Dynamic control method of queuing delay with/without OEO conversion in a multi-stage access network

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Outline

1 Background

2 Network configuration

3 Dynamic control method of queuing delay

4 Characteristics and parameter setup

5 Summary

1 Background - - Future services - -

Various services must be supported in future access network.

The future access network must support various aspects of QoS such as bandwidth and delay performance that each service requires.

TMS (Tiny bandwidth Mass Service), BCS (Broadband Consumer Service). HBS (Huge bandwidth Service)

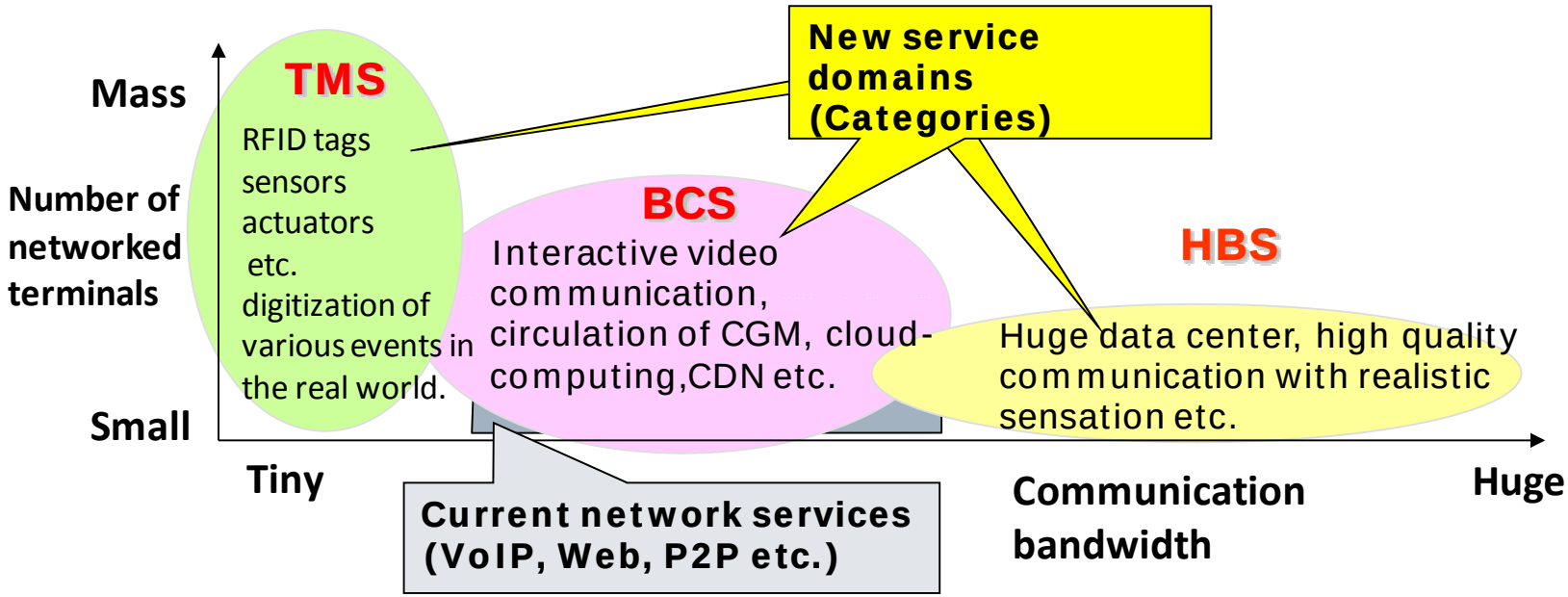
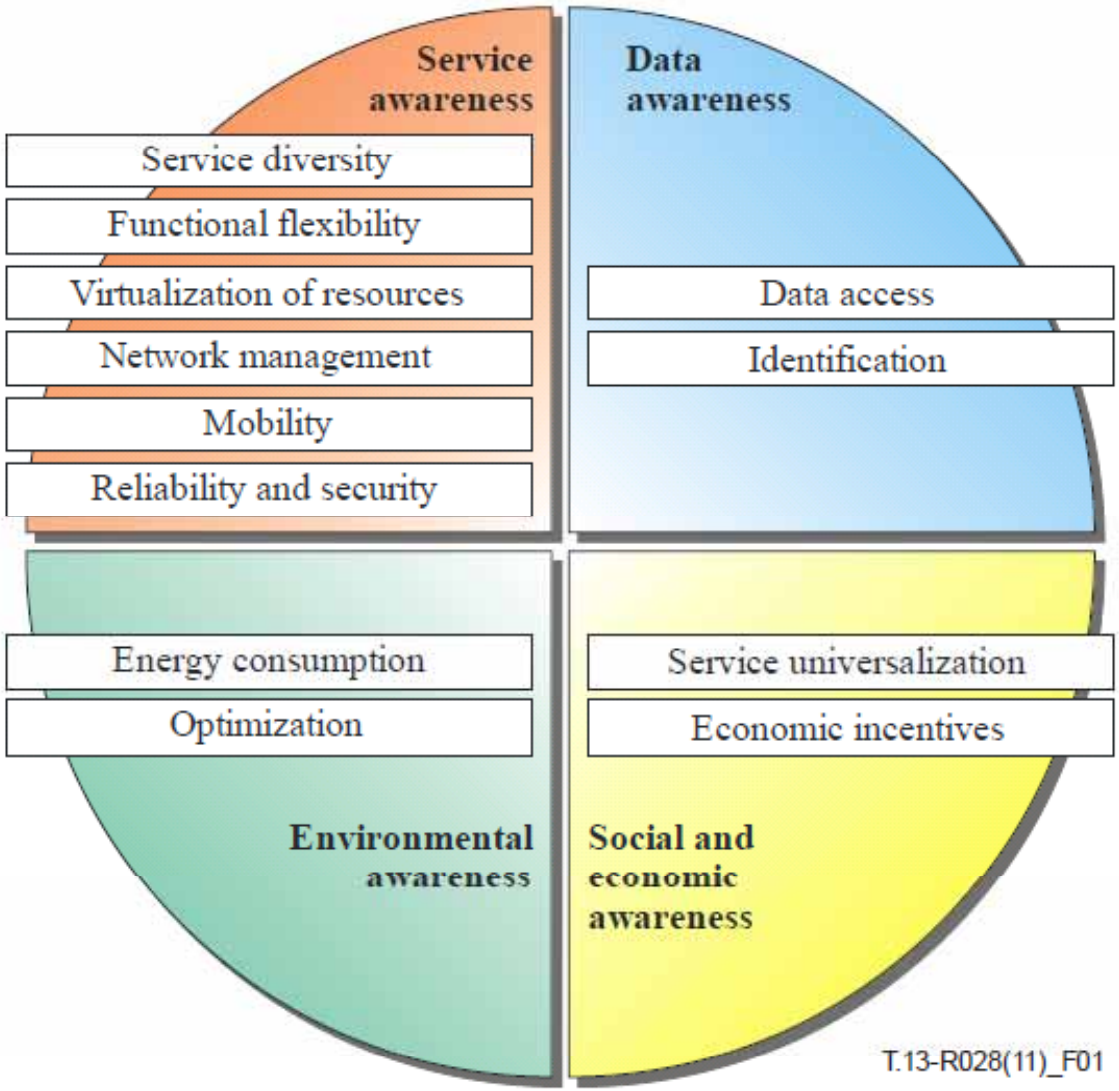


