Many current parallel models are impractical

Artificial factors.

PRAM

A collection of synchronous processors.

Communicate with global random access memory

Processors can access any memory cell in unit time.

Variation of PRAM make it more practical

Network models lack robustness
Motivations

- BSP (bulk synchronous parallel model)
  - A radical variant of PRAM
  - capture key performance bottlenecks
  - drop off the details
- Apparent architectural convergence
- Phenomenal increase of microprocessor performance and capacity.
  - x100 / x1000 64-bit off-the-shelf processors.
  - A large number of data on each processor.
- Network topology lags far behind.
  - high latency, overhead of communication, limited bandwidth
- Physical interconnect underlying a program is different.
LogP model

- A model of a distributed-memory multiprocessor.
- Specify the performance factors of interconnection network without using the structure of it.
LogP model

- Assumptions:
  - To deal with variant latency in asynchronous processor
    - L is the upper bound
  - All messages are of a small and fixed size
  - Network has a finite capacity.
  - Not attempt to model local computations.
LogP model

- Parameters in LogP are not equally important. Trivial params are discarded.
  - A trade-off between capturing more execution characteristics and providing a reasonable framework for analysis.
- Loopholes that other models permit are discouraged
- Encourage techniques that work well in practice
  - Reduced the amount of communication
  - Careful scheduling of communications.
Benefits:

- Solutions to basic theoretical problems under LogP are better than other solutions under traditional models.
- Designing according to the performance result under LogP models helps improve the quality of solutions.
- It's possible to accurately predict the performance on real machines.
Utility of the LogP model

- Predicted and measured times over problem N/P that is the total number of keys per processor.
- Predicted performance vs. measurement.
- LogP helps identify deficiencies.
Model on real machines

- Task: transmission of an $M$-bit message in an unloaded or lightly loaded network.

- Total message communication time:

$$T(M, H) = T_{snd} + \left\lceil \frac{M}{w} \right\rceil + Hr + T_{rcv}$$

<table>
<thead>
<tr>
<th>Machine</th>
<th>Network</th>
<th>Cycles</th>
<th>w bit</th>
<th>$T_{snd} + T_{rcv}$ cycles</th>
<th>$r$ cycles</th>
<th>avg. $L$ (1024 Proc.)</th>
<th>L (M = 160) (1024 Proc.)</th>
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Summary

- The communication network is abstracted into three parameters under LogP.
- Determine lower bound on parallel running time.
- Guide algorithm designs to be more efficient.