Empirical ONU Power Consumption Modeling and Verification for Integrated Optical-Wireless Access Networks

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(Pt9)Abstract— **Energy efficiency has become a fundamental requirement in next-generation broadband access networks, particularly in integrated optical-wireless deployments. Optical Network Units (ONUs) constitute a major share of energy consumption in Gigabit Passive Optical Network (GPON) systems, yet most existing studies rely on simulation or oversimplified static models. This paper presents an experimentally validated power consumption model for commercial ONUs deployed in Brunei's live access network. A developed power meter equipped with an INA260 voltage and current sensor was implemented to measure real-time ONU power draw under dynamic traffic loads injected ranging from 0 to 1 Gbps. The findings show a nonlinear power-rate relationship, where the power initially increases with traffic up to approximately 200–300 Mbps, then saturates at higher rates. A logarithmic empirical model is derived and validated using the coefficient of determination (R2) and the root mean square error (RMSE), confirming its suitability for accurate real-world ONU power estimation. This model enhances energy-efficiency analysis for integrated optical-wireless networks and challenges the legacy linear assumptions commonly used in the prior literature.**

(Pt9)Keyword— **GPON, ONU power consumption, energy efficiency, empirical modeling, developed power meter, Brunei broadband network.**

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