Fig.1 Classification of network services in the future

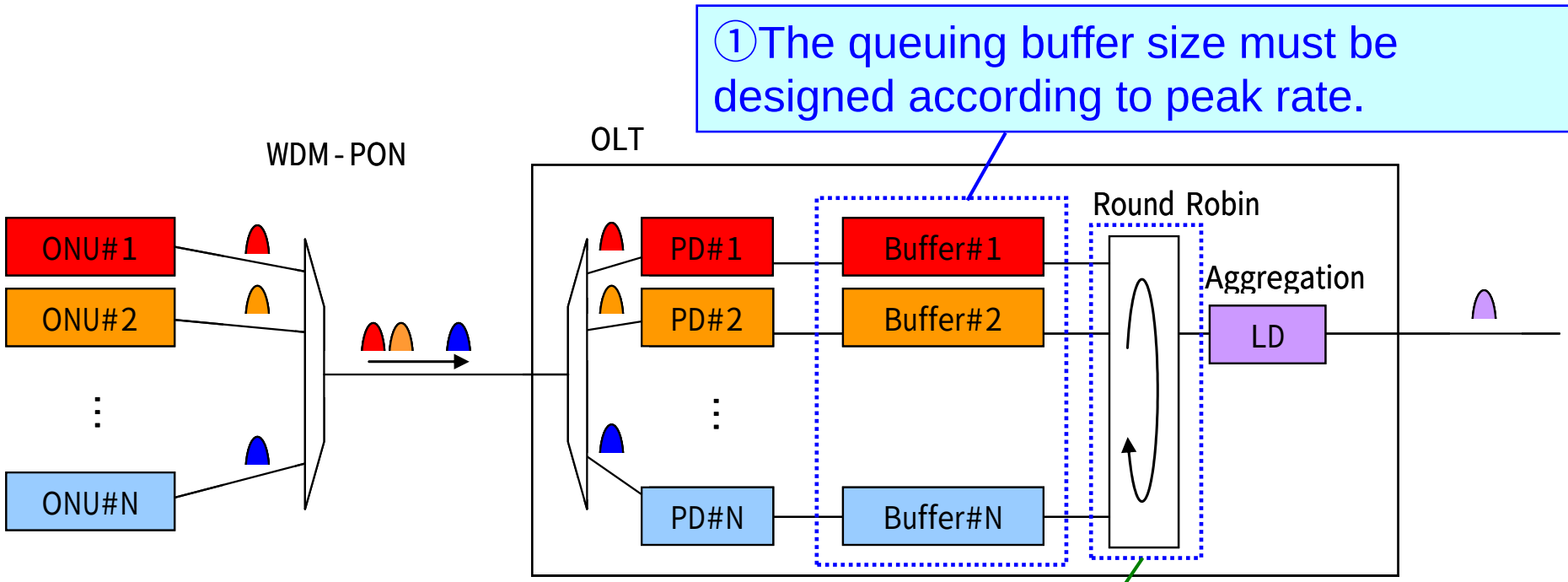
(Ref) http://www.itu.int/ITU-T/focusgroups/fn/output.html#2nd

