WanView

Graphic visualization and analysis of WanCraft's likewise telecommunication networks with ArcView's spatial and topological tools

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INTRODUCTION

Program overview

WanView can be used to visualize and analyze telecommunication wide area networks (WAN). It uses the model structure of WanCraft's telecommunication network-design system, and it is implemented by using ArcView's geographic and topologic display capabilities.

WanCraft models circuit-switched and packets-switched networks using specific metrics for traffic performance and specialized algorithms for topological design, see M. Priem (1999). Supplied with information about user location and communication demand, hypothetical backbone network --location and linkage of switch-nodes (SW)--, among others, the network design process involves tradeoff decisions on performance, reliability, and cost about the final backbone network and access networks --location of connection-nodes (CT) and their linkage to the backbone network and linkage of end-nodes (END) to connection nodes--.

ArcView provides the capability to visualize, explore, query and analyze data spatially, and it is used to implement the visualization of geographic and topologic features of WAN networks in the software system WanView, see ArcView (1997). ArcView works with projects by using a collection of documents, document user interfaces, and scripts. While documents provide different means of visualizing and interacting with the data: views, tables, and scripts; document user interfaces define the controls used to interact with the documents. Specific control rearranges and

customization of ArcView´s functionality is carried out trough scripts implemented in an object-oriented language, Avenue (Avenue (1997)).

WanView uses ArcView´s features to load tabular data, such as text and data from WanCraft database, so that it permits to display, query, summarize, and organize this data spatially.

What does WanView do?

- Visualizes WAN's
- Queries WAN's topology
- Summarizes WAN's performance measures
- Imports WanCraft or likewise data
- Executes WanCraft procedures
- Configures WanCraft setup

What are WanView benefits and disadvantages?

- Uses ArcView's topological display and query capabilities
- Handles its own database support
- Does not export WanCraft database format

How complicates is it to learn and use?

- Assumes experience with telecommunication WANs
- Requires basic knowledge of geographic information system (GIS)
- Entails learning ArcView user interface

- At the programmer level: requires knowledge of relational databases and object-oriented languages.

INSTALLATION

As a prerequisite to run WanView you need to have access to current installations of ArcView and WanCraft systems. WanView is implemented as an ArcView project by using the Microsoft-Windows (MS) versions of ArcView GIS 3.0 and WanCraft 1999. Therefore, it has the same hardware and software requirements than ArcView.

WanView Installation

To install WanView you just copy the appropriate files from the diskette to the PC that needs to run the application. The installation package contains the following files:

`Manual.doc`	This manual, stored as a MS-Word file.
`WanView.apr`	WanView project file that contains the additional menus, tools and procedures required to run the application.
`<file>.avl`	Saved legend files, used to storage the legend class, that determines symbols used to draw theme features.

After coping the files into a desired installation folder, WanView project (`WanView.apr`) should be available for execution. Its execution prompts WanView's project window inside the application window of ArcView as shown in Figure 1.

Figure 1 WanView project as an ArcView application. The menu WAN establishes access to WanView functionality.

Setup work directory

Initially, after accessing the project, it is necessary to set the work directory. This is the pathname to the directory in which ArcView writes auxiliary files of the current project. It is specified trough a dialog box from the option Properties… of the menu Project.

FUNCTIONALITY

WanView functionality is directed to visualize and analyze telecommunication data provided by WanCraft. Following WanCraft's network design process, its functionality is categorized on results of the phases of this process; an initial or parametric stage integrated by user location and traffic demand and proposed backbone location, and a final or result stage composed of backbone network linkage and access network definition, and associated performance measures.

WanView menu, WAN, establishes access to network visualization and WanCraft's design procedures, see Figure 2.

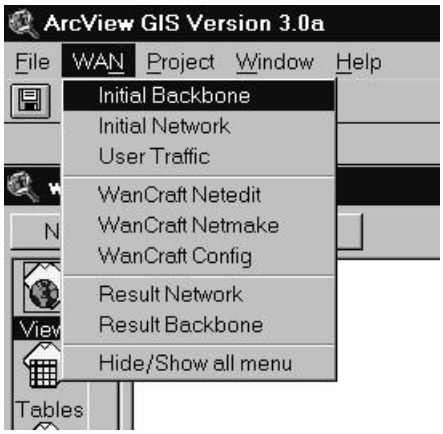

Figure 2. WanView menu options. They allow access to WAN visualization and WanCraft design procedures.

