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Network Flexibility with Multicast Scheduling Algorithms for OFDMA Relay Networks

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Abstract: In the cell systems are move towards smaller cells, orthogonal frequency division multiple access (OFDMA) is a two-hop organizing. The hand-off systems have turned out to be most utilized segment as a part of 4G standards(WiMAX 802.16j, 3GPP LTE-Adv).In the unicast flows are receive an attention in two-hop OFDMA relay networks are not easy to handle on the design of efficient scheduling algorithms in multicast flows. Nowadays multimedia is growing heavily, the importance of multimedia broadcast and multicast services in 4G networks. Whenever work with relay cooperation is critical for improving multicast performance, so we have to balanced with the ability to multiplex multicast sessions and When increasing aggregate multicast flow. Then we highlight policies that carefully group relays for corporation then we balance the ability to multiplex multicast sessions. We then solve the multicast scheduling problem under two OFDMA sub channelization models. We propose the NP-hardness of scheduling by using simpler model and provide efficient algorithms. Evaluation of the proposed solutions revels the efficiency of the scheduling algorithms and significant benefits obtain from the multicasting strategy. The approximation guarantees under both models.

Keywords: Session Multiplexing, Orthogonal Frequency-Division Multiple Access (OFDMA), Relay Cooperation, Scheduling, Wireless Multicast.

I. INTRODUCTION

With the cutting edge remote systems moving toward littler (miniaturized scale, pico) cells for giving higher information rates, there is a resuscitated enthusiasm for multihop remote systems from the viewpoint of coordinating them with cell systems. With an abatement in cell size, hand-off stations (RS) are presently expected to give augmented scope. In this connection, two-jump hand-off empowered remote systems [Fig. 1(a)] have turned into a predominant, required part in the 4G benchmarks (WiMAX 802.16m [1], 3GPP LTE-Adv [2]) because of the plenty of imagined applications (hotspots, office structures, underground passage access, and so on.) they bolster. Orthogonal Frequence division multiple access (OFDMA) has turned into the famous decision for air interface innovation in 4G systems. The whole range is devided into numerous transporters (subchannels), considering various clients to work in pair. This prompts a few physical-layer and planning advantages [3], [4]. The two-bounce system model combined with OFDMA gives a few several qualities (multiuser, channel, and helpful) picks up that can be utilized through shrewd booking. While a few planning works [5]–[7] have concentrated on unicast movement for two-bounce OFDMA transfer systems, multicast activity has not been investigated much in these systems. With 4G systems turning into a key part in the substance conveyance chain, interactive media Broadcast and multicast services (MBMS [8]) are picking up significance as an effective intends to scatter basic data to supporters. The configuration of productive booking calculations for multicast traffic forms a basic part of MBMS and thusly frames the focus of this paper. Multicasting in two-hop relay networks is essentially not the same as the ordinary cellular multicast: The broadcast preference of multicast information is fundamentally decreased on the entrance (second) jump [Fig. 1(a)], where they get to be equal to various unicast transmissions from various RS to Mobile Stations (MS), in this way requiring more transmission assets. Hand-off collaboration components permit numerous RS to all the while transmit the multicast information on the same transmission resource. This holds the broadcast nature of the traffic on the access hop,making cooperation a critical component in improving multicast performance.

