International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

An Efficient and Reliable Data Transmission Service using Network Coding Algorithms in Peer-to-Peer Network

Nilesh P. Sable[a,*], Vijay U. Rathod[b], Parikshit N. Mahalle[c], and Poonam N. Railkar[d]
[a,*]Department of Information Technology, Bansilal Ramnath Agarwal Charitable Trust's, Vishwakarma Institute of Information Technology, SPPU, Pune, India,drsablenilesh@gmail.com
[b]Department of Computer Engineering, JSPM's Imperial College of Engineering & Research, SPPU, Pune, India,vijay.rathod25bel@gmail.com
[c]Department of Artificial Intelligence and Data Science, Bansilal Ramnath Agarwal Charitable Trust's, Vishwakarma Institute of Information Technology, SPPU, Pune, India, aalborg.pnm@gmail.com
[d]Department of Computer Engineering, Smt. Kashibai Navale College of Engineering, SPPU, Pune, India, poonamrailkar@gmail.com
*Corresponding author *E-mail: drsablenilesh@gmail.com

Abstract:
Network coding is a progressive enhancement in natural network routing that increases throughput and reliability for unicast, multicast, and even broadcast transmissions. P2P networks are ideal for implementing network coding algorithms for two reasons: I. A P2P network's topology isn't predetermined. As a result, designing a topology that is compatible with the network coding algorithm is much easier. II. Every peer is an end host in this network. As a result, instead of saving and sending the message, complex network coding operations, such as encoding and decoding, are now easier to perform. The objective of this work is to use the best features of network coding algorithms and properly apply them to P2P networks to create an efficient and reliable data transmission service. The goal of the network coding algorithm is to make better use of network resources and thus increase P2P network capacity. An encoding algorithm that enables an intermediate peer to produce output messages by encoding (that is, computing a function of the data it receives. The decoder's role is to obtain enough encoded packets so that the original information can be recovered. This research work has measured an amount of hypothetical and applied consequences in which the network coding procedure or a variation of it is used to improve performance parameters such as throughput and reliability in P2P network data transmission based on network coding. The comparison of data transmission between network routing and network coding algorithms was the main focus of this paper. According to our simulations, the new network coding systems can reach 15% to 20% upper throughput than supplementary P2P network routing systems.

Keywords: Peer-to-Peer Network, Network Routing, Network Coding.

1. Introduction

A P2P framework is a decentralized network infrastructure in which network participants make a portion of their resources, such as processing capacity, disc storage, and transmission channel capacity, directly available to other network attendees without the need for centralized cooperation situations like servers or stable hosts. A P2P organization is based on the participants' equality, and it is organized through the free cooperation of equals to complete a common task.

In today's network systems, information is typically transmitted via network routing, which usually includes intermediate peers storing and forwarding the information. No processing is done at the intermediated peer during the network routing process. Network coding is a new concept that has recently been introduced. Network coding is a framework in which a peer is permitted to create output message encoding (i.e., trying to calculate a certain function) for its received message. Unlike conventional routing, which requires each peer to simply forward the messages it receives, network coding permits data to be mixed or combined. In this paper, the authors analyze the use of P2P networks for data transmission services, where a file is held by both a web server and a file server and is requested by multiple clients as well as receivers or sink peers. Peers (peers) are usually end-user computers with limited network resources in most P2P networks. The data transmission system must be both reliable and resilient while also delivering high throughput.

Network coding is one of the most effective technologies for increasing system throughput and reliability. This article provides a quick overview of network coding. Messages are generally routed through middle peers between the source peer (initial peer) and the destination (endpoint peer) on today's network, with the intermediate peers storing and forwarding messages. Other than storing and forwarding messages, the intermediate peer in network routing performs no processing operations. In fact, routing isn't a peer's only capability. Network coding has recently gained traction as a means of increasing network throughput while also ensuring high reliability. Network coding is used in many different situations, from wireless networks to network tomography. A multicast network's throughput can be significantly value-added by using network coding. Using the well-known

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

dragonfly communications system, Figure 2 demonstrates the advantages of network coding for data transmission.

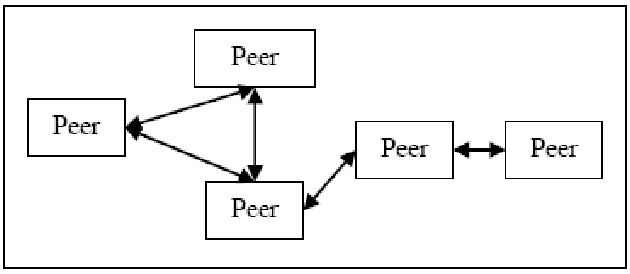


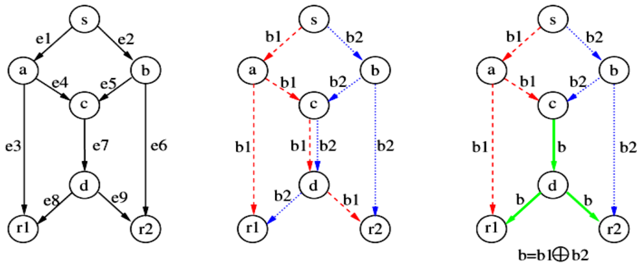
Figure 1: The P2P Network's Fundamental Architecture

Peer s is the source peer, and peers r1 and r2 are two sink or receiver peers in the diagram. Every edge has a capacity of one, meaning it can only send one bit of data per unit of time (second). The two bits b1 and b2 on source peer s can be used to multicast to equally peer r1 and r2. First, as shown in Figure 2 (b), the authors use traditional multicast without network coding. The authors use a dashed line or a red dashed line to denote bit b1, a dotted line or a blue dotted line to denote bit b2, and a bold line or a green bold line to denote both bits b1 and b2 without sacrificing generality. Bit b1 takes two seconds to reach r1, and bit b2 takes two seconds to reach r2. Both bits are received by peer c, and they are forwarded in the order in which they were received. Assume that bit b1 is the first to be transmitted. Then, in four seconds, r1 accepts both bits, and in five seconds, r2 accepts both bits.

