OPTIMIZING THE REDUNDANCY USING CHORUS IN WIRELESS NETWORKS

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ABSTRACT

In Wireless Networks most of wireless broadcast protocols heavily rely on the MAC 802.11-based CSMA/CA Protocol. This Protocol will avoids interference and collision by conservative scheduling of transmissions. But this CSMA/CA broadcast protocol will support only multiple concurrent uncast, it will not support Multicasting. This will degrade the broadcast performance of Wireless Network particularly in loss and large-scale networks. And also if the position of nodes in the network changes then there will be effects in Network Parameters like Delay, Packet Delivery Ratio. Here we are proposing a new broadcast protocol called CHORUS which improves the efficiency and scalability of broadcast service even though there is a mobility in the nodes. This CHORUS is built upon the observation that packets carrying the same data can be effectively detected and decoded, even when they colloid with each other and have comparable signal strengths. This will resolve collisions using symbol-level interference cancellation, and then combines the resolved symbols to restore the packet. This collision-tolerant mechanism significantly improves the Packet Delivery Ratio and at the same time reduces the delay in wireless broadcasting. In CHORUS broadcast protocol, cognitive sensing and scheduling algorithm is implemented in MAC layer that facilitates reduction in an asymptotic broadcast delay which is proportional to the network radius. We evaluated CHORUS PHY-layer collision resolution mechanism with symbol-level simulation, and validated the network-level performance via ns-2, in comparison with a Double Coverage Broadcast (DCB) which used typical CSMA/CA-based broadcast protocol.

Keywords: Collision Resolution, Self-Interference Cancellation, Cognitive Sensing, Optimal-Broadcast.

I. INTORDUCTION

In any network-wide broadcasting the fundamental principle for any communication protocols in multihop wireless networks, is route discovery and information delivery. To do so an efficient broadcast protocol is required to deliver a single packet or a continuous stream of packets from the source node to all other nodes in the network, with high packet-delivery ratio (PDR) and less delay. To improve PDR in a loss network, multiple relay nodes can forward and retransmit each packet. Due to this it will cause transmission diversity. So reduce

delay and resource usage the number of transmissions must be kept to minimum. Otherwise redundant retransmissions waste channel time and slow down the packet's delivery in the network. Hence a delicate balance should maintained between PDR and delay. To do so an efficient broadcast protocol [1] is required. CSMA/CA is the mostly used MAC protocol focused on the MAC-layer scheduling and it has proven to be an effective distributed scheduling scheme, especially via the 802.11 family of MAC standards. But the limitation of CSMA/CA is that it is limited to concurrent unicasts, it will not support multicasting. This sensing and scheduling reduces collision, but misses' transmission opportunities which lowers channel usage and spatial reuse. In this paper, we introduce a new broadcast protocol, Called Chorus, based on a MAC/PHY layer [2] that adopts CSMA with collision resolution (CSMA/CR) technique. Chorus is built upon the key that packets carrying the same data can be detected and decoded, even when they overlap at the receiver with comparable signal strength.

II. COLLISION RESOLUSION SCHEME

Here we introduce the collision resolution scheme of Chorus in physical-layer which focus on how to detect, decode, and combine the collided packets to achieve the diversity gain.

2.1 Collision Detection

A known random sequence is attached by the transmitter at the beginning of each packet as a preamble. The receiver then uses a matched filter to detect the exact arrival time of this preamble. A matched filter is an optimal linear correlator that maximizes the SNR when correlating unknown signals with a known sequence. It outputs a peak value whenever the packet preamble is detected, even if the preamble is hidden in a strong noise. It operates continuously, so that those preambles overlapping with other packets can still be identified. The number of preambles detected in a run indicates the number of overlapping packets at the receiver. The peak output grows linearly with the number of bits in the preamble, and with the RSS of the packet. Therefore, the detection threshold is also a linear function of these two factors (No.of bits in Preamble and RSS of the packet). We have observed that using a 32- bit pseudorandom preamble, the collision detection probability is higher than 98 percent under practical wireless [3] settings. Hence, the preamble introduces negligible overhead to the packet.