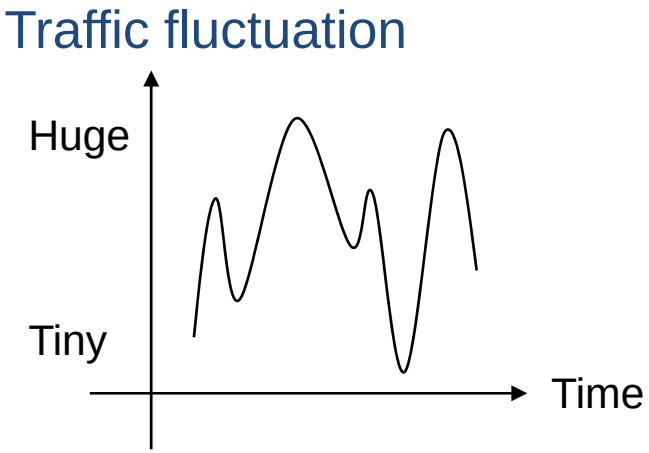
Future network



ITU-T Y.3001 (2011/5)
Future Networks : Objectives and Design Goals

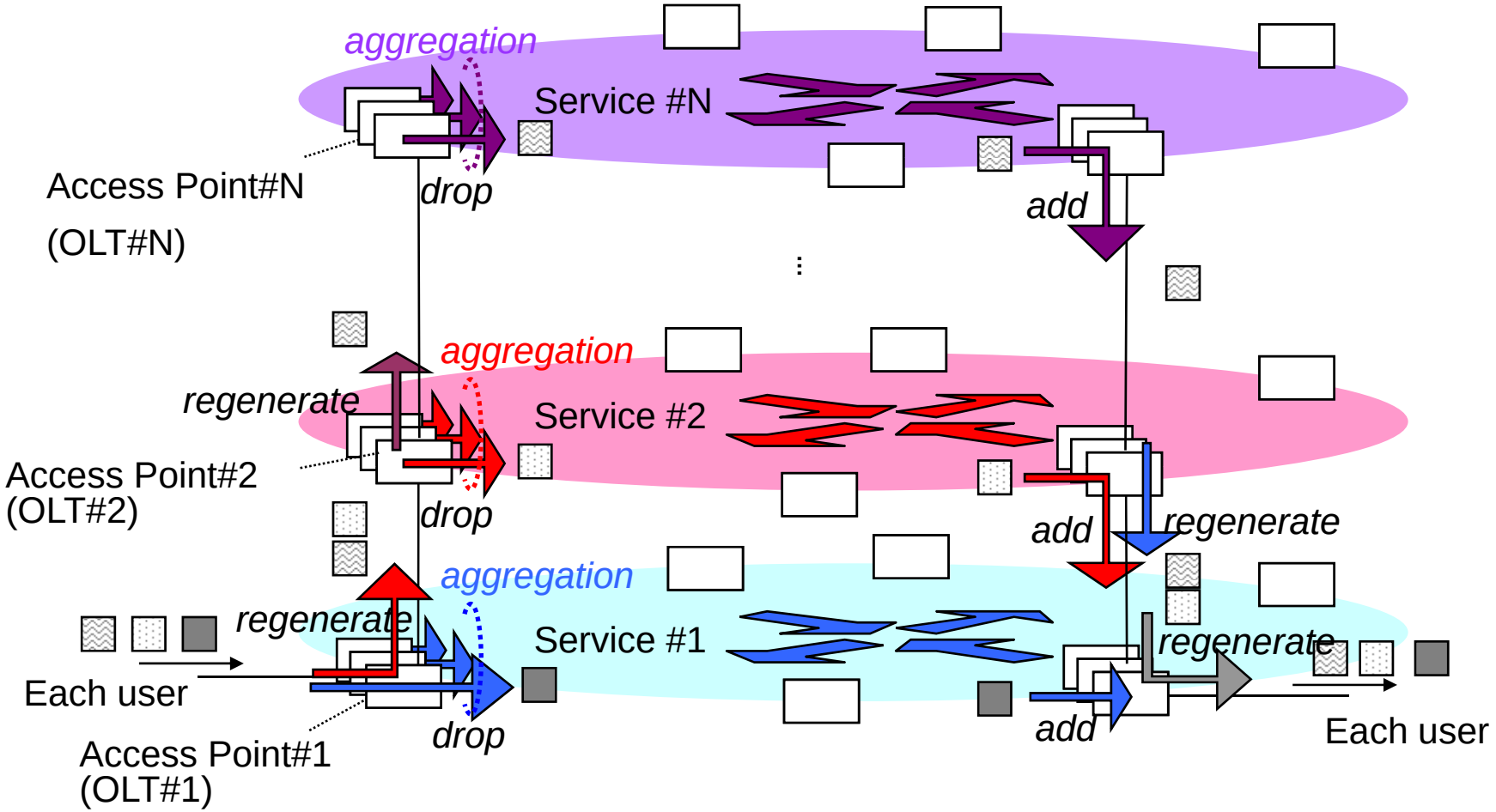
Challenge





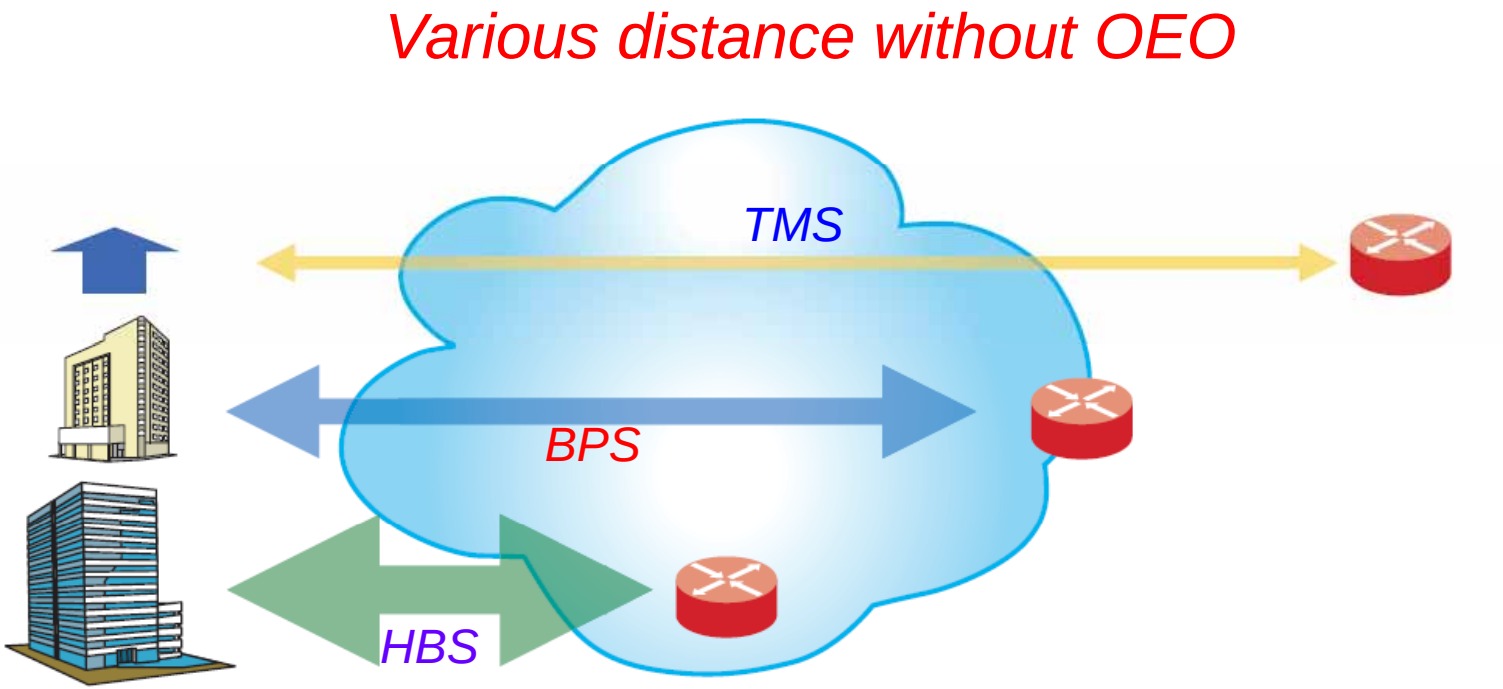
Multi-stage access network

New access network with multi-access points and multi-service planes supporting quality (bandwidth, delay performance) of each service.



Merit: low delay performance, avoiding traffic congestion …

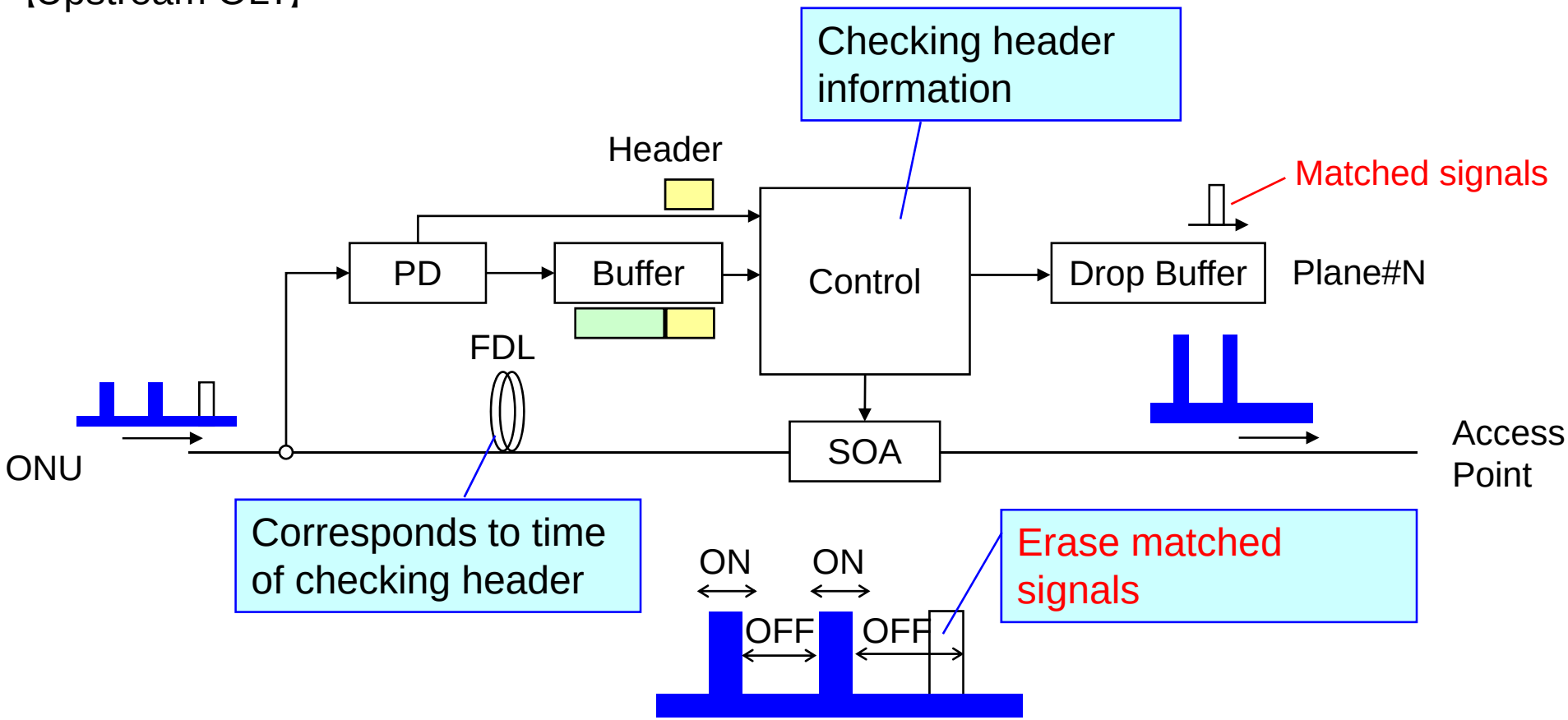
Elastic OLT technology



(reference) Special Feature: “Towards Ultrahigh-speed High-capacity Networks”
NTT Technical Journal, vol.7, no.5, May 2009.