Reflect on employing the network coding framework shown in Figure 2 (c) on the link between peers c and d. When peer c accepts two very different bits, it uses an exclusive OR operation to combine them. The combined bit b is then sent to the d peer. When peers r1 and r2 receive the combined bit and the other received bit, they can xo-ring the combined bit and the other acknowledged bit to recover the original bits b1 and b2. In 4 seconds, the entire transmission can be completed. The following is the definition of the link's throughput (γ) from peer c to peer d:

$$\gamma = \frac{\text{Number of bits from node c to node d}}{\text{Observation duration}} \quad (1)$$

The key objective of this work is to plan a reliable and efficient information transmission provider P2P network by emphasizing the value of network coding algorithms and properly applying them to P2P networks. Network coding is a generalized network routing framework that can be applied to any type of network routing, to improve information transmission efficiency. In the field of network coding, there are two main research streams. One line of research is looking into efficient algorithms to increase data transmission rates while lowering computational costs. The application of network coding is the focus of the other.



(a) (b) (c)

Figure 2: The benefit of network coding for multicasting is illustrated in this diagram. (a). A Directed Acyclic Graph (DAG) is used to represent the wireless network. (b). Network coding-free multicast communication. (c). Network coding facilitates multicast communication.

1. Background and Related Works

For multicast networks, representatives of the network coding arrangement have historically been suggested, and some of them are as follows:

To increase network throughput and utilization in a specific topology, R.Ahlswede et al. recommended network coding [13]. The primary objective of network routing coding is to allow intermediate peers to encode packets for transmission between the initial peer and destination peers. Various network coding strategies have been hypothesized in recent years to improve the performance of P2P systems [18].

A. The concept was first introduced in the year 2000: In multicast networks, where all receivers acquire identifying information, the authors of this paper aim to illustrate the usefulness of network coding. They demonstrated the existence of good or informative codes, but they did not demonstrate how to create them [2].

B. Practical Implementation in 2003: Important steps have been taken in the direction of putting the plan into practice. The authors of this study attempt to show that network coding for wireless multicast networks can be done using only addition and multiplication mathematical functions, thereby reducing code complexity.

C. Algorithms related to network coding were published in 2005-2006: Design algorithms that are extremely useful have been published. The authors of this paper present low-complexity algorithms for designing the functions that each peer in a multicast network uses. A systematic method for designing functions was presented by the researcher [6]. As shown here, selecting functions at random and independently for each peer should work just as well [5].

D. Minimum Cost in 2005: The complexity of computing the subgraphs required to provide the connections, as well as the network cost for a given set of connections, are two important

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

performance parameters discussed by the authors in this paper. While the discovery of a directed Steiner tree in routed networks is NP-hard, the same dilemma in coding networks can be solved in polynomial time and implemented decentralized using a linear programmed logic controller [15].

E. Network Coding in Wireless Networks: Applications from 2006: D.M. Chiu, R. W. Yeung, J. Huang, and B. Fan demonstrated the potential benefits of network coding for wireless applications and described scenarios where it would be particularly useful [13].

F. Applications for network coding in file-sharing systems in 2014: It introduces the PPFEED system, which is a high-performance P2P file-sharing system, and to improve P2P file sharing, it employs linear network coding [14].

2. Proposed Model

In the past, recommended approaches had some issues. A network coding algorithm for multicast is recommended in this manuscript, which reduces the number of transmissions. The main impartial of this research is to use a network coding algorithm to decrease the total amount of transmissions in unicast, multicast, and broadcast communication, as well as to reduce bandwidth consumption in unicast, multicast, and broadcast communication using HTTP file-sharing protocol. An abstract diagram of a network coding algorithm for P2P networks is shown in Figure 3.

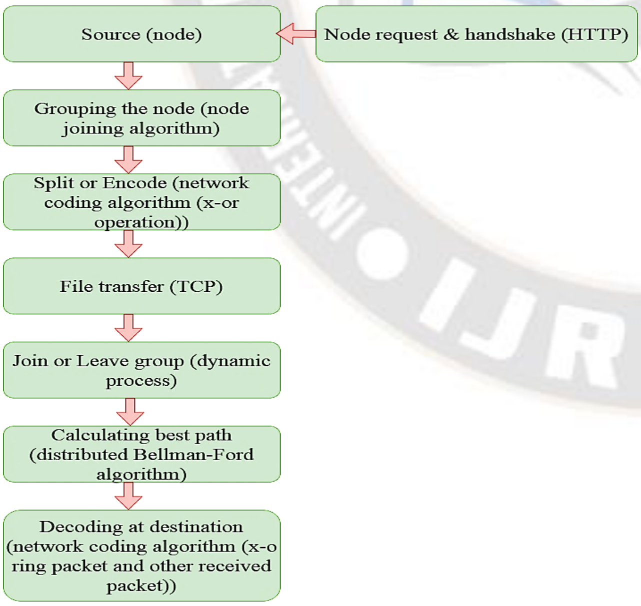


Figure 3: In a file-sharing system, a step-by-step procedure for the network coding algorithm in P2P Networks.

The researchers recommend an information transmission system that is based on P2P networks and network coding algorithms that accounts for network coding overhead. When compared to other information transmission processes, such as network routing, our simulation experiments demonstrated that the suggested network coding algorithm-based information transmission process performs better. Despite the fact that network coding is done with limited network resources, non-network coding schemes are implemented in the same network environment as network coding.