2.2 Iterative Scheme for Collision Resolusion

In general packet usually consists of thousands of symbols, the probability of two collided packets is close to 0.We identify the collision of two packets by detecting their preambles. We first decode the clean symbols therein, and then iteratively subtract such known symbols from the collided ones, thereby obtaining the desired

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symbol. Fig.1 shows collision of two packets (head packet P1 and tail packet P2) from different transmitters. We first decode [4] the two clean symbols A and B in P1. Symbol C is corrupted as it collides with A^1 in P2, resulting in a combined symbol S. To recover C, here we have to remember that Symbols A^1 and A Carrying the same bit.
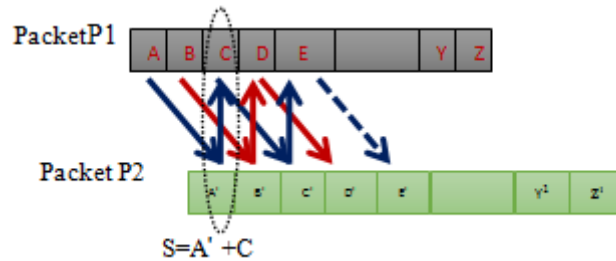

Fig.1: Iterative decoding of two collided packets carrying the same Content.

After that we subtract the A^1 from S, obtaining a decision symbol for C. This decision symbol is normalized using the channel estimation [5] for P1, and a slicer decides if the bit in C is 0 or 1.The decoded bit in C is then used to reconstruct C^1 and decode E. This process iterates until the end of the packet is reached. The iteration for other collided symbols proceeds similarly.

2.3 Packet Format in Chorus

Chorus mainly consists of three fields as shown in Fig.2. First a known random sequence known as Chorus Preamble which is a 32-bit sequence is attached in order to facilitate packet detection. Second a Chorus header field which informs the broadcast source's ID and the packet's sequence number which is nothing but packet identity to the receiver. A 16-bit Cyclic Redundancy Check (CRC) is also included in this header field.

When headers of two packets are collided then chorus will perform the iterative decoding as shown in Fig.1.While performing this, the assumption is both packets carrying the same data. After decoding then proceeds to CRC check of both header and payload. If CRC check fails then packet will discard.
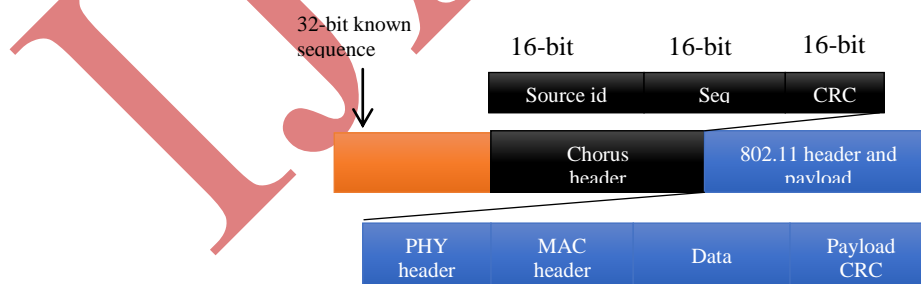

Fig.2: Packet format in Chorus

III. COGNITIVE SENSING AND SCHEDULING SCHEME

To reduce un resolvable collisions occurred when the packets with different data collide, chorus must be integrated the physical-layer with the MAC layer.

3.1 Sensing and Transmissions in Chorus

To achieve the collision-resolution capability, every transmitting node in the network must calls the SEND procedure to perform cognitive sensing, as shown in Fig.3. Each Transmitting node take scheduling decision by the three following rules:
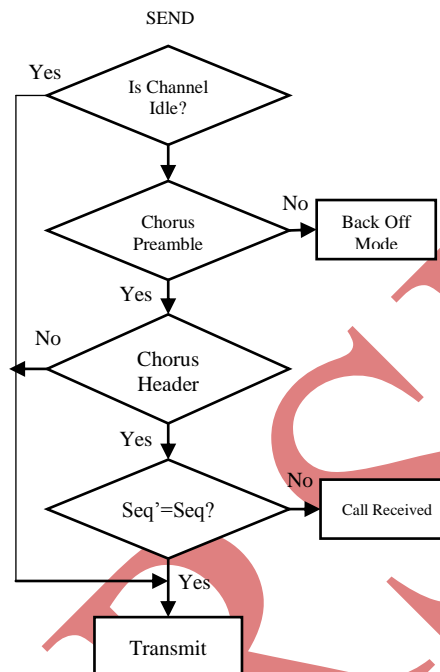

Fig.3: The MAC-layer control flow in Chorus at Sending Node

Rule1: Transmit the packet if the channel is idle.

Rule2: If the channel is busy, check the packet in the queue and the packet in the air is same then transmit.

Rule3: If the channel is busy, but a preamble cannot be detected, or the header field of the packet on the air cannot be decoded, or a different packet is on the air, then start the back- off procedure according to the 802.11. Here back-off technique [6] used is a Binary exponential Back-off refers to a collision resolution mechanism used in random access MAC protocols. This algorithm is commonly used to schedule transmissions of packets carrying different data.

