Abstract—A channel-shared modified accelerative pre-allocation wavelength division multiple access (CMAP-WDMA) media access control (MAC) has been proposed for metro-WDMA networks, as an extension of modified pre-allocation wavelength division multiple access (MAP-WDMA) MAC protocol. Similarly, CAP-WDMA as an extension of accelerative pre-allocation wavelength division multiple access (AP-WDMA) MAC protocol. Performance of CMAP- and CAP-WDMA was extensively investigated under several channel sharing methods (CSMs), asymmetric traffic load patterns (TLPs), and non-uniform traffic distribution patterns (TDPs). The result showed that the channel utilization of the CMAP-WDMA always outperforms that of CAP-WDMA at the expense of longer channel access delay for channel shared case while CMAP-WDMA provided higher channel utilization at specific network conditions but always shorter channel access delay than CAP-WDMA for non-channel shared case. Additionally both for CMAP- and CAP-WDMA, determining an effective CSM is a critical design issue because TDPs and TLPs can be neither managed nor expected while CSM is manageable, and the CSM supporting the best channel utilization can be recommended.

Index Terms—Channel sharing, channel utilization, delay, MAC, traffic, metro-WDMA networks

I. INTRODUCTION

The advance of optical communication technologies have boosted that a volume of multimedia traffic can be simultaneously transmitted between backbone and access networks. This huge traffic brings a bottleneck problem originating from capacity gap between the two networks. A metro-WDMA network based on WDM technology can manage the gap by interconnecting the two networks such that it can result in high transmission rate [1][2]. The transmission efficiency can be further enhanced by designing a proper media access control (MAC) protocol on the top of given network infrastructure because higher layer services are built on the fundamental packet transfer provided by a MAC sub-layer [3]. To this end, a modified accelerative pre-allocation WDMA (MAP-WDMA) has been proposed for the efficient packet transfer via a modified early transmission (MET) stage under a non-channel shared environment, as well as compared its performance with that of a previous approach, AP-WDMA in [4].

However, the resource shortage (e.g., wavelengths) of the network can induce collisions or contentions among stations because the number of channels can be practically lower than that of stations due to restricted number of channels and receiver tuning range such that channel sharing among stations is inevitable. This problem can be resolved by employing optical code division multiple access (OCDMA) technique together with employed MAC protocols, but it provides limited network functionalities and increases system complexity at the expense of high capacity [5]. On the other hand, we can manage the resource insufficiency by extending MAC protocols as suitable as for a channel shared environment. Accordingly, it is necessary to extend MAP-WDMA to be effective even for a channel shared environment and thus generalize it for both channel conditions. Compared with [4], MAP-WDMA considering channel sharing introduces the term of a source group, a group of stations sharing the same channel, and strengthens the priority issue of the source group to avoid contentions among stations for a packet transfer. The issues include the assignation of proper priority to stations in a source group and equivalent circulation of the highest priority among stations to pursue the fairness of packet transfer opportunity. Also, the way to turn over the packet transfer opportunity to the stations with lower priority in order to increase resource efficiency needs to be considered.
In addition, the performance of MAP-WDMA needs to be extensively investigated under diverse network environments, compared with [4] where the performance has been simply analyzed under symmetric traffic load pattern (TLP), an incoming pattern of traffic loads to all stations. As the TLP is hard to predict due to the influx of integrated traffic streams via Internet, it brings much complexity to the performance analysis [6][7]. Thus, the performance investigation needs to be executed under the asymmetric TLP along with various non-uniform traffic distribution patterns (TDPs), a distributive pattern of the traffic load flown into a station to other stations [3][8]. Further, how to group stations should be considered to obtain higher performance because a proper channel sharing method (CSM) can improve performance by efficiently balancing traffic loads for channel shared environment [9][10].

In this regard, we generalize MAP-WDMA to handle the channel shared case, into channel-shared modified accelerative pre-allocation wavelength division multiple access, namely CMAP-WDMA. Similarly, CAP-WDMA from AP-WDMA. The performance of CMAP-WDMA, including latency, channel utilization, and channel access delay are analyzed and compared with those of CAP-WDMA considering diverse network environment scenario. And, an adequate CSM providing the best performance is determined according to TDPs and TLPs as a design issue.

II. NETWORK ARCHITECTURE

Fig. 1 shows the metro-WDMA network, briefly composed by N stations, a passive star coupler (PSC) and optical fibers. Each station broadcasts its packets onto the medium, and other stations determine to receive or discard them. Although the traffic can be various such as video, voice, and data, the packet streamed among stations except control and ACK packets is simply denominated as a data packet. C wavelengths are dedicated to N stations as channels.

