

An Adaptable Innovative Visualization For Multiple Levels of Users

Doris Hooi-Ten Wong and Sureswaran Ramadass

National Advanced IPv6 Centre (NAv6), Universiti Sains Malaysia (USM), 11800 Penang, Malaysia

Abstract: A large amount of data visualization tools have been developed due to large number of network data. Demands from computer users on visualization increase among different levels of computer users. It becomes very difficult to form a comprehensive visualization to the different levels of computer users about those network data on how the networks are interacting. How can we convey the comprehensive network information to different levels of computer user? We propose the traffic stairway, a novel visual graphical representation of network data based on different network data level. Different traffic stairways can represent different network data level. We use an elevator floor metaphor for creating three different individual traffic stairways and an elevator metaphor for combining these traffic stairways to represent the complete network data elevator environment. Existing work in data representation will be discussed. We will explain the methods to create the traffic stairways, describe the visualization and show the stairways usefulness to different levels of computer users.

Key words: Network data visualization • Traffic stairways • Interaction

INTRODUCTION

As the demands on visualization among different levels of computer users is growing tremendously, many of the network data visualization tools as such WatchPoint [1], Otter [2], Network Traffic Visualizer (TNV) [3], ntop [4], Nodemap [5], NAV [6], VISUAL [7], SCPD [8], PortVis [9], NVisionIP [10] and NIVA [11] are widely deployed in recent decade. As the number of network data tremendously increasing, having no possibility to sufficiently explore and understand the overall network interacting. Today's network data visualization tools, it is only designed to visualize very limited types of network data. This makes it difficult for beginner computer user to understand the appropriate network traffic information. These circumstances resulted even for advanced network administrators finding difficulties understanding the existing complicated network data visualization.

Existing network data visualization lack comprehensive network information when dealing with different levels of computer users. Common network data visualization presented entire network data to the user without consider who is the particular target user. While such visualizations present information about the network, beginner computer user still needs to search for the interested network information. This will occur lost as

the beginner computer user does not know where to search and how to search. Some network data visualization even provides three-dimensional (3D) representation. 3D representation is not necessarily better than two-dimensional (2D) representation due to problems such as navigation from different levels of computer users.

In order to produce comprehensive visualization to different levels of computer users, we have proposed adaptable innovative framework (expert-aware approach) [12] to improve the network data visualization. What makes expert-aware approach so special is the ability to classify different computer users into different level of groups according to their network expertise level. This will also accelerate the normal network data visualization speed and improve the understanding level among the computer users.

The need is the ability to present relevant network data to relevant computer user, such as beginner computer user will be given the visualization about low level network information, intermediate computer user will be given middle level of network data and for advanced computer user will be given high level network data. Our proposed solution is the network stairways as shown in Figure 1. Its features consist of low, middle and high level network information which has been classified into three different levels.

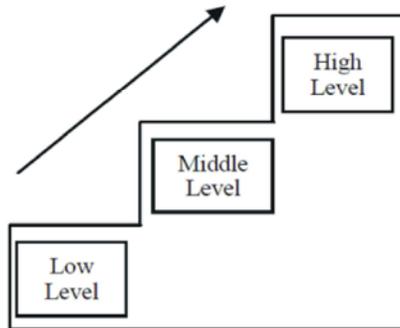


Fig. 1: Network stairways with three different levels

The following sections, we will discuss the existing network data visualization tools in more details. In Section 3, we will describe network stairways and explain how the visualization can be created. Following by Section 4, method for creating NetworkFloor will be discussed. In Section 5 will describe how NetworkElevator uses a list of NetworkFloors to represent different network data level in complete network data elevator environment. Details of implementation as well as usability study will be discussed in the Section 6 and 7. Finally, Section 8 will discuss the conclusion.

Related Works: The existing network data visualization tools typically involve presenting network data regardless on considering level of network data expertise among different levels of computer users. With the increasing of demand from different levels of computer users, the existing network data visualization become useless and meaningless to the beginner user as they feel difficult to understand the complicated and complex visualization. We examine here user-centered visualization for showing relevant network information to the relevant computer users [12] classifying network data into three different levels [13] and providing statistical analysis and learning [14] in visualization.

Visualizing Network Data from Different Levels of Computer Users Perspective: There has been relatively little work that focusing on presenting relevant network data to relevant computer users. One prominent exception is CiChlid [15], which is at least provided visualization to the beginner computer users and advanced computer user. It is still not available to present the sufficient and comprehensive network information to the beginner computer users as it sometimes lead the user getting lost in the visual data exploration.

Presenting Network Data from Three Different Levels

Perspective: Failure in achieving network visual data exploration has led the focus of network data management to classify network data into three different levels. There will be network data level 1 or low level (Primary Level), network data level 2 or middle level (Secondary Level) and network data level 3 or high level (Tertiary Level). Each network data level is represented as a different level of the entire network data information.

