WDM PASSIVE STAR - PROTOCOLS AND PERFORMANCE ANALYSIS

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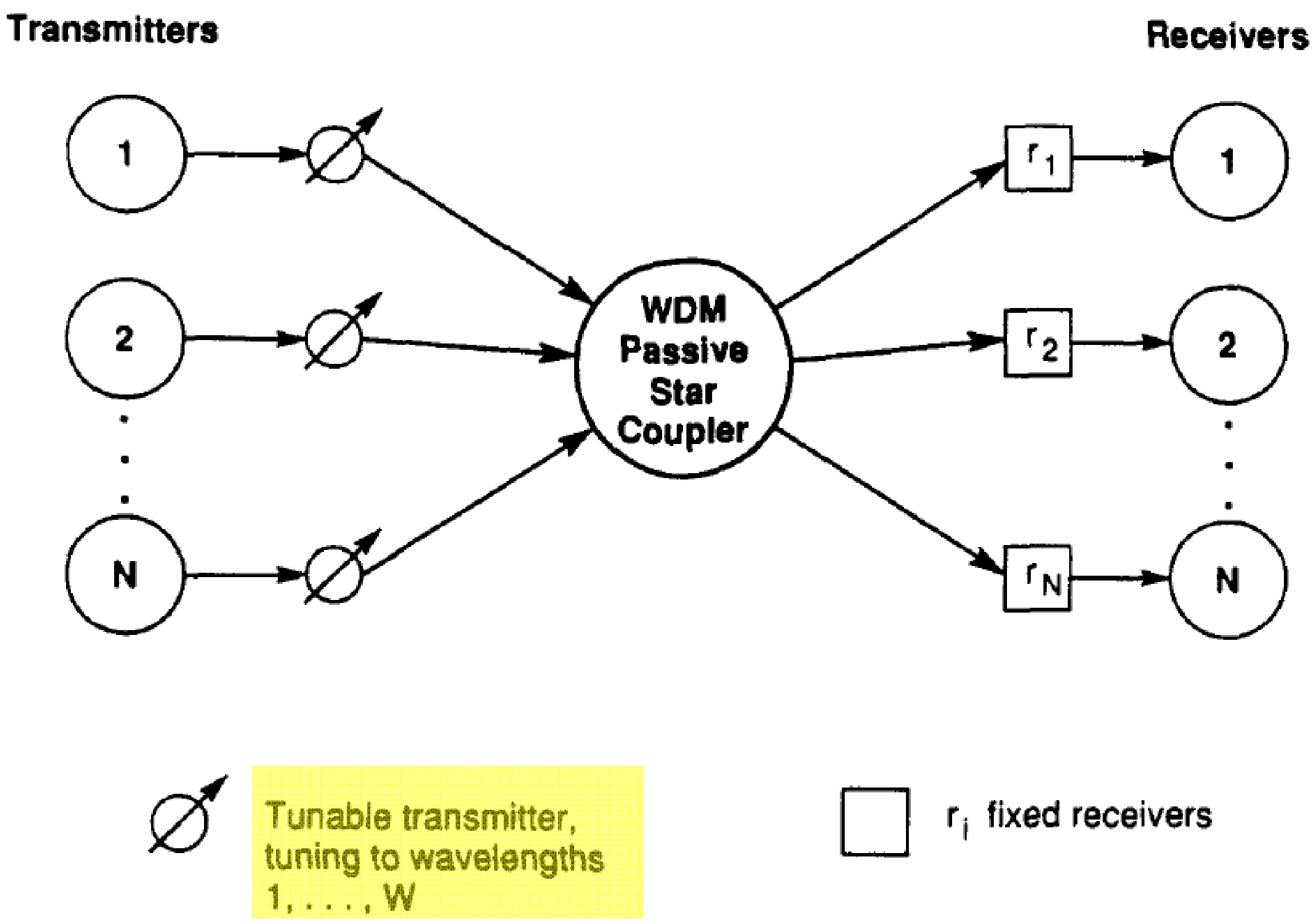

Figure 1 : N Nodes interconnected through a WDM star.

2. The Model

In this paper we analyze a communication system consisting of N nodes, interconnected by a WDM star using W $(1 \leq W \leq N)$ identical channels. The channels are obtained by wavelength

Node i has a buffer capacity of L_i packets. Time is divided into slots of fixed size, and all nodes are synchronized to the beginnings of the slots. At the beginning of each time slot, node i (provided that its buffer is not full) generates a new packet with probability λ_i. The packet transmission time is one slot. The packet is destined to node m with probability d_{im}, ($\sum_{m=1}^{N} d_{im} = 1$ for $i = 1, ..., N$).

Let R_i denote the set of wavelengths that node i can simultaneously receive from, $|R_i| = r_i$. This leads to the division of the N nodes into W (not necessarily disjoint) sets $A_1, \ldots, A_W$ according to their transmission channel, with $A_i = \{m | 1 \leq m \leq N, i \in T_m\}$ and W (not necessarily disjoint) sets $B_1, \ldots, B_W$ according to their reception channel

4. Random TDMA

4.1 Protocol Description

Each node follows a slot transmission schedule $trans$, with $trans[i]$ determining the channel on which node i will be allowed to transmit. If node i is not scheduled for transmission, $trans[i] = 0$.

At the beginning of each slot, a busy node i with $trans[i] = k > 0$ is given permission to transmit on channel k to any of the nodes in the set B_k (the set of nodes that receive on channel k). Node i can choose from its buffer any of the packets whose destination is in the set B_k, and it will transmit successfully if it has such a packet.