III. CMAP-WDMA MAC PROTOCOL

In this section, CMAP- and CAP-WDMA are demonstrated cycle by cycle. The processing time of both MAC protocols is also specified in Figs. 2 and 3, as similar as in [4].

Table 1. Network parameter descriptions.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>j</td>
<td>Identification number (IN) of a destination</td>
</tr>
<tr>
<td>i</td>
<td>IN of a source for non-channel shared case</td>
</tr>
<tr>
<td>a</td>
<td>IN of a source for channel shared case</td>
</tr>
<tr>
<td>c</td>
<td>IN of a source group</td>
</tr>
<tr>
<td>s</td>
<td>The number of sources in c (s =</td>
</tr>
<tr>
<td>S_e</td>
<td>A set of sources belonging to c</td>
</tr>
<tr>
<td>r</td>
<td>The number of idle source groups</td>
</tr>
<tr>
<td>A</td>
<td>The number of time slots shifted forward</td>
</tr>
<tr>
<td>T_p/T_c</td>
<td>Propagation delay/receiver tuning delay</td>
</tr>
<tr>
<td>T_α/τ</td>
<td>Time to check B_α/τ that to check B_τ</td>
</tr>
<tr>
<td>T_s</td>
<td>Time to send a control packet</td>
</tr>
<tr>
<td>T_d</td>
<td>Time to send an ACK packet</td>
</tr>
<tr>
<td>T_XY</td>
<td>Cycle processing time (CPT) where</td>
</tr>
<tr>
<td>X</td>
<td>= {C(control), A(ACK), D(Data)},</td>
</tr>
<tr>
<td>Y</td>
<td>= {CAMAP, CAP}</td>
</tr>
<tr>
<td>T_CPT</td>
<td>Total CPT</td>
</tr>
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</table>

Each station has a fixed wavelength transmitter and a fixed wavelength receiver for control signaling. A fixed wavelength transmitter and a tunable wavelength receiver are employed for a data packet transmission. There are \((N-1)\) buffers to reserve outgoing packets, denoted as \(B_{RN}\) corresponding to other \((N)\) stations. There is a buffer to reserve incoming packets, named as \(B_{RX}\). The buffering capacities of all \(B_{RN}\)s in \((N)\) stations are assumed to be equivalent, and those of all \(B_{RX}\)s in \((N)\) stations are also same. A pair of optical fibers connects a station with others via the PSC. The propagation distances between the PSC and all stations are assumed to be equivalent such that the propagation delay offset induced by different propagation distances among stations can be negligible.
A control cycle for CMAP-WDMA is time-interleaved order of \( c \) \((1 \leq c \leq C)\) and based on following priority rules.

- A control cycle of sources in \( c \) is executed according to their priority; the priority is kept during one period and repeated per \( s \) periods.
- If \( a \) has the highest priority in \( c \) and data packets for \( j \), based on the pre-allocated map in [3], \( a \) can transmit a control packet to \( j \).
- The sequence having the highest priority is \( \ldots \rightarrow a \rightarrow a + 1 \rightarrow \ldots \rightarrow a - 1 \rightarrow a \rightarrow a + 1 \rightarrow \ldots \)
- If \( a \) has the highest priority but no data packets for \( j \), the chance is passed to the second prioritized source. The second prioritized source works as same as \( a \). When \( a \) is the most prioritized during one period, the chance is transferred \( a \rightarrow a + 1 \rightarrow a + 1 \rightarrow \ldots \rightarrow a - 2 \rightarrow a - 1 \).

If at least a source in \( c \) has data packet to \( j \), it can send a control packet for \( j \). Otherwise, all sources in \( c \) wait for an ACK cycle, as shown in Fig. 3. (b). In CAP-WDMA, a control cycle is also time-interleaved order of \( c \). Though the priority among sources in a source group is not issued for AP-WDMA in [3], it is assumed that the priority is changed as the increment of \( a \) in \( c \) and kept for a period to investigate the performance under the same conditions as CMAP-WDMA. \( a \) with the highest priority during a period can send a control packet if \( a \) has a data packet for \( j \). If \( a \) does not have a data packet for \( j \), \( a \) finds another destination \( j \) where it has data packet and transmits a control packet to \( jj \), as shown in Fig. 3. (c).