There are some works such as network management research, which is provided three different levels of visualization. The network data has been presented in numerous visualizations. These visualizations can be matched to Shneiderman's visual information-seeking mantra [16]; overview, zooming in and filtering and details-on-demand. When there are a large number of links in network data visualization, the visualization can get fairly complex. The visualizations will only useful for the advanced network administrators, but definitely less useful to the beginner computer users. This is because beginner computer users not familiar in choosing either overview or zooming and filtering or details-on-demand options.

Enabling Statistical Analysis and Learning from Different Levels of Feedback:

Another area that we are going to discuss is the customization of the network visualization in network data visualization application. Existing network data visualization applications are applicable for the customization. Computer users are able to choose on their preferable view whether is overview, zooming and filtering view or even details-on-demands view.

The customization has been applied and being available in most of the visualization applications but do not really support the network data visualization. It does not response immediately and conveys the customization based on computer user's feedback. Despite the problems, statistical analysis and learning will be applied to response to the computer user's feedback in the shortest time.

Network Stairways: While there are existing network data visualization tools that convey network information to beginner computer users, presenting different level of network information to the user, or even providing customization in the network data visualization application, we have not found a single network visualization application that consists of the above three

mentioned criteria. Our proposed solution is the network stairways, or network visualization based on different computer user's expertise and network data levels and support for the user's customization.

In network world, successful visualization should be able to show to the different levels of computer user with relevant network information instead of dump of network data which is difficult for the different levels of computer users to understand. The network visualization should be able to be classified into three different levels in order to achieve higher understanding level among the computer users. Customization from computer users shall be performed and responded in the shortest time.

A network stairway is a visualization of the network data based on the network levels from the simplest to complicated. Different stairways can be created for the different computer users depending on their network expertise and network simplicity level. Possible attributes such as source IP, destination IP, source port, destination port and protocol. Various visual parameters such as the size, hue, saturation, or shape of the network stairway can then be used to represent the mentioned attributes.

There are two challenges in creating successful network stairways. In selecting those attributes about network data information that best convey information about a network protocol and deciding how to visualize these attributes intuitively.

Network stairways can be gathered and use to represent the entire complete network of the network data elevator environment. Such an overview allows users to see overall trends in the network data, such as different level of network data. Network stairways are generated based on different level that can be understood by the different levels of computer users.

As with any visualizations of network visualization, user understanding and different levels of skills are the concern [17]. Our focus is on presenting relevant network data information to the relevant computer users instead of presenting them all the network data information which they found difficult to understand. The visualization is expecting to be available to present about the network data information in the certain network (e.g. NAv6 Centre network).

Networkfloor: NetworkFloors, the visualization of the network data based on different level of network data information will be discussed in more detail in this section. A simple network data is represented as the lowest floor, the intermediate network data is represented as the middle floor and the advanced network data is represented as the

highest floor. The simple network data will be presented to beginner computer user. Different level of network data will be arranged into the different floors.

The elevator floor metaphor was chosen for its user-friendliness and intuitiveness. Other existing visualization used to present all the network data without filtering the network data to fit to the different levels of computer users' requirement.

Each NetworkFloor represent a group of simple network data which has been filtered and can be understood by beginner user. The simple network data will be presented in the primary and simple environment once the user entered the lowest floor. We found that being presented the network data in the easier and primary environment can lead them to understand the network data easier.

Network Data from Lowest Floor (Level 1): As mentioned earlier in Section 3, NAv6 network data will be used in the research. iNetmon [18] is a network monitoring tool that used to monitor the network and capture the network data by using WinPcap. Based on the survey, application layer protocol such as Web and Mail will be presented in this floor. Possible attributes such as source IP and destination IP will present to the beginner user. They chose to view these two attributes as they only understand and want to view the incoming and outgoing IP information. The simple network data goes to beginner user. They are also permitted to give some feedback by choosing either adjust or panning button. In this floor, we have covered the mentioned three criteria which are relevant user will be presented with relevant network data as well as given relevant feedback button for them to be choose on.

Network Data from Middle Floor (Level 2): According to the survey, some additional application layer protocols such as FTP and H.323 will be presented in middle floor. Possible attributes such as source IP, destination IP, source port and destination port will present to the intermediate user. They chose to view these four attributes as they are taking care more in those attributes if compare with beginner computer user. The intermediate level network data goes to intermediate user. They are also permitted to give some feedback by choosing zooming, deleting, adjusting or panning button. Same with the lowest floor, we have covered the mentioned three criteria which are relevant user will be presented with relevant network data as well as given relevant feedback button for them to be choose and click on.

Network Data from Highest Floor (Level 3): Based on the obtained survey, other application layer protocols such as SNMP and DNS will be presented in this floor. Possible attributes such as source IP, destination IP, source port, destination port and average utilization will present to the advanced user. They mainly choose to view all the attributes as they need to understand all the related information. The advanced or complicated network data goes to advanced user. They are also permitted to give some feedback by choosing either adjust, panning, zooming, deleting, or filtering button. Advanced computer user can give the feedback easily while they are viewing the visualization that presented to them.