2 Network configuration -- upstream OLT --

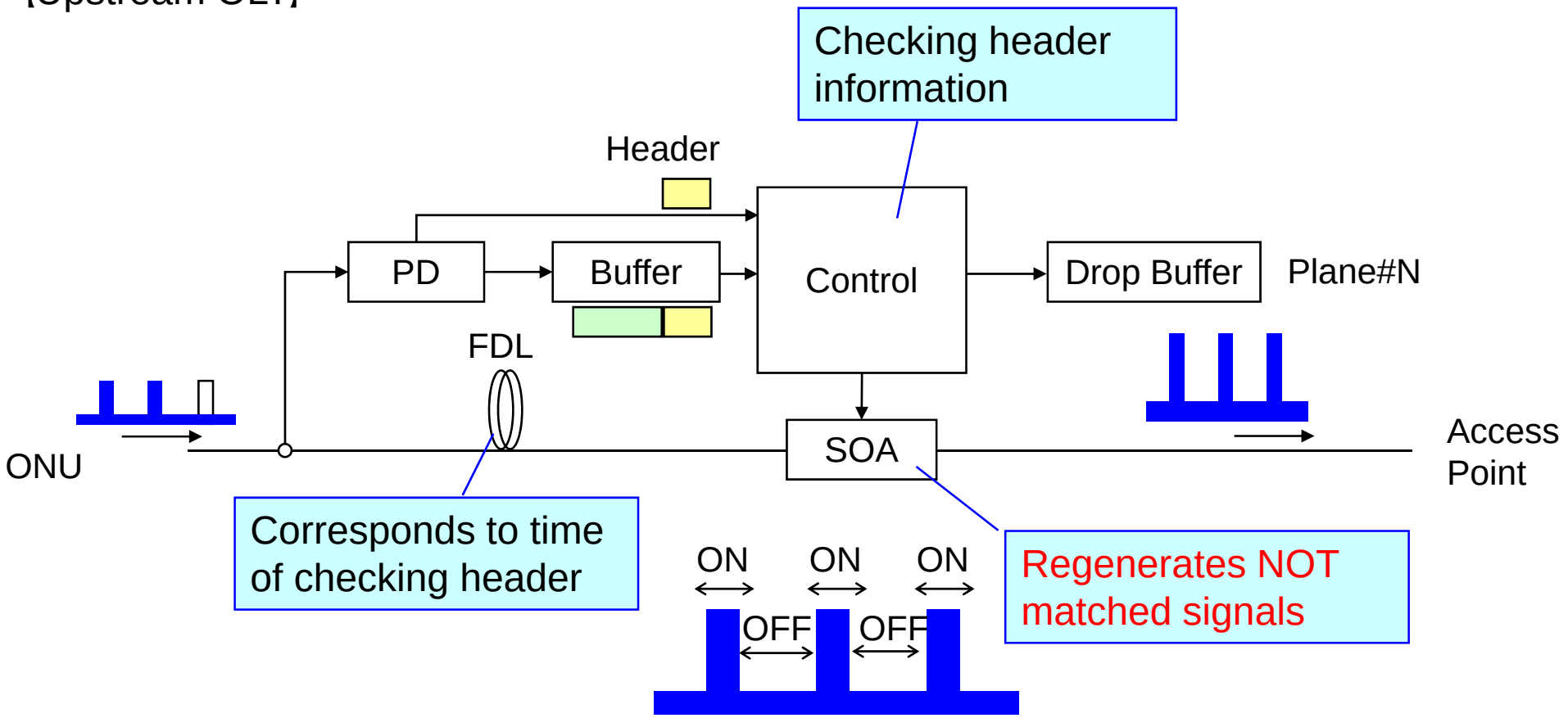
【Upstream OLT】



If the signals match a service, the matched signals are sent to a drop buffer.
The control part turns the SOA bias OFF and erases the matched signal.

2 Network configuration -- upstream OLT--

【Upstream OLT】

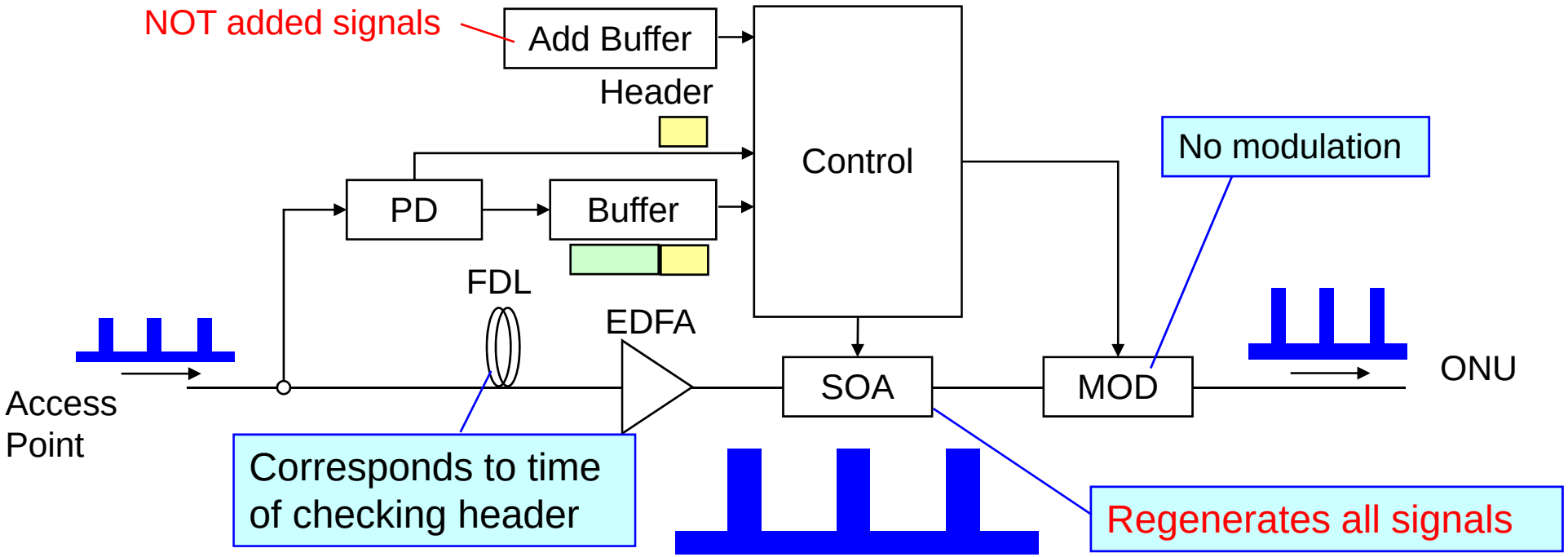


If the signals do not match a service, the unmatched signals are sent to the next access point. The control part turns the SOA bias ON for regeneration.