The following algorithm constructs the collision free transmission schedule *trans*:

1. $\Omega = \{1, 2, ..., W\}$, $\hat{A}_j = A_j$ *for* $j = 1, ..., W$.

2. Choose at random one channel in the set Ω, say channel k.

3. Choose at random one node among the nodes in set $\hat{A}_k$, say node i.

4. $trans[i] = k$,
   $\hat{A}_j = \hat{A}_j - \{i\}$ for $j = 1, ..., W$; $\Omega = \Omega - \{k\}$.

5. If $\Omega \neq \emptyset$ goto 2.

5. Numerical Results

As a specific example we investigated a system consisting of 8 nodes interconnected through 4 channels, and we performed both a validation of

System 3: Each transmitter can tune to all four wavelengths and each node has one receiver, one for each wavelength. The transmitters' and receivers' wavelengths are given by:
$T_i = \{1, 2, 3, 4\}, i = 1, ..., 8,$
$R_i = \{1\}, i = 1, 2,\ R_i = \{2\}, i = 3, 4,\ R_i = \{3\}, i = 5, 6,\ R_i = \{4\}, i = 7, 8.$

System Performance: Once the approximation has been validated, we investigate the system behavior as a function of the system load, the channel access protocol and the system hardware design. The results are depicted in Figures 4-6.

For the performance calculations we chose a homogeneous system with packet generation probability $\lambda_i = b/N$, buffer size $L_i = 4$ and $d_{im} = 0$ for $m = i$, $d_{im} = \frac{1}{N-1}$ for $m \neq i$.

system load

b (the sum of the nodes' packet generation probabilities).

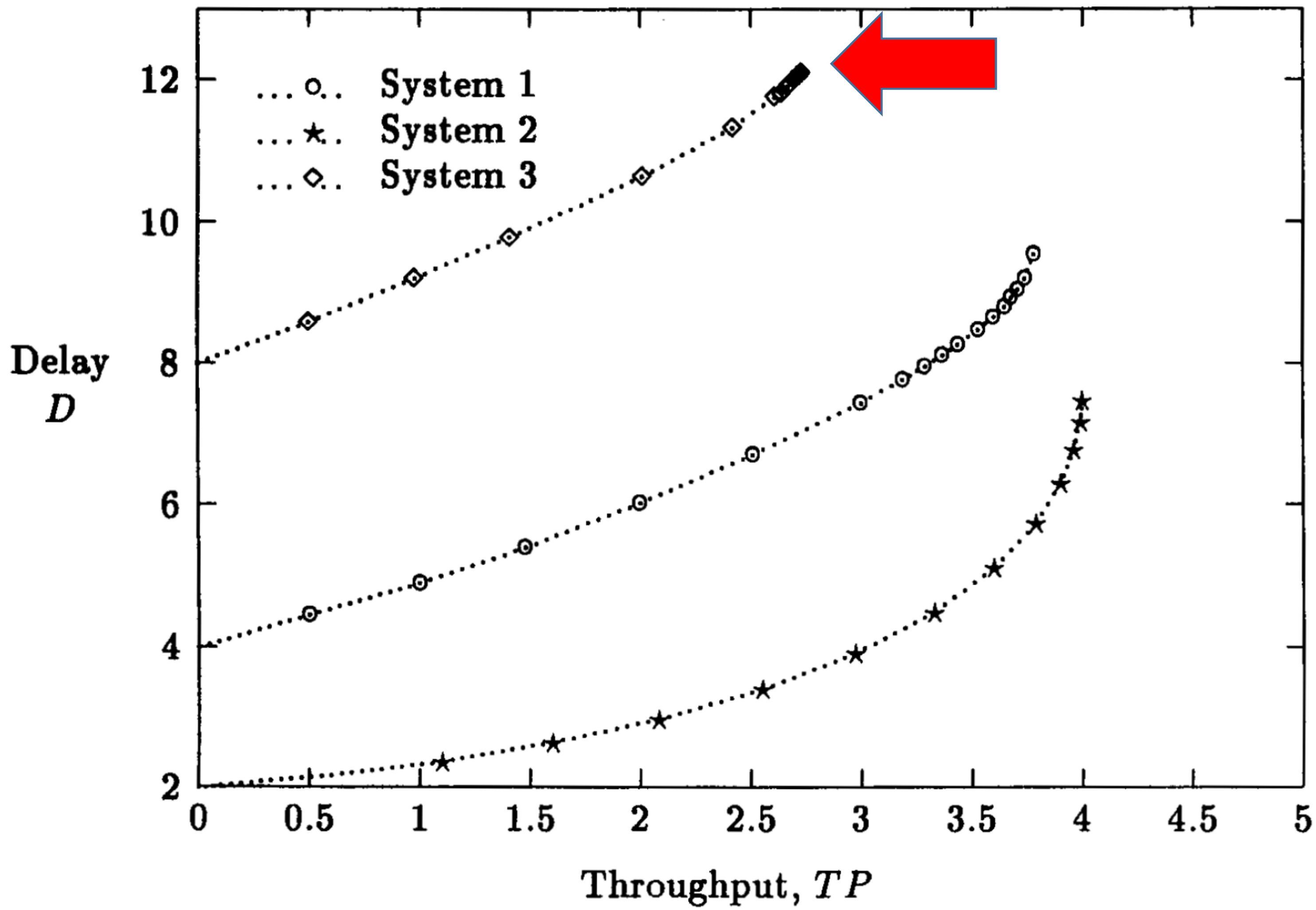

Figure 5: Average packet delay versus system throughput, $N = 8$, $W = 4$, $L_i = 4$, random TDMA protocol.