PACKET ERASURE CODING IN AN UNRELIABLE NETWORK

INTRODUCTION

Erasure coding is a method of data protection by which data is broken into packets. These packets are then expanded and encoded with redundant data pieces so the original data can be retrieved despite loss of packets.

This project investigates the resilience and efficiency of network communication protocols under varying conditions of redundancy and packet loss. We examine the impact of adjusting the *redundancyFactor* alongside the *packetDropRate* on the probability of successful payload decoding at the receiver end.

METHODOLOGY

We vary the values of *redundancyFactor* and *packetDropRate* to examine the probability that a message is successfully sent to and decoded by the receiver.

$$\boxed{m = \rho_{rf} \cdot k}$$

# of packets sent

redundancyFactor

# of original packets after packetizing a message stream

The key was to emulate the idea of an unreliable network. The value of *packetDropRate* which was common amongst all routers, was varied.

Topology Generation

Using a Erdos-Renyi(E-R) graph's stochastic nature, we are able to capture the inherent randomness of real-world network topologies.

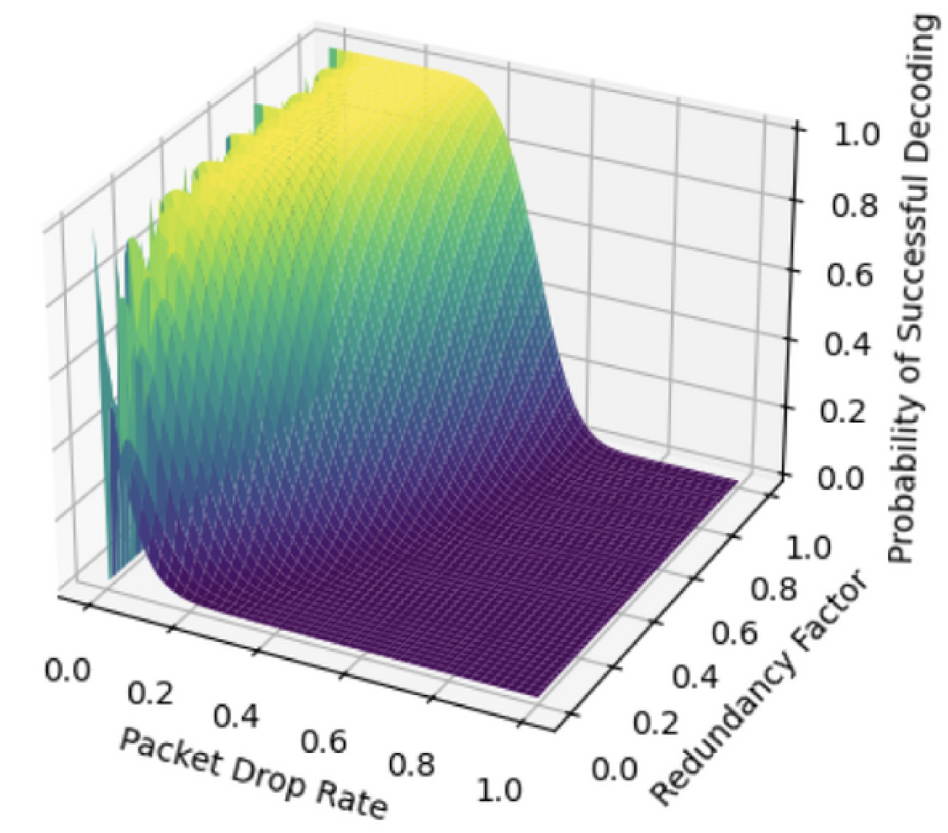
Simulation Parameters

To simulate, a network of 20 nodes was used with the probability of edge creation being 0.2. A random host was designated as the final receiver node. A total of 200 different messages were sent in each experiement, with each being 200 words long.

Encoding and Decoding

Encoding and decoding is parameterized by 2 integers, m (total number of blocks produced) and k (how many blocks necessary to reconstruct the original data).