2 Network configuration -- downstream OLT --

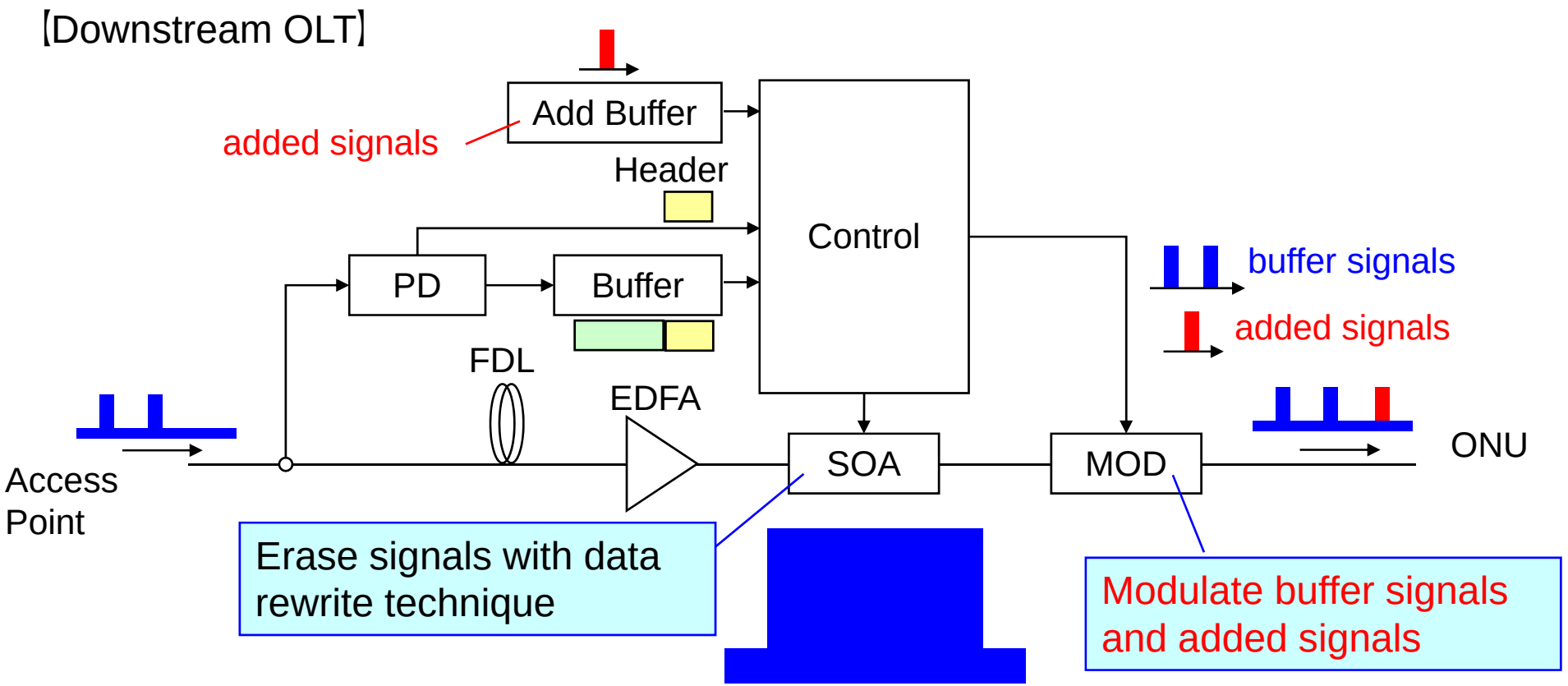
【Downstream OLT】

A downstream OLT needs a function for added signals



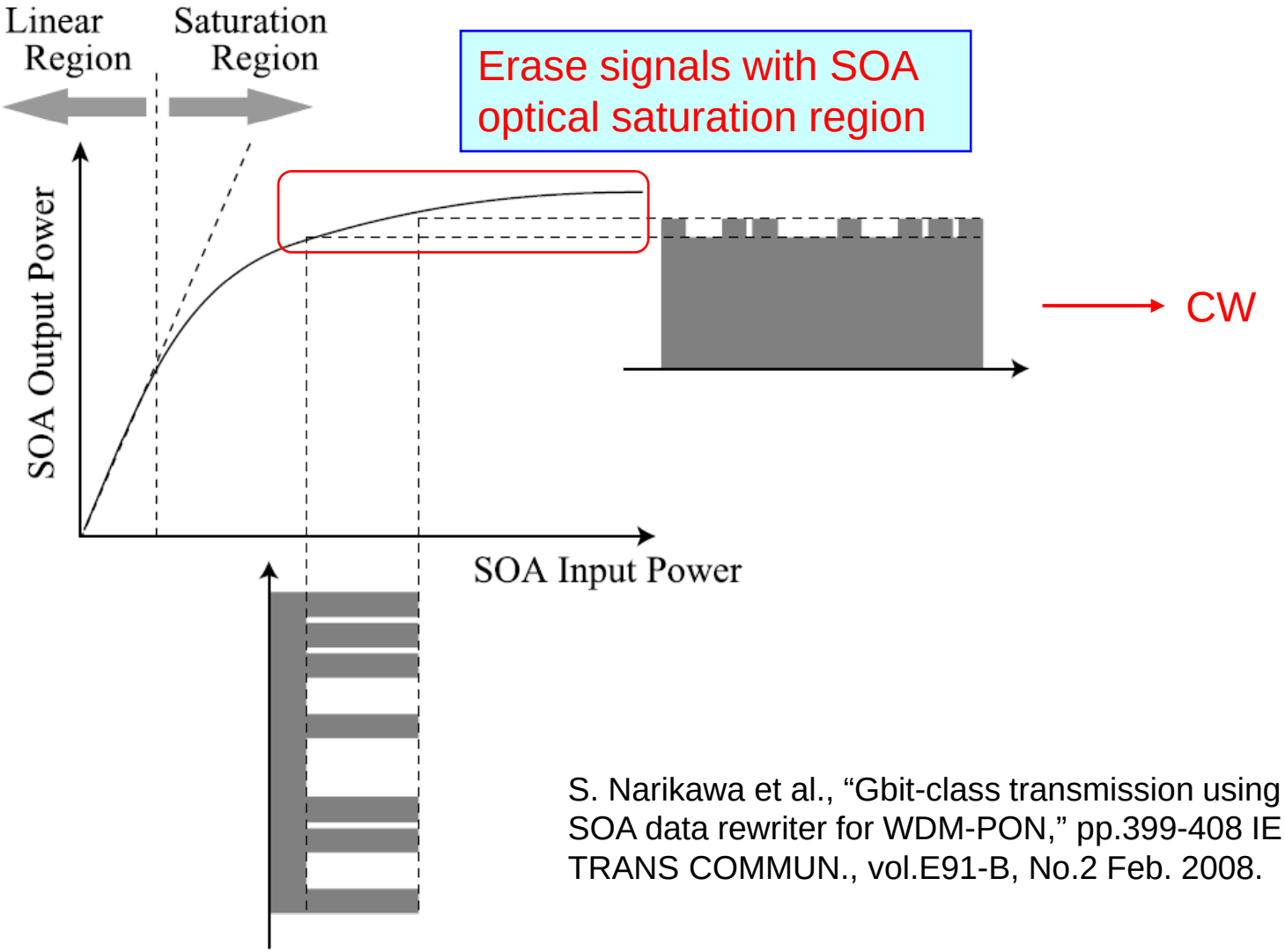
If no signals are present in the add buffer, all the signals are regenerated in the SOA.

2 Network configuration -- downstream OLT --



If signals are present in the add buffer, the downstream signals are erased by SOA optical saturation using a data rewrite technique. Then the buffer signals and added signals are modulated.

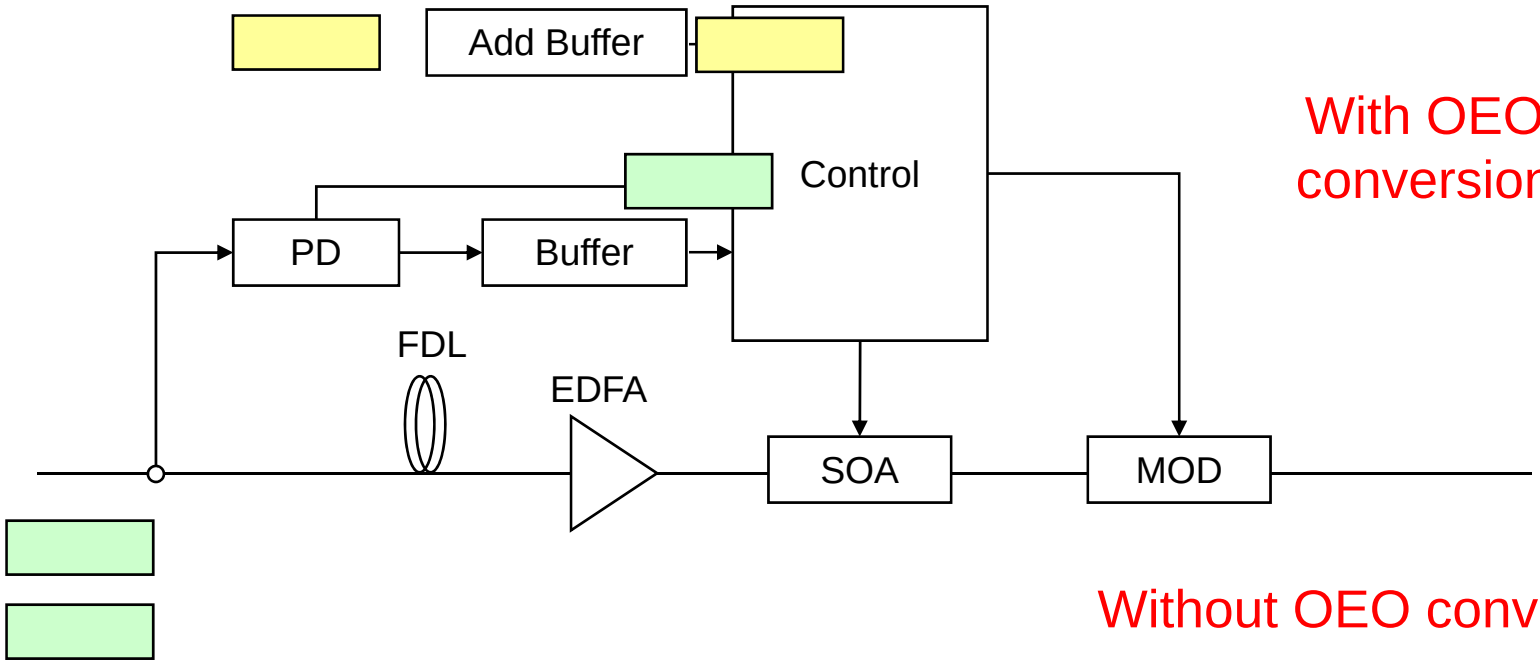
(Reference) data rewrite technique



S. Narikawa et al., “Gbit-class transmission using SOA data rewriter for WDM-PON,” pp.399-408 IEICE TRANS COMMUN., vol.E91-B, No.2 Feb. 2008.

