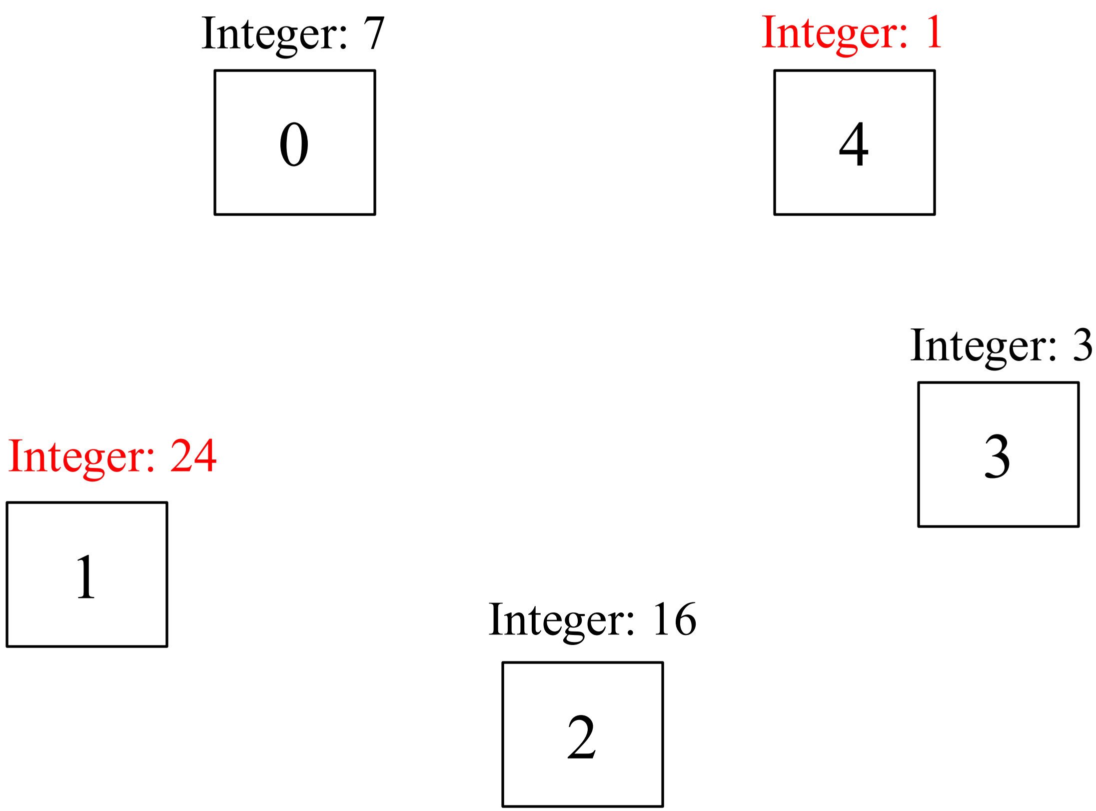
# Interacting Peers Picture



# Interacting Peers

- Each process has an integer
  - Goal: disseminate max and min integers
- Approaches
  - Centralized: use coordinator
  - Symmetric: every process sends value to every other
  - Ring: form a circle; send values around
  - Tree: create a binary (in general, n-ary) tree

# Interacting Peers

- Each process has an integer
  - Goal: disseminate max and min integers to each process
- Approaches
  - Centralized: use coordinator
    - 2 * (P-1) messages but a bottleneck
  - Symmetric: every process sends value to every other
    - P * (P-1) messages
  - Ring: form a circle; send values around
    - 2 * (P-1) messages; no bottleneck, but sequential
  - Tree: create a binary (in general, n-ary) tree
    - 2 * (P-1) messages; less bottleneck, but log(P) steps