3.1 Links Heterogeneity

In P2P networks, link heterogeneity is a common occurrence. Links heterogeneity in P2P networks refers to peers with varying access link capabilities. Here, heterogeneity is demonstrated in two ways. I. P2P networks are connected by two different peers. Three different types of network routing methods are supported by the network coding algorithm.

3.2 Hypertext Transfer Protocol (HTTP)

HTTP is a protocol for accessing data on the World Wide Web. FTP and SMTP are combined into the HTTP function. HTTP is a protocol that has no state. With the help of the hypertext transfer protocol, data from remote peers is stored in a database. Request and response are the two types of hypertext transfer protocol messages.

3.3 Peer Joining Algorithm in P2P Network

The following diagram depicts the number of steps taken by the peer joining algorithm.

- Make the assumption that the server is well known, and that all peers are aware of its IP address thanks to an address translation service like domain names.
- A peer starts a joining procedure by transferring a join request to the server when it needs to recover a data host from the server.
- For each *clustering group Gi*, the server keeps a *counter gci* for the number of individuals in the group and a *list gli* for the list of clusters that include those peers.
- When a peer requests to join a group, the server assigns that peer to that group.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

INPUT: Joining node V
OUTPUT: Updated overlay network

Algorithm:

```
BEGIN
//Suppose the cluster corresponding to node V is Ci
IF |cli| < K
Si=the set of group not in cli;
ELSE
Si=the set of group in cli;
Pick a group gi in S such that gli is the smallest;
If multiple group have the same smallest gl, pick a group gi with
less gci;
Node V is assigned to group gi.
END
```

Notation Used in Node Joining Algorithm

K=Multicast Capacity;
Gi=Each Group;
gci=Counter to store the number of nodes in the group;
gli=list to store the list of cluster which include the node in group;
Ci=each cluster;
Cli=list to store the groups which include nodes in the cluster.

Figure 4: Peer Joining Algorithm in P2P Networks

- The servers then send a list of peers in that group to the joining peer, as well as an update on the number of peers in that group.
- Based on the following factors, the server will allocate the new peer to a group. The co-ordinate of a peer is used to allocate it to a cluster. If there are considerably smaller than *k* groups that include peers from the cluster, the new peer will be allotted to one of the groups that do not include any peers from the cluster.
- When there are several such groups, the one with the fewest clusters is chosen.
- The group with the smallest number of peers is chosen to break the tie.
- Researchers do this to reduce the logical link between clusters and ensure that peers within the cluster receive enough "innovative" messages from a different group, to decode them.
- The new peer will contact them after receiving the list of peers and form an overlay link with them. Because they are in the same group, these peers are referred to as intra-neighbors of the new peer. Inter-neighbors, on the other hand, are neighbors from different social groups.

3.4 Peer Leaving from P2P Network

Peers can be divided into two categories when they emerge from a group. One is pleasant, while the other is abrupt. The departing peer will initiate friendly living by sending "leave" messages to both intra and inter-neighboring peers. So that the P2P network structure is aware of its absence and can make the necessary adjustments. In abruptly leaving, the leaving peer will begin a living process without sending any notification messages to its intra-neighbors and inter-neighbors. This is usually caused by a computer and perhaps even network failure.

3.5 Transmission Control Protocol

The encoded packets are generated by the encoding algorithm. These encoded packets are sent to sink peers using TCP. TCP is a connection-oriented transport layer protocol that is both reliable and efficient. The TCP header format is used to send the encoded packets to the sink or destination peer.

3.6 Network Coding Algorithm

Network coding is a generic network routing configuration that can be applied to any type of network routing to increase the efficiency of information transmission. The broadcasting ratio is determined by dividing the number of data packets received by the total number of packets sent from the source. A formula like this is used to calculate this proportion:

$$B = \frac{\text{Number of node broadcast the packets}}{\text{Total number of nodes in network}} \qquad (2)$$

Finite Fields or Galois Fields are two branches of mathematics that define arithmetic operations. When performing the two core operations of network coding, encoding, and decoding, finite field arithmetic is used. As a result, for any network coding implementation, a well-organized application of finite fields is arithmetic a must. A Galois Field is a finite field, is a set of $\boldsymbol{2^n}$ *n* elements, where n is a positive integer and is usually denoted by the symbol *GF* $(\boldsymbol{2^n})$. Finite fields are used in a variety of fields, including coding theory, algebraic geometry, and cryptography. Assume that in a communication system, each data packet contains *N* binary bits. A packet contains a state vector of *N* or *n* components if every *n* consecutive bit is interpreted as a component in the field *GF* (2^n). The outgoing packets of a coding peer, or intermediate peer, in linear network coding, are direct groupings of the acknowledged packets. The packets must be combined using two basic operations: addition and multiplication, which must be performed over the field *GF* (2^n). The bitwise Exclusive-OR operation is what adds two numbers together. Every *n* consecutive bit, b_0, b_1, b_{n-1}, can be interpreted as the polynomial $b_0 + b_{1x} + ... + b_{n1}\, x_{n-1}$ for multiplication. Multiplication is thus accomplished by calculating the product of two polynomials.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

INPUT: K(original packets $M_1, M_2, \ldots, M_k$)
OUTPUT: A_{new} (encoded packet)

Algorithm:

I. Assume there are K original packets $M_1, M_2 \ldots, M_k$ to be delivered from the source to one or more receivers.

II. Each packet contains encoding vector $A_i = (\alpha_1^i \ldots \alpha_k^i)$ and information vector $X_i = \Sigma^k_{k=1} \alpha_k^i M_k$.

III. Assume there are m packets $(A_1, X_1) \ldots (A_m, X_m)$ that need to be linearly coded at intermediate nodes.

IV. The node first picks a set of coefficients $(\beta_1 \ldots \beta_m)$ in **GF** (2^n).

V. Than calculates the linear combination $X_{new} = \Sigma^m_{i=1} \beta_i X_i$. The new encoding vector A_{new} is obtained as $A_{new} = (\Sigma^m_{i=1}\beta_i\alpha^i_1, \Sigma^m_{i=1}\beta_i\alpha^i_2 \ldots \Sigma^m_{i=1}\beta_i\alpha^i_n)$.

