

## CONFIGURATION MANAGEMENT USING THE DIRECTORY SERVICES

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## Introduction

The rapid and widespread use of computer networking has highlighted the importance of research and development in the area of network management. While a lot of work has been in the areas of performance and fault management, the other areas, viz., configuration, security and accounting management are yet to be fully explored. In this work, we examine the area of configuration management.

## Requirements for Configuration Management

As in the case of any management there are two aspects of network configuration management. The first one is more like monitoring wherein information about the current network configuration is gathered using some network management framework. The framework may involve a manager-agent setup where the manager on a management station talks to an agent on the managed network element using a network management protocol (SNMP/CMIP) to obtain relevant information.

The second and more important aspect of management involves using the information in conjunction with knowledge about the network in particular and networking in general to judge the status of the network i.e. to decide whether the status is OK or not; whether it requires attention or not etc. Furthermore, if a problem is detected, then knowledge if available could be used to rectify or bypass problems or atleast suggest an alternative. In the case of configuration management a large part of the knowledge is contained in the network map - the physical map depicting the physical connections of networks, gateways/routers and nodes. For example, if a link has been severed, on obtaining this information the manager application can decide the impact of the problem and suggest alternate paths if any by looking at the network map. Not only that, it may recommend the optimal path from amongst several alternatives available by considering the various attributes ( properties: speed, cost, average traffic, .. ) of the alternate paths.

Presently, the services of a network map are not available for network management in a global context. Several applications do rely on network configuration related information- but these have been provided on piecemeal basis. A very popular example is the DNS service which is widely used to map domain names to network-addresses and provides some sort of an indexing mechanism.

Most of the existing management systems have concen-

trated on the first aspect i.e. on obtaining the logical picture of the network as seen by the communication elements on the network. The rest is left to the human network manager who is expected to use his/her expertise/knowhow to do the necessary. However, in more advanced intelligent systems a part of the configuration related management may be automated.

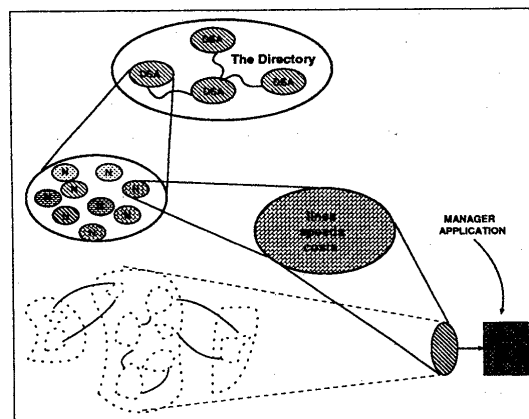
## The Network Map and its nature

It is clear that for configuration management, we need a detailed map of the network which shows all the lines, network elements and the respective properties. The minimal scope of the map will be that which is intended to be covered by the management. If the network management in the global context is the target then the map of the global internet should be available. However building and maintaining the map of the global network is very difficult as:

1. The Network configuration is quasi-static. Nodes, links and networks are being added, updated and deleted someplace or the other.
2. The Network is huge and geographically distributed.
3. The network spans several political and administrative areas. The related information is also controlled and maintained in a distributed fashion.

In short, global network configuration information is unwieldy and growing continuously. It is impossible to service such information in a centralized fashion. The X.500 directory service is just appropriate for such applications.

## The Directory Services



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The Directory is intended to be a very large and highly distributed database. It is structured hierarchically with entries arranged in the form of a tree in which each object corresponds to a node or an entry. Information is stored about an object as a set of attributes. The X.500 directory model comprises of

1. A set of DSAs ( Directory Service Agents)
2. A Directory Information Database which is distributed and replicated among the DSAs.

Users and applications access the Directory through the DUA ( Directory User Agent ) which in turn accesses the DIB by communicating with one or more DSAs.

### Network Configuration Management

The availability of the network map opens up a whole new set of possibilities in configuration management.

#### Provide and Display Configuration information

Information about the network configuration can be made available to the network manager in a graphical form, with additional information about the status of the nodes in the network.

#### Check for correctness/optimalilty of logical configuration

The logical configuration is examined in the context of the network map to detect non-optimality in the routing. Non optimality would involve using a *longer, slower, more expensive* route. An incorrect route path would be one that is non-optimal or that does not lead to the destination.

#### Avoid congestion/ congested paths

The Network map is referenced to find alternative routes in case congestion is detected in some segment of the network. Also, chronic congestion may be avoided by distributing the traffic amongst more routes, if available. In case existing routes are not available then addition of capacity is called for.

#### Detect Bottlenecks

In case one or more than network links converge on a lower capacity link or node a bottle-neck is formed and potential exists for congestion. For such studies the network map is very useful.

#### Find alternate paths

In case the a link in the network is broken. The network map is referenced to find an alternate link which bypasses the problem area.

#### Risk analysis

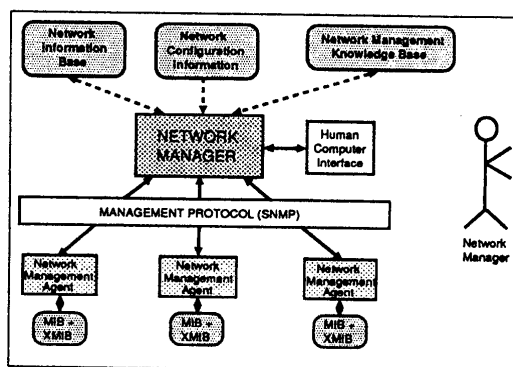
The fault-tolerance of a network is measured in terms of the available alternate links. If the fault-tolerance is low the risk is high. The network map contains the necessary information to carry out such risk-analysis studies.

#### Detect abnormalities in the network

Abnormalities [the severance of a link or the breakdown of a gateway] may be detected by referring to the network map. The routing table of the local gateway is monitored

periodically for changes. If there are any new additions, checks are performed to verify if the route is correct and optimal. If there are deletions, by referring to the network map an intelligent guess can be made about the location of the fault. Apart from the management related activities listed above there are some management related information services that can be provided

1. the location of service providers ( anonymous ftp-servers, archie-servers, WAIS-servers, DNS-servers .. )
2. The charges/costs of communication from one host to another. The *cost* may be computed according to a specified *cost model* which uses parameters like speed, charges, average traffic, number of hops, ..
3. The location of the *cheapest* server.
4. The routing policy related info of intermediate gateways/routers



### Current Status and Future Plans

The system has been designed. The network configuration information for the local backbone networks have been made available. The Manager applications are currently under development.

### References

- [1] Recommendations X.500-X.521: CCITT Blue Book Data Communication Networks Directory
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- [3] G.Mansfield et.al. "An SNMP-based Expert Network Management System", to be published, IEICE Transactions, August, 1992.