3 Dynamic control method of queuing delay

The system cannot control the number of OEO conversions because the transmission of downstream signals with or without OEO conversions depends on the bandwidth of the added signals and the changes caused by the fluctuation of this bandwidth. Therefore, the system cannot satisfy the delay performance requirements of each service.



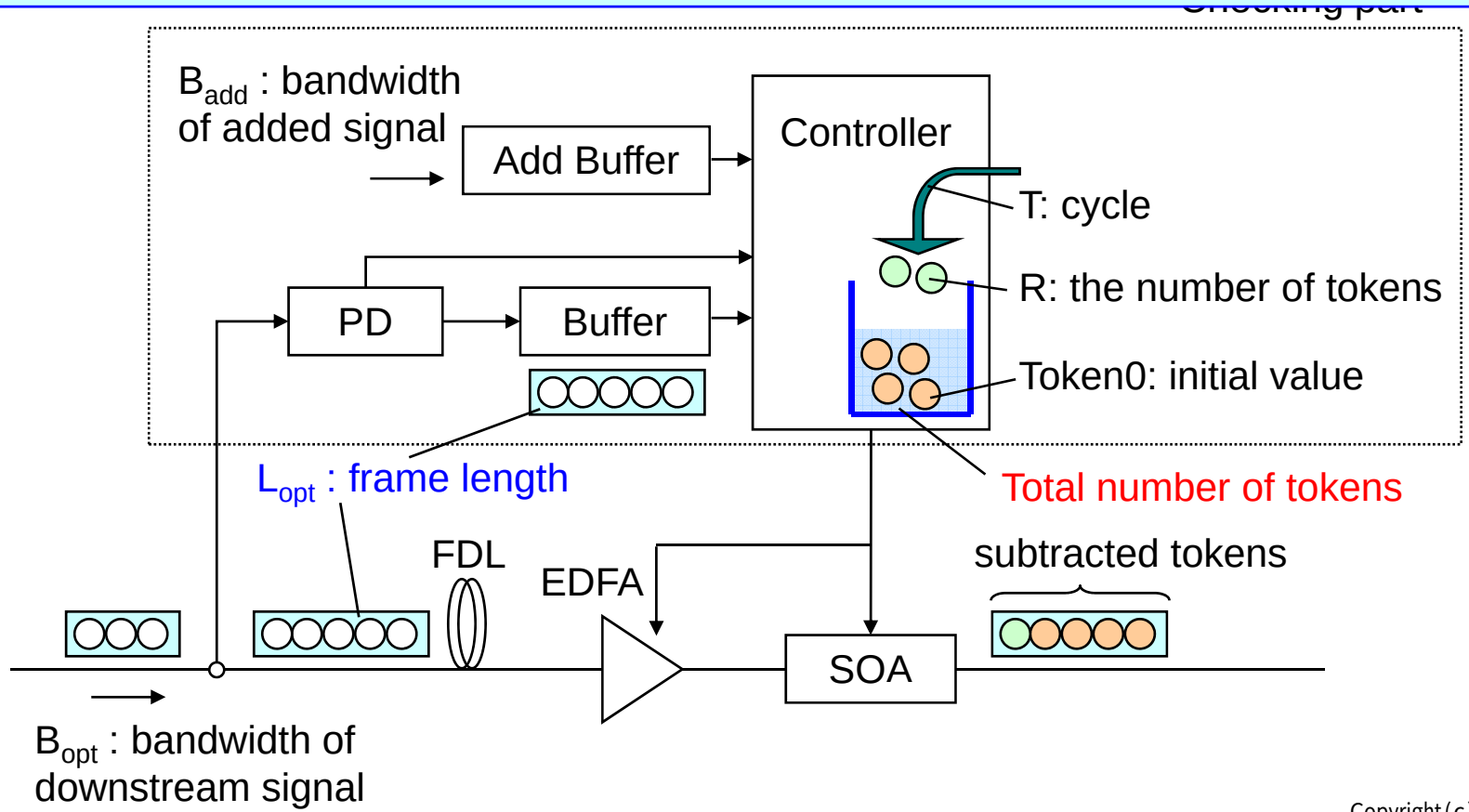
3 Dynamic control method of queuing delay

Token packet method

<Decision Criterion>

frame length > the total number of token : without OEO conversion (O/O mode)

frame length < the total number of token : with OEO conversion (O/E/O mode)



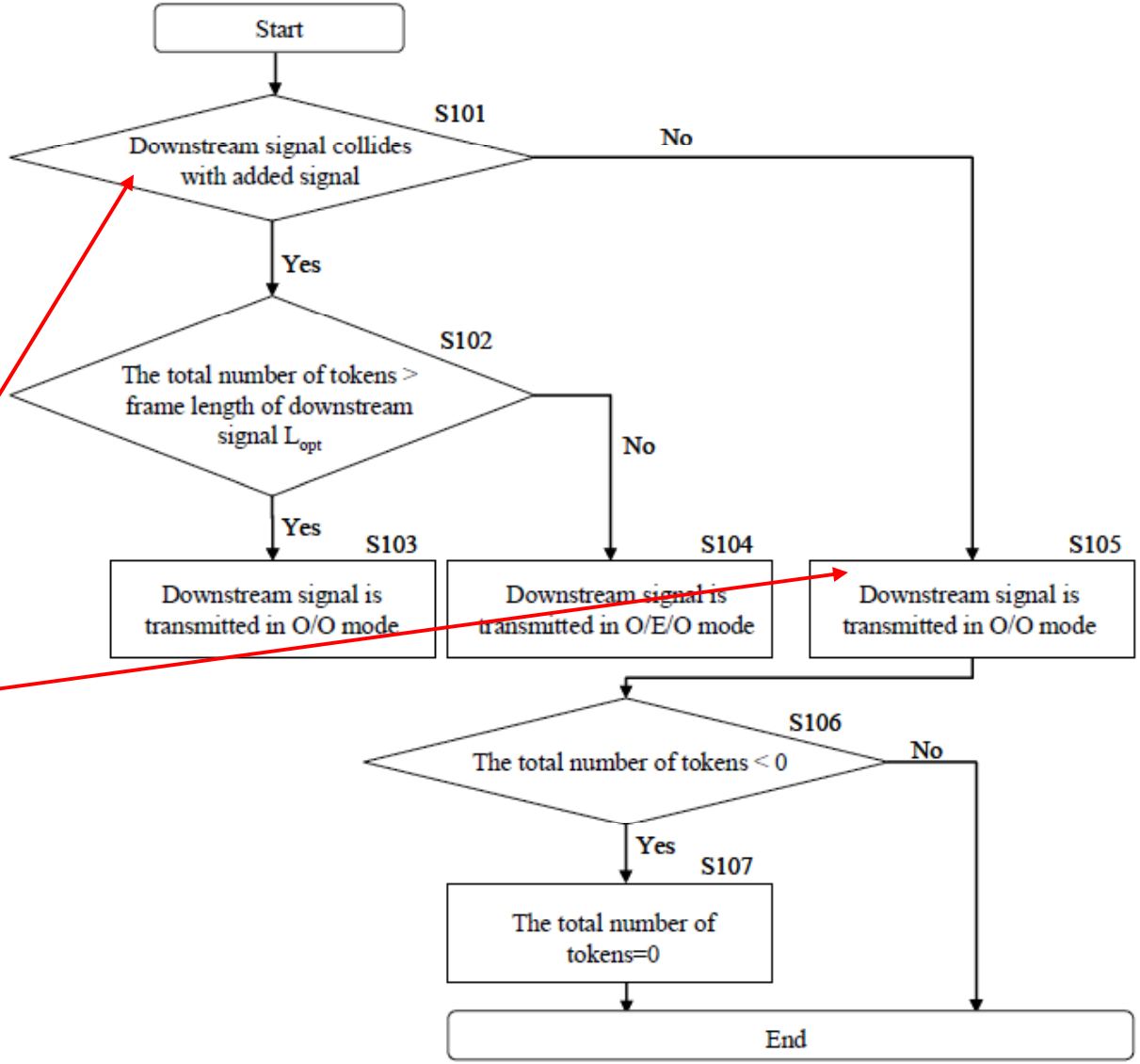
3 Dynamic control method of queuing delay

【Control#1】

Token criteria

+ status of collision

When the downstream signal does not collides with added signal, the downstream signal can be transmitted in the O/O mode even if the total number of tokens is smaller than frame length.