THEORETICAL ANALYSIS



As packet drop rate increases, the probability of a successful decoding decreases exponentially

Assume every router has the same packet drop rate. *N* is the total number of packets created after encoding.

$$\boxed{N = (1 + \rho_{rf}) * n}$$

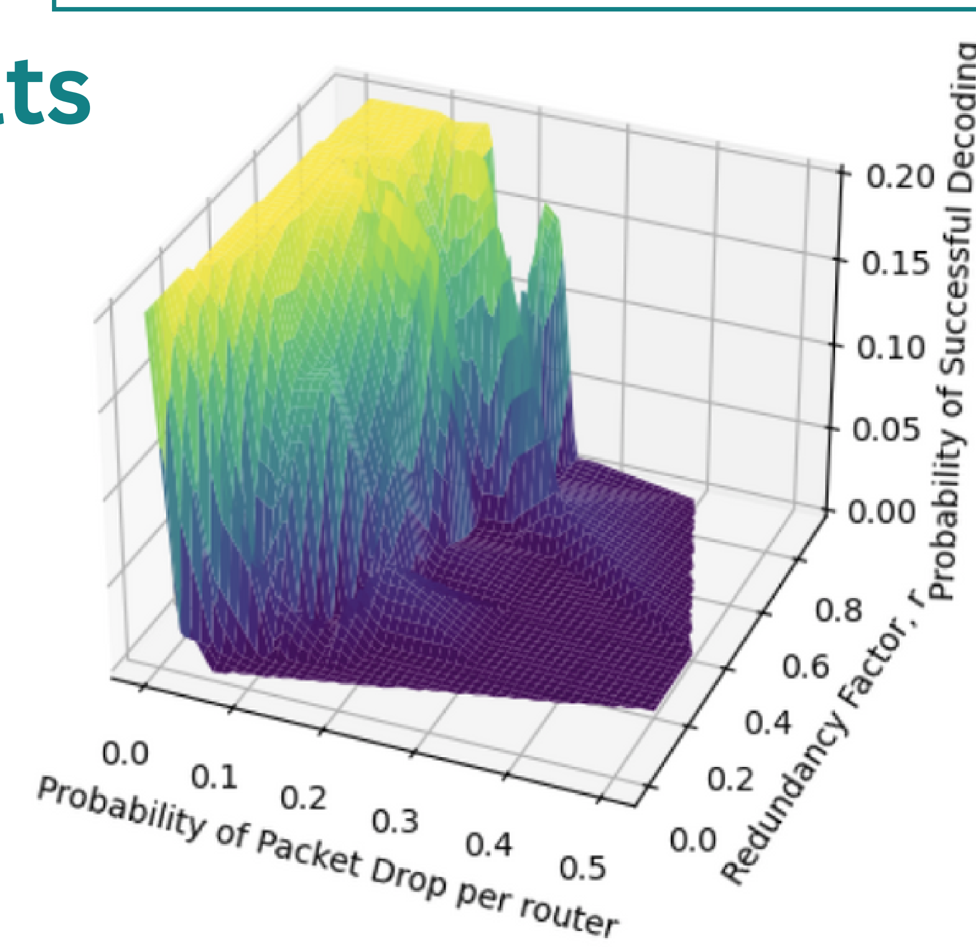
Define *s* as the survival per hop. Then, survival of all hops is

$$\boxed{s = 1 - \omega} \qquad \boxed{s_a = s^h}$$

where *h* is the average number of hops taken by the packet through the network.
Finally, the probability of successful message decoding at the receiver is denoted by

$$\boxed{p = \sum_{k=n}^{N} \binom{N}{k} s_a^k (1 - s_a)^{N-k}}$$

Results



Unreliability in the network can be alleviated by sending redundant packets. However, packet drop rates beyond 0.5 still result in a very low probability of successful decoding.

CONCLUSION

The study confirms the expected relationship between packet drop rates, redundancy factors, and decoding success in unreliable networks. However, the study's scope was limited by computational resources, only simulating a network of 20 routers. To improve the results' applicability to real-world conditions, we suggest using more resources to simulate larger, more complex network structures. Additionally, investigating other packet erasure codes, like Tornado Encoding, could enhance the robustness and efficiency of communication protocols in unstable network environments.

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