B. ACK cycle

An ACK cycle of CMAP-WDMA is implemented as an increasing order of \( j \). If \( j \) receives a control packet from the pre-allocated source \( a \) in \( c \), \( j \) sends an ACK packet to \( a \). When \( j \) does not receive a control packet, \( j \) firstly checks all idle source groups. Then, \( j \) tries the MET to send an ACK packet to idle source \( aa \) in one of idle source group \( cc \) if \( aa \) is the most prioritized in \( cc \) with the smallest \( h \), as illustrated in Fig. 3. (b). Otherwise, \( j \) cannot transmit an ACK packet to any stations and just waits for a data cycle. The MET is different according
to \( r (1 \leq r \leq C) \). When \( r \) is 1, 2, or \( C \), the MET is executed by moving a source group destination pair (SGDP) \( N \) time slots forwards \((h = N)\). Otherwise, corresponding \( h \) is in the range of \((1 \leq h \leq N)\).

In CAP-WDMA, an ACK cycle is also executed as an increasing order of \( j \). If \( j \) has received a control packet from the most prioritized source \( a \) in the pre-assigned source group \( c \), it sends an ACK packet to \( a \). Otherwise, if \( j \) has received a control packet from a instead of \( j \), and \( a \) is the only source having sent a control packet to \( j j \), it sends an ACK packet to \( a \). Otherwise, \( jj \) checks sources in \( B_{tx} \), which have transmitted their control packets to \( jj \), to select the source with the smallest \( h \), and \( jj \) sends an ACK packet to the source, as shown in Fig. 3 (c).

C. Data cycle

In both data cycles of CMAP- and CAP-WDMA, the data packet transmission of all stations is concurrently executed. In CMAP-WDMA, the pre-allocated SGDP \((c, j)\) transmits and receives data packets as scheduled, or new SGDP \((cc,j)\) executes data packet transmission, if \( a_{cc} \), the most prioritized station in \( cc \) and has a data packet for \( j \). Otherwise, no data packet transmission is achieved. In CAP-WDMA, the data packet transmission of the pre-assigned SGDP \((c, j)\) or a new SGDP \((c, jj)\) is executed, as shown in Fig. 3.

It is noteworthy that MAP- and AP-WDMA are trivial cases of CMAP- and CAP-WDMA, respectively. Accordingly, the time flow, MET, and ET flow chart of CMAP- and CAP-WDMA for non-channel shared case \((N = C)\) specified in [4] can be equivalently illustrated with those for channel shared case by excluding the priority checking procedures in a control cycle and changing several terminologies, including \( N \) time slots to \((N - 1)\) time slots for a period \( a \) to \( i \), and SGDP to SDP in Figs. 2 and 3.

V. PERFORMANCE ANALYSIS OF CMAP-WDMA MAC PROTOCOL

In this section, the performance parameters of CMAP- and CAP-WDMA are derived, and all derivation details are simply described, based on [4].

A. Latency Analysis

The latencies of CMAP- and CAP-WDMA, \( L_{CMAP} \) and \( L_{CAP} \), are commonly defined as the sum of the total CPTs of three cycles, \( T_p \), and \( T_r \), as shown in Fig. 2. To obtain \( L_{CMAP} \) and \( L_{CAP} \), the total CPTs need to be derived in advance. As \( N \) stations can transmit control packets, \( T_{CMAP} \) is expressed as \( N \times (T_{tx} + T_{tx} + T_{px}) \). In CAP-WDMA, as the most prioritized source of a source group tries a data packet transmission, \( T_{CAP} \) is obtained as \( C \times ((N - 1) \times T_{px} + T_{tx} + T_{px}) \). And, \( T_{CMAP} \) and \( T_{CMAP} \) are respectively represented as \( N \times (T_{tx} + r \times T_{tx} + T_{px}) \) and \( N \times (T_{tx} + T_{px}) \) because all destinations should execute their ACK cycles in turn whether they have received control packets or not. In \( T_{CMAP} \), \( r \) should be fixed as \( C \) to match the synchronization of the time slot. Latency difference, \( PL \), is positive because of \( N \geq C \), demonstrating that CMAP-WDMA takes more time than CAP-WDMA.

