Comparative Analysis of Load Balancing Algorithms in Dynamic General Graphs

Student Project / Bachelor Project

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Overview

Project Overview

Significance and Goals

- collaboration and coordination in distributed systems
- applied in grid computing, clusters, and clouds
- static field widely studied
- compare protocols using simulations
  - depict an comprehensive analysis
  - report the information obtained

Definitions

Load Balancing

Load balancing in peer-to-peer (P2P) overlay networks is a mechanism to spread various kinds of loads like storage, access, and message forwarding among participating peers in order to achieve a fair or optimal utilization of contributed resources such as storage and bandwidth.

[Datta, 2009]

Definitions

Diffusion-Based Load Balancing

Load balancing protocols where each node simultaneously sends excessive workloads to its underloaded neighbors and receives workloads from its neighbors with higher workloads.

[Berenbrink, 2005]

Deal-Agreement-Based Load Balancing

Algorithmic techniques based on short negotiating between neighboring nodes in load balancing, in which a sender proposes to transfer a load, and then the receiver agrees to receive the proposed load either in full or partly.

[Dinitz, 2022]

Push-Pull Sum Protocol

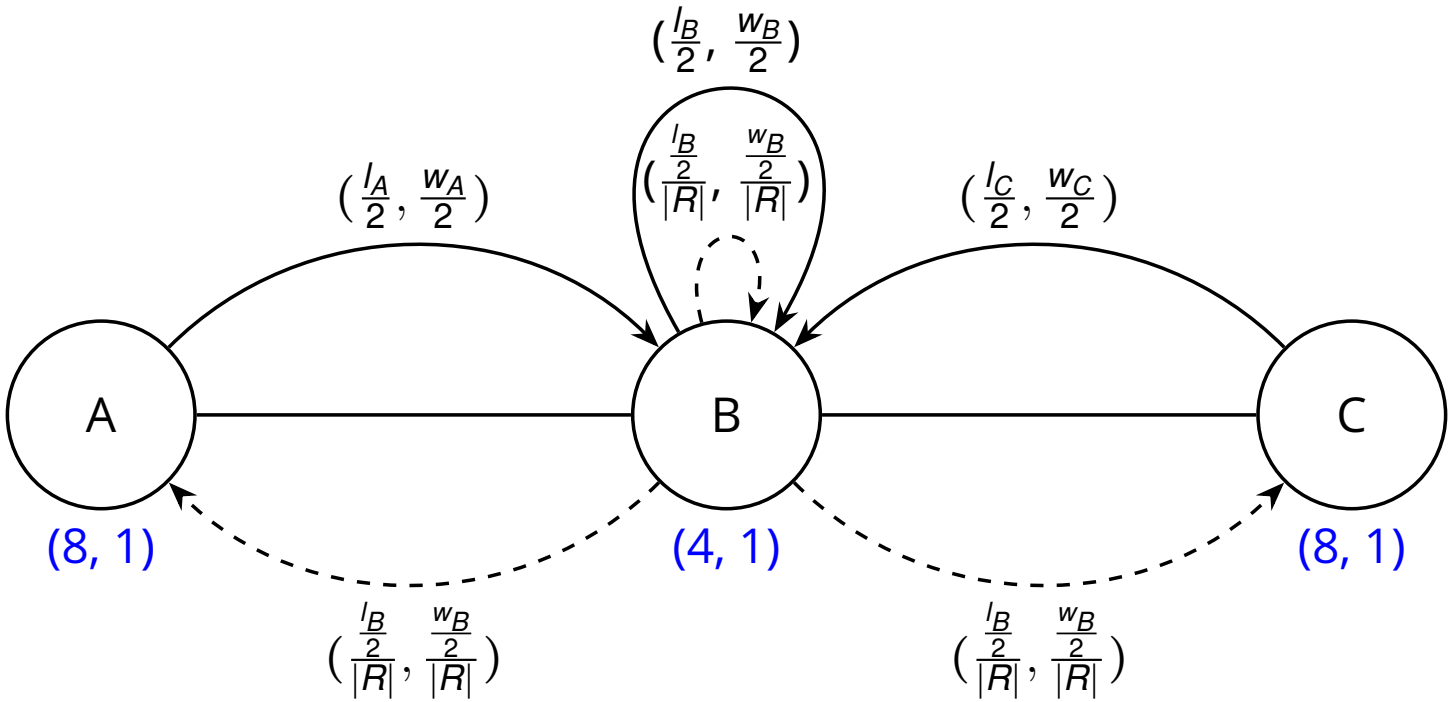

Figure: Example of Push-Pull Sum Protocol

⟶ Push

- - - -→ Pull

(l_{node}, w_{node}) : (Load of node, Weight of node)