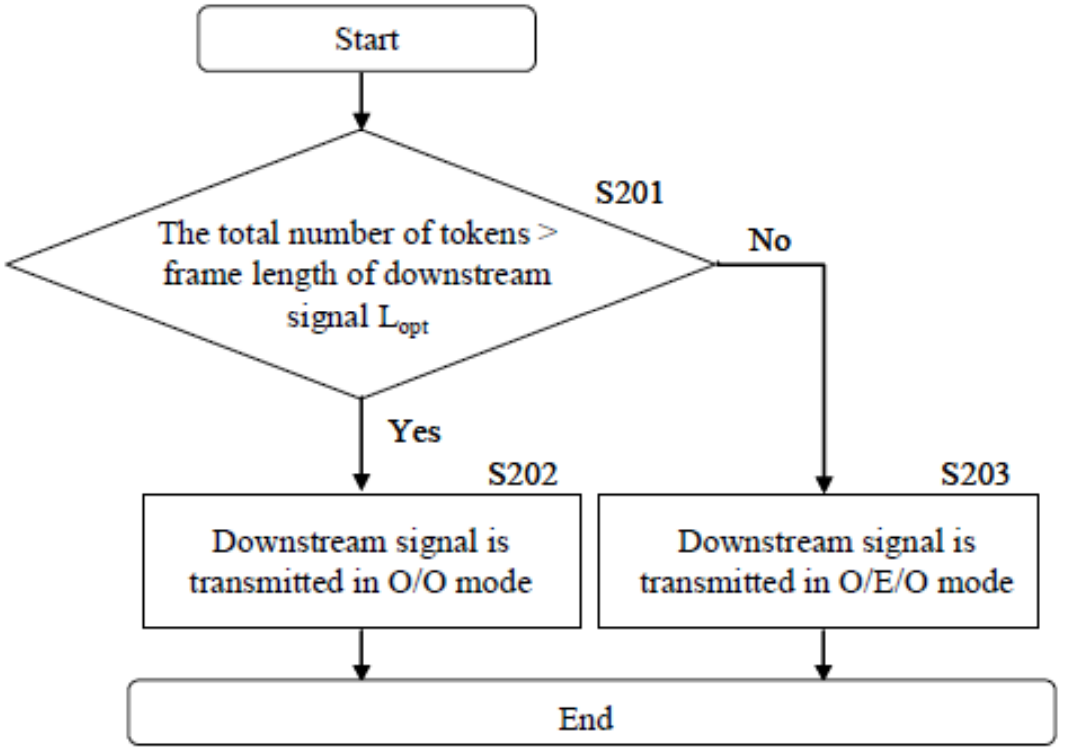


3 Dynamic control method of queuing delay

【Control#2】

Only Token criteria

If the total number of tokens is larger than frame length of the just received downstream signal, the added signal waits even if it arrived before the downstream signal. At the same time, the downstream signal can be transmitted in O/O mode.



4 Characteristics and parameter setup

To investigate the characteristics of each token parameter (R, T, and Token0) and how to set up these parameters to achieve the required number of OEO conversions, we estimated the OEO conversion ratio, the ratio of the number of downstream signals sent under O/E/O mode to the total number of downstream signals.

<Simulation parameter>

Transmission rate : 1 Gbit/s

Optical packet bandwidth (B_{opt}) : 250Mbit/s, 500Mbit/s

Added signal bandwidth (B_{add}) : 250Mbit/s, 500Mbit/s

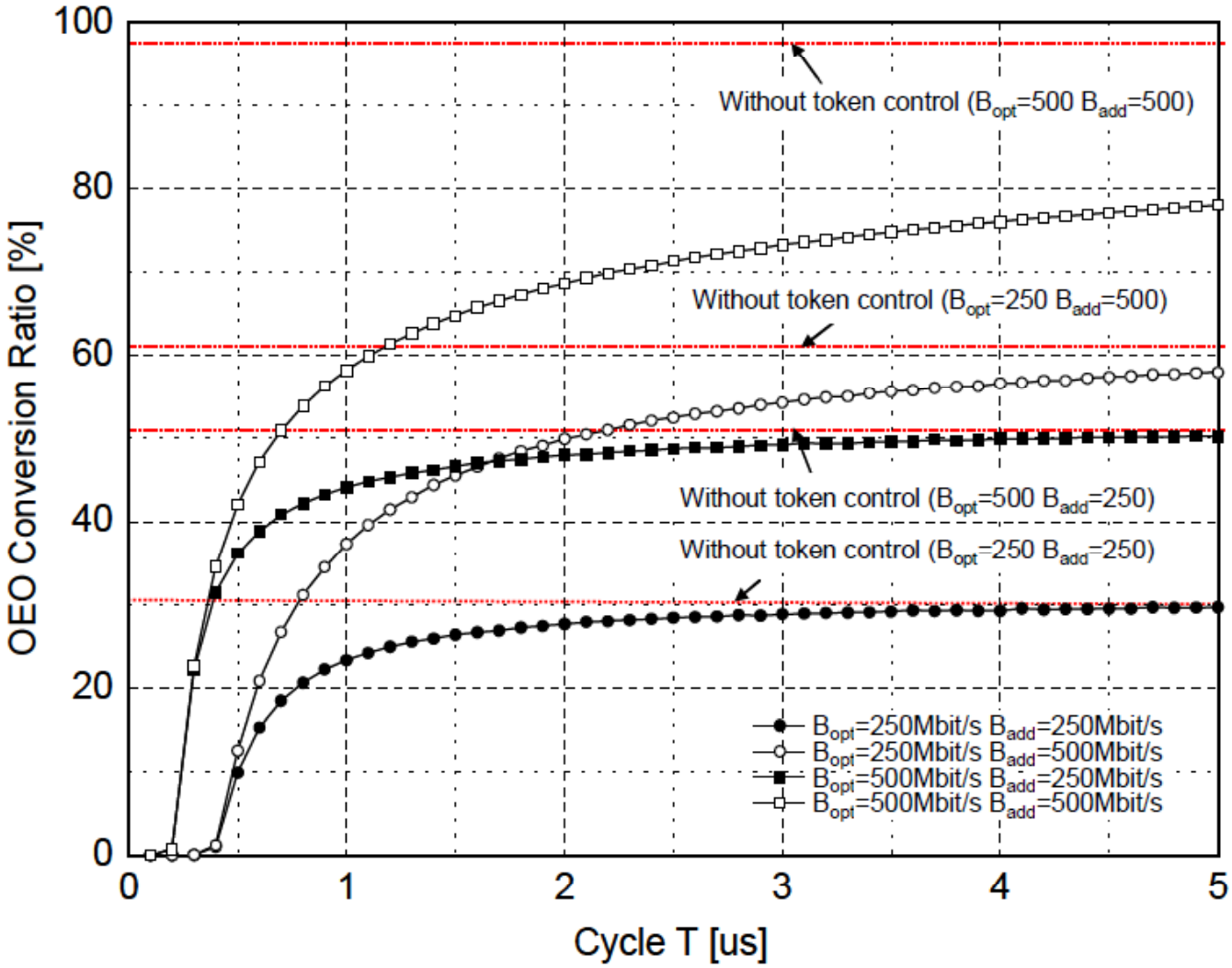
Frame length L_{opt} : 64-1518 bytes

(Header length : 14 bytes , Data length : 46-1500bytes, frame check sequence : 4 bytes)

