward Leaf Node** has no effect. These operations can also be invoked by depressing the function keys F12 and Ctrl-F12, respectively.

3.3.4. Show Brief/Long Descriptions



The **Show Brief Descriptions** and **Show Long Descriptions** menu items determine whether the shape text, when displayed in the right window of the VNRM Explorer, is the brief (summary) description or the long (detailed) description. A longer description is useful in some cases where a complete description of a shape type, e.g., a claim, is not easily displayed in the confines of a graphical shape that must be presented in the context of a larger VNRM argument map. Brief descriptions are the default. The check indicates whether brief or long descriptions are chosen. The user can toggle between brief and long descriptions by clicking on the menu item that is currently not checked. Clicking a checked menu item has no effect.

3.3.5. Refresh

The **Refresh** menu item refreshes the VNRM Explorer interface. **Refresh** can also be invoked by depressing Ctrl-R.

3.3.6. Options

The **Options** menu item is currently not implemented. We plan to provide a capability to customize the user interface and default settings via an **Options** dialog box. This function will also be invocable by depressing Ctrl-O.

3.4. Tools Menu

3.4.1. VNRM Designer



The **VNRM Designer** menu item starts VNRM Designer (section 4), loading the Designer object currently highlighted in the TreeView hierarchy. If a project is highlighted, all the Designer documents in that project are loaded. Invoking Designer on objects that are not Designer objects has no effect. If VNRM Designer is already executing, this command just loads the indicated objects into the existing session, unless they are already loaded. **Designer** can also be invoked by depressing the F1 function key or by right-clicking on the project or document to be edited. This function assumes the availability of Visio Professional.

3.4.2. VNRM Desktops



The **VNRM Desktops** menu item performs the **Designer** operation (section 3.4.1), followed by starting VNRM Desktops (section 5), if necessary, and loading the desktops for the project loaded into VNRM Designer. **Desktops** can also be invoked by depressing the F2

function key or by right-clicking on the project or document whose desktops are of interest.

3.4.3. VNRM Dictionary



The VNRM Dictionary menu item starts VNRM Dictionary (section 6), if necessary, and loads the dictionary terms of the project currently highlighted in the TreeView hierarchy. If an object of a project is highlighted, Dictionary loads the terms for that project. If an element of the !Global branch is highlighted, Dictionary loads the terms from the Global Dictionary. Dictionary can also be invoked by depressing the F3 function key or by right-clicking on the project whose dictionary is of interest.

3.4.4. VNRM Documentor



The VNRM Documentor menu item starts VNRM Documentor (section 7), loading the Documentor object currently highlighted in the TreeView hierarchy. Invoking Documentor on objects that are not Documentor objects has no effect. If VNRM Documentor is already executing, this command just loads the indicated objects into the existing session, unless they are already loaded. Documentor can also be invoked by depressing the F4 function key or by right-clicking on the Documentor document of interest. This function assumes availability of Microsoft Word 97.

3.4.5. World Wide Web Menu

3.4.5.1. Generate HTML



The Generate HTML menu item generates HTML for the object currently highlighted in the TreeView hierarchy. If the Designer node is highlighted, this command generates HTML for all of the Designer documents under that node. If a particular Designer or Documentor document is highlighted, this command generates HTML for that document. Generate HTML can also be invoked by depressing the F5 function key or by right-clicking on the Designer node or the document of interest. This function assumes availability of Visio Professional and SolutionSoft's WordToWeb HTML generator.

3.4.5.2. View HTML



The View HTML menu item views the HTML for the object currently highlighted in the TreeView hierarchy, provided the HTML was previously generated using Generate HTML (section 3.4.5.1). If the Designer node is highlighted, this command views HTML for all of the Designer documents under that node. If a particular Designer or Documentor document is highlighted, this command views HTML for that document. If no HTML was previously generated for the object, this command has no effect. View HTML can also be invoked by depressing the F6 function key or by right-clicking on the Designer node or the document of interest. This function assumes the availability of an HTML viewing capability.

3.4.5.3. Home Page



The Home Page menu item hyperlinks to the Visual NRM Project home page. Although this page is currently under construction, we plan to eventually permit access to Visual NRM tools, documentation, and Visual NRM applications. Home Page can also be invoked by depressing the F7 function. This function assumes the availability of an Internet browsing capability.

3.4.5.4. Search WWW



The Search WWW menu item provides access to a generic internet search engine. We plan to provide a specific function to help download information from the Internet directly into

Visual NRM argument maps, as appropriate, for the argument under construction. **Search WWW** can also be invoked by depressing the **F8** function. This function assumes the availability of an Internet browsing capability.

3.5. Help Menu

3.5.1. User Guide

The **User Guide** menu item brings up a hypertext version of this document. This document can also be invoked by depressing **Ctrl-G**. This function assumes the availability of an HTML viewing capability.

3.5.2. Search For Help On...



The **Search For Help On** menu item is not currently implemented. We plan to include an MS Windows/NT-like help facility. This facility will also be invocable by depressing **Ctrl-H**.

3.5.3.

3.5.4. About VNRM Explorer...

The **About VNRM Explorer** menu item provides additional information about the tool. It can also be invoked by depressing **Ctrl-A**.

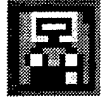
4. VNRM DESIGNER

VNRM Designer uses the Visio extensible drawing package to create and analyze the graphical portion of Visual NRM argument map for a VNRM project. Fig. 12 depicts the Visio interface customized with VNRM Designer specific functions. The VNRM Designer stencil appears in the upper left-hand corner of the figure. Users drag and drop shapes into document pages shown in the body of the interface. A string of the form **document name: page name** identifies each document page in its title bar. Fig. 12 displays pages from three documents: **Information Downgrader**, **Technology Security**, and **Physical Security**. Document-level partitioning forms the highest level decomposition of the assurance argument to be mapped. Pages partition the problem within a document at the next level down. A good partitioning is important for managing complexity and, also, as we will see in section 7, for semi-automatically producing structured textual documents describing the mapping.

VNRM Designer functions are accessible from the Visio interface through either the Designer menu or toolbar icons on the Standard toolbar. The rest of this section describes the functions available to build Visual NRM maps. Each function description includes, as appropriate, preconditions of use, the results of execution, additional means of invocation, and future enhancements. If the function can be invoked via the toolbar, the toolbar icon representing the function is displayed. Since Visual NRM is an evolving prototype, certain functions may not yet be implemented. We describe these future enhancements to provide a more complete picture of where Visual NRM is going. We do not describe Visio-specific functions, but refer the reader to the Visio documentation. However, since this function is crucial to using the VNRM Designer, we illustrate in the section 2 tutorial how Visio-specific functions are used in combination with the custom function to accomplish common tasks.

