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RESEARCH ARTICLE

# Multicasting in modified chordal ring of degree six network topology

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**Abstract**

Wired networking environment presents some interesting challenges to the study of network casting. Hence, graphs are usually used to represent networks of communication. The topology should be well design to meet future reliability demands. Therefore, Modified Chordal Ring of Degree Six (CHRm6) topology had been proposed as mathematical model to represent a network. This paper discussed about multicasting scheme focusing on even and odd nodes. CHRm6 structure is used to derive results in multicasting scheme. In this type of network, CHRm6 involved more total number of nodes to deliver message to multiple destinations simultaneously in terms of multicasting.

***Keywords*****:** Chordal ring, topology, networks communication, broadcasting, multicasting.



## INTRODUCTION

Network casting is the transmission message from single or multiple source nodes to single or multiple destination nodes. There are four types of basic network casting:

- Unicasting - involves one sender and one receiver where a message is sent from one source node to one destination node
- Broadcasting - involves one sender and all connected receivers where a message is sent from one source node to all other destination nodes
- Multicasting - involves may be one or more senders and the message is distributed to a set of receivers (may be no receivers or other number of receivers)
- Anycasting - involves one sender and one of many destination nodes

In this paper, focuses is only places on multicasting in Modified Chordal Ring of Degree Six (CHRm6) topology. Generally, multicasting is the simultaneous transmission of data to a subset of all possible destinations. In particularly, multicast is the delivery of information or message to a multiple destination simultaneously over each communication links of the network only once by using the most efficient strategy to deliver the messages and only create copies when the communication links to the destination nodes split. The nodes in the network copy the message to arrive at multiple receivers only when required [1].

Chordal rings are attractive interconnection network topologies due to their simple structure and their short diameter. Other than diameter, there are some key features of interest such as degree, connectivity, structures, congestion, asymmetric and routing [2][3],[4]. CHRm6 was proposed by [5] and give the best performance in terms of shortest diameter and average path lengths compared to Modified Chordal Rings Degree Four and the conventional chordal rings [6],[7],[8],[9],[10],[11],[12],[13].

This paper is structured in the following sections. Section 2 describes the preliminaries of CHRm6. Section 3 proposed the multicasting scheme for CHRm6. Section 4 gives some conclusions and work recommendation.

## PRELIMINARIES

The CHRm6 structure was proposed by [3]. The definition of CHRm6 was given as follows:

**Definition 1.** The CHRm6 is an undirected circulant graphs. CHRm6 was denoted as $CHRm6(N, s, h_1, h_2, h_3)$ where $N$ is the number of node, $s$ is a ring edge with length 1, while $h_1, h_2$ and $h_3$ are chords by even length where $h_1 < h_2 < h_3$. CHRm6 consists of one ring with $N$ nodes, where $N$ is positive even number of nodes. Each even node, $i_{2k}$ and odd node, $i_{2k+1}$ is additionally connected to four nodes for

$0 < k < \frac{N}{2}$. $i_{2k}$ is connected to $i_{(2k+h_1)(\mathrm{mod}\,N)}, i_{(2k-h_1)(\mathrm{mod}\,N)}, i_{(2k+h_3)(\mathrm{mod}\,N)}$ and $i_{(2k-h_3)(\mathrm{mod}\,N)}$. $i_{2k+1}$ is connected to $i_{(2k+1+h_2)(\mathrm{mod}\,N)}, i_{(2k+1-h_2)(\mathrm{mod}\,N)}, i_{(2k+1+h_3)(\mathrm{mod}\,N)}$ and $i_{(2k+1-h_3)(\mathrm{mod}\,N)}$. The values of $N$ and $h_1$, $N$ and $h_2$, $N$ and $h_3$ must have $\gcd(N,s,h_1,h_2,h_3)=2$. Definition 1 above describe about the inter nodes connection. The example of CHRm6 structure is given as in Fig. 1.

