Learning-Automata-Based MAC Protocols for Photonic LANs

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Abstract

A MAC Protocol for WDM Passive Star Networks, which is capable of operating efficiently under bursty and correlated traffic, is introduced. According to the proposed protocol, the stations which grant permission to transmit at each time slot, are selected by means of learning automata. The choice probabilities of the selected stations are updated by taking into account the network feedback information.

1. The SALP Protocol

The SALP protocol is applied to WDM Passive Star networks using tunable lasers and fixed optical filters. According to the SALP protocol, learning automata are used for determining which station grants permission to transmit on each wavelength. The number of stations is N, while W is the number of wavelengths. Each station is provided with a set of W learning automata, with each automaton LA_i corresponding to a specific wavelength λ_i and determining which station grants permission to transmit on this wavelength ($i = 1, \ldots, W$).

Each learning automaton LA_i contains a probability distribution $P_i(t)$ over the set of stations. Thus, $P_i(t) = \{P_{i,1}(t), \ldots, P_{i,N}(t)\}$, with $P_{i,j}(t)$ being the basic choice probability of station u_j, for wavelength λ_i, at time slot t.

At each time slot t, only one station (let $C_i(t)$) grants permission to transmit on each wavelength λ_i, for $i = 1, \ldots, W$. Wavelengths take turn to select in random order. Each wavelength λ_i selects $C_i(t)$, according to the normalized choice probabilities $\Pi_{i,j} = \frac{P_{i,j}(t)}{\sum_{u_m \in G} P_{i,m}(t)}$, where: G is the set of stations that have not been selected by another wavelength.

At each time slot t, the basic choice probabilities of the selected stations are updated according to the network feedback information. If $C_i(t) = u_j$ and station u_j transmitted a packet during time slot t, then the basic choice probability $P_{i,j}(t)$ is increased. Otherwise, if the selected station u_j was idle, then the basic choice probability $P_{i,j}(t)$ is decreased. Let $S_i(t) \in \{busy, idle\}$ be the state of wavelength λ_i, at time slot t. If $C_i(t) = u_j$ ($i = 1, \ldots, W$), then the following probability updating scheme is used (where: $L, a \in (0, 1)$ and $P_{i,j}(t) \in (a, 1)$ for all t):

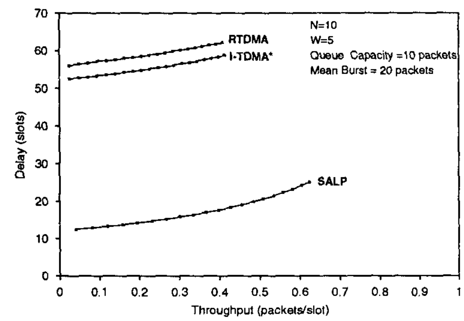

Figure 1: The Delay versus Throughput characteristics of protocols SALP, I-TDMA* and RTDMA.

$$P_{i,j}(t+1) = P_{i,j}(t) + L(1 - P_{i,j}(t)) \quad \text{if} \quad S_i(t) = busy$$
$$P_{i,j}(t+1) = P_{i,j}(t) - L(P_{i,j}(t) - a) \quad \text{if} \quad S_i(t) = idle$$

All the stations use the same learning algorithm and - due to the broadcast nature of the network - the network feedback information is common for all the stations. Consequently, all the automata always contain the same choice probabilities. Furthermore, since the same random number generator and the same seed is used by all the stations, it follows that for each wavelength λ_i, all the stations select the same station $C_i(t)$ which grants permission to transmit. Therefore, although there is no centralized coordination between the stations, the protocol is collision-free.

2. Simulation Results

In figure 1, the Delay versus Throughput performance of SALP is compared to the ones of protocols I-TDMA* and RTDMA. More details on the use of learning automata in WDM star networks can be found in [1].

References

[1] G.I.Papadimitriou and A.S.Pomportsis, "On the use of learning automata in medium access control of single-hop lightwave networks", Computer Communications, vol.23, no.9, 2000.

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