4.1. Designer Menu

4.1.1. Save All



The Save All menu item saves all the Designer documents currently loaded into VNRM Designer. Since the Visual NRM Database (VNDB) is being updated continuously as you edit Designer documents, it is important to always save everything after editing. If there are elements that really should not be saved, the user can either save and then undo the changes individually or not save and perform the Resynchronize VNDB function (section 4.1.12). Note: this is clearly unacceptable; future versions will improve the user's ability to undo operations performed.

4.1.2. View Spine (Blue Eye)



The View Spine menu item hides all except the spine of the argument. The spine includes all shapes that have a blue outline, i.e., Objectives, Threats, Claims, And/Or, and links of these shapes. Abstracting away all but the essential elements of an argument map may be helpful for focusing on specific properties of the map.

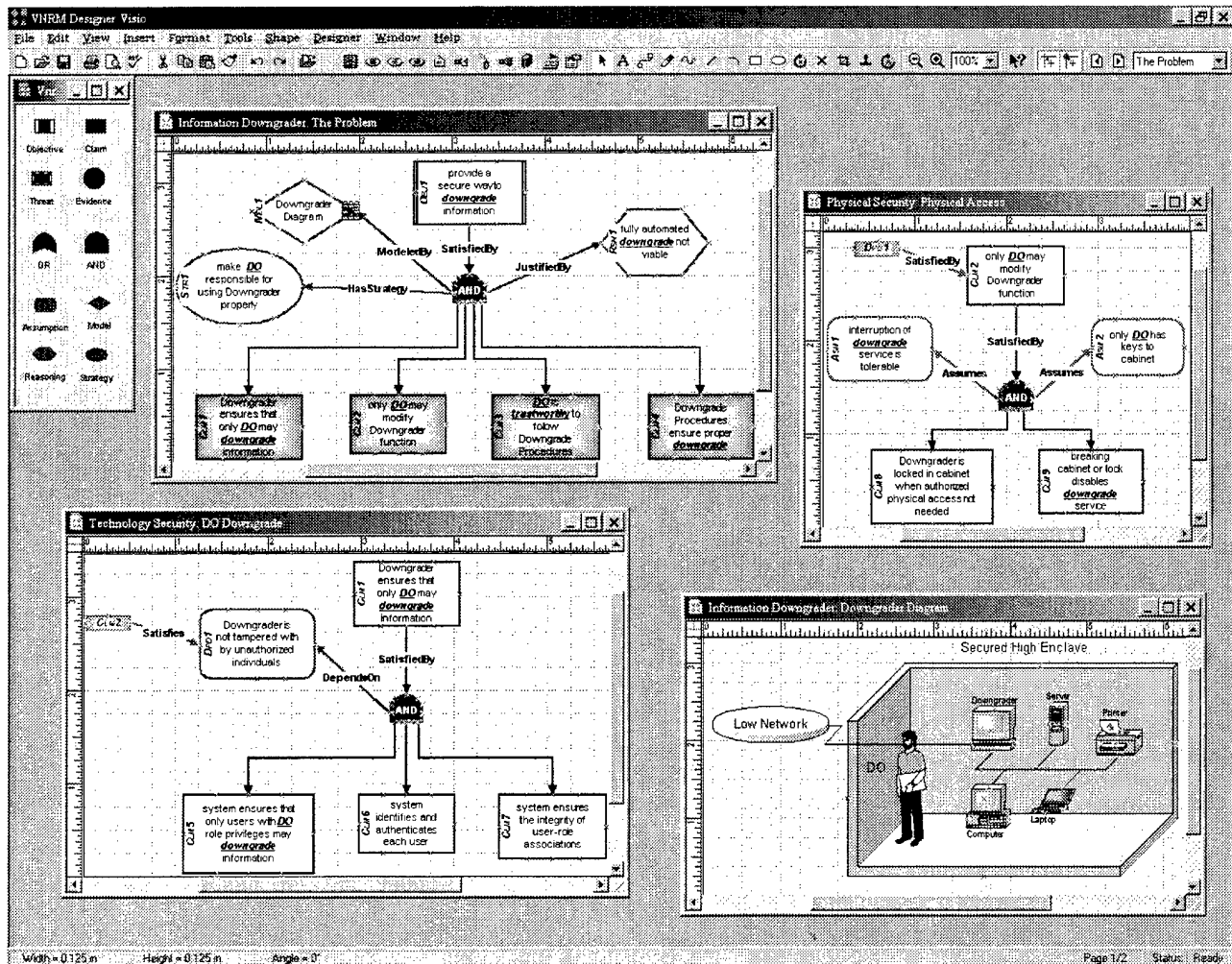


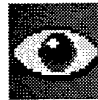
Fig. 12–VNRM Designer interface customizing Visio

4.1.3. View Flesh (Green Eye)



The View Flesh menu item hides an arguments assumption validation, showing only the spine and flesh of the argument. The flesh includes all shapes that have a green outline, i.e., Models, Reasoning, Strategy, and links of these shapes. The spine includes all shapes made visible by View Spine (section 4.1.2). Abstracting away the assumption validation layer of an argument map may be helpful for focusing on specific properties of the map.

4.1.4. View Validation (Red Eye)



The View Validation menu item shows the whole argument map - the spine, flesh, and assumption validation. The assumption validation layer includes Assumptions and the validation shape, which have a red outline. Once an Assumption is validated it becomes a Dependency shape, which is part of the flesh. The spine and flesh includes all shapes made visible by View Flesh (section 4.1.3). Viewing all layers is needed to get a complete picture of an argument map.

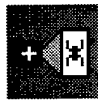
4.1.5. Label Shapes



The Label Shapes menu item labels all of the graphical shapes that appear in the stencil except for And/Or shapes. Labels are uniquely assigned as a three-letter abbreviation of the shape type followed by a number. Shapes can be labeled in a depth-first or breadth-first manner, depending on the Options setting (section 4.1.11). The appropriate setting depends largely on whether the argument map is to be presented in a depth-first or breadth-first manner. The default is breadth-first labeling.

This function labels Validation shapes and those connectors whose labels cannot be determined from their direct pair-wise connections, e.g., the label of a Claim-to-And connection depends on the shapes to which the And is connected. As a side effect of labeling the Validation shapes, each Assumption shape that is validated transforms into a Dependency shape, which is part of the argument flesh. Likewise, each Dependency shape that is not validated transforms into an Assumption shape, which is part of the argument validation.