Model : Poisson process

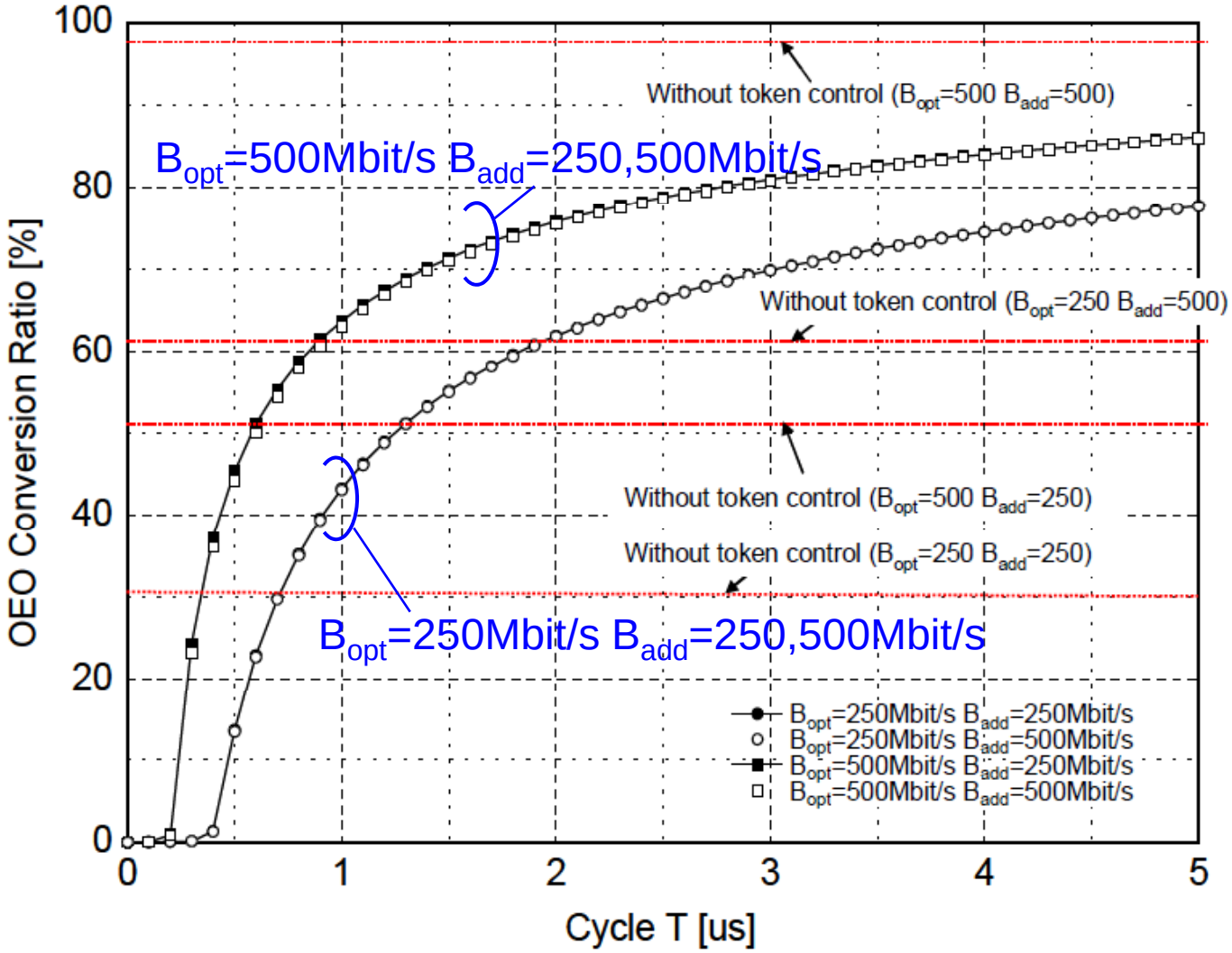
4 Characteristics and parameter setup

【Control#1】Token criteria + status of collision

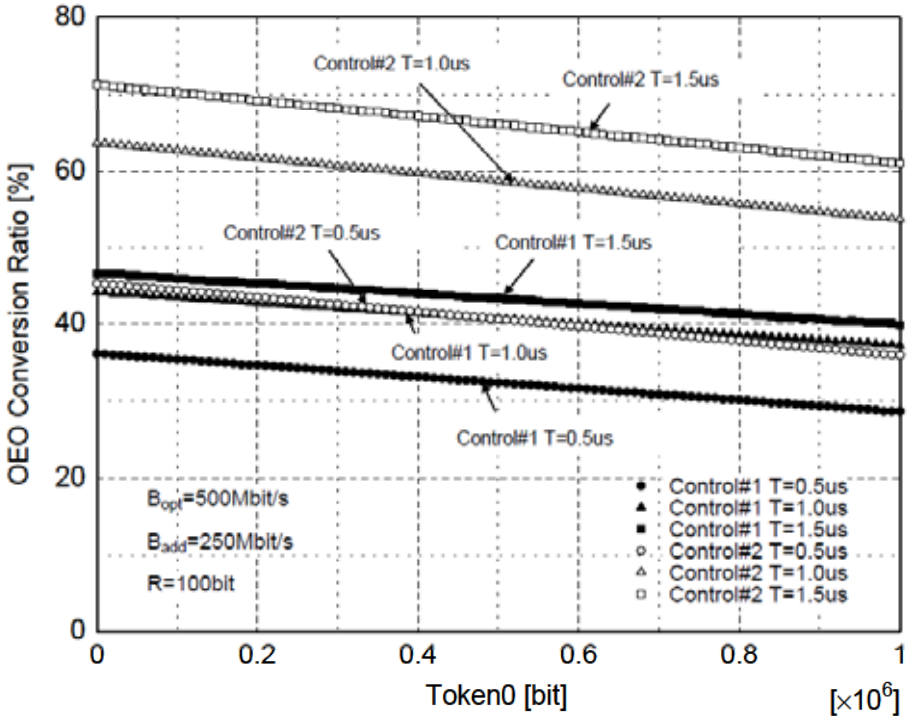


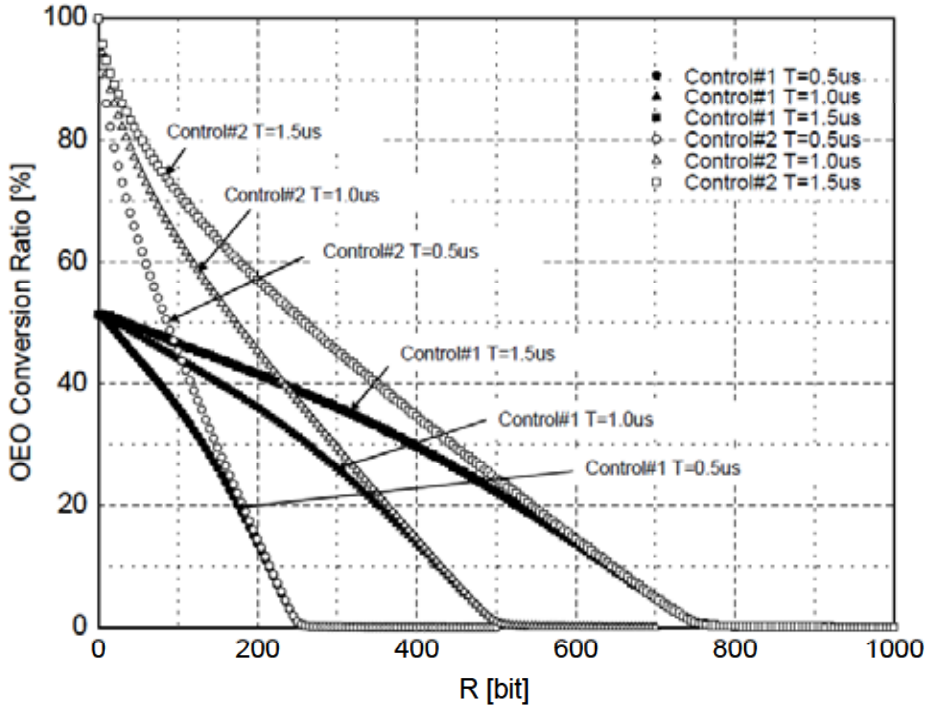
4 Characteristics and parameter setup

【Control#2】 Token criteria



4 Characteristics and parameter setup





The system can also control the number of OEO conversions by adjusting Token0 and R.

4 Characteristics and parameter setup

<Set up procedure>

(1) Set the OEO conversion ratio

(2) Check each bandwidth

(3) Set the number of tokens, R, the cycle given for the number of tokens, T, and the initial value of the number of tokens, Token0, by looking up the database.

// Repeat the above procedure at regular interval.

5 Summary

- We proposed the dynamic control method of queuing delay that uses a token bucket technique.

- We clarified the relationships between the number of OEO conversions and the token parameters.

Various QoS services can be supported in future !!