After successful transmission of packet by the transmitting node the receiving node will perform the actions as shown in fig.4. It will checks whether the collision is occurred or not. If collision is detected then it will perform the iterative decoding as shown in fig.1. After that it will combines the decoded packets and then performs the Cyclic Redundancy Check. If CRC succeeds then it will send the information to the next layer which is nothing but network layer. If CRC fails then it will discard the packet and request the sender for retransmission. The advantages of cognitive sensing and scheduling come at the expense of additional overhead. In 802.11b, the sensing time slot is 20 µs, equivalent to the channel time of 20 bits in the broadcast mode. But Chorus can sense the entire preamble and the header in the same time slot
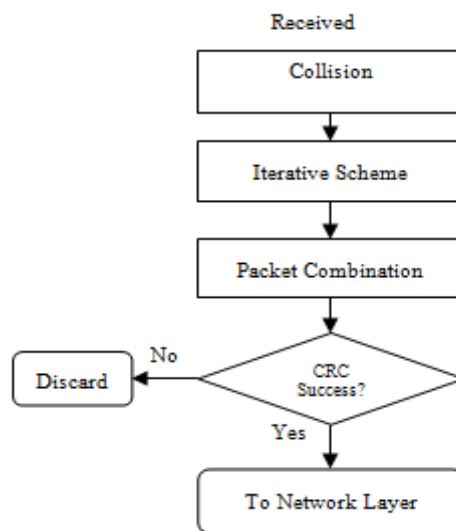
Fig.4: The MAC-layer control flow in Chorus at Receiver Node

3.2 Network Wide Broadcast In Chorus

Chorus has distinct features like Anonymity and decentralization, which means that the source and intermediate nodes do not any topology information and no need to maintain the local states other than the Source Id of forwarded node. The Source procedure shown in Fig. 5 at the source node contains a Chorus packet, and transmits it like a normal 802.11 broadcast packet [7]. After generating the packet it checks the rate of the packet or throughput and then calls the SEND procedure as shown in fig.3. If the receiver requests for retransmission before retransmitting it will checks the maximum retransmissions (5 retransmissions) and send if it will not exceeds, if exceeds it will create new packet.
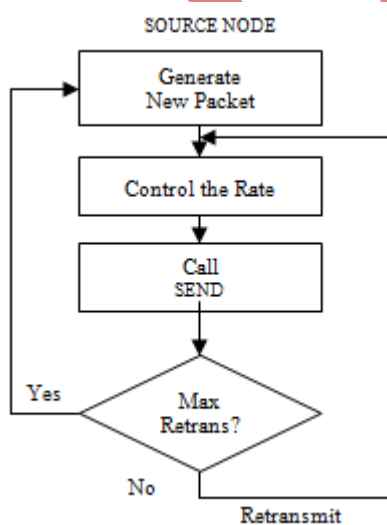

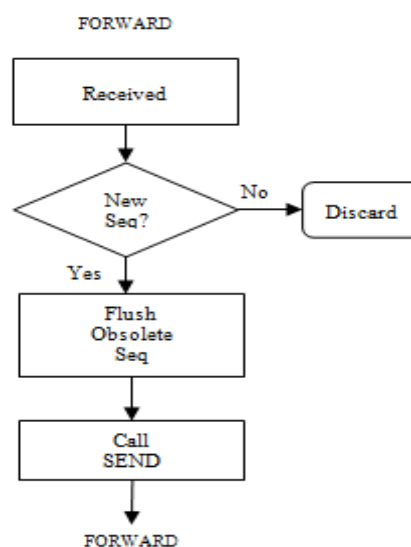**Fig.5: Chorus Broadcast at Source Node**   **Fig.6: Chorus Broadcast at Forwarding Node**

Any neighbour node surrounding source node will take this packet and provides the best service by forwarding it once by following the FORWARD procedure shown in Fig.6. After each successful reception, a receiver flushes those pending packets with obsolete seq, in order to prevent unresolvable collisions between packets with different sequence numbers [8]. If the broadcasting is a continuous stream of packets, then the source will distributes as a batch of packets over the network. In such a case Chorus will control the source rate in order to prevent the congestion and the same time to avoid the collision between packets which are having consecutive sequence numbers.

IV. PERFORMANCE IN GRAPH

Performance is assessed in terms of how the source node broadcasting the packet in normal mode, how the chorus decoding algorithm is performed if any collision is detected, how the cognitive sensing scheme is performed in order to avoid the collisions of packets carrying different data, at this situation how the nodes follow the standard 802.11 back off schemes and finally when the retransmission are happened. This process and all shown in Fig.7.