Since WanView visualization follows in-between WanCraft's two-stage design process, there is a precedence order for the design process and the visualization procedures. Figure 3 shows the allowed sequence of procedure execution as a state diagram, Rumbaugh et al. (1998).

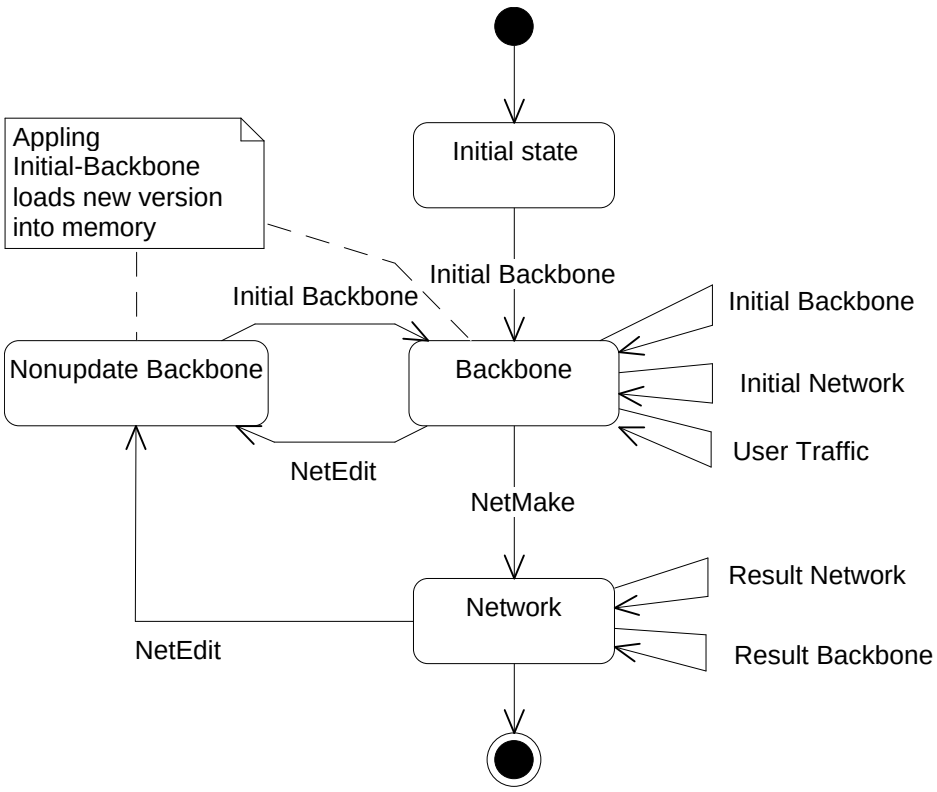

Figure 3. State diagram showing procedure precedence of the two-stage design process.

Location of WanCraft database

The location of the selected WanCraft baseline database is established initially. This must be done for a given WanCraft installation through the identification of the configuration file (`config.txt`) by using a file system selection window that activate automatically.

Initial stage visualization

The visualization of the initial network-design stage is accessed trough the menu options Initial Backbone, Initial Network, and User Traffic. The Initial Backbone option creates a view named Backbone with themes for initial backbone nodes (Initial-

BB Node) and links (Initial-BB Link). The nodes of the backbone are depicted as circled markers and they are located by using their associated site's geographic coordinates; the related links are shown as straight lines connecting incumbent nodes, see Figure 4 for a given example.