Figure 5: Step by step procedure of an encoding algorithm.

Network coding is an encoding algorithm that essentially allows a middle peer to develop output information by encoding (as well as computing certain functions) the data it receives. Unlike traditional routing, which requires each peer to simply forward data received; Information can be mixed using network coding. Network coding advocates intermediate peers performing simple linear operations on incoming packets in a multicast network.

The decoder's main objective is to gather sufficient encoded packets to recreate the original information. The decoder usually receives *K* or more encoded packets. To successfully decode the original information, the sink peer should receive X linear independent coded packets and an encoded state vector. Solving a system of linear equations over a finite field can recover the original information from the linearly combined packets. To improve speed, the encoding and decoding algorithms authors recommend the use of optimal (or low complexity) normal bases.

INPUT: A_{new} (encoded packet)
OUTPUT: K(original packets $M_1, M_2, \ldots, M_k$)

Algorithm:

I. Assume a receiver gets n packets: $(A_1, X_1), \ldots, (A_n, X_n)$

II. The node needs to solve the following n linear equations:

$$X_1 = \Sigma^k_{k=1} \alpha^1_k M_k$$
$$X_2 = \Sigma^k_{k=1} \alpha^2_k M_k$$
$$\vdots$$
$$X_n = \Sigma^k_{k=1} \alpha^n_k M_k$$

III. To successfully recover the original data one needs to have: (1) $n \geq k$ i.e. the number of the received packets is no less than that of the original packets. (2) All equations are linearly independent.

Figure 6: The decoding algorithm is followed by a sequential procedure.

3.7 Distributed Bellman-Ford Algorithm

The distance vector algorithm is another name for the distributed Bellman-Ford algorithm. It's easy and quick to do (i.e., Do not necessitate a significant amount of additional manufacturing period). The shortest paths between a given source peer and all other peers are determined using the distance-vector algorithm.

3. The Benefits of Recommended Algorithm

The following are some of the advantages of using network coding algorithms for P2P information sharing:

4.1 Increases Throughput of P2P Network

P2P network throughput refers to the speed at which a message is transmitted successfully over a communication channel. The provision provided in this network in a one-time unit is referred to as throughput. Assuming that the same file is being transmitted across various P2P networks, throughput can be expressed simply as the time it takes for the transmission to complete. The higher the throughput, the less time it takes.

4.2 Increasing Network Reliability

The network coding algorithm is a more advanced form of network routing optimization that increases throughput while maintaining high reliability. Using a performance metric, assess the network error-handling capability. A more reliable network will have fewer retransmissions, resulting in higher throughput. With little overhead, repeated links can greatly improve P2P network reliability.

4.3 Link Stress

The number of copies of the same packets sent over the same wireless link is known as link stress. It is a measurable statistic

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

that only applies to a P2P network due to the imbalance between the P2P network and the physical network. It can be used to see how effective it is to improve network topology awareness and a P2P network's efficiency.

4.4 Scalability

An overlay system is used to distribute the files. The total available bandwidth grows in lockstep with the size of the network. The scalability issue is eliminated by using data sharing between peers using network coding algorithms.

4.5 Efficiency

The deterministic and simple to implement network coding algorithm. Without the need for peers to combine, the linear coding framework can be built on demand. All the peers have to do is keep the group identifier and the encoding function mapped out at all times. Sinks or destination peers can always recover the original messages after receiving k different messages, which is more efficient than random network coding. The data dissemination is more efficient because data messages are only sent once through the same overlay link.

4.6 Resilience

In P2P network systems, churn is a frequent issue. By including duplicate links, the negative effect of churn is completely eliminated.

4. Experimental Evaluation

Net Beans IDE 8.0.1 software is used to implement the recommended approach. The parameters were used to compare the network coding algorithm to network routing. The network coding gain is the difference in throughput between using network coding and not using it. All of these variables are investigated and the results are presented using Net Beans IDE 8.0.1.

Table 1: Experimentation Parameters

Parameters	Values
Simulator	Net Beans IDE 8.0.1 (Jfree Chart API)
Packet Size	2048 bytes
Area	1000m X 1000m
Bandwidth	2Mb/Sec
Transmission Range	250m

5.1 Throughput

The throughput of a communication channel is the rate at which messages are delivered successfully. Throughput is the amount of service provided by a system in a single time unit. Because the authors allowed different systems to send the same file, throughput is simply the time it takes for the transmission to finish. From time 0 onwards, the authors send the file. The consumed time is then equal to the time it takes for the peers to complete receiving the file, as indicated by the finish time.

The network divides the peers into a square area of 1000m x1000m to calculate the throughput of the overlay network. For each J free chart, the authors use any routing method. The ratio of packets received by the destination peer to packets originated by the source peer is known as the source-destination ratio. When they have less time for P2P network throughput, this ratio performs better, and it rises with network coding algorithms and falls with network routing.