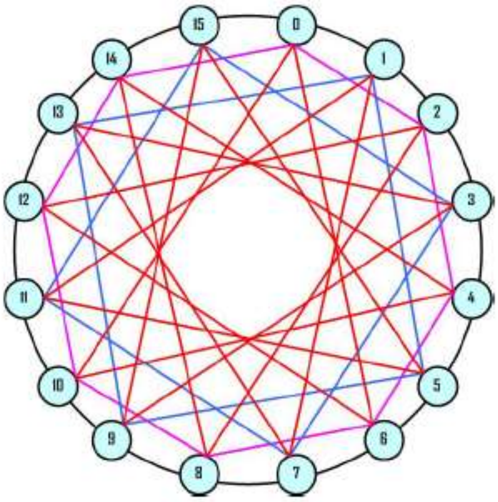


**Fig. 1** CHRm6 structure

### THE MULTICASTING SCHEMES FOR CHRm6

Multicasting allows every source node to decide other nodes whether to be part of the multicast group or not. Membership in a multicast group is open where nodes can joint or leave the group at any time. Multicast routing can be evaluated from the aspects of time it takes to deliver the message starting from source node sends out the message until the last destination and the traffic refers to the total number of communication links involved. The time can be counted in hops. Nevertheless, this research does not consider links or nodes failure. An efficient multicast communication demands for special ability and algorithms.

The multicast scheme originated at source node s (either even or odd source node). Therefore the multicasting time of $s$ is $m(s, CHRm6)$ or $m(s)$.

**Definition 2.** A multicast group, $M_{CHRm6}$ can be represented by a set $M_{CHRm6} = \{s, d_a, d_b, ..., d_{m-1}\}$ where $s$ is for source node and $d_a d_b, ..., d_{m-1}$ represent destination nodes in $M_{CHRm6}$. $M_{CHRm6}$ can be consists of feasible multiple unicast. Let define a unicast as $U = (u, v, P(u,v), t)$ where $u$ is a source node, $v$ is destination node, $P(u,v)$ as a path that a message traverse and $t$ for message passing steps. We assume unicast sets, $U_t = U_1, U_2, ..., U_k$ fulfilling the following conditions:

1. If $(u, v, P(u,v), j) \in U_j$ for each $1 \le j \le k$, then both $u$ and $v$ belong to $M_{CHRm6}$
2. The set $U_1 = (s, d_i, P(s,d_i), 1)$ for some $1 \le i \le m-1$
3. There exist one and only one integer $j$ such that $1 \le i \le k$ and $(s, d_i, P(s,d_i), j)$ appears in node $U_j$ for each destination, $d_i$ where $1 \le i \le m-1$.

Condition 1 in Definition 2 promised that only source node and destination nodes of the given message are involved. While second condition confirmed that the first step of the multicast involves single unicast from source node to one of the set of destinations. Lastly, the third condition assures that each destination nodes receives the message only once.

The concept of multicasting scheme for CHRm6 is same although it is asymmetric. The multicasting scheme is [1]:

- Generate the free table routing.
- Determine the multicast group and their members.
- Find route from the free table routing for multicast group.
- Send the message.

### DELAY IN CHRm6 MULTICASTING

Transmission delay, $d$ is computed as the maximum time traversal by a message from a source node to all destination nodes of multicast group. The message may be queued since the message has to go through a FIFO of an output interface. Let $M_{CHRm6}$ indicates a multicast group that consists of one or more destination while $Z$ denotes the size of the group where $Z=|M_{CHRm6}|$. Ring structure of CHRm6 is used as in Figure 2,3,4,5,6,7,8 and 9 to show an arbitrary group of multicast in CHRm6.

Multicast source node is denoted as $s$ for both cases (even and odd source node). It is assumed that the CHRm6 consists of $M_{CHRm6}$ with $Z = |M_{CHRm6}|$. The CHRm6 can be expressed as $CHRm6 = (N_{CHRm6}, M_{CHRm6})$ where $N_{CHRm6}$ represents the number of destination nodes in one multicast group $M_{CHRm6}$ belongs to the total number of nodes in the CHRm6, $N_{CHRm6}$ and more particularly $M_{CHRm6} \in CHRm6$.