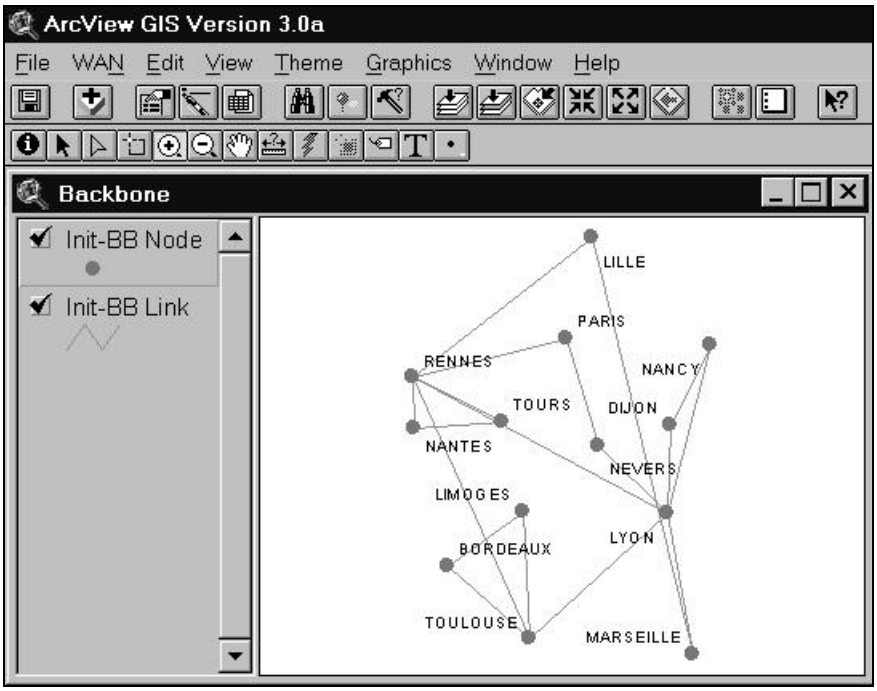

Figure 4. Initial backbone network view.

The Initial Network option creates a view called Network with a theme for sites (Site). Sites are shown as circle marks located by using their geographic coordinates (Lambert projection).

The User Traffic option creates a view called User-Traffic with themes for user-traffic demand (User Traffic), users (User), and sites (Site). The user traffic demand is shown as links between users. These links contain several attributes related to the

demand, which may be seen by opening its associated table. Users and sites are depicted as explained previously.

Access to WanCraft applications

WanCraft main operation is accessed trough the menu options: WanCraft Netmake, WanCraft Netedit, and WanCraft Config. WanCraft Netmake calls a WanCraft procedure to generate the network (backbone network and access network). By default, this procedure uses the backbone network defined at the initial stage; optionally, it may be executed with a backbone-search heuristic by using a specific option (-r). WanCraft Netedit carries out a WanCraft procedure that edits the initial or proposed backbone network. Since WanView has its own data support structure and this does not refresh WanCraft database changes automatically, you should rebuild the initial stage visualization in the case of a change of the initial backbone, that is, execute Initial Backbone after use of WanCraft Netedit. The option WanCraft Config allows the edition of WanCraft's configuration file (`config.txt`). All these options are executed through a MS-DOS prompt; to get detailed information about these features see the WanCraft manual.

Final stage visualization

After the design phase, option WanCraft Netmake, has been accomplished, information about topology and performance of the designed network is available. The visualization of the final network-design stage is accessed trough the menu options Result Network and Result Backbone.

The option Result Network adds several themes to the Network view. Themes Node and Link summarize the whole network. Nodes types are shown categorized with specific colored markers, switch nodes as large circles, connection nodes as triangles, and end nodes as small circles. Colored segments of different thick classify links designed as backbone links, trunk links, and access links. Figure 5 shows an inset of a given network view.

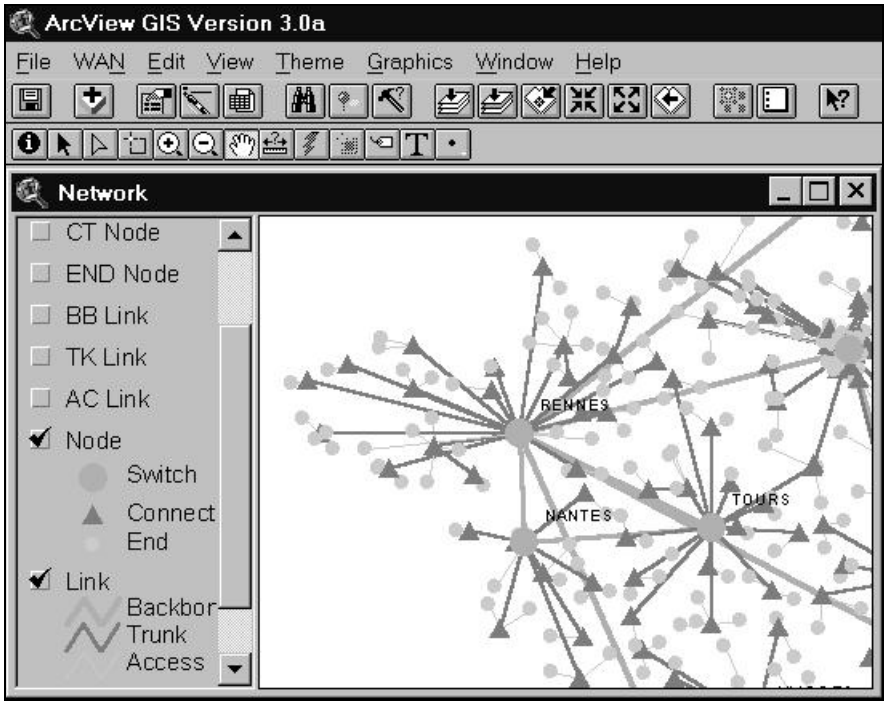

Figure 5. Inset of a resultant network view showing nodes and links.

