

# A Proposal and Survey for Energy Efficient FiWi Network via Rate Adaptation

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**ABSTRACT:** Energy consumption due to Internet access is increasing drastically in recent decade. As the numbers of users are increasing day by day, focus on reduction in energy consumption of various networks is an essential part of network challenges. Most of the energy saving mechanisms can reduce the energy consumption of the networks only during its idle state, i.e. when there is no traffic or lowest traffic conditions are there. However, energy consumption of the network during traffic processing is addressed by very few researchers. Therefore we try to reduce the energy consumption of the network during its active state. We find link rate adaptation schemes suitable for reduction in energy consumption when network equipment or switches are in active state.

**KEYWORDS:** Rate Adaptation; Energy Saving; FiWi Network

## I. INTRODUCTION

In this paper we propose to apply a rate adaptation scheme in FiWi access network that is a combination of wireless front end and optical back end network. FiWi access networks have an advantage of high bandwidth of optical network as well as the ubiquity of the wireless network. Architecture of a FiWi network is shown in fig 1[1]. Energy saving is achieved via PSM in wireless sub-networks [2]. Optical sub-network uses ONU sleep mechanism for energy saving in idle state [2]. In this paper we are going to apply a rate adaptation method during transmission of downstream data, so that overall link rate would be optimal.

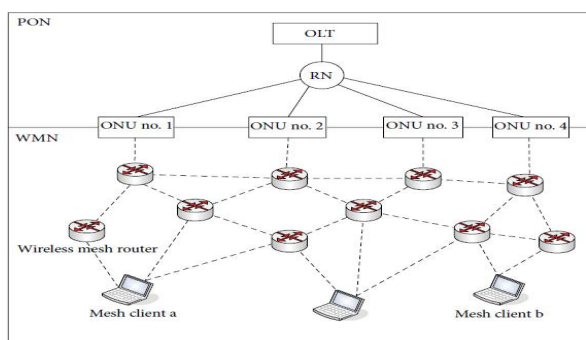


Fig. 1 Architecture of FiWi

In a FiWi access network the front end sub-network may be combination of WiFi and Wi-max or smiley it is a WLAN network. User ends also referred as STA are associated with APs. The optical access network, PON uses the various enabling technologies like TDM-PON, WDM-PON or the hybrid PON (combination of TDM-WDM-PON) the OLT is directly connected to the core Internet network and performs all the controlling functionalities, hence also referred as centre office [3]. Various ONU are connected with single OLT through the distributed optical fiber links. ONU are the interface between both the sun-networks. ONU performs the protocol translation for the sub-networks.

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All most all the power saving mechanism try to save the energy consumption via sleeping the network equipments or LAN switches. User end devices are kept in standby mode during its idle state for energy saving. Generally lower data rate link consumes less power as compared to higher data rate link. Adaptive link rate mechanisms try to lower the link rate according to traffic arrival conditions. An end to end dedicated link can work on various data rated with non-uniform data arrival pattern, hence optimal data rate for a specific link can be selected. For example Ethernet links for internet access are available with various data rate varying from 10Mbps to 10Gbps. This wired link may be a copper wire or optical fiber link. In general this links reduces their data rated during idle time. In this example the least power is consumed by 10Mbs link that is also depend on which Network Interface Card (NIC) is installed. Similarly high data rate link in wireless system also affect the power consumption of switches and end user devices [4].

## II. RELATED WORK

In [4] an approach titled as “scaling of link and switch speed” is defined for management of energy consumption in IT equipments, the author also proposed an algorithm for scaling the Ethernet link data rate. He had taken link rate as a function of queue length or buffer size. He considered the queue length or buffer size of both the PCs and LAN switches. The simulation result of the above algorithm shows that it efficiently reduces the energy consumption of a link or switch without degrading the performance of the network or without involvement of additional delay. A Rapid PHY Selection (RPS) mechanism is proposed in [5] to switch between various link rates, again the performance is not degrading by the above selection mechanism. In paper [5] a hybrid mechanism that combines sleeping and rate adaptation for 10G-EPON is proposed. Here they considered two link rates for downstream data transmission as 1Gbps and 10 Gbps and link rate is switched between these two rates on the basis of downstream bandwidth. Paper [6] talked about reduction of energy consumption of a network via sleeping and rate adaptation, they considered Abilene and Intel network topologies for test case. They also consider a frequency scaling and voltage scaling at hardware primitives for rate adaptation. In this paper we will only considering the rate adaptation mechanism because energy saving via seeping is already optimal scheme for idle state.