The total delay, $D_{Total(MCHRm6)}$ from $s$ to $M_{CHRm6}$ is a sum of the total delay by every link of CHRm6 from $s$ to all destinations $d \in M_{CHRm6}$. The formula for total delay in CHRm6 is discovered as :

$$D_{Total(M_{CHRm6})} = D_{(s-M_{CHRm6})} = \sum_{i=1}^{Z} D(L_i) + \sum_{i=1}^{n} D(L_i),$$

where $Z$ is the size of $M_{CHRm6}$, $n$ is the total number of links of a path and $D(Li)$ referred to the links that involve in the delay.

Delay can be computed for a specific destination, $d_i$ within a multicast group such as $d_i \in M_{CHRm6}$ where $a \le i \le (m-1)$. Let $P_{(s,d_i)}$ referred to path within CHRm6 for a multicast group, $M_{CHRm6}$ and $L_{(n,Z)}$ represents the total number of links that message has to traverse to reach $d_i$. The total delay from $s$ to $d_i$ is given by:

$$D_{(S \to (d_i \in M_{CHRm6}))} = \sum_{L_{n,Z} \in M_{CHRm6(s,d_i)}}^{Z} D(L_{n,Z}).$$

## THE MULTICASTING SCHEME FOR CHRM6

The concept of multicasting scheme for CHRm6 is same although it is asymmetric. The multicasting scheme is:

- Generate the free table routing.
- Determine the multicast group and their members.
- Find route from the free table routing for multicast group.
- Send the message.