4.1.6. Add Hyperlink



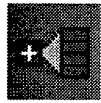
The Add Hyperlink menu item attaches a button to a shape that can be assigned an arbitrary URL or file hyperlink. As long as the web browser used can understand the link type, users can traverse the link to more information pertaining to the shape, e.g., more detailed specifications or evidence regarding the assurance argument. To add a hyperlink, select the shape to be hyperlinked and invoke the Add Hyperlink function. The button can then be double-clicked to assign the link initially. Changes to the link can be made by right-clicking the button to edit the link, as usual in Visio. Links can be made to external files or URLs by editing the Link to File or URL textbox, or to pages within the same Designer document, by editing the Named location in file textbox. In the latter case, VNR Designer has already assigned the document name in the first textbox. Intuitive screen tips can also be provided in the Descriptive name of link textbox. Once assigned, the link can be followed by double clicking.

4.1.7. Deselect All



The Deselect All menu item deselects all shapes in all pages of all documents currently loaded into VNR Designer. This function is a useful precursor to Validate Assumption (section 4.1.8), since that function requires that only those shapes participating in a validation be selected.

4.1.8. Validate Assumption



The **Validate Assumption** menu item designates the claims or evidence in one part of an argument map that validates an assumption in another part of the map. The user must select the validated Assumption shape and the validating Claim or Evidence shapes, and only those shapes, before invoking **Validate Assumption**. Invoking **Deselect All** (section 4.1.7) before selecting the shapes that participate in a validation will help to ensure that only the desired shapes are selected. **Validate Assumption** labels the Validation shapes and sets up all of the necessary hyperlinks between the Validation shapes. To ensure that labeling is current, the user may need to invoke **Label Shapes** (section 4.1.5).

4.1.9. VNRM Dictionary



The **VNRM Dictionary** menu item starts VNRM Dictionary (section 6) and loads the dictionary terms of the project currently loaded into VNRM Designer. Dictionary terms are highlighted in shape text. The addition or deletion of dictionary terms updates this highlighting.

4.1.10. VNRM Desktops



The **VNRM Desktops** menu item starts VNRM Desktops (section 5) and loads the virtual desktops defined for the project currently loaded into VNRM Designer. This permits adding or deleting desktops from the database and moving between desktops in the VNRM Designer.

4.1.11. Options



The **Options** menu item presents the options dialog box. Currently only the choice between depth-first and breadth-first labeling (section 4.1.5) is provided. We plan to provide other options for customizing VNRM Designer as the prototype evolves.

4.1.12. Resynchronize VNDB

The **Resynchronize VNDB** menu item refreshes the information in the VNDB relating to the project currently loaded based on the current state of the project in VNRM Designer. This should be used only if the database has been corrupted, perhaps due to a system crash. All of the Designer documents for a project must be loaded when the function is invoked. Once completed, the user must manually **Set Root Page** (section 3.1.4) for every document in the project in VNRM Explorer.

4.1.13. Re-Apply Dictionary Formatting

The **Re-Apply Dictionary Formatting** menu item refreshes the VNRM Designer interface by reapplying the dictionary highlighting for all shapes currently loaded. This should only be done if the highlighting becomes inconsistent with the current state of the dictionary.

4.2. Miscellaneous Operations

4.2.1. Adding New Document

To add a new Designer Document, click on the **File|New|VnrmDesignerDrawing** menu item. This creates and opens a new unnamed document, ready for editing. Currently, documents can be renamed only from VNRM Explorer. If **VnrmDesignerDrawing** does not show up under the **File|New** menu, you need to place the **VnrmDesignerDrawing.vst** file from the **Vnrm\Sesame** folder into your **Visio\Solutions** folder, and restart VNRM Designer.

4.2.2. Saving Documents

Use the **SaveAll** command in the Designer menu item to save all the documents. To save an individual document, choose the document to be saved and click **File|Save**. Do not change the name of the document using **File|Save**, since Visual NRM does not remember changes to files explicitly created by the user.

4.2.3. Saving Window Settings

To save a page's window size and position in the VNRM Designer interface, right-click anywhere in the window that is not already occupied by another shape or connection. Select **Save Window Settings**. The next time you invoke that window, it will automatically appear with that size and position.

4.2.4. Restoring Window Settings

To restore to default settings a page's window size and position in the VNRM Designer interface, right-click anywhere in the window that is not already occupied by another shape or connection. Select **Restore Window Settings**. The window will return to its default size and position.

4.2.5. Adding New Page

To add a new Designer page within a document, click on the **Insert|Page** menu item. This invokes a dialog box with three tabs. Click the **Page Properties** tab, name the page in the **Name** text box, and click the **Open Page in New Window** checkbox, if you want your current page to stay open.

4.2.6. Opening Page

To open an existing Designer page within a document, click on the **Edit|Go To|Page** menu item. Click the page you want to open, click the **Open Page in New Window** checkbox (if you want your current page to stay open), and click **OK**.

4.2.7. Changing Page Name

To change the name of a page within a document, click on the **File|Page Setup** menu item. This invokes a dialog box with five tabs. Click the **Page Properties** tab and change the name in the **Name** text box.

4.2.8. Deleting Page

To delete a page from a document, chose **Edit|Drawing Page|Delete Page** and select the page to be deleted from the dialog box that appears. This operation cannot be reversed so make sure you delete the right page.

4.2.9. Size Page to Fit Drawing

To re-size a page to fit tight around a drawing, click on the **File|Page Setup** menu item. This invokes a dialog box with five tabs. Click the **Page Size** tab and check the **Size Page to Fit Drawing** checkbox. This is useful for making the most out of the space you have available while viewing the whole page.

4.2.10. Page Zooming

Visio provides various Zooming capabilities under the **View** menu item. Choose the **Zoom** level that best fits your preference. Choosing **Whole Page** followed by sizing the page to fit the drawing (section 4.2.9) is nice for getting the most out of the screen real estate.

4.2.11. Aligning Shapes

To align shapes, select the shapes to be aligned and click the **Tools|Align Shapes** menu item. Select the type of alignment desired from the dialog box that appears.

4.2.12. Distributing Shapes

To distribute shapes on a page, select the shapes to be distributed and click the **Tools|Distribute Shapes** menu item. Select the type of distribution desired from the dialog box that appears.