R : Requests

Deal-Agreement-Based Load Balancing Protocol

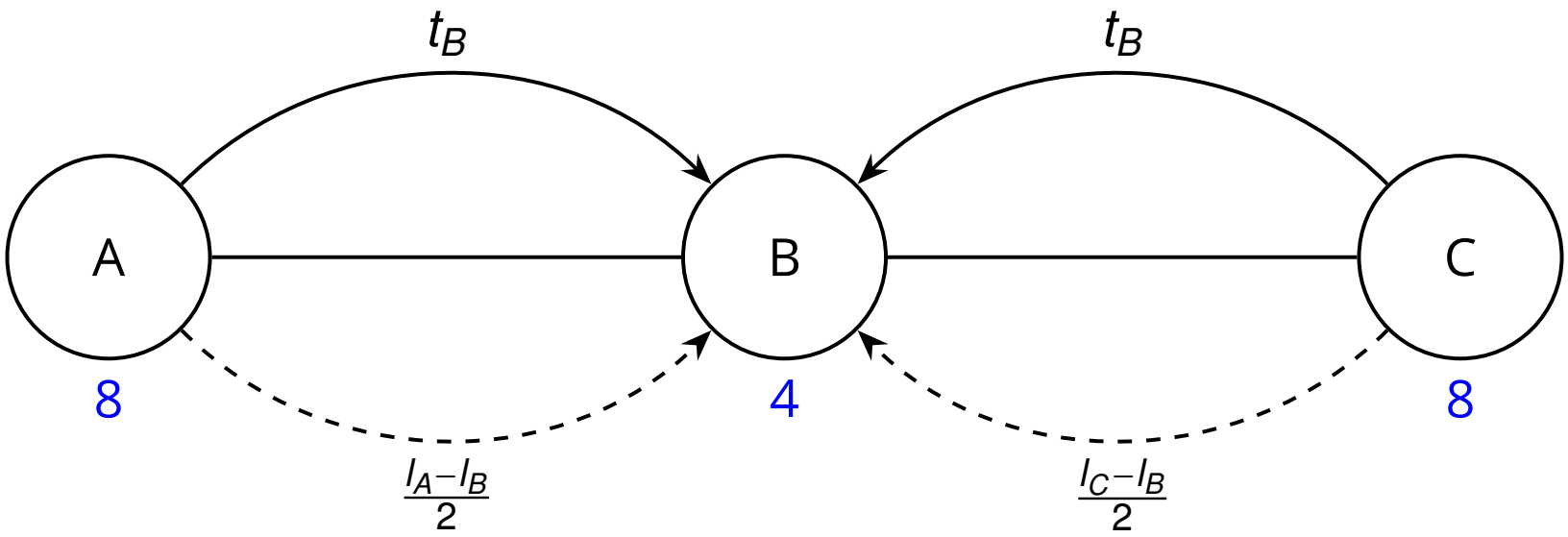

Figure: Example of Deal-Agreement-Based Load Balancing Protocol

⟶ Actual Deal

- - - -→ Proposal

l_{node} : Load of node

t_{node} : Load to transfer

Diffusion-Based Load Balancing Protocol

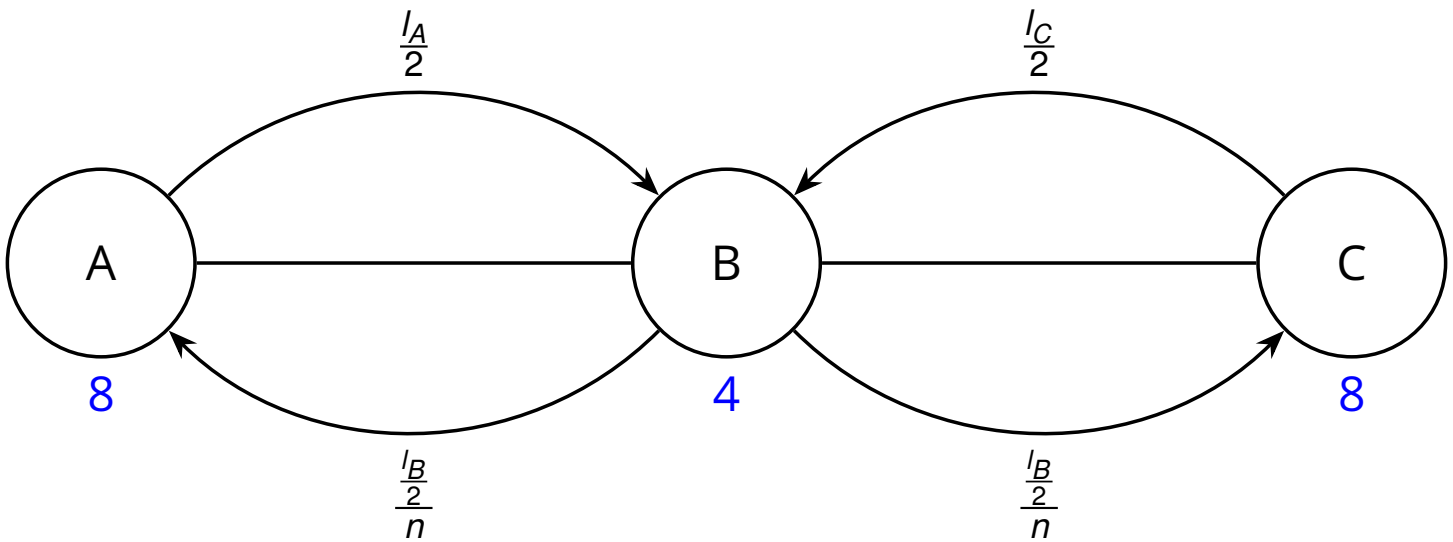

Figure: Example of Diffusion-Based Load Balancing Protocol

$\longrightarrow$ Actual Deal $\quad$ l_{node} : Load of node

n : Networksize

Loads Round 2

- Push-Pull Sum Protocol
  - A : $l_A - \frac{l_A}{2} + \frac{\frac{l_B}{2}}{|R|} = 8 - 4 + \frac{2}{3} = \frac{14}{3}$
  - B : $l_B - \frac{\frac{l_B}{2}}{|R|} - \frac{\frac{l_B}{2}}{|R|} - \frac{\frac{l_B}{2}}{|R|} + \frac{\frac{l_B}{2}}{|R|} + \frac{l_A}{2} + \frac{l_C}{2} = 4 - \frac{2}{3} - \frac{2}{3} - \frac{2}{3} + \frac{2}{3} + 4 + 4 = \frac{32}{3}$
  - C : $l_C - \frac{l_C}{2} + \frac{\frac{l_B}{2}}{|R|} = 8 - 4 + \frac{2}{3} = \frac{14}{3}$
- Deal-Agreement-Based Load Balancing Protocol
  - A : $l_A - t_B = 8 - 1 = 7$
  - B : $l_B + t_B + t_B = 4 + 1 + 1 = 6$
  - C : $l_C - t_B = 8 - 1 = 7$
- Diffusion-Based Load Balancing Protocol