B. Channel Utilization Analysis

The channel utilization of CMAP-WDMA, \( U_{CMAP} \), is obtained from \( R_{c\text{CMAP}}(h) \), which is the probability that at least a source in \( c \) succeeds data packet transmission to \( j \) with the help of the MET \((0 \leq h \leq N)\) at present time slot and is represented as

\[
R_{c\text{CMAP}}(h) = \left\{ \begin{array}{ll}
1 - \prod_{a \in S_{c}, a \neq j} (1 - \sigma_a p_{aj})^N, & h = 0 \\
\frac{C - 3}{2CN} \prod_{a \in S_{c}, a \neq j} (1 - \sigma_a p_{aj})^N, & 1 \leq h \leq N - 1 \\
\frac{3N + C - 3}{2CN} \prod_{a \in S_{c}, a \neq j} (1 - \sigma_a p_{aj})^N, & h = N
\end{array} \right.
\]

where \( \sigma_a \) is the traffic load flown into \( a \) and the matrix element of a TLP. \( p_{aj} \) is the probability that \( a_j \) is distributed to \( j \) and the matrix element of a TDP. Eq. (1) is a generalized version of Eq. (10) in [4], which is just confined to non-channel shared case, by changing several parameters \((C \leq N, N \leq (N - 1), a \leq c \) and \( a \) to \( i \) such that the derivation of Eq. (1) can be similarly explained as in [4]. Finally, \( U_{CMAP} \) is obtained by adding \( R_{c\text{CMAP}}(h) \) according to \( h \) and averaging it with respect to \( c \) and \( j \). The channel utilization of CAP-WDMA, \( U_{CAP} \), is referred in [3].

C. Channel Access Delay Analysis

The channel access delay of CMAP-WDMA, \( D_{CMAP} \), is defined as the waiting time until \( c \) succeeds a packet transfer with the help of MET though it has failed at its pre-allocated time slot. \( D_{CMAP} \) is obtained by averaging \( D_{c\text{CMAP}}(k) \) according to \( k \) \((1 \leq k \leq N)\), \( j \), and \( c \) where \( k \) is the number of waiting time slots until successful data packet transmission.
$D_{cCMAP}(k)$ is the multiplication of $k \times L_{CMAP}$ and $P_{cCMAP}(k)$ that is the probability the data packet transmission of a SGDP $(c,j)$ succeeds at the time slot pre-assigned for a SGDP $(c,j \oplus k)$ and given as $P_{cCMAP}(k) = A \times B \times D \times E$

$$A = [1 - R_{cCMAP}(0)] \times \prod_{t=1}^{k-1} [1 - R_{c(\oplus t)CMAP}(N - t)]$$

$$B = R_{c(j\oplus k)CMAP}(N - k)$$

$$D = \prod_{c=1}^{w=N-k} \left[ 1 - R_{c(j\oplus k)CMAP}(w) \right]$$

$$E = \sum_{u=1}^{(N-k)} \left\{ 1 - R_{(c\oplus u)(j\oplus k)uCMAP}[N - (k \oplus u)] \right\}$$

in case of $(1 \leq k \leq N - 1)$. The explanation of $A$, $B$, $D$, and $E$ is similarly given in [4]. For $k = N$, $P_{cCMAP}(k)$ is expressed as $1 - \sum_{k=1}^{N} P_{cCMAP}(k)$. In CAP-WDMA, $P_{cCAP}(k)$, the counterpart of $P_{cCMAP}(k)$, is obtained by replacing $R_{cCMAP}(k)$ in Eq. (1) with $R_{c}(h)$ in [3], and the counterpart of $D_{CMAP}$ in CAP-WDMA, $D_{CAP}$, can be derived under the same procedure as $D_{CMAP}$.

V. NUMERICAL RESULTS OF PERFORMANCE PARAMETERS

In this section, the analytic behaviors of CMAP- and CAP-WDMA are investigated under diverse network environments.

A. Latency

As shown in Fig. 4, the latencies of CMAP- and CAP-WDMA are illustrated according to $c$. The values of $t_{tx}$, $t_{rx}$, $T_s$, $T_p$, and $T_r$ are given as same as the counterparts in [4]. As a result, $L_{CMAP}$ and $L_{CAP}$ for non-channel shared case (case I) show insignificant difference. However for channel shared case (case II), $L_{CMAP}$ is higher than $L_{CAP}$, and this situation becomes remarkable as $C$ increases. These results are originating from that all sources can try control cycles in CMAP-WDMA, while the most prioritized source can try a control cycle in CAP-WDMA such that the total CPT difference of the two protocols increases.