Table 2: Performance Evaluation of Transmission Time for Unicast

Parameter	File size in KB	Time taken to receive the file in MS	
		Network Coding	Network Routing
Transmission time for unicast	100	284.3457	241.6938
	200	266.3632	226.4087
	300	648.2722	551.0314
	400	942.964	801.5194
	500	1317.136	1119.566
	600	1239.334	1053.434
	700	1665.524	1415.695
	800	1132.374	962.4329
	900	1318.219	1120.486

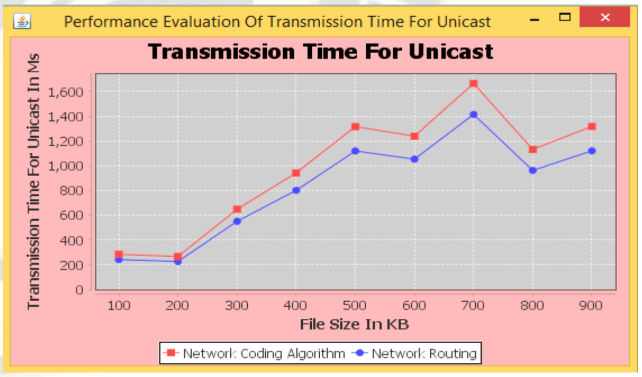


Figure 7: Unicast Transmission Time Performance Evaluation

Table 3: Multicast Transmission Time Performance Evaluation.

Parameter	File size in KB	Time taken to receive the file in MS	
		Network Coding	Network Routing
Transmission time for the multicast	100	104.37	88.7145
	200	244.5373	207.8567
	300	481.0335	408.8785

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

	400	684.2347	581.5995
	500	749.7712	637.3055
	600	823.4545	699.9363
	700	1377.468	1170.848
	800	1062.344	902.9924
	900	1428.284	1214.041

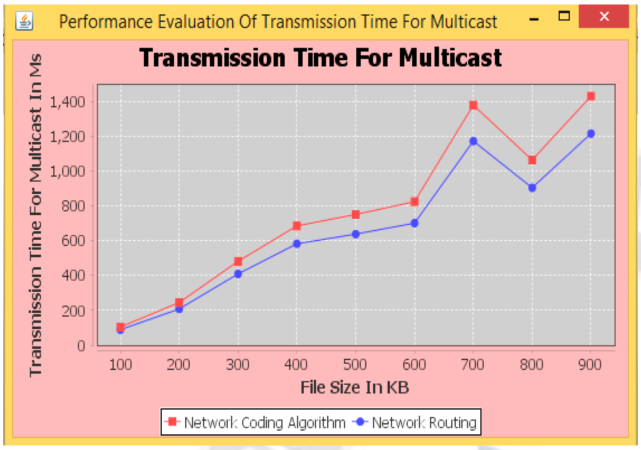


Figure 8: Multicast Transmission Time Evaluation Performance.

Table 4: Broadcast Transmission Time Performance Evaluation.

Parameter	File Size in KB	Time Taken to Receive File in MS	
		Network coding	Network routing
Transmission time for broadcast	100	119.0525	101.1946
	200	269.7399	229.2789
	300	415.9783	353.5816
	400	463.0865	393.6235
	500	618.8246	526.0009
	600	591.4801	502.7581
	700	902.3446	766.9929
	800	978.4413	831.6751
	900	868.5122	738.2354

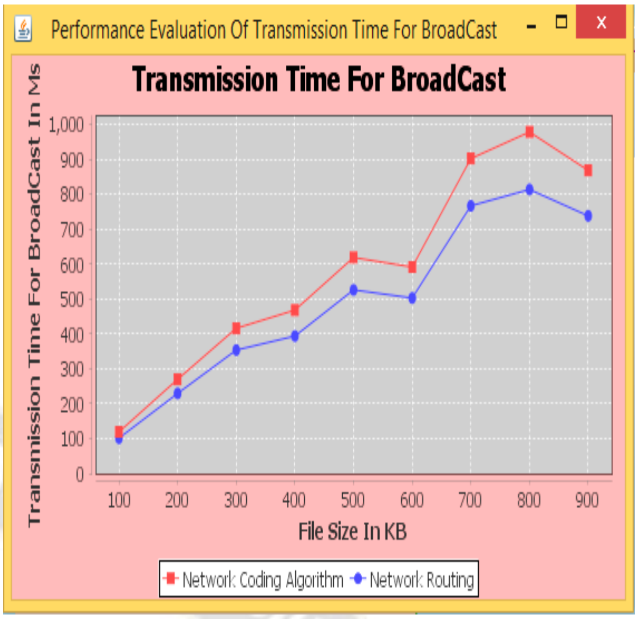


Figure 9: Transmission Time Performance Evaluation for Broadcast.

5.2 Scalability

The ability of a P2P network or process to handle increasing amounts of work or to be expanded to accommodate that growth is referred to as scalability. Show a set of transmissions with a range of 100 to 300 meters and a number of peers ranging from 50 to 150. If three peers appear at an identical period, the peer's communication variety will be chosen. The transmission range *(T)* is determined using the following formula:

$$T = \frac{Transmission\ range}{Number\ of\ node\ U\ or\ M\ or\ B\ the\ Packets} \quad (3)$$

Where, U=Unicast, M=Multicast, and B=Broadcast the packets. In terms of network coding algorithm, the ratio rises, while in terms of network routing, it falls.

Table 5: Performance Evaluation of Transmission Range.

Parameter	File Size in MB	Number of Packets	Transmission Length in Meters	Network Coding
Transmission range	1MB	512	100	5.12
	2MB	1024	150	6.82666
	3MB	1536	200	7.68
	4MB	2048	250	8.192
	5MB	2560	300	8.53333

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

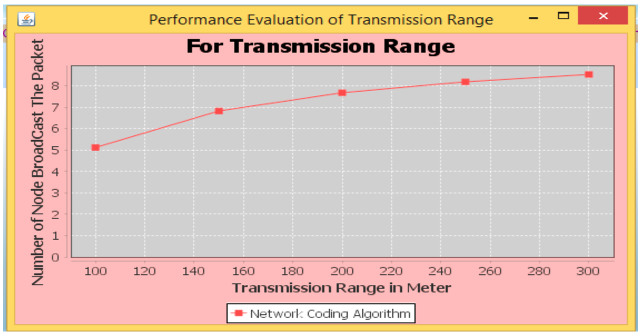


Figure 10: Ratios of Throughput Peers vs. Transmission Range.