4.2.13. Selecting Multiple Shapes

Multiple shapes can be selected by holding down the **Shift** key as you select the shapes desired. Visio also supports rubber-banding by dragging a selection box around the shapes you wish to select. Shift-clicking a selected shape deletes the shape from a collection of selected shapes.

4.2.14. Removing Validation

To remove an individual Validation shape from a Validation Stack, right-click the shape to be deleted and choose **Remove Validation** from the pop-up menu that appears. If only one validation shape is in the Validation Stack, this operation is equivalent to **Remove Validation Stack** (section 4.2.15).

4.2.15. Removing Validation Stack

To remove a shape's Validation Stack, right-click the shape to which the stack is attached and choose **Remove Validation Stack** from the pop-up menu that appears. This operation will transform Dependency shapes into Assumptions shapes upon the next re-labeling (section 4.1.5).

4.2.16. Editing Long Description

Users can enter brief summary descriptions of a shape by double-clicking the shape. Sometimes a more detailed description is necessary to fully explain the purpose of the shape. To enter a detailed description of a shape, right-click the shape and select **Edit Long Description** from the pop-up menu. Enter the text in the shape just as when entering the brief summary. When finished, click the **X**. Although the text does not show up in the graphic, it has been stored in the database and will show up in the tables produced using the VNRM Documentor (section 7).

4.2.17. Undoing Operations

There is currently no support for undoing operations performed. All undos have to be performed manually. Using the Visio undo operation is dangerous since the database is not updated to reflect the new undone state. Invoking the **Resynchronize VNDB** (section 4.1.12) command makes the VNDB consistent with the current state of the Designer.

5. VNRM DESKTOPS

VNRM Desktops provides a virtual desktops function. When used in combination with VNRM Designer, this permits associating different segments of an assurance argument map for their simultaneous elaboration or examination. As shown in Fig. 13, the VNRM Desktops interface consists of three parts: the pull-down menu, the desktops list box, and the desktop viewer. The figure shows a virtual desktop, called *DORestrictedDowngrade*, in the desktops list box with its layout shown in the desktop viewer. Desktops are selected by clicking the down arrow on the right-hand side of the list box. Desktops may be renamed by editing the name in the desktops list box in-line. To the left of the list box is a button that, when clicked, invokes the pull-down menu. Each page in the desktop viewer also has a pull-down menu upon clicking. This section describes the functions available from button and page pull-down menus.

5.1. Button Pull-Down Menu

To invoke the Button Pull-Down Menu, click the button to the left of the desktops list box.

5.1.1. Add

The Add menu item creates a desktop out of the current page layout in the VNRM Designer interface. Add clears the desktops list box permitting the user to enter the name of the new desktop. Once entered, the user must hit the carriage return. Add then inserts a small-scale version of the current VNRM Designer page layout in the desktop viewer. Note that VNRM Designer must be running when Add is called or an error is generated.

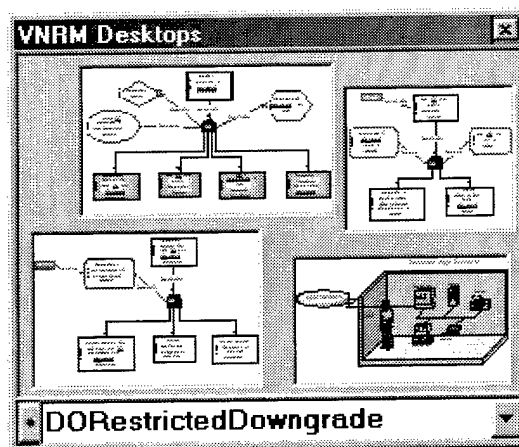


Fig. 13—VNRM Desktops interface

5.1.2. Delete

The Delete menu item deletes the desktop displayed on the desktop viewer from the list of accessible desktops and loads the next one in the list, if any.

5.2. Page Pull-Down Menu

To invoke the Page Pull-Down Menu, click a page in the desktop viewer.

5.2.1. Remove from Desktop

The **Remove from Desktop** menu item removes the page selected from the desktop displayed in the desktop viewer.

5.2.2. Save as Default Settings

The **Save as Default Settings** menu item saves the position settings for the page selected as the default page position setting. This default is used as the initial page position whenever VNRM Designer loads the page. The page position in individual desktops may vary from the default depending on the placement of the page when the desktop was added. **Save as Default Settings** sets the page position in the desktop as the default.

5.2.3. Load Default Settings

The **Load Default Settings** menu item changes the position setting for the page selected to the default page position setting. This default is used as the initial page position whenever VNRM Designer loads the page. The page position in individual desktops may vary from the default depending on the placement of the page when the desktop was added. **Load Default Settings** reverts the page position in the desktop to the default.

6. VNRM DICTIONARY

VNRM Dictionary is a compact interface for reviewing, extending, or revising the terms and definitions of the global dictionary or a project-local dictionary (see section 2 for the distinction between the global and a local dictionary). The tool provides the same functions as those provided in VNRM Explorer for accessing the dictionaries, but with an interface that has a smaller footprint for convenient simultaneous access with VNRM Designer or VNRM Documentor.

As shown in Fig. 14, the VNRM Dictionary interface consists of three parts: the pull-down menu, the term list box, and the definition text box. The figure shows the term **downgrade** highlighted in the term list box with its definition shown in the definition text box. Terms and their definitions are selected by clicking the down arrow on the right-hand side of the list box and are edited in-line. To the left of the list box is a button which, when clicked, invokes the pull-down menu. The rest of this section describes the functions available from this menu.

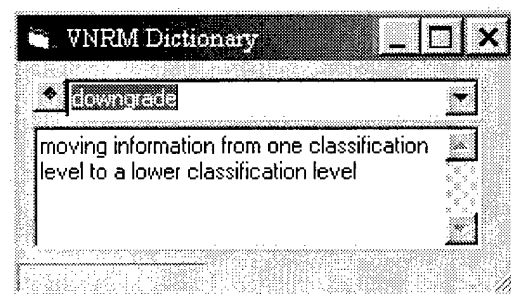


Fig. 14—VNRM Dictionary interface

6.1. Pull-Down Menu

To invoke the Pull-Down Menu, click the button to the left of the term list box.

6.1.1. Add

Selecting **Add** from the pull-down menu clears the term list box, permitting the user to type in the terms to be added. After hitting the carriage return key, the term is added to the dictionary with a null definition. Users can then type the term's definition in the Definition text box. To accept the definition, click on the term. Terms may not currently have spaces in them. To define phrases, use dashes instead of spaces.