B. Channel Utilization

To investigate $U_{CMAP}$ and $U_{CAP}$, following network environments are considered. First, we employ three heuristic CSMs, including neighboring CSM (N-CSM), even-odd-neighboring CSM (EON-CSM), and interleaved CSM (I-CSM). The source grouping of N-CSM and I-CSM is explained in [3], that of EON-CSM is represented as $c = \frac{i}{2}$ for odd number indexed stations and $c = \frac{i}{2} + \frac{N}{2}$ for even number indexed stations. Second, we consider three asymmetric TLPs, including M type, D type, and W type TLPs which are expressed as $(1 \times N)$ matrix, and its element corresponding to $i_{th}$ column is an ingress normalized traffic load to $i$. Here, we exemplify three TLPs for numerical analysis at $N = 8$ as:

- $M_{MB} = [0.75, 0.375, 0.5, 0.625, 0.625, 0.5, 0.375, 0.75]$ for M type TLP
- $M_{DB} = [0.125, 0.25, 0.375, 0.5, 0.625, 0.75, 0.875, 1]$ for D type TLP
- $M_{WB} = [0.125, 1, 0.125, 0.125, 0.125, 1, 0.125]$ for W type TLP

These three TLPs are designed to have the same average of traffic loads as 0.5625 but different standard deviation (STD), $d_{TLP}$, an indicator of TLP asymmetry. Namely, the higher $d_{TLP}$ is, the severer the TLP asymmetry results in. The $d_{TLP}$s of the three TLPs at $N = 8$ are 0.14, 0.28, and 0.44, respectively. These matrices can be expanded for another value of $N$ with similar patterns. Third, we employ uniform TDP and three non-uniform TDPs, including disconnected type, mesh type, and ring type TDPs as in [3][8].

Under aforementioned conditions, following results are provided. Although the results shown in Figs. 5 and 6 do not involve all conditions, it is shown that $U_{CMAP}$ for case II is mostly higher than $U_{CAP}$ regardless of $N$, $C$, TLPs, TDPs, and CSMs except low traffic load ($\sigma \leq 0.2$), which is opposite to the
result of case I because sources in $C$ of CMAP-WDMA can execute their control cycles according to given priority. Following performance results are analyzed to provide a CSM supporting the best performance with respect to TLPs and TDPs. At symmetric TLP in CMAP-WDMA, the performance and the determination of a proper CSM are only determined by $d_{TDP,CSM}$, the intensity of TDP non-uniformity, which is represented as

$$d_{TDP,CSM} = \left( \frac{1}{C} \sum_{c=1}^{C} X_{TDP}^c - \left( \frac{1}{C} \sum_{c=1}^{C} X_{TDP}^c \right)^2 \right)^{\frac{1}{2}}$$  \hspace{1cm} (3)$$

where $X_{TDP} = \frac{1}{2} \sum_{a \in S_c} p_{ai}$. Namely, the higher $d_{TDP,CSM}$ is, the poorer channel utilization is guaranteed. Thus, through numerical analysis, the performance order of CSMs according to TDPs is as follows:

- At disconnected type TDP: I-CSM > EON-CSM > N-CSM.
- At mesh type TDP: N-CSM > EON-CSM > I-CSM.
- At ring type TDP, the performance order of CSMs is negligible.

For an instance, I-CSM can be recommended when the traffic is symmetrical flown into a station but distributed to others with a disconnected manner. These results hold even though $N$ and $C$ change, and whether traffic load is high or low. For CAP-WDMA, several CSMs do not affect channel utilization at symmetric TLP because only one source in a source group can try a packet transfer such that the combination of TDP and CSM does not significantly affect the performance.

At asymmetric TLP for case I, $U_{CMAP}$ is even higher than $U_{CAP}$ when $d_{TLP}$ is high like W type TLP, as shown in Fig. 6. It implies that CMAP-WDMA is more tolerable to the asymmetric TLP than CAP-WDMA even in case I. For case II, $U_{CMAP}$ depends on two parameters including $d_{TDP,CSM}$ and $d_{TLP,CSM}$ which is the intensity of TLP asymmetry and represented as

$$d_{TLP,CSM} = \left( \frac{1}{C} \sum_{c=1}^{C} X_{TLP}^c - \left( \frac{1}{C} \sum_{c=1}^{C} X_{TLP}^c \right)^2 \right)^{\frac{1}{2}}$$ \hspace{1cm} (4)$$

where $X_{TLP} = \frac{1}{2} \sum_{a \in S_c} p_{ai}$. Even though $d_{TDP,CSM}$ and $d_{TLP,CSM}$ can affect on $U_{CMAP}$, we select a CSM by considering only one of the two parameters inducing greater performance variation. On the other hand, as $U_{CAP}$ is only determined by $d_{TLP,CSM}$. That is, $d_{TLP,CSM}$ is the only factor. For an instance, at
Won Park and Yong WDMA according to asymmetric TLPs at $N = 32$, uniform TDP employing N-CSM for $N \geq C$.