In order to allow flexibility on analysis, the Node and Link themes information is shown disaggregated by node-type and link-class in a series of themes. By using the original markers, links by class are shown at themes BB Link, TK Link, and AC Link; and nodes by type are depicted at themes SW Node, CT Node, and END Node.

Clustering visualization by node type for end nodes and connection nodes is shown at themes END Node by SW Area and CT Node by SW Area. END Node by SW Area shows end node markers colored by switch node to which they are associated; it shows the end-node region of influence of switch nodes; see Figure 6. CT Node by SW Area does a similar work than the previous but for the case of connection nodes.

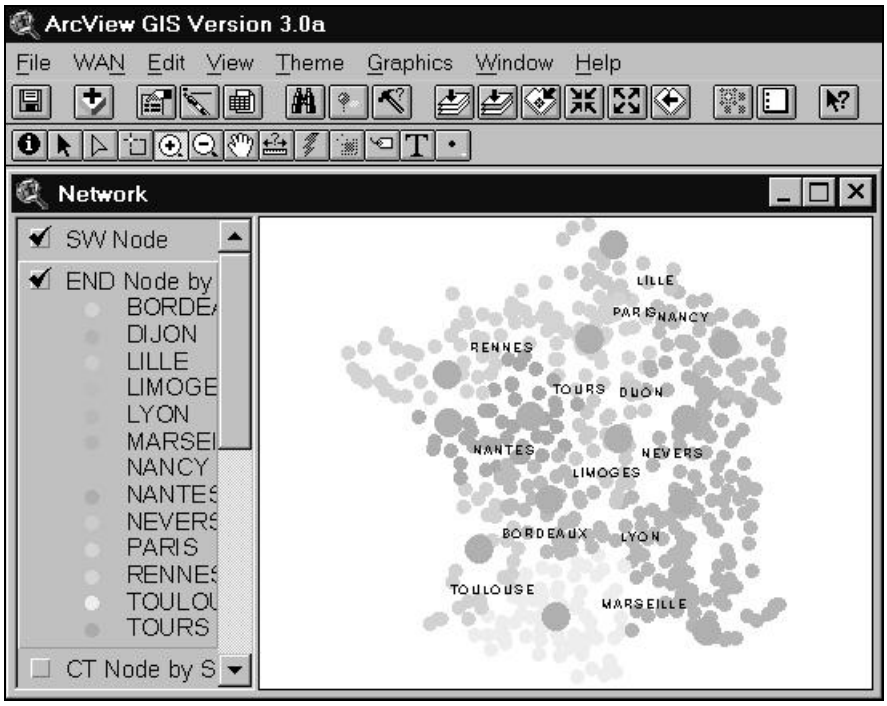

Figure 6. Clustering visualization of end nodes by switch node.

The visualization of the final backbone network is accessed trough the menu option Result Backbone. This option adds themes related to the final backbone network and its performance to the Network view. The final backbone network is specified in themes Node and Link. A series of themes describe backbone features such as links categorized by amount of VBR channels and bandwidth level and nodes

classified by amount of VBR channels and power level, see Figure 7 for an example. Finally, traffic routes among nodes are contained in theme Route.

