Optimising Latency in Peer-to-Peer (P2P) Networks

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Background

P2P networks provide the communication fabric over which Blockchains share distributed ledger and transaction information. Using a gossip protocol (also referred to as an epidemic protocol), information spreads across P2P networks from node to node (computer to computer).

P2P networks range in size from a small number of nodes to many tens of thousands of nodes. The delays incurred as information traverses across the network from the point of origin is affected by the diameter of the network, the structure of the peer overlay and delays introduced by the physical limitations of each store-and-forward hop.

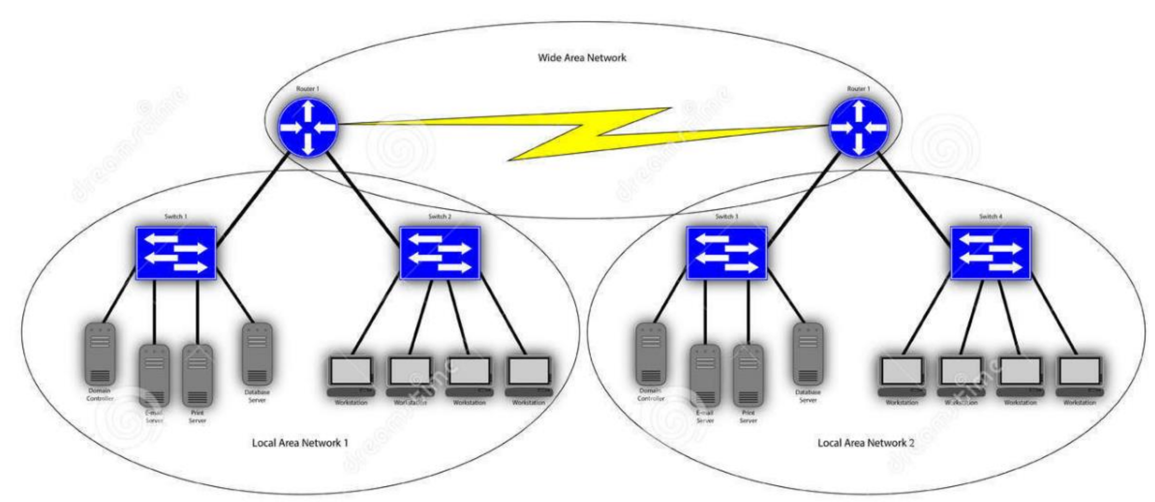
Lower network latency → financial advantage

This project aims to demonstrate that by accommodating the limitations of the underlying data transport infrastructure, it is possible to optimise the overall latency of P2P networks using information that a transmitting node can derive from knowledge it already possesses.

