Adaptive Fuzzy Controller for Energy Conservation

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INTRODUCTION

Energy Conservation is an important topic in telecommunication networks. Different power saving mechanisms have been proposed for the idle or under-utilized links such as Dynamic Voltage Scaling (DVS), Dynamic Ethernet Link Shutdown (DELS), and slowing clocks. In this paper, we present a fuzzy sleeping method that works based on the traffic estimation technique and can be applied for those flows which are not delay sensitive.

PROBLEM STATEMENT

Generally, there are three states for the link or any interface: awake, asleep, and transition between them. By combining the mini-idle time slots, a larger idle interval can be obtained in which the link can transit to the sleeping mode or prolong its previous sleeping state.

THE STRUCTURE OF THE ADAPTIVE FUZZY CONTROLLER

The output of the fuzzy controller is a combined variable to dynamically change the status of the link, which is called the sleeping index. The fuzzy controller consists of two inputs, buffer occupancy and the estimated data rate. There are several traffic rate estimators such as Exponentially Weighed Moving Average (EWMA) filters which can recursively predict the incoming traffic rate. Also, there is a buffer to temporarily store the incoming packets when the link goes to the sleeping mode.

There are three membership functions for each input. The linguistic terms related to the buffer occupancy are light, medium, and full corresponding to the queue length that has occupied the buffer capacity. The estimated data rate is described by three expressions: low, medium, and fast, proportional to the speed of the incoming traffic. The Two linguistic variables assigned to the output are asleep and awake to determine the next status of the link.

A set of "If-Then" rule is used to derive a consequence similar to the human reasoning process, as shown in Table 1. Then, the inputs are combined based on the well-known Mamdani model to produce the values for the output. The standard Centroid method is applied to calculate a crisp output value according to the defined membership functions. The fuzzy surface viewer for the output is derived from Matlab by using fuzzy logic toolbox.

Table 1: The fuzzy conditional rules

Estimated Traffic Rate \ Buffer Occupancy	Light	Medium	Full
Low	asleep	asleep	awake
Medium	asleep	awake	awake
Fast	awake	awake	awake

Accordingly, the sleeping index is adaptively configured based on the different combinations of the inputs.

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