# Visualization of ATM virtual path connection networks

J. Feng and E.H. Blake

Collaborative Visual Computing Laboratory
Department of Computer Science
University of Cape Town
Rondebosch, 7701
South Africa

E-Mail: jfeng@cs.uct.ac.za, edwin@cs.uct.ac.za

## ABSTRACT

**ATM supports multiple quality of service classes for different application requirements. A Quality of Service is associated with a virtual path connection. Dynamic reconfiguration can generate an optimal virtual path connection network and maintains sufficient capacity to carry the established calls in progress. We developed a tool to present information specific to the changes of virtual path network. We visualize network traffic characteristics including dynamic routing, variable link utilization, capacity distribution and objects information. This visualization provided new insight changes of reconfigurable virtual path connection networks. Our tool is intended to help administrators and researchers understand networks as well as identifying anomalies and bottlenecks within these networks.**

Keywords : Visualization, ATM networks, virtual path(VP), virtual path connection(VPC), dynamic reconfiguration

## 1 INTRODUCTION

Virtual paths(VPs) and Virtual Path connections(VPCs) are important connects in ATM networks. Being connection-oriented, ATM networks establish VPs for the purpose of communication between network end-users[4]. A VPC consists of a series of VPs and specifies a route to be traversed from an originating node through a number of intermediate nodes to a destination node. This end-to-end connection between origin-destination (O-D) pairs creates fully connected logical networks based on sparse physical networks. A logical network formed by VPCs is known as a VPC network(VPCN).

The VPCN creation process can be used to adjust the capacities of the VPCs in order to optimally size the VPCN. Bandwidth is logically assigned to a VPC by reserving a certain part of the bandwidth on each transmission link for the exclusive use of the VPC. Capacity can thus be reserved on a VPC in anticipation of call arrivals so that new VCCs can rapidly be set up along predefined routes. By managing the virtual path connection, one can optimize network operations based on network utilization. Visualization is widely accepted to help understand the dynamic connectivity involved in ATM networks.

In this paper, we describe a tool which visualizes the characteristics of ATM broadband networks and provides a concise display of the changes in the virtual structure of the networks. It converts abstract data into a simply and easy understanding manner. Utilizing this information, a user can quickly identify and locate problems and various other ATM specific network features.

## 2 BACKGROUND

The most common technique for visualizing networks involves node and link diagrams[5]. Those traditional network analysis tools usually present a static picture of network connectivity. However, dynamic reconfiguration of the network alters the virtual path connection. Dynamic reconfiguration is a network management control which assigns transmission capacity on the communication links in order to form dedicated logical paths for each origin-destination flow. XFG[2] is an efficient deterministic algorithm to rapidly computer an optimal network configuration.

Conventional network analysis tools tend to concentrate more on the structure of the network, and less on the various forms of traffic in the network, this is addressed by Becker, Eick and Wilks[1]. Although there is a significant research interest in the area of virtual path connection[6], the problem of VPC management remains a problem of current interest. Most existing network management tools fail to address the concerns of complex virtual path connections and logical routes.

SeeNet[1] and Avatar[8] were developed when ATM networks were less widespread. As a result, many ATM characteristics were omitted and this degrades the value of their visual output. Neither of these tools took the dynamic routing ability, changing link capacities, node and link redundancies of ATM networks into account. We have therefore developed our tool to support these features. We employ visual representation to simplify the information into understandable way.

# 3 DESIGN

The purpose of this visualization is to display the dynamic changes of VPCN in pictorial form and lead the user into a better understanding of the traffic patterns and their implications.

## 3.1 Overview

The structure of our tool is shown in Figure1. It consists of three major components.

- Data Engine: the original data set of DROP[2, 3] input and output files.
- Parse Engine: extract information from the body of data, and generate data structure used by visualization engine.
- Visualization Engine: provide visualization functions in user interface and graphical views.

We make use of parse engine which is completed abstracted from the other components. This means we replace the data set without the need to change any of the interface code. This is particularly useful to work on different data source.

## 3.2 Data Engine

We use XFG[3, 2], a dynamic reconfiguration technique, computes the virtual path connection of an ATM network and subsequently achieves the maximum revenue for the network. The source data includes MDL file which is the input file of XFG and XFG file which is output of each reconfiguration.

## 3.3 Parse Engine

Parse engine has two parts: MDLparser and XFGparser. MDLparser is the input parser, extracting nodes and links information. It consists of functions to read from files and contains a list for nodes and a list for links. These list are initialized for each new .MDL file. XFGparser is the out parser for DROP. Its primary functions are to extract route information and generate OD pair information for visualizing the dynamic changes of VPCN.