6.1.2. Delete

Selecting **Delete** from the pull-down menu deletes the term that appears in the term list box. Note that this deletes the definition as well. To rename the term and keep the same definition, simply edit the term text to the new term and hit the carriage return. The definition can be modified as well, but remember that to accept the new definition you need to click on the term.

6.1.3. Undo

Selecting **Undo** from the pull-down menu undoes the previous pull-down menu operation. An **Undo** of an **Add** operation deletes the term added. Likewise, an **Undo** of a **Delete** operation adds the term deleted. An **Undo** of an **Undo** operation reverses the **Undo**. Note that **Undo** does not undo changes to the definition of a term. Such changes must currently be undone manually.

7. VNRM Documentor

VNRM Documentor integrates the argument maps produced using VNRM Designer into textual, Microsoft Word documents. The Word document is based on a template that takes as parameters project and document properties definable in VNRM Explorer (section 3.1.3). The Designer document structure and claim tree hierarchy of the map can be used to layout the Word document automatically. Fig. 15 depicts the Word interface customized with VNRM Documentor specific function. The figure shows a part of the chapter on the Personnel Security aspects of the Downgrader example. VNRM Documentor translates the hyperlinked shapes available in VNRM Designer as Word tables that specify the graphic index and page number to which each shape is linked. A column of the table is also reserved for the detailed description of shapes that are permitted in VNRM Designer (section 4.2.14). Documentor cross-references the page numbers in the Word document, preserving much of the ease of navigation provided by Designer. These tables are maintained using VNRM Documentor functions and should not be edited directly.

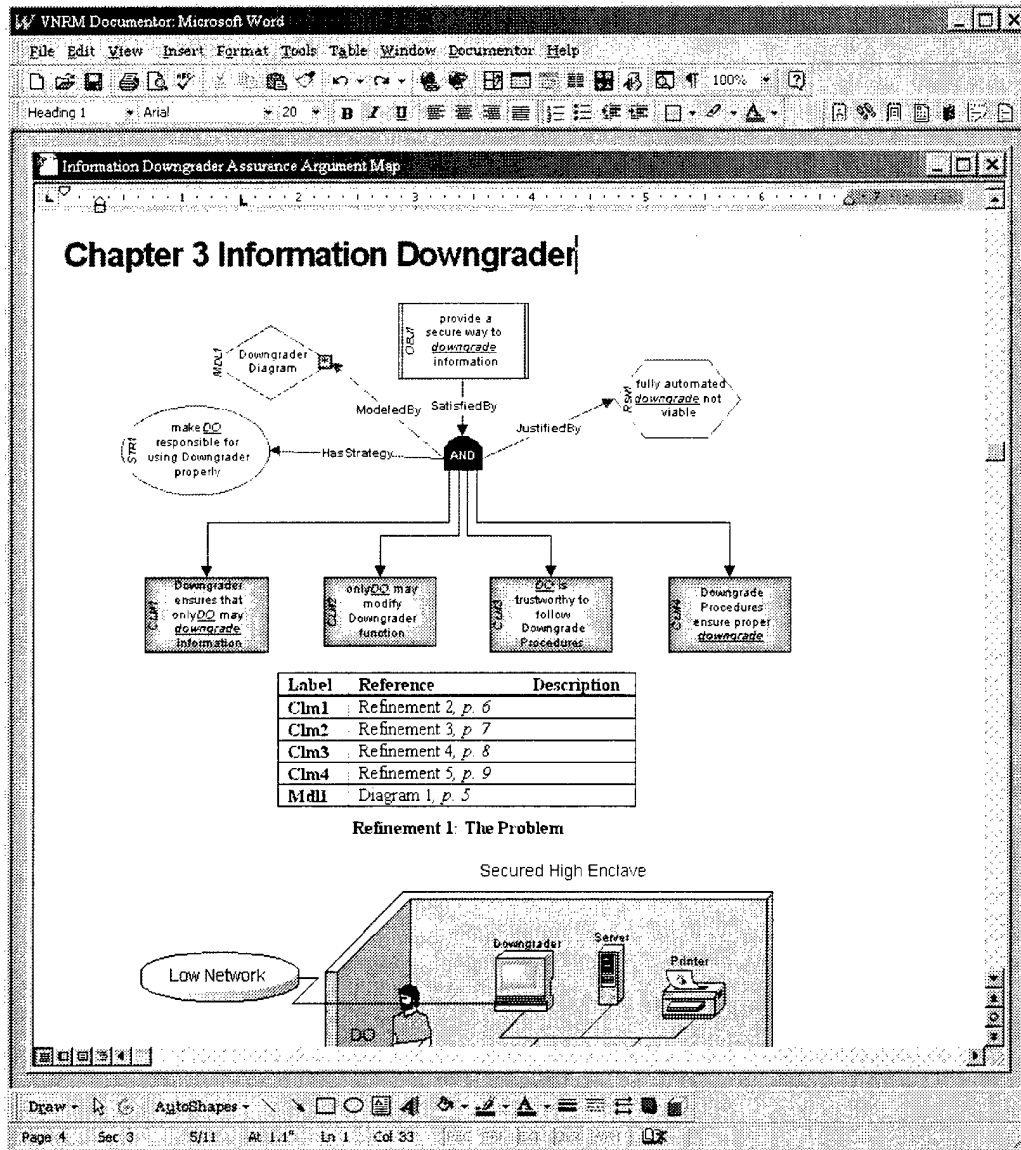


Fig. 15–VNRM Documentor interface customizing Microsoft Word

VNRM Documentor functions are accessible from the Word interface through either the Documentor menu or through toolbar icons on a special Visual NRM toolbar. The rest of this section describes the functions to document Visual NRM maps. Each function description includes, as appropriate, preconditions of use, the results of execution, additional means of invocation, and future enhancements. If the function can be invoked via the toolbar, the toolbar icon representing the function is displayed. Since Visual NRM is an evolving prototype, certain functions may not yet be implemented. We describe these future enhancements to provide a more complete picture of where Visual NRM is going. We do not describe Word-specific functions, but refer the reader to the Word documentation

7.1. Documentor Menu

7.1.1. Import VNRM Map



The Import VNRM Map menu item allows the user to import VNRM Designer pages or whole documents into the VNRM Documentor. The user controls the importation through the dialog box shown in Fig. 16. The interface provides options to insert Designer documents into separate chapters or to insert document pages into an appendix. The first option lists the documents that are not already imported in the window on the left of the interface. The user selects the documents to be imported. Once submitted, the pages of each document are imported, in the order selected, into a chapter using chapter section headings to reflect the hierarchy of the pages. Use of this option assumes that a root page is set for each document (section 3.1.4). The second option lists all document pages that are not already imported in the left window. Again, the user selects the pages to be imported, but, once submitted, the pages are sequentially attached at the end of the report.