II. SYSTEM DESCRIPTION

A. Related Work

Relays: Several works [7], have researched the capability of hand-off empowered remote systems to give enhanced scope and limit. Booking of unicast information has gotten higher accentuation [5]–[7], so far in these systems. The majority of the prior works [10], [11] concentrated on TDMA variations where the planning choice lessens basically to choosing whether to utilize a transfer or not and for which specific client. They don't abuse various OFDM channels and the subsequent differing qualities accessible over the transfer and get to jumps. Then again, OFDM planning answers for routine cell systems[3],[5] can't be straight forwardly stretched out to two-bounce hand-off systems, where stream preservation crosswise over jumps frames a vital segment. The later works [5]–[7] have taken a gander at utilizing differing qualities and spatial reuse picks up in transfers utilizing OFDMA. In any case, every one of these works are limited to unicast information. Multicasting: Unlike unicast works, the OFDMA booking takes a shot at multicast information have to a great extent been limited to one-jump cell systems [7]. These arrangements can't be specifically extended to transfer systems, where the way of multicast movement and its telecast leverage is essentially adjusted on the entrance jump. Multicasting with transfers has gotten expanded consideration as of late. Data theoretic works [9] have taken a gander at limit limits for a multicast framework with transfers. Utilization of system coding at transfers to encourage multicasting has likewise been concentrated on in [12], [13]. Layered video, being a prominent application for multicast, has been upgraded for transfers. While every one of these works have taken a gander at different parts of multicast transmission with transfers, they don't consolidate OFDMA planning. Notwithstanding making the issue essentially diverse, fuse with OFDMA booking is additionally a critical part in cutting edge broadband access systems like LTE and WiMAX. In this course, our earlier work [12] considered the reconciliation of multicast and unicast activity in hand-off systems with OFDMA and provided some scheduling heuristics for the coexistence of heterogeneous traffic. However, it did not consider session multiplexing or its tradeoff with relay cooperation that arises within multicast scheduling and, hence, did not address the multicasting problem with relays rigorously.

B. System Model

We consider a downlink OFDMA-based, transfer empowered, two-bounce remote system as appeared in Fig. 1(a). An arrangement of M MS are consistently situated inside of the large scale cell. A little arrangement of R RS are added to the halfway belt of the system ($R < M$). MS more remote from the base station (BS) interface with the RS that is nearest to them taking into account most noteworthy sign to-clamor proportion (SNR). The one-bounce joins in the middle of BS and RS are alluded to as hand-off joins, in the middle of RS and MS as access connections, and in the middle of BS and MS as immediate connections (equal to transfer joins for booking purposes).

Downlink information streams are considered and expected to start in the Internet and predetermined toward the MS. All stations are thought to be half-duplex. Let P_B, P_R denote the most extreme force utilized by the BS, RS for their transmission ($P_R \leq P_B$), which is part similarly over all sub channels, and no force adjustment crosswise over channels is expected, given the negligible additions coming about because of it [6]. An arrangement of aggregate OFDM sub channels is considered, with two models for gathering of subcarriers to frame a sub channel [1]: dispersed change (DP) and bordering stage (CP). As the name recommends, the subcarriers constituting a sub channel are picked arbitrarily from the whole recurrence range in DP, while contiguous subcarriers are picked in CP. In DP, a solitary channel quality worth (arrived at the midpoint of over whole range), which is regular to all its sub channels, is encouraged back by a RS/MS. This permits a RS/MS to utilize a typical rate on all sub channels. While the arbitrary decision of subcarriers in a sub channel kills channel assorted qualities, it midpoints out impedance and diminish criticism. Then again, in CP, the high connection in channel picks up crosswise over nearby subcarriers influences sub channel differences, whereby a RS/MS can utilize diverse rates to suit distinctive sub channel increases through planning. Be that as it may, this requires criticism on all suit different sub channel gains through scheduling. However, this requires feedback on all sub channels from RS/MS. Note that the measurement, feedback, and choice of rate levels (modulation and coding levels, MCS) are standardized [1] for the two modes and directly provided by the MS (through RS) and RS to the BS in uplink frames, which the BS then directly uses for scheduling its transmissions to the RS and MS. Hence, for scheduling purposes, it suffices to model the rates being same (DP) or different (CP) on different sub channels for a user.

C. Potential Gains

Relay networks give three types of assorted qualities picks up. Consider the frequency response of three channels for three MS in Fig. 1(b). Multipath fadding and client mobility result in free blurring crosswise over clients for a given channel, adding to multiuser assorted qualities. Besides, the vicinity of various channels and the relating recurrence specific blurring results in various channels encountering distinctive increases for a given MS, adding to channel differing qualities. These additions make it conceivable to schedulemultiple clients in coupled, while giving great quality channels to a large number of them (e.g., channels 3, 2, and 1 distributed to MS 1, 2, and 3, separately).