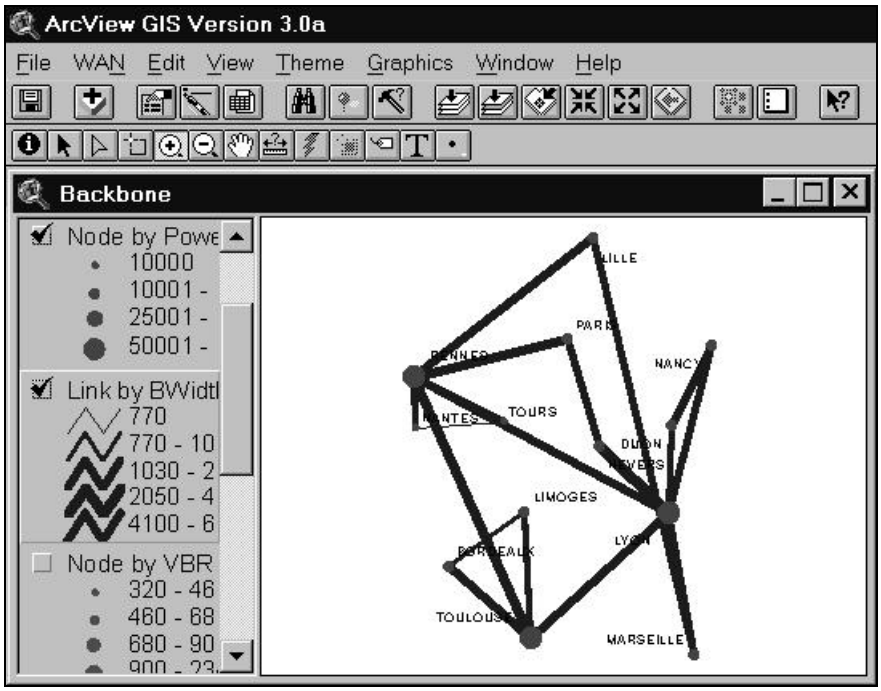

Figure 7. Describes switch nodes and links classified by power and bandwidth respectively.

Customized user interface

The user interface (menus, buttons, tools, popups) may be reduced to a minimal appearance for this application or expanded to full ArcView functionality for upgrade purposes by using the toggle menu option Hide/Show all menu.

TECHNICAL

WanCraft data structure

WanView covers the telecommunication-network information structure of WanCraft's system. The network structure of WanCraft is composed of two data sets. First, a set of data that defines parameters for the design process; and a second collection of data that reports the solution of the design process. These data sets are stored in several ASCII files, on comma-separated format (extension csv). The design process consists of two phases, one dedicated to the design of the access network and a second committed to tuning the proposed backbone network.

The parameter definition set contains information about physical sites and their communication traffic demand (`location.csv` file), specification of backbone nodes (`mainpath.csv` file), and general configuration on the design process parameters and procedures (`config.txt` file). Solution or output of the design process depicts information about the proposed network structure and performance: selection of nodes (`nodelist.csv` file), description of links (`linklist.csv` file), statement of traffic routes (`routes.scv` file), report on performance and cost (`netlog.txt` file), and other detailed miscellaneous reports of traffic structure.

WanView data structure

WanView inherits and expands WanCraft's data structure features. Moreover, it organizes the system modeling by using a more robust approach, object-oriented analysis and design.

The organization of WanView data is depicted in a class diagram, coded on UML, (Rumbaugh et al. (1998)), see Figure 2. As it is shown, the main classes describe physical sites and their potential regional aggregation, users and their traffic demand categorized by traffic type, networks with associated nodes and links cataloged by node type and link class and type, and configuration and routing of network backbone. Actually, there are not operations assigned to the classes, since these are implemented at WanCraft, for the case of the design process, and ArcView for the visualization process. Furthermore, the version of ArcView used does not allow direct class implementation; therefore, the visualization operations of WanView are implemented in procedures assembled with ArcView's scripting language, Avenue.