## 3.4 Visualization Engine

The visualization engine is designed to work only with the XFGparser and MDLparser classes. It includes two graphical view windows and a interface menu window as shown in Figure2. The main purpose of the menu window provides detailed network information not present in two view windows. The graphical view shows the overall network context, but due to space reason, text information on each individual route is not provided in the scene.

# 4 IMPLEMENTATION

## 4.1 Functions

Our tool supports spatial information of the physical network as well as the logical connection on top of it. The two distinct views clarify physical links and logical network generated by the virtual link properties of ATM networks.

Our tool allows the user to interact with the network and query the objects on the graphical view which brings more information of network objects. Our implementation provides the user with current text information on the network topology and useful graphical views of the changes in the virtual path connection network.

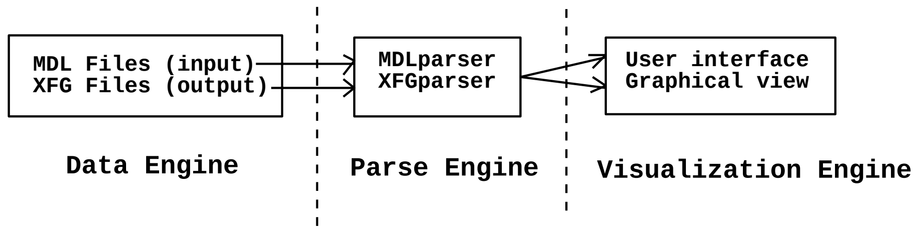


Figure 1: Overview structure of visualization tool

### 4.2 Language

The tool is written in DIISH(Dynamic Interactive Inventor SHell) - an in-house development environment based on Open Inventor and Tcl/Tk. The philosophy of DIISH is to use TCL to create inventor scene graphs. It was designed to assist in the development of visualization systems. The advantages are:

- Simply to add custom C++ functions to a TCL-Inventor system,
- Allow TCL commands to directly manipulate Inventor objects, and
- Short development cycle.

SGI's Inventor 2.1 is the current graphical library. Using this library, we can take advantage of powerful graphical objects and their features with minimal programming effort.

Recently, this tool has been ported to PC using OpenGL. OpenGL today is widely recognized and accepted as an industry standard API for real-time 3D graphics. So we build this tool as cross-platform system.

## 5 DISCUSSION

**Extracting:** Visualization revolutionize the way we understand large body of data. This research focuses on extracting the information latent in large database using novel visualization. This difficulty in extracting this information is understanding the complexity of the database.

**Task-Oriented:** This research is task-oriented since the analysis needs of each dataset are often unique. This visualization help frame interesting question as well as answer them. By focusing on the specific analysis needs and targeting the user tasks, we ensure a thorough understanding of the system requirements and can draw attention to the spot where the problem raise. For data analysis, a visual display is useful if it insights and understanding.

**Multiple Linked View:** For important datasets, one view is often not sufficient to answer all interesting questions. Many views, each answering separate, but related questions, may work together to provide insight. As shown in Figure2, two windows on the left hand side visually present the utilization of physical links in two different configuration states. Meanwhile in the window on the right hand side, two barcharts clearly show differentiation of two states.

**data Encoding:** Tying the visual attributes of the glyphs to code characteristics shows the distribution of the statistics in the database. Position, size, color are the several visual attributes used in this tool. For example in the Figure2, the width of the line indicates the usage of that link.

## 6 CONCLUSION

We have presented new version visualization tool for showing the structural characteristics of VPC networks and the changing traffic carried on it. Visually, the user can understand the geographical layout of the physical connection immediately with little explanation. At the same time, virtual path connection in the logical level can be detected. From the initial experience with the system, interaction has the equally importance to help understanding the VPC networks.

### 6.1 FUTURE WORK

Application of the system in practice will yield useful feedback to update this tool. Allowing interaction with a live ATM feed may reveal some interesting results when evaluating this system in real world.

## REFERENCES

[1] Richard A Becker, Stephen G. Eick, and Allan R. Wilks. Visualizing network data. *IEEE Trans-*

