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Management by Delegation: Network Management for the Real World

**A discussion on the evolution of next generation network analysis tools
by Karl Auerbach, President, Empirical Tools & Technologies". March, 1993.**

Introduction

The need to administer, manage and monitor corporate-wide computer networks has become increasingly more difficult and complex. These networks require installation, configuration, operation and maintenance. Multi-platform environments and multiple geographically-dispersed sites complicate these tasks creating the network nightmare many companies are experiencing today.

Several network management tools and programs exist that attempt to cure some of the problems associated with these diverse network environments. However, current network management products are either overly general or highly focused monitoring devices, often on proprietary platforms, designed to accomplish a limited range of tasks. For example, many general purpose network management stations are mainly glorified SNMP MIB browsers; protocol analyzers provide a greater amount of information at specific lower levels. Most of today's tools are passive monitors with limited, if any, ability to control the network. But none of these tools are combined or consolidated in one program that provides all the information a network administrator, manager or integrator needs to know when installing, configuring, operating, troubleshooting and maintaining a network. Network management software needs to transcend these limitations by providing comprehensive network management and control systems that support the multi-platform, multi-site, geographically-dispersed environments of today's networks.

Empirical Tools & Technologies believes there is a need in today's market for a consolidated network analysis software product that provides "real tools for real networks". Tools that provide proactive interaction with computer networks and meaningful information that can aid in network installation, diagnosis, and troubleshooting. Empirical is working to develop a new category of network software tools that make it possible to interact with the network, not only passively monitoring network traffic, but actively probing network devices to seek out a wide range of valuable information and interpret that information.

Management by Delegation

Empirical's philosophy of how real network tools should be designed is based on a hierarchical framework that emulates the traditional business organizational model using "management by delegation" and "management by exception". At the top of the organizational chart, top managers formulate policy and deal with global issues. As one progresses down the framework, implementation of the policies becomes more specific as subordinates gather information and carry out the policies set by upper management. Subordinates operate with a degree of autonomy as specified by their superiors.

Management by delegation can be applied directly to the management of a network. At the bottom of the hierarchy are devices that "reach out and touch" or

investigate and manipulate the network. At the upper level of the hierarchy are tools that control and command the lower level probing devices.

The upper level or superior tools are a platform for the execution of intelligent applications that use the lower level tools. Much of the overall sophisticated data analysis and global control functions are performed here. Ultimately, the superior tools or command and control engines coordinate among themselves and exchange information.

However, the subordinate probes are also sophisticated devices. They receive delegated authority, operate with as much autonomy as the delegation provides and report back to superiors as necessary. Because the subordinate probing mechanisms are active devices, the intelligent applications can make use of them to perform remote diagnostic tests or to establish remote watchposts for significant and interesting network events. This allows for remote operation of probes and for the coordination of multiple probes.

The tools being developed by Empirical today will ultimately evolve into a new automated approach to network administration. These tools will form the foundation for a homeostatic, hierarchical network architecture that will delegate management decisions to specific network probes and control stations. This will allow the network to administer itself with little or no human intervention beyond the setting of performance goals.

The first step is to perfect the network tools capable of actively investigating the network and storing the data received in a meaningful form. The next step is to create an automated infrastructure that uses the human models of "management by delegation" and "management by exception" to give the local probe tools the authority to automatically make the necessary adjustments in network traffic.

This paper, presented as part of the Interop '93 Spring Presentation Theater, is offered to introduce the first generation of tools that form the foundation of this new infrastructure. It offers an explanation of the goals these tools can attain and a glimpse at the way network management will evolve in the future using tools that open the doors to homeostatic networks.

Empirical's View of Network Management Tools

Many of today's network management station packages are little more than graphics-based MIB

browsers. They still require human intervention to perform tests, apply or interpret the data and place those conclusions into a perspective that results in a direct course of action. This is costly and getting more so; MIS professionals and qualified network managers are very expensive. And, in some cases, it's hard to find experts who want to do the mundane type of work needed for network analyses. Today's tools need expert operators and, as such, cannot be readily applied by the masses.

Empirical's mission is to create new kinds of network tools. The objective is threefold:

- Help smart, expensive people work smarter;
- Make it possible for less expensive, less experienced personnel to handle more mundane networking tasks;
- Decrease the overall cost of network administration by increasing the "intelligence" of the network itself.

With these tools, companies will be able to make expensive personnel more efficient and create "self-repairing" computer networks requiring minimal or no human intervention.

Today, if it costs \$100,000 to install a network, it typically costs \$50,000 to run and maintain it. Networks are inherently unreliable and a lot of time and money are lost to network downtime. As an example, is it an efficient use of time for lawyers, billing at \$200 per hour, to sit and wait for a network to come up so they can complete their tasks? No, obviously not. And, it is just as inefficient for an expert network manager to try to isolate problems that cause a network or node connection to fail. These kinds of problems could easily be found by a probing device and, under previously specified configuration requirements, repaired without human intervention. A flexible and solid network is an important competitive tool in business industry today and the cost of running it affects the bottom line of the entire organization.