Network Elevator: Having described our different floors of network data visualization, we will now turn to place them into the complete elevator. Different floor consists of different level of network data which is suitable to different levels of computer users.

Previously, computer users will be presented with the entire network data information which causes them to be lost and uncertainty condition, eventually they are not able to comprehend the represented visualization. NetworkElevator is designed to facilitate and overcome the problem. While NetworkFloor specifies how to represent different level of network data into different floors, NetworkElevator specifies how to combine and layout the floors for complete elevator for different comparison viewing. We have used the elevator metaphor because the higher the floor the higher and more complicated information that will be getting from there. For instances, a lower floor usually entertain the easy and simple task and even simple questions from users. A higher floor usually deals with complicated and advanced questions from the users. It looks easier for the different levels of computer users to enter the particular floor to view the network data information instead of viewing the entire network data information which they are not able to understand the whole entire information from the network data.

Implementation: NetworkElevator has been implemented by using Java. The right choice of graph depends not only on the type of data we are going to visualize, but also on the objective we are trying to achieve. Lowest floor with simple network data (less dimension) will be presented with simple bar graph or pie chart or histogram. Link graph, parallel coordinate plot or treemap can be used in the middle floor and highest floor. Network Elevator will assign the different level of network data into different NetworkFloor and different visualization



Fig. 2: Visualization for beginner computer user

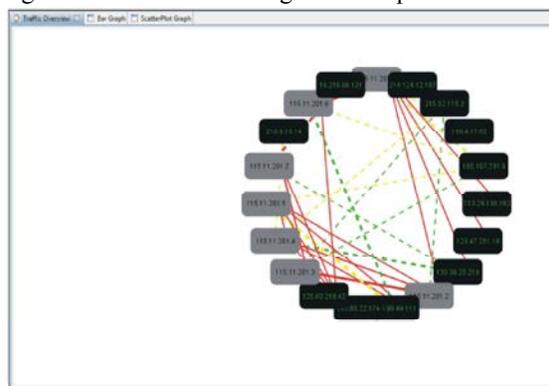


Fig. 3: Visualization for intermediate computer user

will be used from different NetworkFloor and different visualization will be used from different NetworkFloor. Thus, simple network data will be easily be represented by using simple bar graph and the same will be happened on the intermediate and advanced network data.

Figure 2 and 3 showed the initial screenshot of the visualization for beginner and intermediate computer users. Refinement is being done for the advanced computer users' visualizations.

Usability Study: We conducted a usability study to determine whether beginner, intermediate or even advanced computer user could understand the visualization by looking at the presented network data visualization. We conducted the usability study with 30 network administrators (Advanced User), network analysts (Intermediate User) as well as network officer (Beginner User). Before presenting improved visualization to the users, we had requested each user to answer some biographical questions to determine their expertise level. We can rely on users' biography information but not their expertise level as users will not know how to rate their expertise level. Besides the capture network data also had been classified into three different levels. Based on the

expertise level, if the user is categorized as beginner computer user, he or she will be presented with the simple network data or lowest floor of network data information for the beginner user. The same condition goes to intermediate and advanced computer users. When asked about the visualization, can they understand the visualization; all the users characterized NetworkElevator as easy to use and comprehensive network data visualization being shown to them. They found it is very useful for them to understand the network information.

They feel very comfortable with the improved visualization as their expertise level being considered as one of the criteria in network data visualization. Different levels of computer user managed to understand the visualization and able to give feedback on the displayed visualization. The shortcomings for the existing visualization have been solved by applying the novel method and improved visualization. Different levels of computer user no longer complaint on the irrelevant network data visualization; network data can be fully presented to the relevant computer user without wasting the network data information; and sufficient feedback is permitted among the user and intuitive interaction can be achieved.

CONCLUSION

In this study, we have proposed and designed to visualize effectively network data information among computer users, one needs to know and understand the visualization well. Unfortunately, existing visualization never consider about different levels of computer users' requirement on different network data. We believe that these circumstances can be improved by re-introducing the novel method and re-designing the improved visualization for the network data visualization environment purpose.

Network stairway has been presented as a novel method for conveying comprehensive network data visualization in network environment. NetworkFloor consists of three different floors which managed to collect and present different level of network data to the computer users with different expertise level. The combination of the NetworkFloors has led to the complete and comprehensive NetworkElevator.

NetworkElevator can be extended to other field which related to visualization. We believe that these network stairways can assist different levels of computer users to understand the different network data visualization and give their feedback on the visualization. The aim of the research is to achieve that the presented data can fit to

relevant computer user, the relevant network data can be classified into different level and different levels of computer user manage to give their feedback on the visualization that represented to them.

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