Energy Efficiency in XG-PON with the Use of Optimized Sleep Mode Method

Introduction
Energy efficiency is a significant innovation sector, where different methods can be applied. The noteworthy increase of energy consumption in telecom networks, as shown in figure 1, led to migration to the next generation networks, which is considered to be a quite promising and environmentally friendly approach.

XG-PON (10 Gigabit Passive Optical Network) is an Access Network, as shown in figure 2, that allows its active optical components to be switched to sleep mode when they are underactive or when there is no traffic.

Figure 1: Prediction of energy consumption growth in telecom networks.

Figure 2: XG-PON architecture.

Set up values
The simulation follows the ITU-T 984.3 specification where:
- ActiveHeld power=4.69 Watts
- ActiveFree power=4.69 Watts
- DozeAware power=2.78 Watts
- SleepAware power=2.78 Watts
- Listen power=1.7 Watts
- Asleep power=0.9 Watts

Figure 3: ONU power management states in doze and cyclic sleep period.

Results
A sufficient energy efficient mechanism has been developed. The appropriate sleep time periods have been found either for the Listen or Asleep mode state. The network either in Listen or Asleep state presents positive behavior regarding to the minimization of the ONU’s mean power consumption. The mean packet delay in upstream channel is not increasing immensely maintaining XG-PON’s functionality and good performance.

Figure 4: Mean power consumption in ONU.

Figure 5: Mean packet delay in upstream direction.

Conclusions

Contribution
- To propose a sleep mode mechanism that a) finds the optimal sleep period for the ONUs to further remain in sleep mode state,
- b) reduces the energy consumption and,
- c) maintains XG-PON’s functionality and good performance.

Tools & Methodology
- Design a simulation tool in Matlab that uses event-driven programming.
- Use of ONU power management states based on ITU-T 984.3 specification, as shown in figure 3.

Figure 6: Mean packet delay in downstream direction.

Figure 7: Throughput of the network.

Key References