Fibre-Optic AWG Networks Supporting Real-Time Communication in High-Performance Embedded Systems

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Abstract

High-performance embedded systems communicating heterogeneous traffic with high bandwidth and strict timing requirements are in need of more efficient communication solutions. This thesis proposes two multi-wavelength passive optical networks able to meet these demands. The networks are based upon a single-hop star topology with an Arrayed Waveguide Grating (AWG) placed in the centre. The intended application areas for the two networks are short range embedded communication systems like System Area Networks (SANs) and router architectures with electronic queuing. The AWG's attractive property of spatial wavelength reuse, as well as the combination of fixed-tuned and tuneable transceivers in the end nodes, enables simultaneous control and data traffic transmission. This, in turn, makes it possible to support heterogeneous traffic with both hard and soft real-time constraints.

Additionally, two Medium Access Control (MAC) protocols, one for each network solution, are developed. Traffic scheduling is centrally controlled by a node, the protocol processor, residing together with the AWG in a hub. All nodes use Earliest Deadline First (EDF) scheduling and communicate with the protocol processor through physical control channels. A case study, including simulations, in the field of Radar Signal Processing (RSP) and simulations using periodic real-time traffic are conducted for the two application areas respectively, showing very good results. Further, a deterministic real-time analysis is conducted to provide throughput and delay guarantees for hard real-time traffic and an increase in guaranteed traffic is achieved through an analysis of existing traffic dependencies in a multichannel network. Simulation results incorporating the traffic dependency analysis indicate a considerable increase in the possible guaranteed throughput of hard real-time traffic.

Keywords: Arrayed Waveguide Grating (AWG), real-time communication, optical communication, network architecture, optical network, medium access control (MAC) protocol, real-time analysis, traffic dependency analysis