D. Planning Model

Frame Structure: We consider a synchronized, time-opened framework (WiMAX, LTE) with BS and RS transmitting information in casings. Each edge comprises of a few time-spaces and must be populated with client assignments crosswise over channels for LTE (no channel sharing crosswise over openings) and client assignments crosswise over both time-openings and channels for WiMAX. To address both models nonexclusively, it is adequate to consider the issue with one time-opening per outline since directs in other time-spaces can be considered as extra channels accessible to the time-space under thought [6], [15]. Besides, the opened casing structure permits us to decouple the planning of unicast and multicast movement, with our attention being on the last mentioned.

III. MULTICASTING STRATEGY

A. Participation versus Session Multiplexing

While relay cooperation is critical for multicast, the key question, however, is the following: Is relay cooperation always beneficial? Interestingly, there exists a subtle tradeoff between cooperation gains and the ability to multiplex multicast sessions effectively, both of which are essential for maximizing the aggregate multicast system performance. Consider the following example with two sessions and 10 channels on each hop (Fig. 2, $w_k = 1$). Users 1, 3 belong to session, while 2, 4 belong to session. The DP model is considered, where the transmission rate to a user (or relay) per channel does not vary across channels and are directly assumed as indicated in Fig. 2(a) on the relay ($r^{rel}_{a,R1,i} = r^{rel}_{b,R1,i}, r^{rel}_{a,R2,i} = r^{rel}_{b,R2,i}$) and access ($r^{acc}_{a,R1,i}, r^{acc}_{a,R2,i}, r^{acc}_{a,R1,i}, r^{acc}_{b,R2,i}$) hops for a single channel . Note that the purpose of this example is to merely highlight the tradeoff—the actual magnitude of the gains resulting from addressing the tradeoff would in turn depend on various factors such as channel model, transmission power, etc. Furthermore, with relay-hop rates being significantly higher than the access-hop rates in our example, the access hop forms the bottleneck, whose performance consequently depends on the scheduling strategy employed.

In the no-reuse strategy (NR), multicast information lessens to unicast on the entrance bounce, requiring the accessible channels to be part both crosswise over relays and crosswise over sessions inside of a relay. This outcomes in a channel split of (4, 1, 1, 4) channels to clients (1, 2, 3, 4), individually, giving a for each session throughput of 24 Mb/s and a net throughput of 48 Mb/s as showed in Fig. 2(a). At the point when relay participation (C) is utilized for a session, concurrent agreeable transmission from both the relays happen on the same channel to expand the SNR pick up at theMS, which takes into consideration a higher rate to be utilized on a channel on the entrance bounce (e.g., accept 6 Mb/s can be expanded to 7 Mb/s for clients 1, 4, and 48 Mb/s expanded to 50 Mb/s for clients 2, 3) as appeared in Fig. 2(b). In spite of the fact that transmissions crosswise over relays convey the same information on the same channel for a given session, there will be common impedance if the helpful transmissions happen at various rates. Subsequently, the agreeable transmissions need to happen at the same rate (7 Mb/s), namely that of the bottleneck user in the session (user 1 in session 1 and user 4 in session 2). This results in an allocation of five channels for each session with users (1, 2, 3, 4) receiving an allocation of (5, 5, 5, 5) channels, where the five channels are reused across relays within a session (between users 1 and 3 in session A, and 2 and 4 in session B) through cooperation. This provides a per-session throughput of 35 Mb/s and hence a net throughput of 70 Mb/s, which is a gain of about 45% over the baseline.