As shown in Fig. 16, the user also has the option of automatically or manually updating the fields within the report generated. The fields of the document include, among other things, the (Visio) pages constructed using VNRM Designer, which are imported as OLE links. Although automatic update keeps fields automatically consistent with modifications to the pages in Designer, the overhead associated with this automation can be significant for nontrivial argument maps. We, therefore, suggest manual database field update for all but the most trivial maps. Users update fields when in the manual mode using the Update Fields menu item described in section 7.1.4

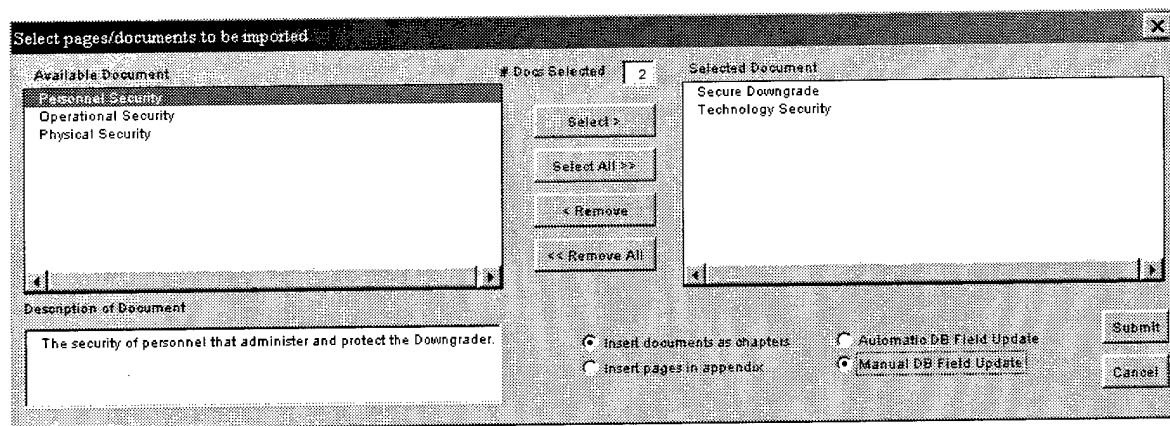


Fig. 16—Dialog box for importing VNRM maps

7.1.2. Identify Project (footprints)



The Identify Project menu item instantiates various fields of the Word document template using the properties identified in the project and document properties dialog (section 3.1.3). Not all information in the dialog needs to be completed for the Identify Project function to be useful; the function uses whatever information is available to instantiate the corresponding document fields. Users may also instantiate fields manually through normal Word text editing. The < and > characters delimit fields in the document template that may be instantiated either automatically or manually.

7.1.3. Update All Tables



The **Update All Tables** menu item updates all of the tables in the document that use data from the VNDB. This includes the tables placed after each page imported that describe the hyperlink cross-references and the table of dictionary terms, if one has been generated (section 7.1.7), which is usually attached at the end of the report. While **Update Fields** (section 7.1.4) updates the fields in these tables, this command reconstructs these tables, extending them as required by the current state of the VNDB.

7.1.4. Update Fields



The **Update Fields** menu item updates all of the fields of the document that use data from the VNDB. This includes the VNRM Designer pages, which were imported as OLE links, and the tables placed after each page, which describe the hyperlink cross-references. Note that **Update Fields** does not extend the cross-reference tables to include additional rows indicated by the VNDB.

7.1.5. VNRM Dictionary



The **VNRM Dictionary** menu item starts VNRM Dictionary (section 6) and loads the dictionary terms of the project whose document is currently loaded into VNRM Documentor.

7.1.6. Insert Term in Dictionary



The **Insert Term in Dictionary** menu item adds a term highlighted in the Documentor document to the project local dictionary. The function invokes VNRM Dictionary with the term inserted, ready for the user to define the term. If the term is already defined, its current definition is displayed. Remember that terms may not have any spaces; dashes can be used instead.

7.1.7. Update Dictionary Table



The **Update Dictionary Table** menu item updates the document's table of dictionary terms. The table includes dictionary terms of the project whose document is currently loaded into VNRM Documentor. If the document contains no dictionary table, one is inserted at the end of the document. If no terms are defined, the **Update Dictionary Table** generates an error.

REFERENCES

1. DoD, "The Network Rating Methodology: a Framework for Assessing Network Security," <http://www.chacs.itd.nrl.navy.mil/Projects/VisualNRM> under Related Links, Sept. 1997.
2. C.N. Payne, J.N. Froscher, C.E. Landwehr. "Toward a Comprehensive INFOSEC Certification Methodology," *Proc. 16th National Computer Security Conference*, pages 165-172, Baltimore, MD, Sept. 1993.
3. D.M. Kienzle and W.A. Wulf, "A Practical Approach to Security Assessment," *Proc. New Security Paradigms Workshop*, Langdale, Cumbria UK, Sept. 1997.
4. J.R. Williams and G.F. Jelen, "A Framework for Reasoning about Assurance," ATR 97043, Arca Systems, Inc., Vienna, VA, Apr. 1998.
5. C. Pygott, S.P. Wilson, "Uses of an Argument Framework; its Data Model and Generic Features," DRA/CIS3/PROJ/ A53XL/95011/1.0, Defence Research Agency, Malvern, UK, Mar. 1996.
6. J.A. McDermid, "Support for Safety Cases and Safety Arguments using SAM," *Reliab. Eng. Syst. Safety* **43**, 111-127 (1994).

