Aalto University

Distributed Algorithms 2022

5 CONGEST model: Bandwidth limitations

LOCAL model

=

port-numbering model

+ unique identifiers

Nodes have distinct labels from {1, 2, …, poly(n)}

CONGEST model

=

LOCAL model

+ bandwidth limitation

Messages at most $O(\log n)$ bits

LOCAL · unbounded messages

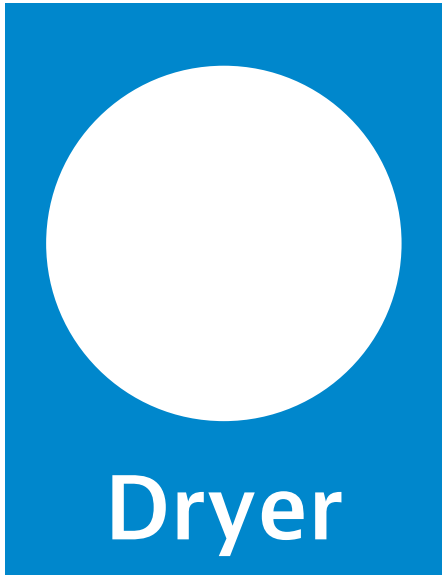
- everything trivial to solve in O(diameter) rounds: gather full input and solve locally

CONGEST · bounded messages

- gathering everything is way too expensive
- O(diameter) and $O(n)$ is nontrivial

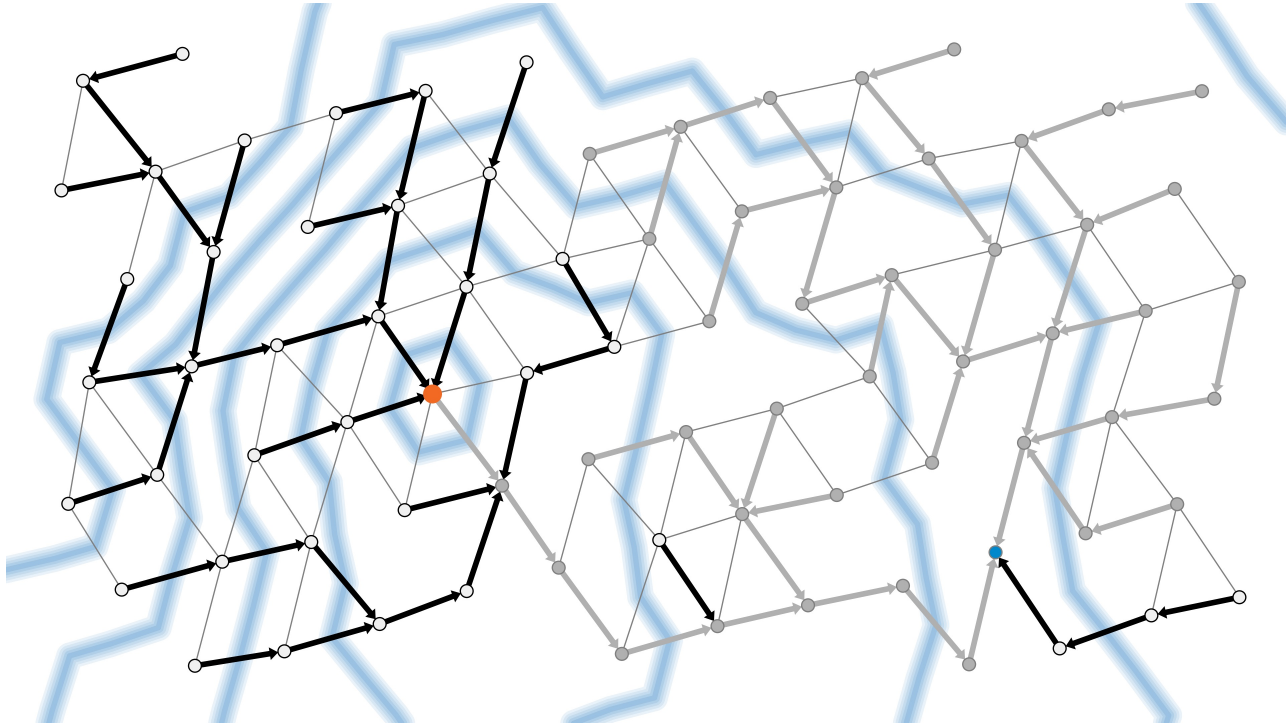
Designing efficient algorithms in CONGEST model

Pipelining



Pipelining

- Multiple operations in progress ***simultaneously***
- Using ***different resources***
- In APSP algorithm:
  - multiple waves
  - using different communication links



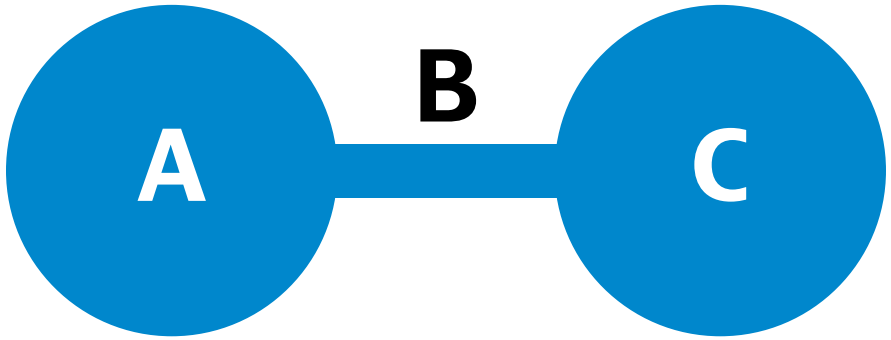
Pipelining

- ***Does not reduce the total number of messages***
  - only removes idle periods between messages
- If all communication links are already sending useful data every round, no room for pipelining

What kind of problems cannot be solved fast in CONGEST model?

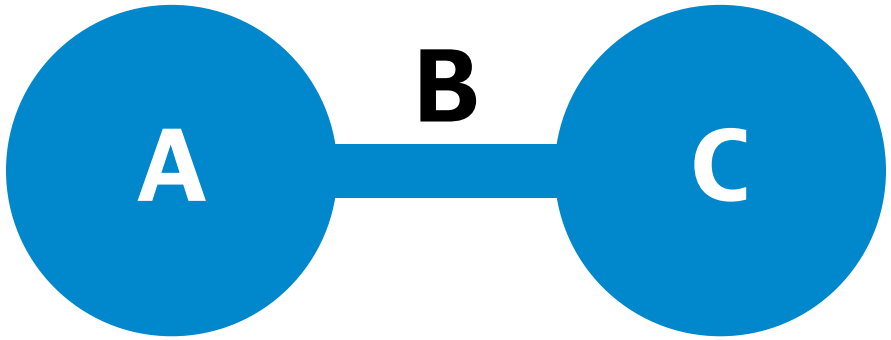
Typical hard problems

- **A:** complicated, lots of information
- **B:** **bottleneck**
  - can only send small number of bits per round from A to C
- **C:** need to know A



Proving hardness

- Counting argument
- ***Many*** possible inputs in A
- ***Few*** possible messages across bottleneck B



Proving hardness

- Counting argument
- ***Many*** possible inputs in A
- ***Few*** possible messages across bottleneck B
- Contradiction:
  - ***different*** inputs in A
  - ***same*** messages across B
  - ***same*** output in C