Now, consider an alternate reuse strategy (**R**), where the available channels on the access hop are reused at each relay. However, instead of coupling themselves through cooperative transmissions (at the bottleneck user rate in the session), the relays operate independently at their respective rates subject to the interference that arises. The resulting channel rates are reduced on the access hop due to interference (e.g., assume 6 Mb/s reduces to 5 Mb/s, and 48 to 45 Mb/s) as indicated in Fig. 2(c). However, decoupling the relays' transmissions now allows us to efficiently leverage the high rates experienced by the session at different relays by allocating varying number of channels across relays unlike in cooperation. This in turn enables statistical multiplexing of sessions, which allows an asymmetric channel allocation to even users within a session, resulting in an allocation of (9, 1, 1, 9) channels to users (1, 2, 3, 4), respectively. Here, the 10 channels are reused at both the relays without any cooperation. This provides a per-session throughput of 45 Mb/s and a higher aggregate multicast flow of 90 Mb/s as shown in Fig. 2(c). This is a gain of about 30% over relay cooperation, which we refer to as the session multiplexing gain. Note that this statistical multiplexing gain comes at the cost of cooperation gain and interference.

Hence, scenarios where users are closer to their associated RS than to the interfering RS (e.g., user clustering in hotspots) are appropriate for leveraging multiplexing gain, where the loss due to interference and consequently also the gain from cooperation tends to be low. On the other hand, when interference across relays is high, the benefits from cooperation outweigh multiplexing gains. This is evident from an alternate (higher interference) example in Fig. 2(d) and (e), where the high interference between relays reduces access-hop channel rates when channels are reused without cooperation (e.g., assume 6 Mb/s reduces to 4 Mb/s for users 1, 4, and 48 to 40 Mb/s for users 2, 3), and translates to increased rates (e.g., assume 6 Mb/s increases to 10 Mb/s for users 1, 4, and 48 to 54 Mb/s for users 2, 3) when cooperation is leveraged with a correspondingly increased session bottleneck rate (10 Mb/s). Here, cooperation provides a higher per-session throughput of 50Mb/s, delivering a net throughput of 100 Mb/s. This is a 35% gain over the 72-Mb/s throughput delivered by reuse strategy. Thus, given a transmit power, every relay pair must determine if the rate loss due to interference is significant enough to translate it to a rate gain through cooperation (**C**), or sustain the interference to leverage session multiplexing gain through channel reuse (**R**).

B. Collaborating Relay Components

To strike a good balance between cooperation and multiplexing gains, we need an intelligent combination of cooperation and reuse strategies. This requires that we first partition the set of active relays into subsets, where: 1) there is negligible interference across relay subsets that promotes better session multiplexing through channel reuse across subsets; 2) the appreciable interference within subsets necessitates cooperation between the member relays serving the same session. We define a relay to be active if it has at least one user subscribed to a multicast session. While relays with no subscribed clients can aid the transmissions in neighboring relays through cooperation, they also reduce the potential gain from session multiplexing by creating more interference and are hence not considered. However, the algorithms can be easily adapted to incorporate inactive relays as well.

IV. MULTICAST SCHEDULING UNDER DP

With distributed permutation, all channels of a session experience the same rate in a component (due to cooperation), but vary across components. The scheduling problem (MDP) can be formulated as the following integer program (IP):

MDP: Maximize $\sum_{k=1}^{K} A_k$

Subject to $F_{k,c}X_{k,c} \geq A_k \forall k \in [1,k], c \in [1,C] \sum_k X_{k,c} \leq N \;\; \forall c;\; X_{k,c} \in \{0,1,\dots,N\}$. $F_{k,c}$ represents the weighted effective rate of session k in component c, i.e., $F_{k,c} = w_k r_k(c)$, where $r_k(c) = \min\{r_k^{rel}, r_k^{acc}(c)\}$ is the bottleneck rate of the session in component that takes into account cooperation and interference. captures the session’s (weighted) effective bottleneck rate, which we also refer to as flow (since it is over two hops). Thus, the goal is to maximize the aggregate flow that can be delivered to multicast sessions. The first constraint captures flow conservation, where the flow received by a multicast session is restricted to the minimum flow (A_k) across all components. Furthermore, while multiple channels can be given to a session ($X_{k,c}$), the total across sessions is restricted to in each component (second constraint). The session’s weight (w_k) is folded into its modified flow rate in each component ($F_{k,c}$). We propose the following linear program (LP)-based polynomial-time algorithm (LSDP) to solve MDP.