Appendix

COMPLETE DOWNGRADER REFINEMENT

| Term | Definition |
|------------------|--|
| DO | Downgrade Officer |
| downgrade | moving information from one classification level to a lower classification level |
| High | a classification level that dominates Low |
| Low | a classification level dominated by High |

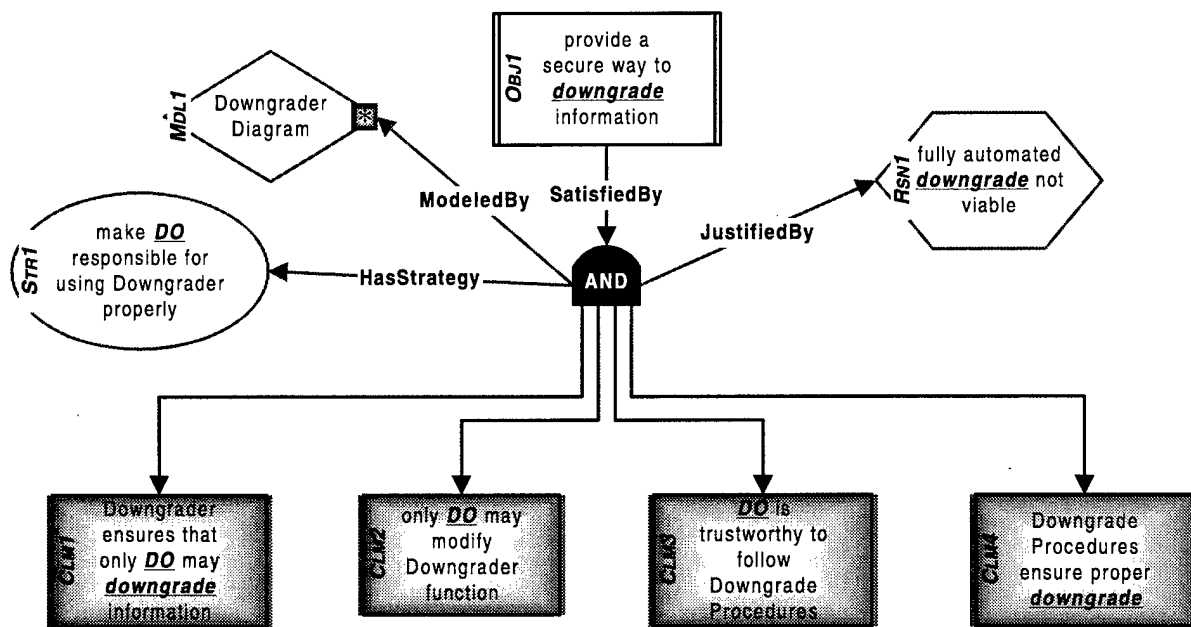


Fig. A1-Downgrader: The Problem

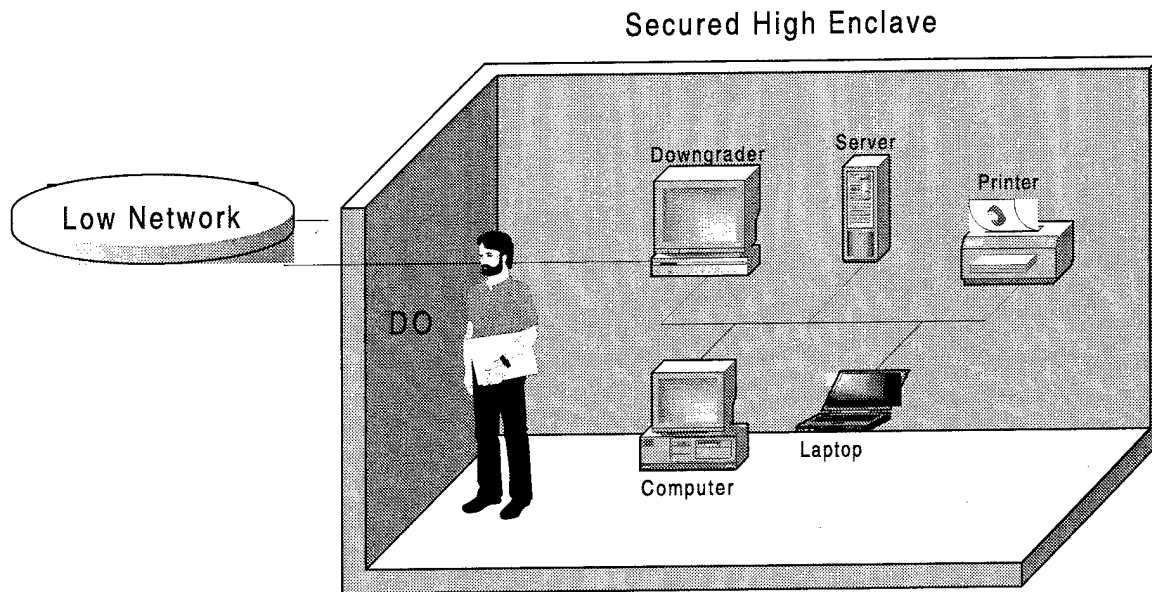