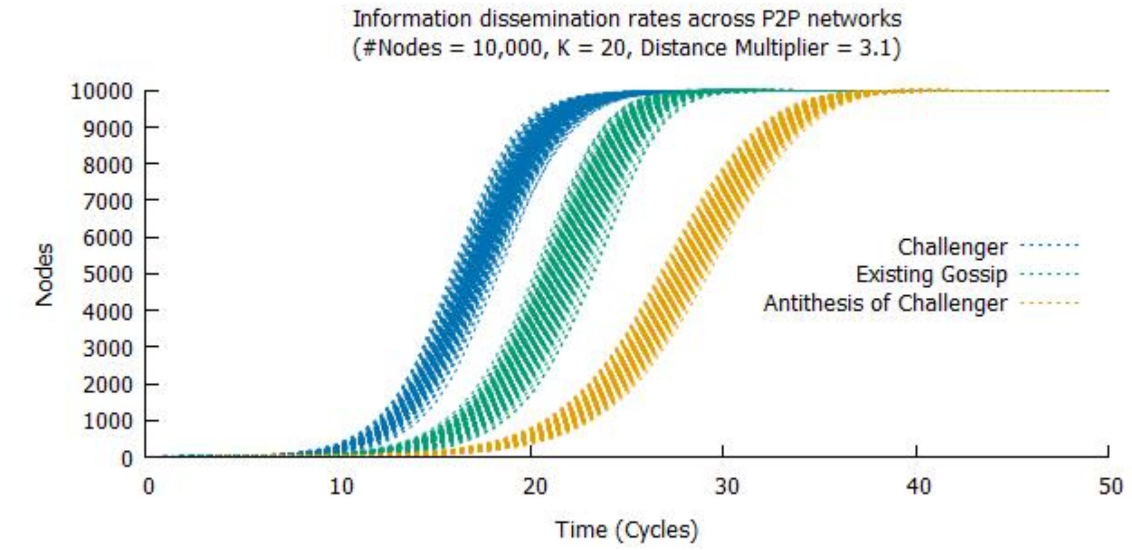
The Problem

P2P networks may be structured or be of ad-hoc composition; they may contain nodes that behave in an erroneous, selfish, or malicious manner. Overlay management protocols are designed to provide a peer structure that will accommodate these challenges whilst minimising the possibility of the network partitioning and also reducing its hop-count diameter.

In the absence of underlying network layer broadcast or multicast mechanisms, a node is unable to share information simultaneously with all its peers. Nodes use serial network interfaces (e.g. Ethernet) to communicate and relay on long-haul WAN routers that concentrate traffic over serial interfaces.



The result is a stream of replicated, non-concurrent information traversing serial connections, destined for the nodes' peers.

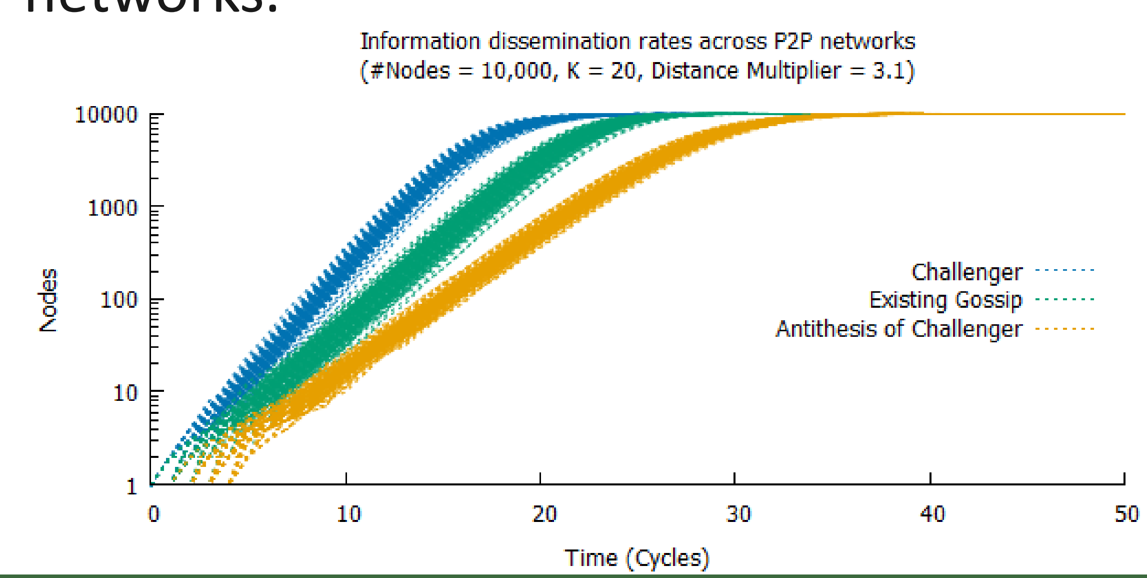


The Results

A Java emulator, PeerSim, was used to model various network topologies. The graphs shown here depict 300 simulations for each of three selection criteria (the existing Gossip approach; the challenger approach; and the opposite approach to the Challenger) for randomly generated P2P networks consisting of 10,000 nodes.

The distinct banding shows the importance of the selection criteria.

The rate of information transfer (*infection)* takes time to reach a critical momentum. The logarithmic scale below shows how the early *infection* rates have an impact on the overall rate of transfer across P2P networks.



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