Algorithm 1: Multicast Scheduler under DP: LSDP

```
Solve the LP relaxation of MDP with solution $X^*_{k,c}, A^*_k$.
$\mathcal{C} = \{1, \dots, C\}$
while $\mathcal{C} \neq \emptyset$ do
    Loss due to integrality restoration.
    for $c \in \mathcal{C}$ do
        $Z_{k,c} = 0, \forall k, i$ and $B_k = A^*_k, \forall k$.
        for $i \in [1, N]$ do
            $Z_{k',c} = Z_{k',c} + 1$, where $k' =$
            $\arg\max_k \{\min\{F_{k,c}, B_k\}\}$
            $B_{k'} = B_{k'} - \min\{F_{k',c}, B_{k'}\}$
        end for
        $L_c = \sum_k \{A^*_k - Z_{k,c}\} \cdot F_{k,c}$
    end for
    Integral allocation for component with smallest loss.
    $c' = \arg\min_{c \in \mathcal{C}} L_c$
    Update $\hat{X}_{k,c'} \leftarrow Z_{k,c'}, \forall k$
    Update $A^*_k = \min\{A^*_k, F_{k,c'} \cdot \hat{X}_{k,c'}\}, \forall k; \mathcal{C} \leftarrow \mathcal{C} \backslash c'$
end while
```

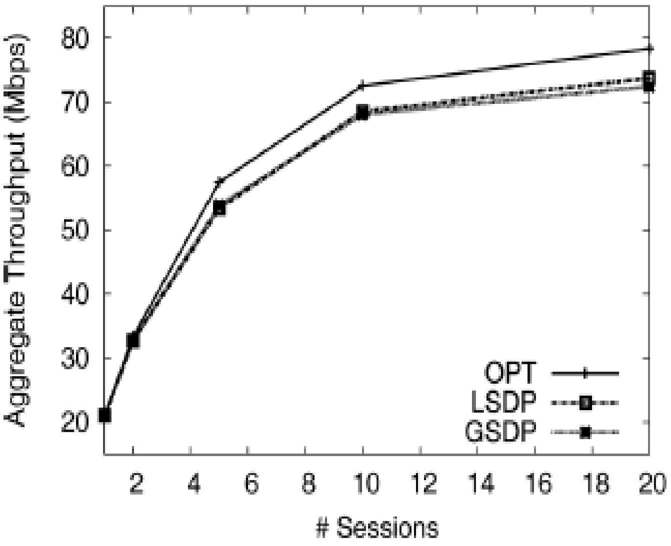
While the standard[1] allows for both DP and CP models, support for DP has been made mandatory due to its simplicity. Furthermore, recall that the scheduler has to run at the granularity of frames (5 ms in WiMAX, 1 ms in LTE). Hence, having a fast but efficient scheduling algorithm for the DP model that can operate in the absence of an LP solver (unlike LSDP) is useful from an implementation perspective.