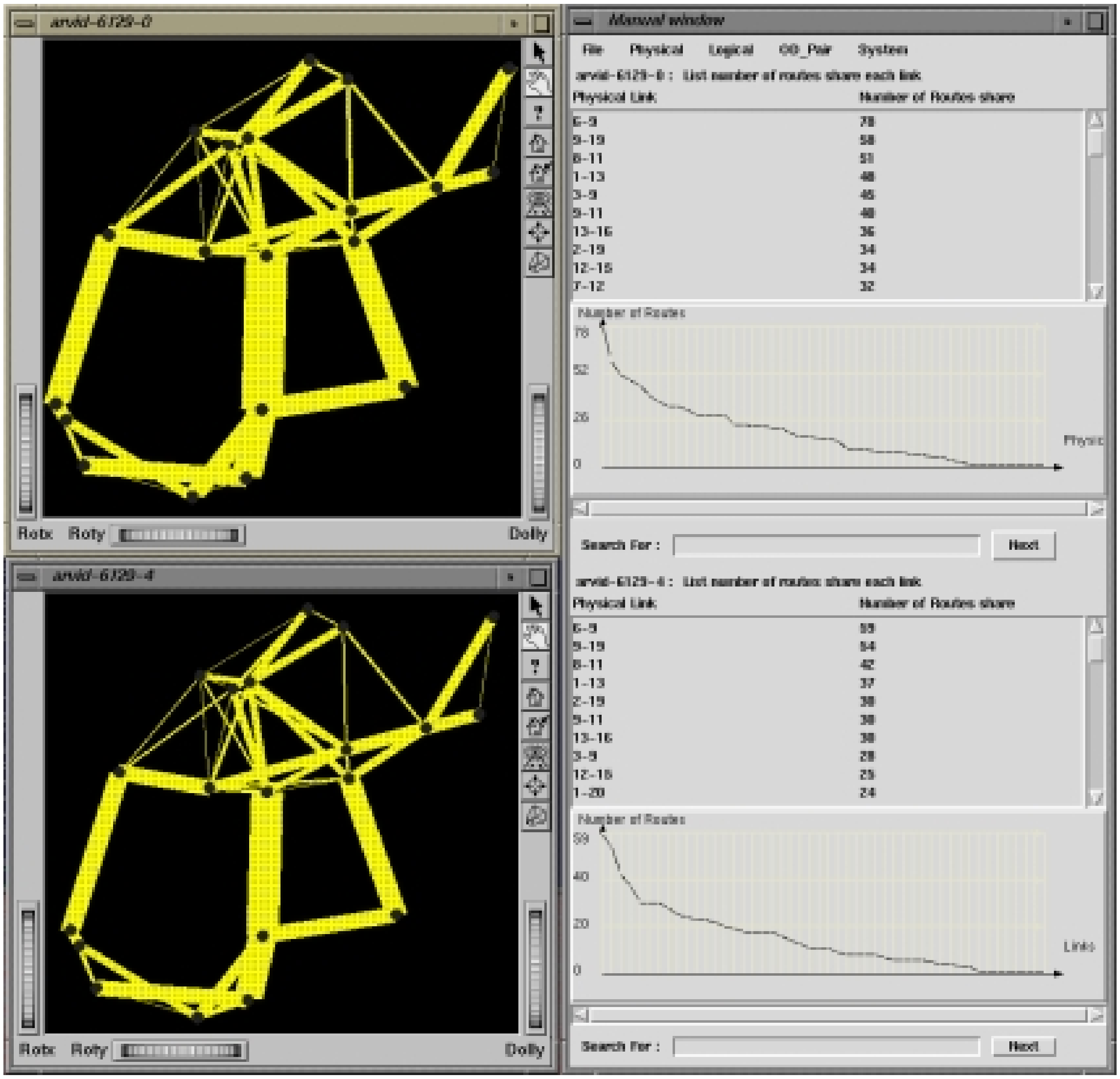


Figure 2: Two graphical view windows and user interface window

*actions on Visualization and Computer Graphics*, March 1995.

[2] S.A. Berezner and A.E. Krzesinski. Call admision and routing in ATM networks based on virtual path separation. In *4th Int Conf on Broadband Communications*, Stuttgart Germany, April 1998.

[3] S.A. Berezner and A.E. Krzesinski. Optimal reconfiguration of large Manhattan grids. Technical report, University of Natal and University of Stellenbosch, 1998.

[4] Martin P. Clark. *ATM networks : principles and use*. Chichester : Wiley-Teubner, 1996.

[5] Stephen G. Eick. Aspects of network visualization. *IEEE Computer Graphics and Applications*, pages 69–72, March 1996.

[6] D. P. Griffin and P. Georgatsos. A TMN system for VPC and routing management in ATM networks. Technical report, Foundation of Research and Technology - Hellas, Crete, Greece, 1995.

[7] O. Saal, J. Feng, A.E. Krzesinski, and E.H. Blake. Visualisation of atm network connectivity and topology. In *SATNAC'98 Proceedings of 1st Annual South Afrocan Telecommunications, Networks and Applications Conference*, pages 71–78, University of Cape Town, South Africa, September 1998.

[8] Will H. Scullin, T. T. Kwan, and Daniel A. Reed. Real-time visualization of world wide web traffic. Symposium on Visualizing Real-time Data, October 1995.