  - A : $l_A - \frac{l_A}{2} + \frac{\frac{l_B}{2}}{n} = 8 - 4 + \frac{2}{3} = \frac{14}{3}$
  - B : $l_B - \frac{\frac{l_B}{2}}{n} - \frac{\frac{l_B}{2}}{n} + \frac{l_A}{2} + \frac{l_C}{2} = 4 - \frac{2}{3} - \frac{2}{3} + 4 + 4 = \frac{32}{3}$
  - C : $l_C - \frac{l_C}{2} + \frac{\frac{l_B}{2}}{n} = 8 - 4 + \frac{2}{3} = \frac{14}{3}$

Comparison in Round Two

	Push-Pull Sum	**Deal-Agreement-Based**	**Diffusion-Based**
l_A	$\frac{14}{3}$	7	$\frac{14}{3}$
l_B	$\frac{32}{3}$	6	$\frac{32}{3}$
l_C	$\frac{14}{3}$	7	$\frac{14}{3}$

Table: Loads in Round Two

Setting

Setting

- dynamic general graphs
  - may change arbitrarily between the computational rounds
  - remains connected at any round
- continuous
  - any amount of load may be transferred over edges (must not be integers)
- synchronous
  - time of message delivery is constant
- single-proposal vs. multi-proposal
  - propose load transfers to only one / several neighbors in the same round

Approach

Simulations

1. implement protocols
2. simulate using peersim
3. compare convergence time measured in rounds

References


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The End

Questions? Comments?