disconnected type TDP, following performance order is obtained:

- At M type TLP: N-CSM > EON-CSM > I-CSM ($d_{\text{TLP}_{\text{CSM}}}$) and I-CSM > EON-CSM > N-CSM ($d_{\text{TDP}_{\text{CSM}}}$). As the variation induced by $d_{\text{TLP}_{\text{CSM}}}$ is much greater than that by $d_{\text{TDP}_{\text{CSM}}}$, the order is shown as I-CSM > EON-CSM > N-CSM.
- At D type TLP: As the variation order due to $d_{\text{TLP}_{\text{CSM}}}$ is the same as that due to $d_{\text{TDP}_{\text{CSM}}}$, the order is shown as I-CSM > EON-CSM > N-CSM.
- At W type TLP: N-CSM > EON-CSM > I-CSM ($d_{\text{TLP}_{\text{CSM}}}$) and I-CSM > EON-CSM > N-CSM ($d_{\text{TDP}_{\text{CSM}}}$). As the variation induced by $d_{\text{TLP}_{\text{CSM}}}$ is much greater than that by $d_{\text{TDP}_{\text{CSM}}}$, the final performance order is N-CSM > EON-CSM > I-CSM.

The performance order of CSMs due to other TDPs can be similarly obtained through numerical analysis.

C. Channel Access Delay

As shown in Figs. 7 and 8, $D_{\text{CMAP}}$ is shorter than $D_{\text{CAP}}$ for case I because $U_{\text{CMAP}}$ is roughly better $U_{\text{CAP}}$ under most non-uniform TDPs and large valued $N$. This result is induced by that the possibility of a successful data packet transmission for originally pre-assigned SDP becomes high such that one SDP, having failed its data packet transmission at its pre-allocated time slot, has lower possibility to succeed MET or ET.

Contrarily, for case II, $D_{\text{CMAP}}$ is longer than $D_{\text{CAP}}$ regardless of $N$, $C$, and several TDPs, TLPs, and CSMs because of two reasons. One is that $L_{\text{CMAP}}$ is higher than $L_{\text{CAP}}$ to improve channel utilization, as illustrated in Fig. 4. Another is that $U_{\text{CMAP}}$ is better than $U_{\text{CAP}}$. Accordingly, whether TLP is symmetric or asymmetric, and which TDP is employed, the performance order of channel access delay according to CSMs is opposite to that of channel utilization. For example, if the performance order of channel utilization lines up as I-CSM, EON-CSM, and N-CSM, that of the channel access delay follows as N-CSM, EON-CSM, and I-CSM. As mentioned, the performance order according to CSMs is reversed at symmetric TLP, but the performance difference among the three CSMs induced by channel access delay is insignificant, compared with that induced by channel utilization. Further, at asymmetric TLP, this result still holds, as shown in Fig. 8. In this regard, it is better to select a CSM supporting higher channel
utilization at the expense of an unremarkable channel access delay increment.

V. CONCLUSIONS

MAP-WDMA MAC protocol designed to provide an efficient packet transfer for a non-channel shared metro-WDMA network has been generalized as CMAP-WDMA to be even suitable to a channel shared case. Remarkable change is taken a place in a control cycle where all sources in a source group try packet transmission under proposed priority rules, and a MET stage can be only executed when all sources have no transmittable packets. And, the performance of CMAP-WDMA is extensively investigated and compared with that of CAP-WDMA, an extended version of AP-WDMA considering channel sharing under practical network environments. As a result, a trade-off between high channel utilization and short channel access delay exists between two MAC protocols according to channel conditions. Namely, improved channel utilization in CMAP-WDMA is achieved at the expense of longer channel access delay, compared with those of AP-WDMA for the channel shared case, which is completely opposite to the non-channel shared case. Through analytic behavior investigation, the choice of an appropriate CSM supporting the best channel utilization can be a critical design issue case by case with respect to various TDPs and TLPs. Further, this performance analysis can be adaptively expanded to other analytic TDP, TLP, and CSMs models.

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