Decentralised overlay network - Tapestry

Project Proposal - Team 26

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1. Project Title

Implementation of a Decentralized Overlay Network Inspired by Tapestry

2. Problem Statement

In large-scale distributed systems, efficient routing and resource location are critical challenges. Traditional fully connected networks are impractical due to high storage and maintenance costs, while unstructured peer-to-peer (P2P) networks suffer from inefficient search mechanisms. Tapestry, a structured overlay network, addresses these issues by providing scalable, fault-tolerant, and efficient routing with prefix-based matching.

This project aims to implement a decentralized overlay network inspired by Tapestry. The system will support efficient message routing, dynamic node membership, and resilience against node failures while ensuring fast lookups in a scalable network.

3. Framework and Technologies

- **Programming Language:** Go (Golang)
- **Communication Protocol:** gRPC
- **Data Structures:** Prefix-based routing tables
- **Hashing Mechanism:** SHA-1 or similar
- **Storage (Resources):** In-memory or simple file-based storage for node states

3.1. Reasoning Behind Technology Choices

- **Go (Golang) & gRPC**: gRPC provides high-performance, remote procedure calls (RPCs) with built-in support for error handling and serialization using Protocol Buffers. All of us have experience with gRPC in Go from the Assignment.
- **Prefix-Based Routing Tables**: The original Tapestry paper implements a prefix based routing system, using SHA-1, so we will be implementing the same.

4. Project Objectives

4.1. Implement Node Discovery & Routing:

- Nodes should be able to join and leave dynamically without breaking the system.
- Efficient routing using prefix-based forwarding. $O(\log n)$ hops for a routing request.

4.2. Resource Location & Lookup:

- Implement mechanisms for storing and locating resources.
- Ensure lookups occur in logarithmic time complexity.

4.3. Fault Tolerance & Adaptability:

- Handle node failures by reconfiguring routing tables.
- Implement redundancy mechanisms to ensure continued operation despite node failures.

5. Deliverables

- Implementation of a Tapestry-inspired overlay network with routing, resource lookup, and fault tolerance.
- A written report detailing the implementation approach, technical challenges, and results.
- A presentation and demonstration showcasing the working system and its capabilities.