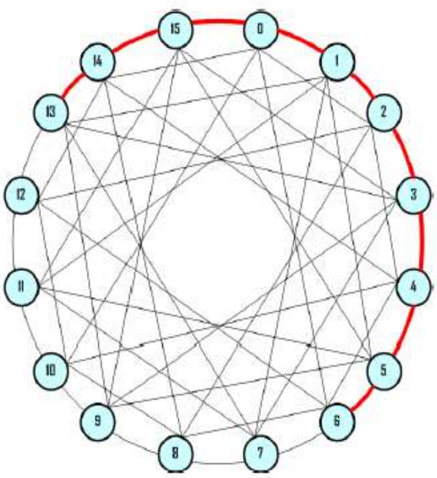


**Fig. 2** CHRm6(16,1,2,4,6) Multicast for Ring Group.

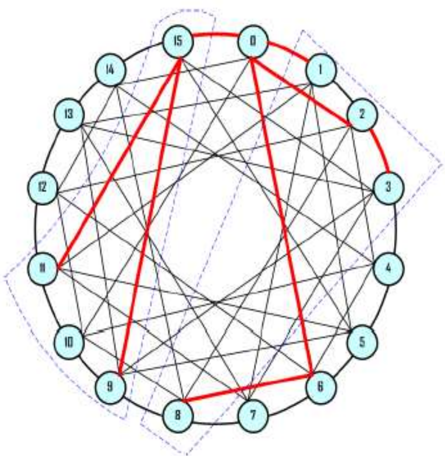


**Fig. 3** CHRm6(16,1,2,4,6) Multicast Left and Right Group from Source Node

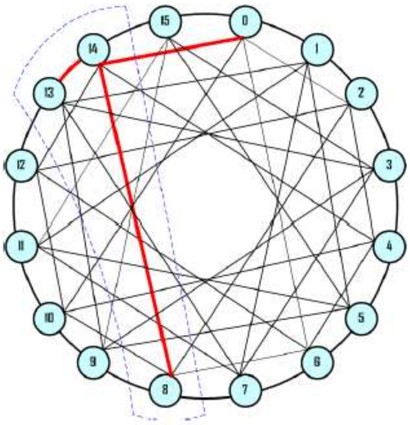


**Fig. 4** CHRm6(16,1,2,4,6) Multicast Left Chord Even Intermediate Node

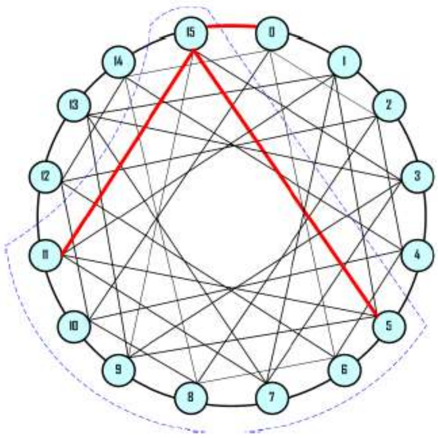


**Fig. 5** CHRm6(16,1,2,4,6) Multicast Left Ring Odd Intermediate Node

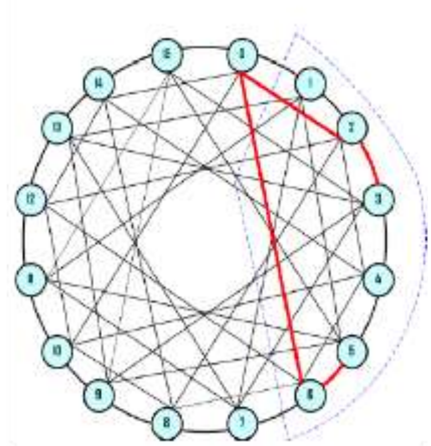

**Fig. 6** CHRm6(16,1,2,4,6) Multicast Right Chord Even Intermediate Node.

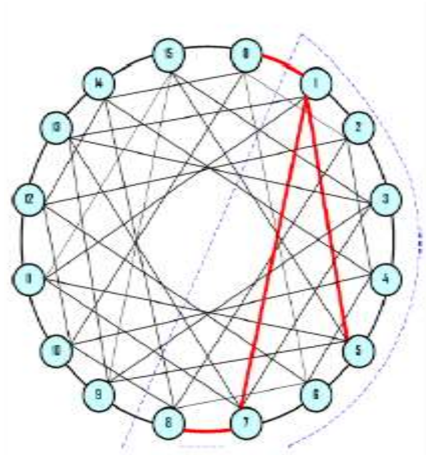

**Fig. 7** CHRm6(16,1,2,4,6) Multicast Right Ring Odd Intermediate Node

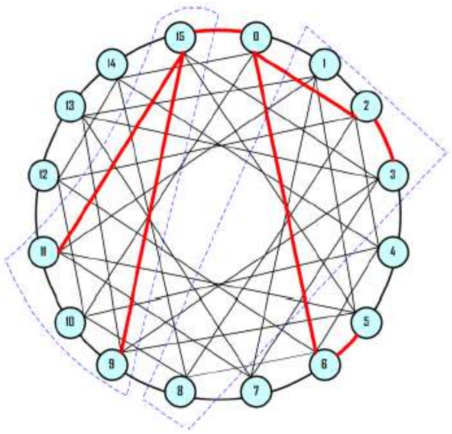

**Fig. 8** CHRm6(16,1,2,4,6) Multicast Left Ring Odd and Right Chord Even Intermediate Nodes.

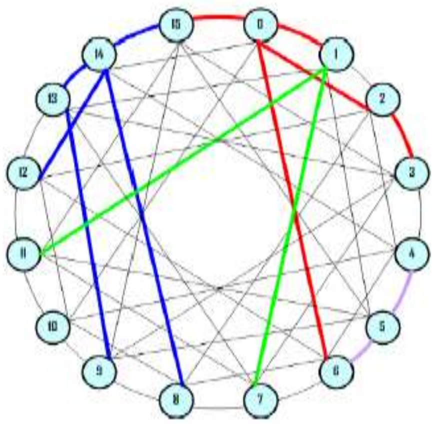

**Fig. 9** CHRm6(16,1,2,4,6) Multicast of Multiple Groups

## CONCLUSION

This paper presented multicasting scheme from theoretical aspect. The multicasting scheme was used the CHRm6 network model to obtain the results in multicasting. The multicasting schemes are based on $N$. This theoretical concept is based on no nodes or links failure. Future research may deal with nodes or links failure.

## ACKNOWLEDGEMENT

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