

Policy Refinement for Traffic Management in Home Area Network – Problem Statement

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Abstract

Traditional home area network equipment is usually unmanaged and network traffic is served in best effort fashion. The unmanaged network and conventional network traffic flows style sometimes cause many the quality-of-service issues in home area network (HAN). Traffic management rules can be employed in HAN through the policies to prioritise traffic and assign bandwidth limits to different traffic types according to HAN user requirements. However very little work has been done yet on the subject of how these requirements would be communicated to the gateway device by using the policies and how the policies would be refined into device level configurations to accomplish the user requirements. In this paper we briefly discuss our research problem, the research goals and our initial research methodology in the area of policy refinement for policy-based traffic management in home area networks.

Keywords: Policy, Policy-based traffic management, Policy refinement, Home area network, Autonomic networks.

1 Problem Statement

In a traditional home area network (HAN), there can be several types of network traffic e.g. VoIP, audio & video on demand, web and many more. Usually the HAN traffic works in best effort fashion and quality-of-service (QoS) is not guaranteed. The quality can deteriorate when a bursty traffic e.g. UDP based download or upload, tries to consume maximum of the available bandwidth, which can cause bandwidth unavailability for other traffic types. This leads the network into a state of congestion, which chocks other traffic flows and results in poor quality of network applications. Mostly the solution to resolve congestion issue is considered in getting more bandwidth for the network but logically it just alleviates the issue temporarily but doesn't provide any long lasting remedy for better traffic management. By adding more bandwidth, greedy network applications would attempt to consume more of the bandwidth and chances of congestion would always remain there. Every network application has its own set of requirements and having extra bandwidth might give an edge to bursty traffic but it doesn't always work for all other traffic types. Increasing the bandwidth doesn't always improve the quality of VoIP if a competitor bursty traffic also exists along the network path. In HAN most of the user generated traffic has equal priority with no bandwidth constraints that means the packets would be queued on the gateway device in a first-in first-out (FIFO) queue (depending on default configuration). When two UDP traffic (VoIP and Streaming) of equal priority compete for bandwidth, their quality can suffer because of varying bandwidth availability, which can result in great packet loss and unwanted packet delays. We know that policies can be used to manage QoS requirements, therefore by separating the VoIP and streaming traffic into two different priority queues with optimal flow rate can drastically improve the quality both traffic.

Policy-based traffic management (PBTM) provides a flexible and robust mechanism to allocate bandwidth and to prioritise the network traffic. It is a better approach to accomplish HAN user requirements and to manage the network traffic accordingly. The best advantage of using PBTM is that policies can be changed at run time without affecting underneath working model. It means traffic management policies can be changed dynamically and it is the very basic need in managing the HAN traffic because user requirements can change time to time. To cater the issue, autonomic policy refinement can play a very important role in establishing a policy-based traffic management system on residential gateway device. The quality of network traffic is measured in terms of QoS parameters -i.e. packet loss and delay, our research questions are:

- (1) How the QoS requirements for a traffic flow or aggregate would be communicated to the gateway device using policies?
- (2) How a comprehensive policy can be devised from the user requirement and then refined into configuration rules, which also contains desired QoS settings?

2 State of the Art

Extensive significant work has been done to manage QoS requirements in access and core networks using policy-based network management (PBNM). Different architectures are proposed in [2] for the control plane of a software router that integrates signalling protocols and control mechanisms for QoS and in [3] using PBNM. The paper [2] claims that the use of proposed architecture can meet the end-to-end QoS requirements for most the internet applications if applied on the access network routers. Traditional PBNM systems focus on the management of core networks and the internet in the broader sense. The access and the core networks use policies to meet service level agreements (SLAs) for different service users. However the concept of end-to-end QoS in the big picture would remain in a status-quo if QoS is not ensured at the edge networks. PBNM can play a significant role in managing home networks focusing on users' requirements. We purpose an intelligent gateway device to control and manage all outgoing and incoming traffic. The device can be configured according to user requirements through a policy manager; it would make HAN users' life much easier. The paper [4] proposes similar solution but it focuses more on intelligent control centre (ICC) to connect all other networks with in HAN e.g. power line network, PC network, wireless network, home automation network, and home gateway.

