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## A three-dimensional evaluation model for network management system

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### Abstract

The growing of network applications and the advances in network services demand for more complex and flexible network management systems. It becomes difficult to evaluate the performance of such a system using the traditional, simple and arbitrary evaluation methods especially when the system is designed for a specific purpose. Systematic evaluation models should be built to evaluate if a system meets the specified requirements while does not sacrifice much of the network performance. In this paper, we propose a three-dimensional evaluation model for network management system which takes cost, impact, as well as operation into consideration at the same time. We define evaluation index as a performance indicator, which is detailed elaboration for the proposed model. We believe that the three-dimensional evaluation for network evaluation can be better suited in nowadays network environment.

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*Keywords:* network management, evaluation model, index

### 1. Introduction

The widespread network applications and network services bring a new challenge to network management along with the convenience they provided. Networks become wider and more interconnected, and each network application and service also becomes more complex. Many people take advantage of network service to publicize unhealthy or even harmful information, leading to serious consequences to the society. Thus network management becomes one of the most important concerns of the network in enabling the provision of appropriate network services. However, the workload of the network management systems becomes heavy in such a complex network environment because of the need to execute many management tasks or manage a large number of network equipment[1,2]. Along with it, network management system evaluation becomes a complicated task.

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Network service users start to request healthier network environment and timely responses while prefer to keep the network performances uncompromised. It requires the network management system to provide a variety of management functions without visibly sacrifice any network performance. On the other hand, the application of network management system may lead to unintended outcome of the network[3,4]. For example, the management system may accidentally block normal services when trying to stop the abnormal ones or misidentify a normal user to be a malicious one. Another practical issue, which is also the precondition and guarantee of the deployment of a network management system, is the system deployment cost. The advantages and disadvantages of a network management system should both be fully considered during an evaluation. The future network management system evaluation models are required to be more flexible, expansible and systematic than offered by the existing evaluation methods[5].

In this paper, we propose a three-dimensional evaluation model for network management system which takes cost, impact, as well as operation evaluation into consideration at the same time. As a detailed elaboration for the proposed model, we define an evaluation index which is based on the proposed evaluation index architecture. The rest of the paper is structured as follows: Section 2 describes the three-dimensional evaluation model for network management system; Section 3 presents a prototype of the evaluation index architecture and Section 4 summarizes the contribution of the paper.

## 2. Three-dimensional evaluation model

Based on the requirements of network management, we aim to develop an evaluation model that is flexible, extendible and systematic. he model should evaluate the network environment in multiple dimensions, multiple levels and many side factors. We first describe the process of network management system evaluation and then discuss the proposed three-dimensional evaluation model.

### 2.1. The process of network management system evaluation

On the whole, the purpose and goal of network management system evaluation is to evaluate whether the system meets the management requirements of the network, whether the system should be deployed and gives suggestion about how to deploy such a system.

The process of a network management system evaluation can be summarized as follows: Firstly, the characteristics and performance of the network are formally described and analyzed. Secondly, based on the specified network requirements, clear and specific network management goals are proposed for assessment of the network management system. Thirdly, simulation or application evaluation method can be used to evaluate the reliability, function and performance of the network, as well as the impact on network environment and network entities caused by the deployment of the system. Finally, by summarizing and comparing the advantages and disadvantages, as well as considering the estimated cost of the deployment of the management system, a conclusion is drawn on whether such a system should be deployed, and if it should, suggestions and guidance of the deployment process are provided.

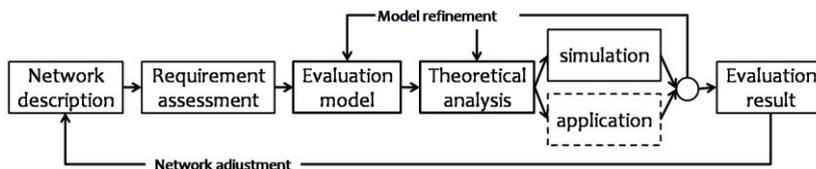


Fig. 1. The process of a network management system evaluation

## 2.2. Three-dimensional evaluation model

Based on the requirements of network management, we aim to develop an evaluation model that holds flexible, extendible and systematic characteristics. The 3-dimensional evaluation model we propose takes multiple dimensions, multiple levels and many side factors into consideration, and emphasizes the cost evaluation and impact evaluation compared with currently existing methods.

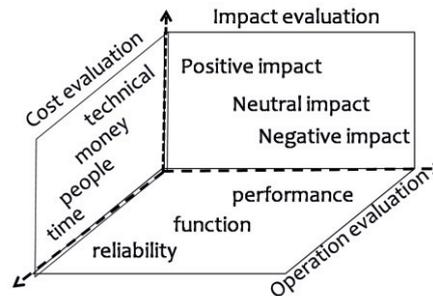


Fig. 2. Three dimensional evaluation model

Figure 2 shows the three dimensions of network management evaluation: cost, impact and operation. Each dimension consists of multi-level index layers which will be explained in the next section. Each dimensional factor is independent of the other two and changes in one dimension will not have any effect on the others. However, they are connected in a systematic way that an overall evaluation can only be made based on all of the three dimensions. The 3-dimensional evaluation reaches conclusion about whether and how the system should be deployed. The evaluation contexts of each dimension are described as follows:

- Cost evaluation factors: human resource, time cost, capital resource, technical cost and other resources of system deployment and maintenance.
- Impact evaluation factors: the positive impact, negative impact and neutral impact on network service and users after system deployment.
- Operation evaluation factors: system reliability, function and performance evaluation. Reliability evaluates the likelihood that the system is under normal operation, function evaluation places emphasis on the functions the system provides in normal operation, and performance evaluation refers to the efficiency of the system functions.