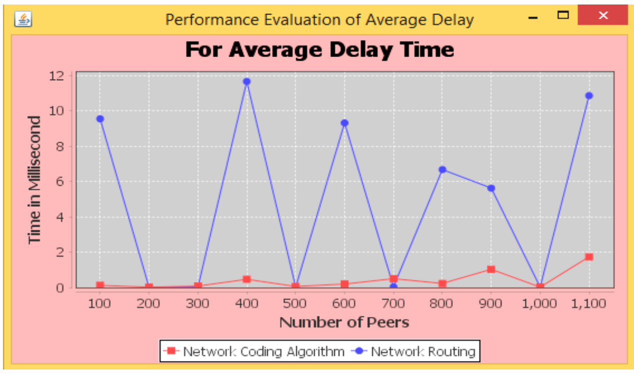


Figure 11: Average Delays vs. Total Number of Peers

5.3 Reliability

This technique also known as encoding and decoding methodologies, is a smart network routing enhancement that boosts throughput while ensuring higher level reliability. This metric is used to evaluate a P2P network's capabilities to accept errors. The average delay is the time it takes for a data packet to arrive at its destination, as shown in the results. Any buffering that occurs during route discovery latency, as well as queuing at the interface queue, is included. This is the average total time it takes for a packet to travel from its origin to its destination peer. A formula like this is used to calculate the average delay:

$$Average\ Delay = \frac{S}{N} \qquad (4)$$

The total time spent delivering packets to each destination is *S*, and the total number of packets acknowledged by all endpoint peers is *N*. This ratio rises when it comes to network routing and falls when it comes to the network coding algorithm. The graph depicts the number of peers vs. one point-to-other point delay, with the number of peers on the *X-axis* and the end-to-end delay on the *Y-axis*.

Table 6: Performance Evaluations of Average Delay

Parameter	Number of Peers	Delay	
		Network Coding	Network Routing
Average Delay	50	0.12084	9.54097
	60	0.01730	0.01796
	70	0.08004	0.01978
	80	0.46110	11.65370
	90	0.05847	0.02298
	100	0.19515	9.30509
	110	0.49657	0.0395
	120	0.22825	6.66700
	130	1.02675	5.61989
	140	0.01950	0.02127
	150	1.73549	10.85090

5.4 Consumption of Transmission Channel Capacity in P2P Networks

The network coding algorithm could help network resources be used more efficiently. In the peer joining algorithm, clusters encompass groups, and every group contains different peers. We can automatically delete groups and clusters if they do not contain any peers. We can save bandwidth and CPU time by employing this technique to connect two clusters via an overlay link. For P2P networks, bandwidth consumption (λ) is calculated using a formula such as:

$$\lambda = \frac{Bandwidth\ Consummation\ in\ Peer\ to\ Peer\ Network}{Number\ of\ Node\ Unicast\ or\ Multicast\ or\ Broadcast} \qquad (5)$$

Table 7: Performance Evaluation of Bandwidth Consummation

Parameter	Group Size	Bandwidth Consummation	With Peer Joining Algorithm
Bandwidth consummation	2	3200	1600
	4	3400	850
	6	3600	600
	8	3800	475
	10	4000	400
	12	4200	350
	14	4400	314.2887
	16	4600	287.5
	18	4800	266.6666
	20	5000	250.0000
	22	5200	236.363636

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

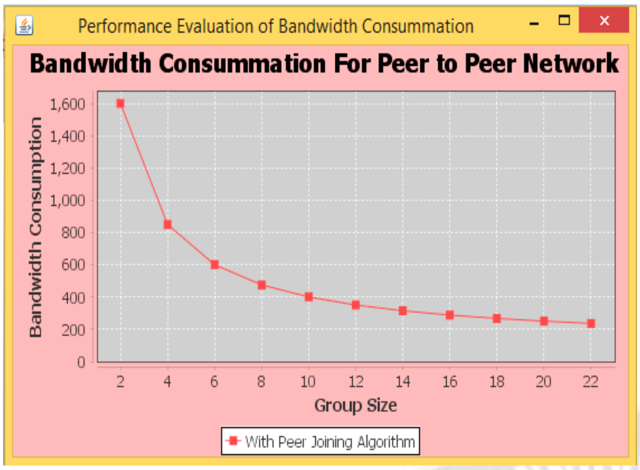


Figure 12: Ratios of Bandwidth Consummation in with Peer Joining Algorithm.

In a P2P network, this ratio decreases when the peer joining algorithm is used and increases when the peer joining algorithm is not used. The bandwidth consumption with the peer joining algorithm is shown in the results.

Table 8: Analyzing the Overall Performance of All Parameters

Key Parameters	Ratio of Throughput	Scalability	Reliability	Bandwidth
Network Routing	Decreases	Decreases	Decreases	Increases
Network Coding Algorithm	Increases	Increases	Increases	Decreases

5. Future Work

Network coding algorithms have a challenge trying to construct code when two or more sources are multicasting on the network at the same time. When there are multiple sources, the issue becomes more complicated. Multiple users and multiple destinations will be a difficult problem for network coding algorithms to solve in the future.

6. Conclusion

Information is typically routed through intermediate peers from the source to the destination, with the intermediate peers storing and forwarding the data. Instead of performing any processing on the message, the intermediate peer in network routing simply stores and forwards it. In general, the traditional multicasting technique in a network environment is not optimal. The role of encoding received messages allows a peer to generate output messages. Unlike traditional routing, which requires each peer to simply forward receive messages; network coding allows information to mix. A multicast network's throughput, reliability, scalability, and efficiency can all be greatly improved by using a network coding algorithm. The new network coding algorithms can achieve 15 percent to 20 percent higher throughput than other P2P multicast systems, according to our simulation results.

