INVENTION DISCLOSURE

1. **Invention Title.**

Multi-Domain Scheduling for Subordinate P2MP Networks with Pass-Through Reporting

2. **Invention Summary.**
A concept for a single scheduler supporting multiple separate scheduling domains to support cascaded point-to-multipoint networks (subordinate P2MP networks) resulting in a unified and cohesive shared transmission environment.

3. **Invention Description**.

a. **Describe the invention in detail**.
The present invention will use EPON P2MP networks to describe the concepts, but other P2MP network architectures are also relevant.

In EPON networks an end device – called an Optical Network Unit (ONU) – reports its upstream bandwidth requirements by sending a REPORT message containing fullness information for each of its queues. The Optical Line Terminal (OLT) receives the REPORT messages and translates queue fullness for an ONU into upstream bandwidth requirements. The OLT then sends a GATE message to a particular ONU with instructions on when the ONU can transmit, and for how long the ONU can transmit, on the upstream channel. The interpretation of REPORT messages and corresponding scheduling of ONUs for upstream transmission is generally called “scheduling” or “dynamic bandwidth allocation”.

There may be good reasons to cascade P2MP networks. One potential architecture in which P2MP networks are cascaded is when the EPON Protocol over Coax (EPoC) technology is used in access networks.

Consider a P2MP network with cascaded P2MP networks (hereafter referred to as subordinate P2MP networks) as shown in Figure 1. In Figure 1, there are three (2) subordinate networks: 1.1, 1.2, and 1.3.

Figure 1

It is desirable to maintain a single scheduler for the purpose of coordinating transmissions between the various P2MP networks and end devices. This will improve overall network efficiency, minimize frame delay and frame delay variation, and simplify the Aggregation Device by alleviating the need for a scheduler on each Aggregation Device.

The present invention also includes the notion of Pass-Through Reporting, in which the messages used by end devices to report their upstream bandwidth requirements (REPORT messages sent by ONUs in the case of EPON or EPoC) are “passed through” the aggregation device and consumed only by the centralized multi-domain scheduler. This scenario is

depicted in Figure 2, which shows REPORT messages from ONU 1.1.1 and ONU 1.3.3 passed through Aggregation Devices 1 and 3, respectively.

Figure 2

The centralized multi-domain scheduler interprets the REPORT messages from ONUs (in the case of EPON), and using another invention disclosure the multi-domain scheduler can surmise the bandwidth requirements for a particular Aggregation Device

The multi-domain scheduler, armed with information about the ONU bandwidth requirements, as well as requirements for the corresponding Aggregation Devices, can then schedule each device to minimize frame delay across the subordinate P2MP networks, as well as minimize frame delay while resident in the Aggregation Device awaiting upstream transmission across the parent P2MP network (P2MP Network #1 in the figures). *In essence, the multi-domain scheduler is able to schedule the Aggregation Device immediately after the scheduling of the ONUs which are downstream from the Aggregation Device*. This scenario is depicted in Figure 3, which shows the OLT containing the multi-domain scheduler sending GATE messages with upstream transmission times that are coordinated in time to minimize delay and frame delay variation across the entire network, which also maximizes the use of network resources.

Figure 3

b. **Why was the invention developed? What problem(s) does the invention solve? How is it better?**

This invention was developed after considering a potential EPoC architecture in which a centralized scheduler is used to schedule upstream transmissions for all devices in the network.

c. Briefly outline the potential commercial value and customers of the invention.

Time domain scheduling of upstream transmissions in a network which utilizes EPoC technology, or similar technology dependent on upstream scheduling, will be very challenging. The vendor who can conquer this will have a tremendous advantage. The concepts contained in this invention disclosure can greatly simplify the requirements of Aggregation Devices as well as minimize service-degrading network characteristics such as frame delay and frame delay variation.

4. **HOW is your invention different from existing products, processes, systems?**

INVENTION DISCLOSURE

The concept of subordinate P2MP networks and how to schedule end devices in such a network are novel concepts brought about by the standardization of EPoC technology. Therefore, nothing similar is known by the inventor.