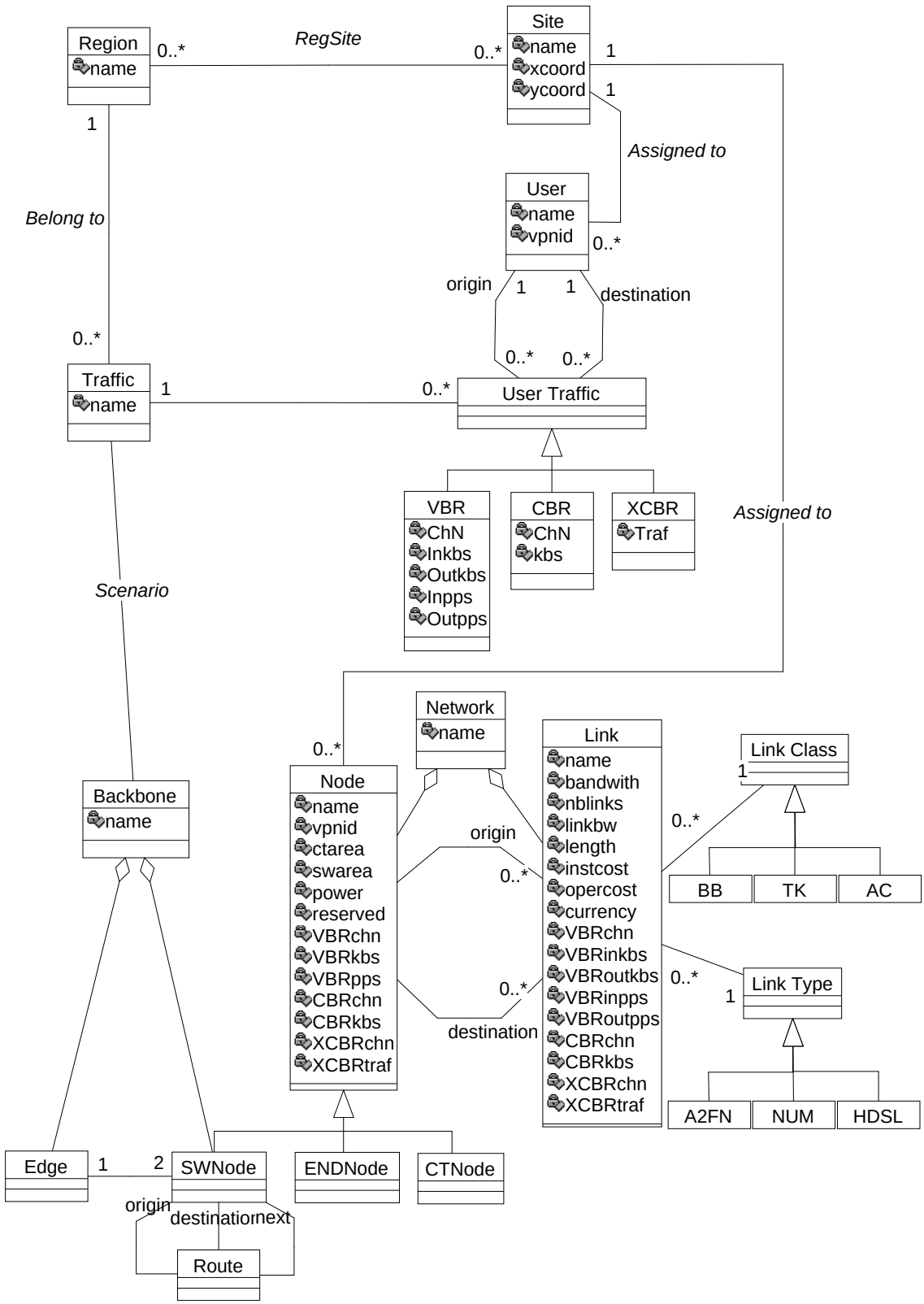

Figure 2. WanView class diagram. It models and expands WanCraft data structure.

Data acquisition

WanView data is obtained trough a series of import process from WanCraft's data files. These processes are implemented within WanView by using scripting procedures programmed with Avenue.

WanCraft's definitions about physical sites and their communication traffic demand (`location.csv` file) are disaggregated and imported into WanView tabular data structures (files `site.txt`, `user.txt`, `traff.txt`, and `usertraff.txt`) following relationships of these attributes as showed in Figure 2. The script ImpLocation implements this import procedure; see at the project window under the script document interface.

The initial backbone network in WanCraft (`mainpath.csv` file) is specified with an adjacency matrix. This is imported into WanView following a normalized format (files `BBoneIni.txt`, `BBEdgIni.txt`, and `BBNodIni.txt`), see Figure 2, by the specification of script ImpMainPath.

After the execution of the design process, information about the proposed network structure and performance is available. WanCraft's node information of the whole network (`nodelist.csv` file) is imported into WanView almost without change (files `Network.txt` and `Node.txt`), see Figure 2, by using script ImpNodeList. Likewise, all network link information of WanCraft is transferred with minor modification to WanView following the specification of script ImpLinkList.

Main Procedures

Menu options, see Figure 2, are implemented with script programs that are located at the Script document user interface. Table 1 shows menu options and their associated Avenue script.

Table 1. Menu options and associated scripts.

Menu option	Script name
Initial Backbone	VisIniBBone
Initial Network	VisIniNet
User Traffic	VisUserTraf
WanCraft NetEdit	WanCraftNetEdit
WanCraft NetMake	WanCraftNetMake
WanCraft Config	WanCraftConfig
Result Network	VisResNet
Result Backbone	ViewResBBone
Hide/Show all menu	ToggleAll

The general structure of Initial and Result network procedures follows a general sequence of actions: import of WanCraft data, creation of databases, construction of associated graphical features, and their visualization. These actions are implemented with series of programs; for more details see the script document user interface at the project window.

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Rumbaugh, J., Jacobson I., and G. Booch (1998). *The Unified Modeling Language Reference Manual*. Addison-Wesley Object Technology Series.