References

[1] Shao, X., Wang, C., Zhao, C., Gao, J.: Traffic Shaped Network Coding Aware Routing for Wireless Sensor Networks. IEEE Access. 6, 71767-71782 (2018).

[2] Aljohani, A., Ng, S.: Distributed Joint Source-Channel Coding-Based Adaptive Dynamic Network Coding. IEEE Access. 8, 86715-86731 (2020).

[3] Martinez-Penas, U., Kschischang, F.: Reliable and Secure Multisport Network Coding Using Linearized Reed-Solomon Codes. IEEE Transactions on Information Theory. 65, 4785-4803 (2019).

[4] Afolabi, I., Bagaa, M., Boumezer, W., Taleb, T.: Toward a Real Deployment of Network Services Orchestration and Configuration Convergence Framework for 5G Network Slices. IEEE Network. 35, 242-250 (2021).

[5] Wang, C., Shao, X., Gao, Z., Zhao, C., Gao, J.: Common network coding condition and traffic matching supported network coding aware routing for wireless multihop network. International Journal of Distributed Sensor Networks. 15, 155014771985397 (2019).

[6] Hayashi, M., Cai, N.: Secure Non-Linear Network Code Over a One-Hop Relay Network. IEEE Journal on Selected Areas in Information Theory. 2, 296-305 (2021).

[7] Liu, B., Han, C.: Research on wireless network virtualization positioning technology based on next-generation agile IoT technology. Advances in Data Science and Adaptive Analysis. (2021).

[8] Arora, K., Singh, J., Randhawa, Y.: A survey on channel coding techniques for 5G wireless networks. Telecommunication Systems. 73, 637-663 (2019).

[9] Adaptive Wireless Network Coding for Infrastructure Wireless Mesh Networks. KSII Transactions on Internet and Information Systems. 13, (2019).

[10] HUANG, Z., WANG, X.: Research on the Optimization Problems in Network Coding. Journal of Software. 20, 1349-1361 (2010).

[11] Savva, G., Manousakis, K., Ellinas, G.: Network coding-based routing and spectrum allocation in elastic optical networks for enhanced physical layer security. Photonic Network Communications. 40, 160-174 (2020).

[12] PU, B., YANG, L., WANG, W.: Generation and Extension of Linear Network Coding. Journal of Software. 22, 558-571 (2011).

[13] Hu, X., Chen, Z., Yin, F.: Joint detection and decoding for physical-layer network coding in power line channel. IET Communications. 11, 2735-2742 (2017).

[14] Li, L., Li, D.: A distributed estimation method over network based on compressed sensing. International Journal of Distributed Sensor Networks. 15, 155014771984149 (2019).

[15] Sun, Q., Li, S., Chan, C.: Matricidal Characterization of Optimal Linear Network Codes over Cyclic Networks. IEEE Communications Letters. 17, 1992-1995 (2013).

[16] Wachter-Zeh, A., Stinner, M., Sidorenko, V.: Convolutional Codes in Rank Metric with Application to Random Network Coding. IEEE Transactions on Information Theory. 61, 3199-3213 (2015).

[17] Polgar, Z., Suta, Z.: Computing Coding Solutions for Opportunistic Network Coding Used in Wireless Mesh Networks. Wireless Personal Communications. 107, 2019-2045 (2019).

[18] Park, J., Cho, D.: Separated Random Linear Network Coding Based on Cooperative Medium Access Control. IEEE Networking Letters. 3, 66-69 (2021).

[19] Jin, Y., Ruan, P.: Adaptive Cooperative FEC Based on Combination of Network Coding and Channel Coding for Wireless Sensor Networks. Journal of Networks. 9, (2014).

[20] Gupta, D., Singh, D.: Dynamic Queue and TCP based Multipath Congestion Control Scheme for Wired Network. International Journal of Computer Applications. 123, 45-50 (2015).

[21] WU, L., JIN, Z., ZHAO, A., ZHOU, Y.: Multi-view video transmission method based on depth-map and distributed video coding. Journal of Computer Applications. 32, 2441-2444 (2013).

[22] Gu, J., de Lamare, R., Huemer, M.: Buffer-Aided Physical-Layer Network Coding with Optimal Linear Code Designs for Cooperative Networks. IEEE Transactions on Communications. 66, 2560-2575 (2018).

[23] Li, S., Sun, Q.: Network Coding Theory Via Commutative Algebra. IEEE Transactions on Information Theory. 57, 403-415 (2011).

[24] Datta, M.: Relative generalized Hamming weights of affine Cartesian codes. Designs, Codes and Cryptography. 88, 1273-1284 (2020).

[25] Etzion, T., Wachter-Zeh, A.: Vector Network Coding Based on Subspace Codes Outperforms Scalar Linear Network Coding. IEEE Transactions on Information Theory. 64, 2460-2473 (2018).

[26] Huang, W., Ho, T., Langberg, M., Kliewer, J.: Single-Unicast Secure Network Coding and Network Error Correction are as hard as Multiple-Unicast Network Coding. IEEE Transactions on Information Theory. 64, 4496-4512 (2018).

[27] Guang, X., Yeung, R., Fu, F.: Local-Encoding-Preserving Secure Network Coding. IEEE Transactions on Information Theory. 66, 5965-5994 (2020).

[28] I. Sulieman, N., D. Gitlin, R.: Efficiently Secure Broadcasting in 5G Wireless Fog-Based-Fronthaul Networks. International Journal of Wireless & Mobile Networks. 10, 01-12 (2018).

[29] Li, Z., Wang, A.: Distributed Joint Source-Channel Coding Using Low Density Parity Check Codes. Sensor Letters. 10, 1842-1846 (2012).

[30] Bao, X., Li, J.: Generalized Adaptive Network Coded Cooperation (GANCC): A Unified Framework for Network Coding and Channel Coding. IEEE Transactions on Communications. 59, 2934-2938 (2011).