Fig. A2-Downgrader: Downgrader Diagram

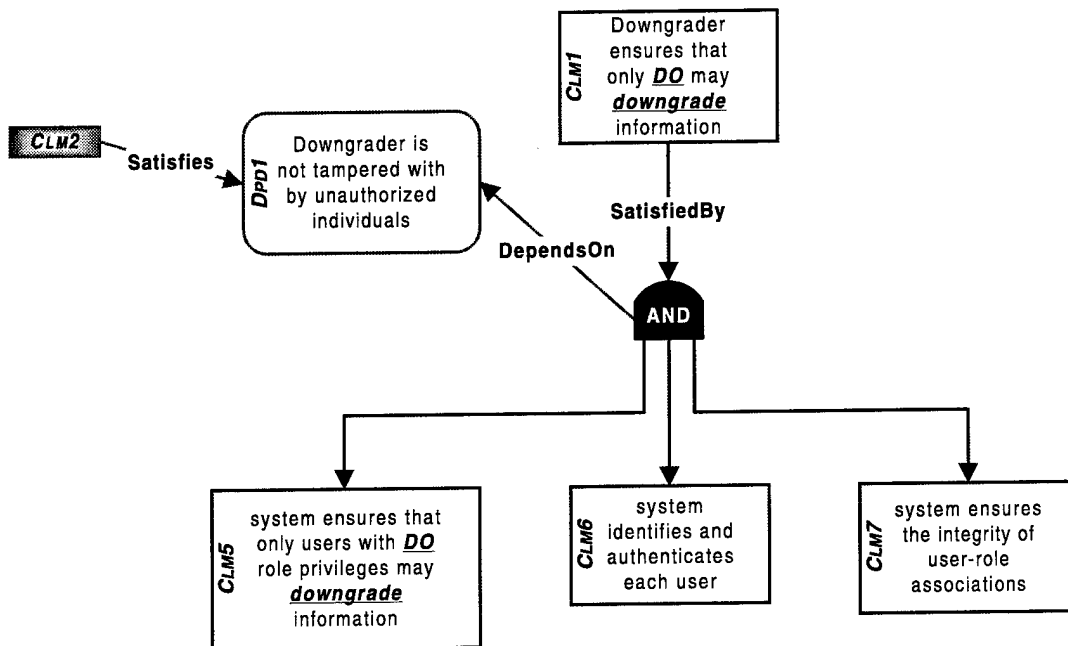


Fig. A3-Technology Security: DO Downgrade

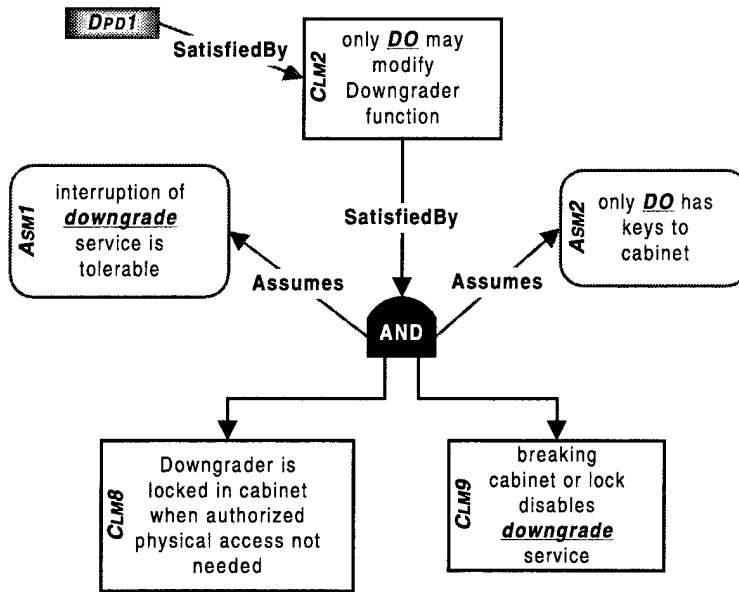


Fig. A4-Physical Security: Physical Access

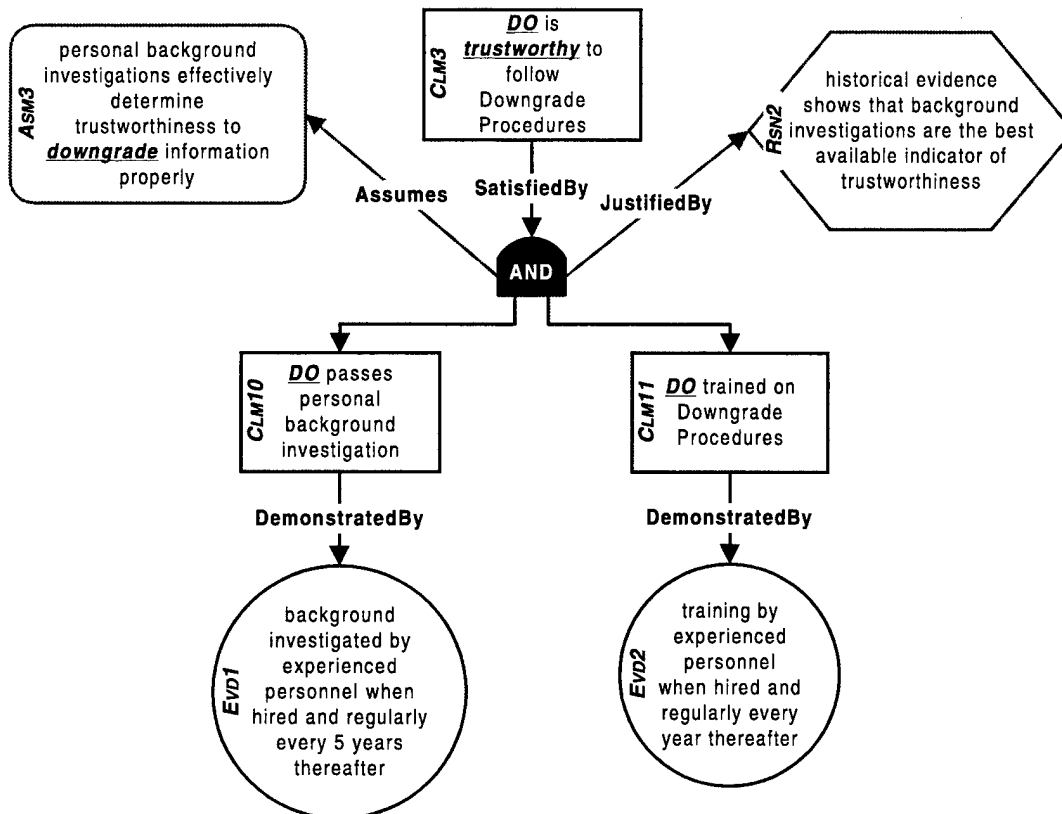


Fig. A5-Personnel Security: DO Trustworthy

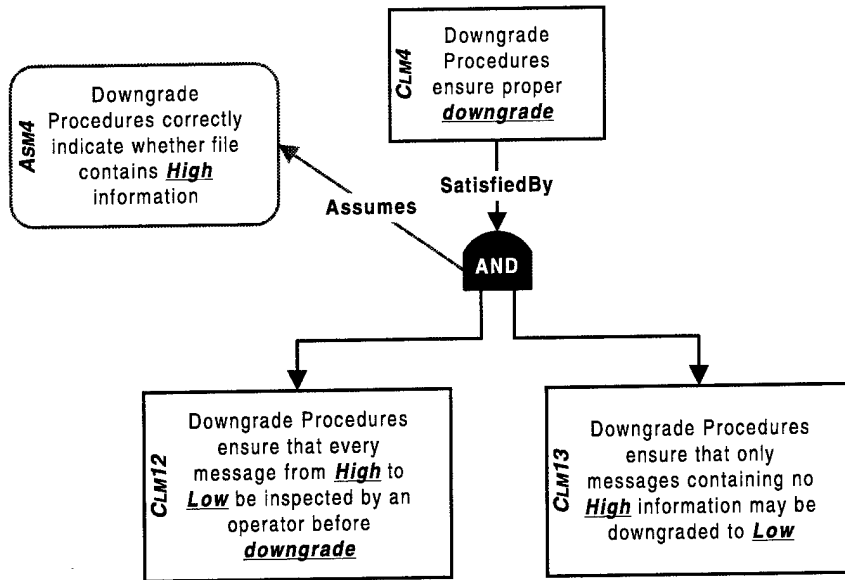


Fig. A6—Operational Security: Downgrade Procedures

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