Policy refinement is an essential part of policy authoring but still it is a largely overlooked research domain. Some of the significant work has been discussed in [5] but most of the models used for policy refinement are not suitable for autonomic traffic management in HAN. Some of the common issues with policy refinement techniques are listed here:

- The human operator must have deep understanding of both the business level policy and domain specific knowledge such as security or network QoS;
- It is hard to check the accuracy and consistency of transformation carried out by the human operator;
- A policy author can only construct a policy by using accurate syntax in addition to having precise semantics;
- The human input must be compiled and interpreted to produce an output which is domain specific;
- There is no specific approach defined yet for autonomic policy creation and refinement from user requirements.

3 Goal Statement

The goal of our research is to provide solutions to HAN users to manage their networks effectively without any hassle. And at the core, the research objective is to define efficient, robust and cost-effective autonomic policy refinement algorithms and policy-based traffic engineering techniques for quality of service user requirements in home area network and to prioritise different types of HAN traffic according to HAN user needs. We have simulated HAN in our research lab, and our research experiments testbed has used the settings and configurations as discussed in research artefacts. We have successfully executed the experiments to observe the affect of policies in managing the home area network traffic and our next step is to use a formal policy refinement model to define policies from the user requirements.

4 Research Artefacts

Figure 1 shows the role of policy-based network management in HAN. The residential gateway device or the router is policy execution point to manage different types of traffic according to HAN user requirements. Policy decision point (PDP) fetches the required policies from the repository and through policies are executed and refined into configurations on the policy execution point (PEP). Policies can be managed through the management console.

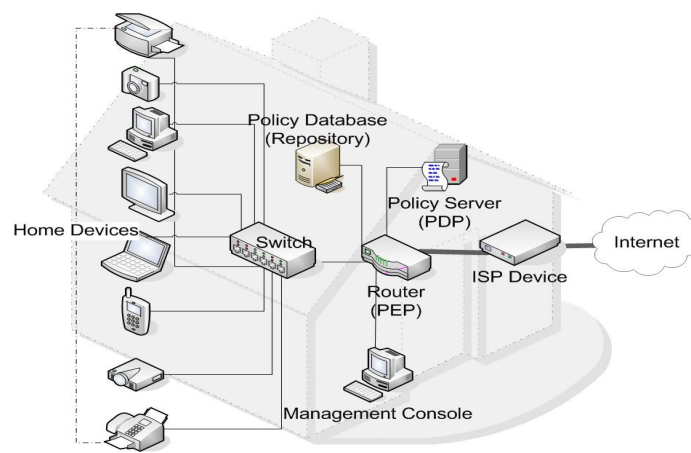


Figure 1: PBTM in HAN.

4.1 Equipment and Applications

We are using a Linux machine with Ubuntu Linux distribution as a gateway (software router) for HAN. We have used traffic control (TC) application for setting up filters and queues on the router for network different traffic using shell scripts. IPTables package is used for defining NATing, routing and prioritisation rules using shell scripts, and TCPDump for packet and queues analysis using a perl script. This is our initial work for our project; it was to setup a test environment for our future research work. However, this testbed would be further refined and built to the next level for the future research requirements. The interesting aspects of the testbed that we would be looking at in HAN traffic management are:

1. Use of policy continuum [6]
2. Formal policy specification language
3. Use of autonomic policy refinement techniques [1]
4. Building traffic management tool for HAN users

5 Methodology

We are using a combination of methods used in ontological and epistemological research. Ontological modelling will be used as a methodology to more rigorously define key concepts and variables in policy refinement theory. The ontology-based formalization will allow a gradual transformation from a simple vocabulary of the fields to a formal model of policy refinement using information models and ontologies. Thus in first instance, ontology of the policy refinement will be developed, possibly reusing existing work of FOCALÉ and DEN-ng [1]. The empirical study of the policy refinement will be undertaken by a spectrum of well-known data gathering and validation methods. To analyse real home area network, we have setup a testbed and analysed the impact of policy on different network traffic. We might also use a set of initial theories to model and test policy refinement techniques for bandwidth allocation and traffic priority settings. The results of the experiments may then be compared to the empirical results for validation with other techniques. Decision about policy language and policy model has not been made yet and all possibilities will be considered as research progresses.

6 Conclusion

We have presented the key challenges being addressed in our research and outlined the major elements of ongoing research work in a number of inter-related network management fields that are relevant to policy-based traffic management, quality of service and policy refinement. The primary research methodology is an experimental one, potentially using elements of actual deployments of policy-based traffic management system that can be tested with real network traffic.

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