[31] To, D., Choi, J.: Convolutional Codes in Two-Way Relay Networks with Physical-Layer Network Coding. IEEE Transactions on Wireless Communications. 9, 2724-2729 (2010).

[32] Ghanem, S., Gharsellaoui, A., Tarchi, D., Vanelli Coralli, A.: Physical layer aware adaptive network coding schemes for satellite communications. International Journal of Satellite Communications and Networking. 35, 537-549 (2017).

[33] Ronkainen, H., Edstam, J., Ericsson, A., Östberg, C.: Integrated Access and Backhaul: A New Type of Wireless Backhaul in 5G. Frontiers in Communications and Networks. 2, (2021).

[34] Zhu, F., Zhang, C., Zheng, Z., Farouk, A.: Practical Network Coding Technologies and Softwarization in Wireless Networks. IEEE Internet of Things Journal. 8, 5211-5218 (2021).

[35] Vijay, R., Chirchi, V.: File Sharing between Peer-to-Peer using Network Coding Algorithm. International Journal of Computer Applications. 129, 9, 24-29 (2015).

[36] Rathod, V., Chirchi, V.: Results and Performance Analysis of File Sharing Between Peer-to-Peer Using Network Coding Algorithm. International Journal of Computer Science and Information Technologies. 7, 3, 1136-1144 (2016).

[37] N. P. Sable, V. U. Rathod, P. N. Mahalle and D. R. Birari, "A Multiple Stage Deep Learning Model for NID in MANETs," 2022 International Conference on Emerging Smart Computing and Informatics (ESCI), 2022, pp. 1-6, doi: 10.1109/ESCI53509.2022.9758191.

Dr. Nilesh P. Sable has overall 14 years of experience, presently working as SPPU Approved Associate Professor in the Department of Information Technology, Vishwakarma Institute of Information Technology, Pune, India. He has done a Ph.D. in Computer Science & Engineering from Kalinga University, Raipur on Research Problem Statement "STUDY ON RELATIONSHIP STANDARD MINING CALCULATIONS IN DATA MINING" – Ph. D awarded on 3rd June 2018. He obtained M.Tech. (Information Technology) degree from JNTU, Hyderabad in 2014 and a B.E. (Information Technology) degree from the University of Pune, Pune in 2008. He is SPPU Approved Ph.D. Research Guide. He has published 40+ papers in National, International conferences and journals. He had Filed and Published 10+ Patents and Copyrights. He is the author of a couple of books with an international publisher like Lambart.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 1s
DOI: https://doi.org/10.17762/ijritcc.v10i1s.5819
***Article Received**: 22 August 2022 **Revised**: 28 October 2022 **Accepted**: 20 November 2022*

Mr. Rathod Vijay Uttam has overall 10 years of experience in which 3+ for Industrial experience and 7+ for teaching, presently working as SPPU Assistant Professor in the Department of Computer Engineering, JSPM's Imperial College of Engineering & Research Pune, India. I am pursing Ph.D in Computer Engineering from SPPU Pune research centre at BKC ,MET, Institute Of Engineering, Nashik on Research problem Statement on "OPTIMAL PATH SELECTION BASED ON CHANNEL INTERFERENCE AND CONGESTION ANALYSIS: A DEEP LEARNING APPROACH ". He obtained ME (Computer Network Engineering) degree from Dr.BAMU, Aurangabad in 2016 and a B.E. (Computer Science &Engineering) degree from the Dr.BAMU, Aurangabad in 2010. I have also completed Post Graduate Diploma (CDAC) from YCP, Mumbai on Advance Computer Programming. He has published 20+ papers in National, International conferences and journals. He had Filed 3 Patents.

Dr Parikshit is a senior member IEEE and is Professor and Head of Department of Artificial Intelligence and Data Science at Vishwakarma Institute of Information Technology, Pune, India. He completed his Ph. D from Aalborg University, Denmark and continued as Post Doc Researcher at CMI, Copenhagen, Denmark. He has **22 + years** of teaching and research experience. He is a member of the Board of Studies in Computer Engineering, Ex-Chairman Information Technology, SPPU and various Universities and autonomous colleges across India. He has 9 patents, 200+ research publications **(Google Scholar citations-2179 plus, H index-22 and Scopus Citations are 1100 plus with H index -15)** and authored/edited 40+ books with **Springer, CRC Press, Cambridge University Press,** etc. He is editor in chief for IGI Global –International Journal of Rough Sets and Data Analysis, Associate Editor for IGI Global - International Journal of Synthetic Emotions, Inter-science International Journal of Grid and Utility Computing, member-Editorial Review Board for IGI Global – International Journal of Ambient Computing and Intelligence. His research interests are Machine Learning, Data Science, Algorithms, Internet of Things, Identity Management and Security. He is a recognized PhD guide of SSPU, Pune, and guiding 7 PhD students in the area of IoT and machine learning. Recently, **FIVE** students have successfully defended their PhD. He is also the recipient of “Best Faculty Award” by Sinhgad Institutes and Cognizant Technologies Solutions. He has delivered 200 plus lectures at national and international level. He is also the recipient of the best faculty award by Cognizant Technology Solutions

Poonam N. Railkar: Dr. Poonam N. Railkar received PhD degree from SPPU University Pune in the year 2022. She completed her Master in Computer Engineering (Computer Networks) from Pune University Maharashtra, India in the year 2013. From September 2012 working as an Assistant Professor in Department of Computer Engineering, STES’s Smt. Kashibai Navale College of Engineering, Pune, India. She has published 20 plus papers at national and international journals and conferences and authored 1 book. She has guided more than 20 plus under-graduate students and 3 plus postgraduate students for projects. Her research interests are Internet of Things, Identity Management, Security and Database Management System Applications.