SolarWheels: An Interactive Situation Awareness Visual Display for Large-Scale Computer Networks

2013 VAST Challenge MC2 Award: Outstanding Creative Design

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ABSTRACT

SolarWheels is an interactive situation awareness display designed to visualize the states of a global computer network. It incorporates three communication zones of interaction (ambient, notification, and interaction) to provide different levels of information and communication. It is also a collaborative environment that supports multiple users' interaction and collaboration. With the proposed design features and technology, SolarWheels can serve as a new way to visualize the hierarchical computer networks and facilitate control room collaboration.

Keywords: situation awareness, visual analytics, ambient information display, computer network, situated interaction, Microsoft Kinect.

Index Terms: [Human-centered computing]: visual analytics, information visualization, interaction design, ambient intelligence; [Networks]: Network Security.

1 INTRODUCTION

The VAST 2013 Situation Awareness mini challenge 2 provides a fictional company with global computer network and asks designers to create a visualization on a large display to show system state of the entire network. The goal of the visualization is to offer the data analysts in a control room a clear and quick view of the changes, issues, and statuses of the network.

From our interviews with visual analytics working professionals, in a typical control room, the modern Internet based computer networks are of a hierarchical nature, i.e. each network has several child networks, which also has their own corresponding children. A large network may have tens of thousands of sub networks with many levels. However, computer issues might only happen at a tiny portion of the large network. One computer has many different measurements to reflect different perspectives. It is hard to visualize all information of all computers at once. An interactive visualization that allows the user to drill down the network's hierarchy may be necessary.

Incorporating the Ambient Information Display design scheme [2], we propose SolarWheels, a large-display situation awareness visualization able to show the history and states of the hierarchical levels of a global computer network based on the physical interactions from multiple system analysts.

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2 THE SYSTEM

SolarWheels is inspired by the Solar System and the wheels commonly seen in our daily life. We applied the metaphors of orbiting planets, solar coronas, planetary hierarchies, along with the circular shape and spoke element of wheels. Together the display, as a collection of modified form of Solar Systems, is able to interactively visualize a global computer network.

2.1 Visualizing the data

The number of displayed SolarWheels indicates the number of regions currently being monitored. The dynamic wheel graph is an integration of pie diagram, moving dots, and network traffic curves, formulated from the aforementioned metaphors.
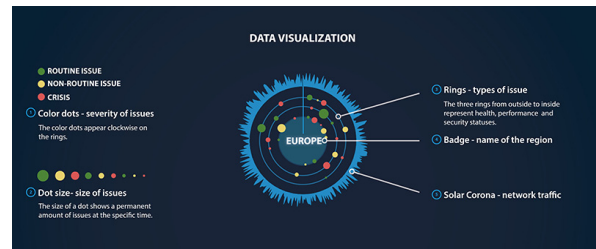

Figure 1: Design of a single SolarWheel

Each wheel shows the following dimensions of information (Fig 1): a) Badge in the center of wheel: the name of the region. b) Radius of the wheel: the amount of issues in the region. c) Three rings in each wheel: from inner to outer ring - statuses of security, health, and performance. d) Issue dots on the rings: issues that are happening on a particular ring of status. An issue dot has these attributes: 1) color: issue severity, i.e. green for routine issues, yellow for non-routine issues, and red is for crises; 2) size: the volume of issues on a ring with a particular severity (e.g. number of networks/computers being affected); 3) transparency: an issue is in a more transparent color when it has been assigned to an analyst or is under investigation; 4) the orbiting sequence of the issue dots: the temporal sequence (history) of issues. e) The outside variation "corona-like" curve of a wheel: network traffic. The curves and dots are continuously moving along the track to visualize history statuses. The full circle shows one day (or any other time length) of history. As time goes on, new dots appear and old dots fade out.

2.2 Zones of communication

To interact with a big display, previous researchers have proposed "zones of communication" (and their respective modes): ambient zone, notification zone, and interaction zone [1]. One advantage of applying these different zones in our SolarWheels system design is the system analysts are able to have layers of situated-based interaction: from informal to direct, implicit to explicit,

peripheral to focused attention [2]. This allows the analysts to view the visualization with levels of attention while always maintaining the system informative and sufficient of communication.
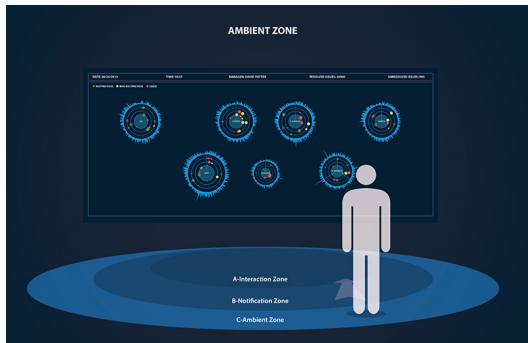