Zero Level:
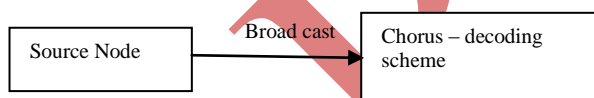
First Level:
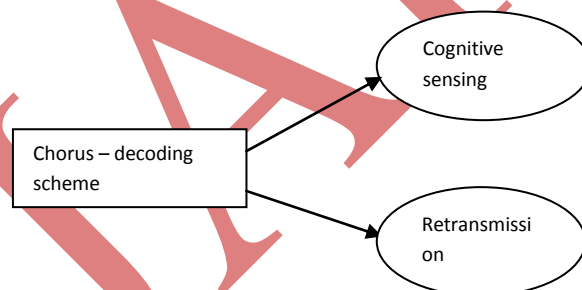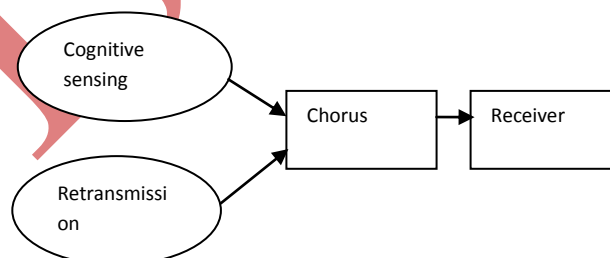

Second Level:

Fig.7: Data flow Diagram

V. SIMULATION ENVIRONMENT

We have taken different number of node (5, 10, 15, 20, 25, 30, 35, and 40) over a square area of $1000 \times 1000 m^2$. Each simulation has been run for 15 milliseconds of simulation time. The propagation channel is a two-ray ground reflection model with the data rate of 1 Mbps.

VI. SIMULATION RESULTS

In this section, we show and analyze the simulation results of Packet delivery, Delay comparison, throuput and Performance analysis of our system.
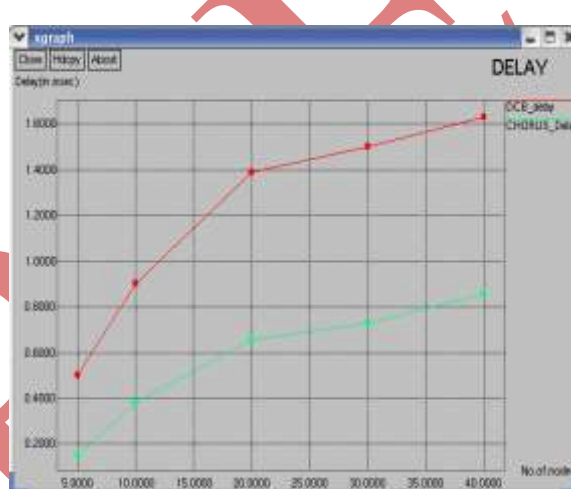

| Fig.8.1 | Fig.8.2 |

Fig.8.1: Comparison Graph of PDR for Chorus and DCB (CSMA/CA)

Fig.8.2: Comparision Graph of DELAY for Chorus and DCB(CSMA/CA)
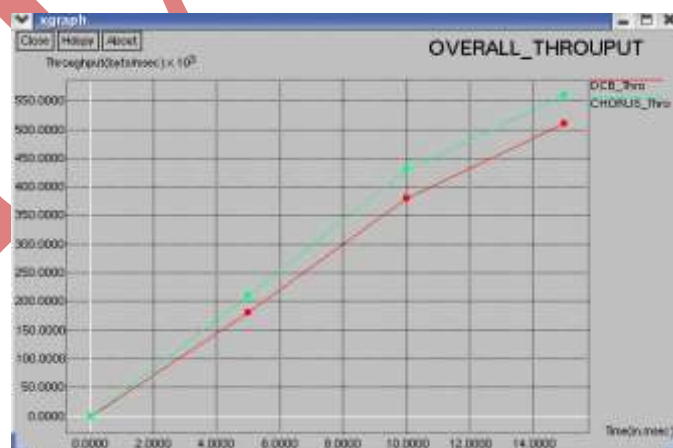

Fig.8.3: Comparision Graph of THROUPUT for Chorus and DCB(CSMA/CA)

VII. CONCLUSION

In this paper we provided practical results that demonstrate the feasibility and advantages of a collision-resolution protocol for wireless broadcast. We introduce Chorus, which allows forwarding nodes which are having same outgoing packets to transmit at the same time, and then allows physical-layer iterative decoding scheme to resolve collisions at the receiver. By decoding multiple versions of a packet at once, Chorus achieves transmit diversity and improves PDR without any retransmission. Most importantly, with its cognitive sensing scheme in MAC layer, Chorus significantly simplifies the CSMA scheduling and improves its spatial reuse.

VIII ACKNOWLEDGEMENT

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