Algorithm 2: Greedy Scheduler under DP: GSDP

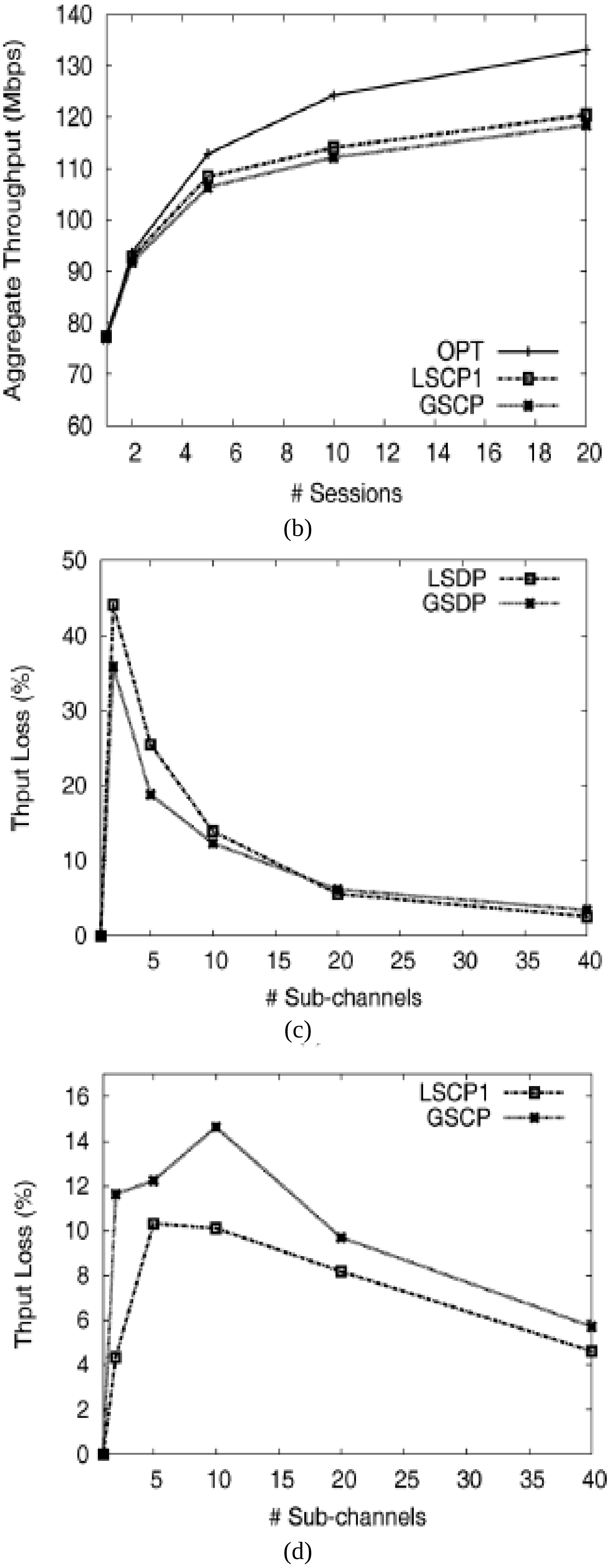
```
$A_{k,c} = 0, E_{k,c} = 0, \forall k, c; valid\_ses = 1,$
$\mathcal{K} = \{1, \dots, K\}$
$U_{k,c} = \frac{F_k^{\min}}{F_{k,c}}, \forall k, c$, where $F_k^{\min} = \min_c F_{k,c}$
Available channels, $M_c = N, \forall c$
while $valid\_ses == 1$ do
    for $k \in [1, K]$ do
        $S_{k,c} = [U_{k,c} - E_{k,c}]^+, \forall c$, where $[x]^+ = \max\{x, 0\}$
        if $\Pi_c(M_c + E_{k,c}) == 0$ then $\mathcal{K} \leftarrow \mathcal{K} \backslash k$ end
    end for
    if $\mathcal{K} \neq \emptyset$ then
        $k' = \arg\max_{k \in \mathcal{K}} \frac{\min_c\{F_{k,c} M_c\}}{\sum_c M_c}$
        $A_{k',c} = A_{k',c} + 1$, if $S_{k',c} > 0, \forall c$
        $E_{k',c} = \frac{A_{k',c} F_{k',c} - \min_c\{A_{k',c} F_{k',c}\}}{F_{k',c}}, \forall c$
        $M_c = N - \sum_k A_{k,c}, \forall c$
    else
        $valid\_ses = 0$
    end if
end while
```

V. PERFORMANCE EVALUATION

An event-driven packet-level network simulator written in C++ coupled with the GNU LP kit is considered for evaluation of the proposed solutions. A single-cell relay-enabled OFDMA downlink system is considered, with a cell radius of 600 m. MS are uniformly distributed within the cell, while RS are distributed uniformly within a region of 250m $\leq$ r $\leq$ 350 m from the BS.