## III. PROPOSED WORK

The paper proposes rate adaptive mechanism for the back-end of the network, while at the front end traditional power saving mechanism may be used to achieve energy efficiency.

### A. At Back End:

Major part of energy consumption in a FiWi access network is due to downstream data flow that is from OLT to ONU. EPON is the backend network of FiWi access network; hence in the active state of the ONU, let us adapt the lower data rate link if traffic is low at the link. EPON consist of an OLT that serves various ONUs and based on TDMA. Fiber optical link between OLT to ONU is called distributed fiber link. An Asymmetric 10G-EPON system is shown in fig. 2 and let a coexist 1G-EPON is also considered with it. Now two downstream data rates links 10Gbps and 1Gbps are available with 1Gbps upstream link is available as shown in Fig.3 [7]. Here OLT monitors the downstream data for each ONU and request accordingly to switch the data rates. Let switching request is completely based on the downstream bandwidth. Let a downstream bandwidth  $B$  is considered as threshold bandwidth. If downstream data is above the threshold bandwidth then the link is switched to high data rate link otherwise it operates at low data rate link.

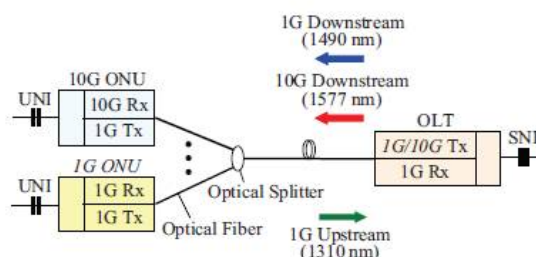


Fig. 2 Asymmetric 10G-EPON[7]

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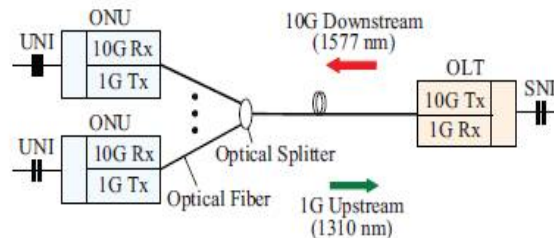


Fig. 3 coexistence of 1G-EPON Asymmetric 10G-EPON [7]

## B. At Front End:

In the front part of FI-WI network, energy saving is supposed to be achieved by standard PSM [2]. This allows default power managementscheme, calledPower Save Mode (PSM), which allows an802.11 station to sleep for most of the time and only wake upperiodically to receive the packets buffered at the Access Point(AP). There are different variants of PSM are also available in the literature. Any of these modes may be used in front-end to achieve power saving in FI-WI network.

## C. Discussion:

The data rate of a link affects the energy consumption of almost all type of networks whether it is a wired Ethernet or a wireless end to end link. The link rate in processor is also can be considered in this range. The link rate adaptation is a prominent mechanism for energy efficiency during active state of various type of network equipment. Rate adaptation is based on traffic arrival pattern hence performance and QoS cannot be degraded. Simulation of some related work on the rate adaptation mechanism proved that the delay due to lowering the data rates is tolerable by applying some delay constraint. EPON can switch between two available data rates and can achieve effective power saving. If we analyze the overall FiWi network then it can reduce the energy via PSM at front end, via sleeping and rate adaptation in back end. Therefore, the proposed framework is applicable to FI-WI network. Rate adaption can also allow us to use a frequency and dynamic voltage scaling that can reduces the operating voltage. Both the scaling methods are common in microprocessors.

## IV. CONCLUSION AND FUTURE WORK

Rate adaptation schemes are useful in all types of networks those are using the point to point links. It may be applicable on Broadband access network, WLANs, PONs or in any kind of hybrid networks like FiWi access networks. They reduce the effective active state power consumption; hence can be efficiently combines with sleeping mechanisms. It is expected that this mechanism may bring substantial reduction in energy consumption of FiWi network also.

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