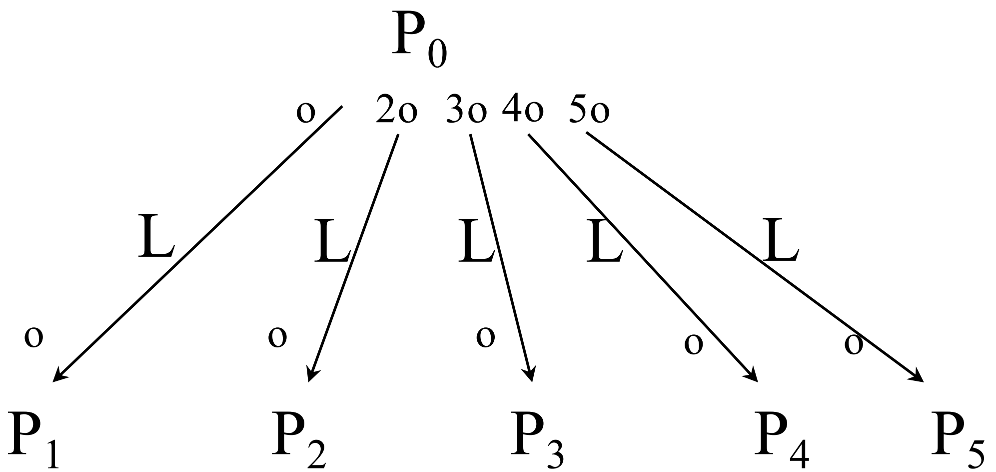
# Interacting Peers

- How to know which implementation to choose?
- Can use analytical models
  - **LogP** model most widely used model
  - L (latency), o (overhead), g (gap), P (number of cores)
    - Allows mostly architecture-independent analysis of parallel algorithms
    - Latency: time for a single byte to travel between endpoints
    - Overhead: time to copy a message from user address space to network
    - Gap: mandatory time between consecutive messages (represents the inverse of network bandwidth, bytes/second)

# LogP Model applied to broadcast

Sent at time:

Message travels



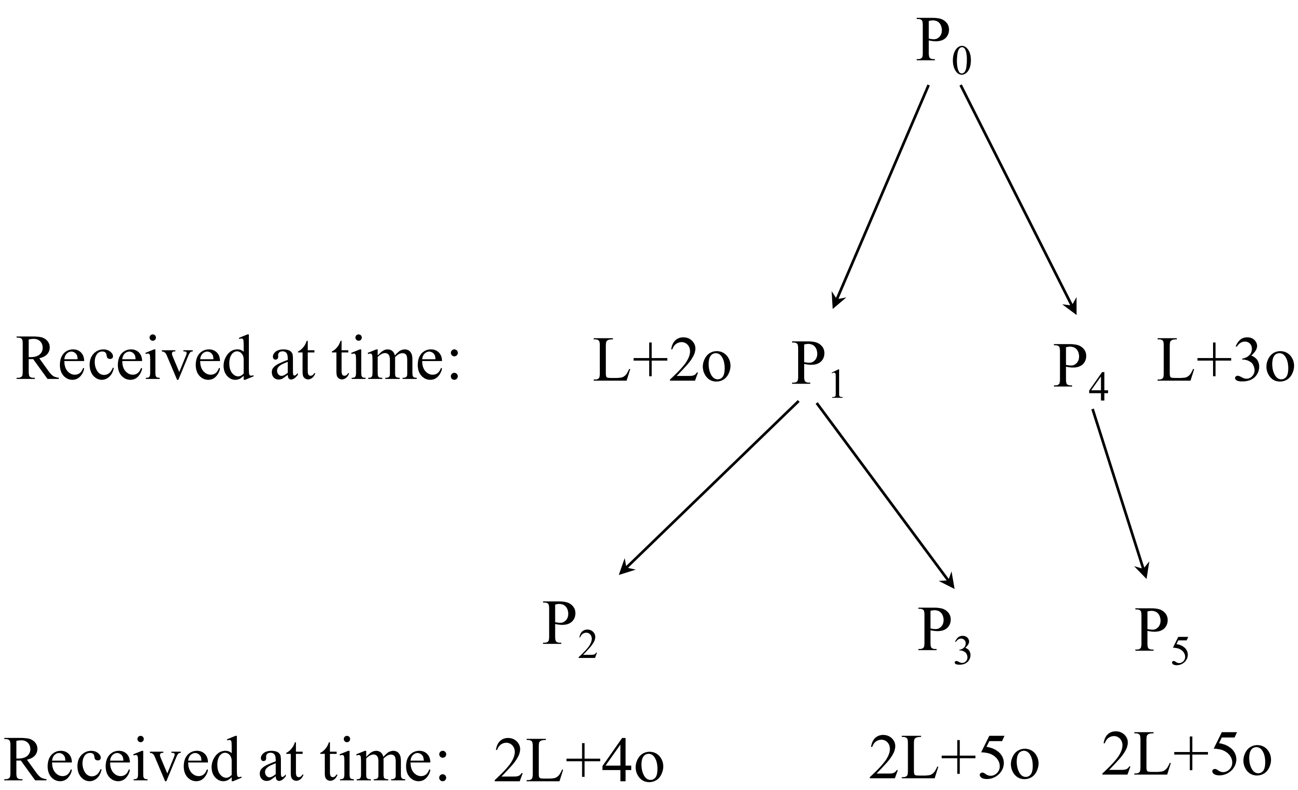

Received at time: L+2o L+3o L+4o L+5o L+6o

Broadcast completion time is L+6o, assuming o > g

More accurate to say completion time is roughly L + 6 * max(o,g)

# LogP Model applied to broadcast

(Assumes o > g)



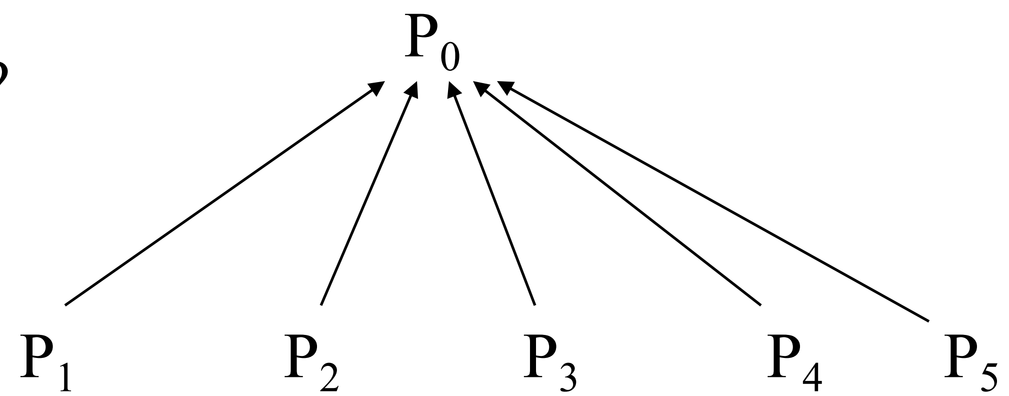

Broadcast completion time is 2L+5o (compared to L+6o on previous slide).
Which is better depends on the values of L and o.

# What about a reduction (fan-in and fan-out)

- Let’s use LogP to compare a two-level tree to symmetric
  - Two-level tree clearly takes L+6o for the fan-out (see previous slide; it’s just a broadcast).
    - What about the fan-in? Is it just L+2o, since P1 through P5 all send to P0?

# LogP Model applied to fan-in

Received at time???




Sent at time: L+o L+o L+o L+o L+o

Fan-in completion time (when $P_0$ receives all messages) is not L+2o

-- would imply infinite bandwidth (imagine if a million processes sent to $P_0$)

-- in reality, receives all messages at roughly L+6*max(o, g), just like fan-out

# What about a reduction (fan-in and fan-out)

- Let's use LogP to compare a two-level tree to symmetric
  - Two-level tree clearly takes L+6o for the fan-out (see previous slide; it's just a broadcast).
    - What about the fan-in? Is it just L+2o, since P1 through P5 all send to P0?
      - No, because overheads cannot be parallelized
      - In addition, the gap parameter represents finite bandwidth
  - Symmetric?
    - Seems like maybe L+6o
      - But in reality, that is the minimum---much more complicated than this; involves sends and receives at each node

# Interacting Peers

- Generalizations
  - Example: all-to-all
    - Implementations are not at all clear here
    - Must worry about contention
    - May want intelligent scheduling

For details, if interested, the LogP paper is at:
https://dl.acm.org/doi/10.1145/155332.155333