(a)



(b)

(c)

(d)

Fig. 3. Performance of multicast scheduling algorithms. (a) Impact of sessions (DP). (b) Impact of sessions (CP). (c) Impact of channels (DP). (d) Impact of channels (CP).

In summary, depending on various parameters (number of active relays, transmit power, number of components, DP versus CP modes, etc.), the relative importance of reuse versus cooperation strategies varies. This emphasizes the need for a joint reuse and cooperation scheme like JRC that automatically tries to adopt the strategy (or a combination of strategies) that best serves the current network condition.

VI. CONCLUSION

We considered the problem of multicast scheduling in two-hop OFDMA relay networks. We showed that intelligent grouping of relays for cooperation is needed to address the tradeoff between cooperation and session multiplexing gains. We designed efficient scheduling algorithms (with performance guarantees) at the core of the multicast strategy to address the tradeoff and maximize aggregate multicast flow. Design of network coding mechanisms for multicast retransmissions and its joint incorporation with OFDMA scheduling deserves independent attention and forms an interesting avenue for further research.

VII. REFERENCES

[1] N. Challa and H. Cam, “Cost-aware downlink scheduling of shared channels for cellular networks with relays,” in Proc. IEEE Int. Conf. Perform., Comput., Commun., 2004, pp. 793–798.

[2]H. Viswanathan and S. Mukherjee, “Performance of cellular networks with relays and centralized scheduling,” IEEE Trans. Wireless Commun., vol. 4, no. 5, pp. 2318–2328, Sep. 2005.

[3] M. Herdin, “A chunk based OFDM amplify-and-forward relaying scheme for 4G mobile radio systems,” in Proc. IEEE ICC, Jun. 2006, vol. 10, pp. 4507–4512.

[4] A. So and B. Liang, “Effect of relaying on capacity improvement in wireless local area networks,” in Proc. IEEE WCNC, Mar. 2005, vol. 3, pp. 1539–1544.

[5] M. Andrews and L. Zhang, “Scheduling algorithms for multi-carrier wireless data systems,” in Proc. ACM MobiCom, Sep. 2007, pp. 3–14.

[6] K. Sundaresan and S. Rangarajan, “Efficient algorithms for leveraging spatial reuse in OFDMA relay networks,” in Proc. IEEE INFOCOM, Apr. 2009, pp. 1539–1547.

[7] H.Won, H. Cai, D. Y. Yun, K. Guo, and A. Netravali, “Multicast scheduling in cellular packet data networks,” in Proc. IEEE INFOCOM, Apr. 2007, pp. 1172–1180.

[8] S. Deb, S. Jaiswal, and K. Nagaraj, “Real-time video multicast in WiMAX networks,” in Proc. IEEE INFOCOM, Apr. 2008, pp. 1579–1587.

[9] J. Du, M. Xiao, and M. Skoglund, “Capacity bounds for relay-aided wireless multiple multicast with backhaul,” in Proc. WCSP, Oct. 2010, pp. 1–5.

[10] D. Gunduz, O. Simeone, A. J. Goldsmith, H. V. Poor, and S. Shamai, “Multiple multicasts with the help of a relay,” IEEE Trans. Inf. Theory, vol. 56, no. 12, pp. 6142–6158, Dec. 2010.

[11] P. Fan, C. Zhi, C.Wei, and K. B. Letaief, “Reliable relay assisted wireless multicast using network coding,” IEEE J. Sel. Areas Commun., vol. 27, no. 5, pp. 749–762, Jun. 2009.

[12]J. Du,M. Xiao, andM. Skoglund, “Cooperative network coding strategies for wireless relay networks with backhaul,” IEEE Trans. Wireless Commun., vol. 59, no. 9, pp. 2502–2514, Sep. 2011.

[13] Y.-J. Yu, A.-C. Pang, Y.-C. Fang, and P.-F. Liu, “Utility-based resource allocation for layer-encodedmultimediamulticasting over wireless relay networks,” in Proc. IEEE GLOBECOM, Dec. 2009, pp. 1–6. 1854–1858.