## 3. Three-dimensional evaluation index architecture

The evaluation index architecture consists of three dimensions: cost, impact and operation. Cost reflects the cost required in order for the network management system to be deployed plus the cost to meet the management goals. The cost includes technical cost and non-technical cost. Technical cost refers to network bandwidth, computing and network address, etc. Non-technical cost means human resource, time cost, etc. Impact evaluation assesses the impact of the deployment of network management system from the perspective of user, service and network domain. Operation evaluation aims to assess the usability and validity of the network management system. In other words, it assesses when there is a need of network management, whether the system can implement policies in time and handle them properly. There are three aspects of operation evaluation, namely: reliability, function and performance. We provide the detailed definition and components of each main evaluation dimension below.

3.1. Cost evaluation factors:

- Technical cost:
  - ◆ Bandwidth cost: the bandwidth that the system needs when in operation.
  - ◆ Computing cost: the computing resources needed when the system is in operation, for example, computer, server, etc.
  - ◆ Address cost: the system equipment deployment location and IP resources needed.
- Non-technical cost: the human resource, time, and capital needed.

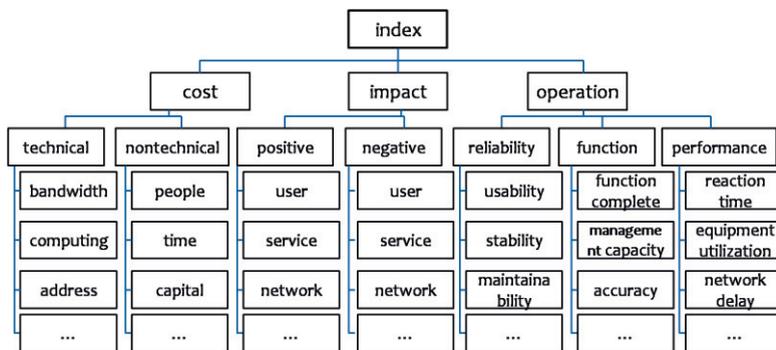


Fig. 3. Three dimensional evaluation index architecture

3.2. Impact evaluation factors:

- Positive impact evaluation:
  - ◆ Healthy service ratio: it can be represented by the ratio of healthy services over available services that a user can access.
- Negative impact evaluation:
  - ◆ Service not accessible rate: service not accessible rate represents the probability that a user requests a service and is unable to access it.

3.3. Operation evaluation factors:

- Reliability
  - ◆ Usability: Usability refers to the property that network information can be accessed and used by authorized entities. More precisely, usability means network service can be accessed and used by authorized users or entities when requested, even when the network is partially not available or downgraded.
  - ◆ Stability: Stability means when in the situation of network environment change, e.g., a sharp rise in network flow, the ability of the network monitor equipment to continue providing proper service.
  - ◆ Maintainability: Maintainability can be measured by error maintainability and demand change maintainability. Error maintainability is the amount of work that is needed to fix when there is

- system error; demand change maintainability is in case of demand change or system transplantation, the amount of work needed for the system to operate properly.
- Function evaluation
    - ◆ Function complete rate: function complete rate refers to the system management function complete rate for the supported network management functions. It considers what functions can be completed and what cannot be completed by the system. There are two reference functions: standard network management functions, which include the network configuration management, performance management, accounting management and security management, etc.; and special system functions, which are based on the special network management system.
    - ◆ Management capacity: management capacity refers to the number of systems or equipment that the network management system can support. This index reflects the management capacity of the network management system.
    - ◆ Accuracy: accuracy is the degree of closeness between test result and real situation, and can be measured by the false alarm rate. False alarm includes false alarm about user, service and process.
  - Performance evaluation
    - ◆ Reaction time: reaction time refers to the time that the system receives a network alarm, to formulating and selecting a management policy, and finally carrying out the action defined in the policy correctly. This index reflects the degree to which the system can meet the requirements of the special network management system.
    - ◆ Equipment utilization ratio: system equipment utilization ratio refers the usage of CPU, memory, and network interface card of the dedicated network management system equipment in a unit time. The index indicates the utilization.
    - ◆ Network delay: network delay refers to the delay caused by the deployment of network management system which includes the system classification network and network monitor equipment. The system classification network classifies network flow based on different user classification rules and service classification rules. Both the system classification network and the network monitor equipment can cause the network transmission to slow down.

#### 4. Conclusion

This paper proposes a 3-dimensional model for evaluating network management systems. Combined with the concept of cost evaluation and impact evaluation, the model gives a collective evaluation on the network management system, which can provide a different opinion of whether such system should be deployed and how. Based on the model, a 3-dimensional evaluation index architecture is built to elaborate the details of the evaluation model. The proposed model can evaluate the network management system more comprehensively and effectively

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