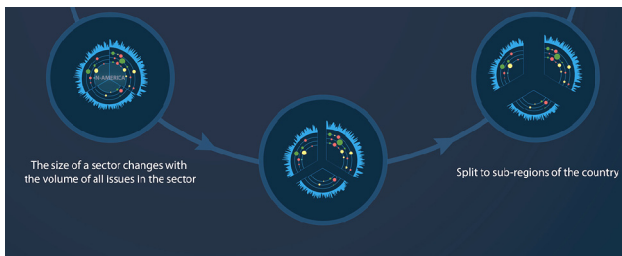Figure 2: Viewing from the Ambient Zone

Figure 3: The transitional splitting: North America expands into three smaller sectors of Canada, USA, and Mexico.

Not only is our design based on distance-dependent semantics, with which a system reacts per the surrounding spatial conditions [2] (here in particular, the distance between the system and the user), but it's also able to detect and identify multiple analysts, recognize their gestures and eye gazes as input. Therefore, we propose the system to be comprised of a large touch screen, new generation of Microsoft Kinect sensor(s) (each supports up to 6 people recognition), RFID reader (capable of identifying who exactly are accessing the system), and eye tracking module(s) (e.g. NUIA eyeCharm compatible with Kinect).

The zones function as follows: **Ambient Zone** (beyond 5 meters): The analysts stand in this distanced area, as if they are viewing a dynamic gallery exhibit, to have an overall view of the computer networks with the highest level of hierarchy, i.e. the networks of the six continents and one headquarters (Fig 2). **Notification Zone** (2 to 5 meters): When an analyst enters this zone, different stages of wheel transitions will take place. For example, when an analyst enters Notification from Ambient, the North America SolarWheel splits in to three sectors of Canada, United States, and Mexico (Fig 3). When she completely stops in Notification, the three sectors will expand into three smaller SolarWheels (Fig 4). **Interaction Zone** (0 to 2 meters): In this zone the analyst can see most information details, e.g. the Midwest region of United States. She can also use physical gestures to interact with a wheel to perform more actions, e.g. tap on an issue dot to see its detailed description (Fig 5), assign an issue to the corresponding personnel, pin/lock a wheel so it can continue the monitoring without collapsing back to its mother wheel. The wheel transition is also available, e.g. when one enters from Notification to Interaction in an attempt to examine USA SolarWheel, it splits into sectors of MidWest, North East, South, East, and West. Once she completely stops in Interaction, the sectors will expand into five complete SolarWheels, getting ready
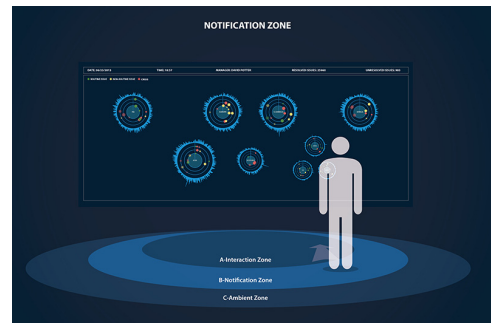
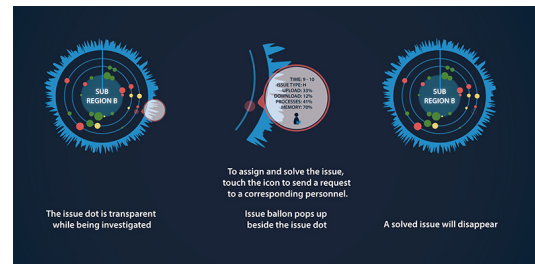

Figure 4: North America becomes three smaller

Figure 5: In Interaction Zone, one can tap on an issue dot to view detailed information and/or perform actions.

Figure 6: The system supports multi-user input.

for the analyst's actions or examination.

SolarWheels supports interaction with multiple users. As demonstrated in Fig 6, the right analyst is in Interaction Zone, interacting with SolarWheel of MidWest of USA, while the left analyst enters Notification Zone to view the six data center SolarWheels split from their mother HQ SolarWheel.

3 CONCLUSION

To reflect the hierarchical nature of computer network and control room settings, we designed the situation awareness display with a strong character of hierarchy. The three zones of communication (Ambient, Notification, and Interaction) fit well in a large control room space, interpret human movements as interactions, and support the direct navigation in the visualization to show different levels of details. [SolarWheels Video: http://vimeo.com/72357002]

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