

Network Management Resource Costs

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INTRODUCTION

The reliance on computer communications networks for business and commerce, education, entertainment and many other applications demands these resources are managed effectively. In this context, “management” refers to ensuring security and performance, recovering from faults and accounting for utilisation. Each of these activities requires knowledge of the network configuration, and information about the networked devices. It is on the basis of this knowledge that management decisions to change the configuration and network behaviour are taken. Hence the manager requires as full and accurate a set of information about the network under their control as it is possible to get. Typically, this information resides across the network and is transferred (to the network manager) to assist the network manager’s decision making.

Therefore, network management creates network traffic and consumes network resources, as information is collected, transferred, and processed, and commands move to their required destinations. Because a typical computer network uses the same network facilities, data links, processors, network interfaces, switch, and router storage as ordinary user data, the management process must be efficient. Resources consumed by network management activity: bandwidth, processor time, and data storage space are not available to “real” network users and hence have a direct impact on the level of service experienced by users. Historically, this has meant network management designs being constrained to a greater or lesser extent by their resource consumption, and one development aim is often to deliver an effective network management service with as little resource consumption as possible. Indeed, proponents of particular network management paradigms, particularly the first version of the *de facto* standard Simple Network Management Protocol (SNMPv1) (Case, Fedor, Schoffstall, & Davin, 1990), made much of the minimal resource demands of their design. More recently, other network management proposals often

use SNMPv1 as a benchmark for comparative resource consumption.

It is therefore appropriate to consider the resource impacts of different network management paradigms to gauge likely effects on networks they manage. In this chapter, we identify the characteristics of various network management systems, describe how the ways in which these tools are used by a network manager generate work (traffic and processing loads) for the network, consider appropriate ways to measure their behaviour, and discuss performance data.

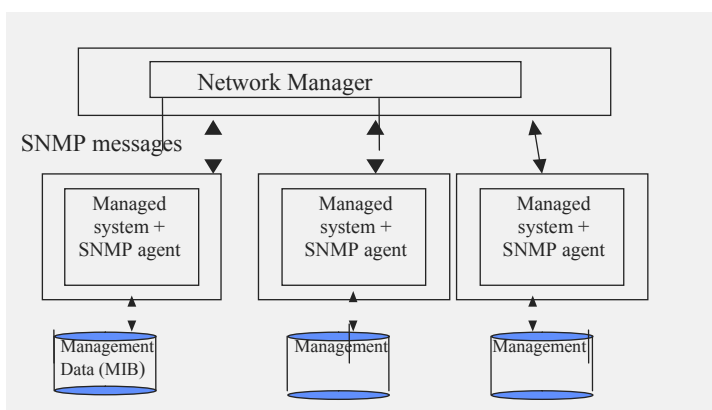
NETWORK MANAGEMENT: AN OVERVIEW

The history of network management in the form discussed here starts in the late 1970s, with standard protocols to monitor network devices, first gateway devices and later network host systems and interconnection devices. It is important to realise that in typical computer communications networks (e.g., a TCP/IP based system), the same physical network carries both user and management data. This differs from the telecommunications approach of a separate “management network.” Hence, in computer networks, managers and users share and compete for bandwidth, processing, and storage capacity.

Client-Server Based Network Management

In its simplest, in a deployment model exemplified by SNMPv1, a single, central network management platform receives information from network devices by “agent” programs resident on the devices in response to management platform requests. The data are then collated and presented to the (human) network manager (Figure 1). This simple client-server, single point of concentration approach creates a single point of failure or loading, since more management data are generated

Figure 1. SNMP in a centralised system



in emergencies, possibly making the original problem even worse.

The Search for Alternatives

Concerns over data volume and concentration have led researchers to explore alternatives. In particular, addressing the problem of the quantity of data transferred created improvements in the effective payload of SNMP, version 2's bulk transfer operation among the most significant. Other proposals reduced the volume of data by *preprocessing*, introducing a hierarchy of managers so the required data need not travel so far with decisions taken nearer the point of impact.

More Resource-Intensive Management Support

With increases in processing and communication capability, network management approaches are less driven by resource conservation. Version 3 of SNMP (Frye, Levi, Routhier, & Wijnen, 2003) is a good example. The imperative for security in the network management function means strong authentication and encryption have become part of the protocol. Clearly, the added processing and data transfer increases the resource requirements, as will be discussed later in this article. Finally, the 2004 announcement (Pras et al., 2004) that SNMP-based network management is likely to be superseded by systems based on XML further increases the processing and bandwidth requirements of network management.

Device Capability

Resources consumed by network management are not available for users; therefore, designers have attempted to minimise network management's impact. For example, deploying SNMP agents across network devices (workstations, servers, printers, etc.) makes it desirable to keep management functions simple. Arguably, developments in processor power make this less significant with the extra power available even in "basic" components allowing more complex functions. Running counter to this is the drive for greater network management support deployed to ever more devices and the wish to have mobile devices in a network. The fact that these devices often have limited (battery) power makes simplicity and resource efficiency desirable goals. A further driver is the wish to limit power consumption on mains-powered networking devices, since keeping devices "on" solely for network management is inefficient. These issues and the development of so-called power saving network management architectures are outside the scope of this article, though we are currently pursuing research in that area.

PERFORMANCE ISSUES

Our discussion of measuring performance begins with a definition of the performance parameters used. Standard measures of a communications system's performance are speed (the rate at which it carries information) and accuracy (the proportion of errors

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