Recognizing that wide area links are an expensive, often scarce resource, Empirical's architecture can result in significantly lower management traffic as compared to an SNMP-only mechanism. A local administration point is given instructions on how the network components under its range of control are to operate. SNMP will be used as a means to interact with network devices. Generally this interaction will occur only at the lowest level of the Empirical architecture. Thus, the large potential burden of SNMP traffic will be removed from wide area links.

The PC As A Platform

It is no longer prohibitively expensive to distribute intelligence throughout the network. PC horsepower continues to increase while the cost of processing power continues to drop. This, coupled with the continued capability and flexibility enhancements of primary PC operating systems, offers a powerful platform for network analysis.

NetScript

The means by which various parts of Empirical's tools coordinate among themselves is through a new language similar to PostScript. PostScript defines what the page is supposed to look like and offers a language to create it. Likewise, NetScript, defines what the control is to look like and offers a language to create it. NetScript is a programming language in which control statements are embedded. It is designed to be easily and directly interpreted by the probes. NetScript primitive operations will allow scripts to originate, monitor and respond to network traffic.

The lower level operation is governed by one or more of these scripts which the probe executes. Scripts may be simple analogues to existing network test programs, such as "ping" or they may be more complex. A script could periodically interact with various network devices to determine their status. If conditions were outside some limit, the script would guide the probe through a sequence of actions to bring network operation back to normal. Multiple scripts may be run simultaneously and could be downloaded from control consoles or used from a local library stored on the probe.

For example, consider a script to check whether a network file server is being subjected to an excessive burden. This can be expressed as a script. The script could add a server, remove a client and remeasure the results to insure they are acceptable.

Another example would be a script that could monitor a host to detect when it is the target of a connection attempt from some other host. The probe could then take action to prevent the consummation of the connection attempt or to break such a connection if it succeeds in being established.

Network Configuration Database

Each probe will be able to construct a local network configuration database. The local database reflects

the network population and topology from the point of view of a particular probe. NetScripts running on that probe are able to reference the local database and insert information into the database. Probes can detect configuration changes by noting changes to the database. Control and command consoles may consolidate the databases from numerous probes to form an overall view of the network topology and its population. The databases may then be used to generate configuration files for the individual network devices. User tools on both the probes and the control consoles permit operators to make inquiries of the database and to make changes to it.

Presentation Hardware

The minimum system requirements for Empirical's products utilizes readily available equipment that is inexpensive to purchase and to allocate for network analyses.

Minimum System Requirements

- Operates on a portable or stationary standard Intel-based IBM PC or compatible. 80386/16MHz or faster system is recommended for satisfactory response
- 640K RAM
- 1MB hard disk space
- Supports standard internal/external Ethernet adapters through readily available packet drivers
- Display adapters supported
 - Color VGA
 - Monochrome VGA
 - Standard Monochrome

Additional System Recommendations

- Mouse support
- Color monitor

Operating System Requirements

- Supports MS-DOS v5.0

Evolution of Network Management

The evolution of network management presents several steps that are essential to attain the type of real, useful tools needed by network managers and integrators.

Step 1 - Extend local, human-agent operated control over a LAN by developing portable tools at the bottom of the hierarchy that probe the network and manipulate devices. Familiar tools, such as ping, traceroute, SNMP, and ICMP, are used to make inquiries and

manipulate the network.

Step 2 - Make these devices resident on the network as local agents. NetScript programs may be conveyed either in-band, on the network itself, or out-of-band (e.g., dial-up telephone). This is the first step toward homeostatic networking - creating pseudo-intelligent entities that can change local conditions and report the results via FAX, modem, e-mail or pager.

Step 3 - Develop multiple levels of network delegation that create an authoritative network hierarchy. This, coupled with the simultaneous creation of an easy-to-use user interface that automates these network tools, makes them accessible to less experienced, technical personnel at an easily affordable level.

Summary

Empirical's philosophy is based on a belief that it is impossible to build effective tools without extensive,

practical testing of ideas on real-life networks. Consequently, Empirical is an active participant in the Internet community, the IETF, the Interop network and the TCP/IP Bake-off. Empirical also continues to have its products tested by leading network authorities worldwide.

Empirical recognizes that no single tool is adequate for all needs. Empirical intends to build strong links between its own products and other specialized tools and general purpose management systems. This will allow Empirical's substantial tools to complement and work in conjunction with tools already in use.

Finally, Empirical intends to support all major network protocols including TCP/IP, Novell's IPX, SNMP, DECnet and NFS, just to name a few.

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