The Local and Congest models

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This note summarizes the definition of the fault-free, message-passing, synchronous distributed computing model with unique IDs, described in class on Tuesday, 8/23.

1. **Communication network:** This is modeled by an undirected, connected graph. The nodes of this graph represent computational entities and the edges represent bidirectional communication links.
2. **Input:** The communication network is also the input to the problem.
3. **Input Distribution:** Initially, each node is only aware of its neighbors in the communication network.
4. **Output:** Each node is responsible for only computing its "part" of the output. For example, in the GraphColoring problem, each node is responsible for computing just its color in the $(\Delta + 1)$-coloring being computed.
5. **Communication via messages:** Each node can communicate with its neighbors in the communication network by sending messages to its neighbors (and receiving messages from its neighbors).
6. **Synchronous computation and communication:** There is a clock that ticks continually and at each clock tick every node performs three steps: (A) Send a message to each neighbor, (B) Receive a message from each neighbor, and (C) Perform computation. A clock tick is called a *round*.
7. **Nodes are infinitely powerful:** This means that computation in Step (C) is completed instantly, i.e., at that particular clock tick, no matter how difficult the computation may be.
8. **System is fault-free:** Nodes suffer no faults during the execution of the algorithm and similarly communication links suffer no faults. This means that nodes do not crash or otherwise behave badly and messages are not lost, delayed, or corrupted. Specifically, messages sent in Step (A) are all received in Step (B).
9. **IDs are unique and small:** Each node has a unique ID. We assume that each ID is represented using at most $\lceil c \log_2 n \rceil$ bits for some constant $c \geq 1$. Thus IDs are small in size, i.e., logarithmic relative to the size of the network, but sufficiently large so that nodes can have unique IDs.

This fault-free, message-passing, synchronous distributed model with unique IDs for nodes is called the Local model. Note that in this model there is no restriction on the size of messages. A closely related model, called the Congest model, is identical to the Local model except that every message is restricted to have size $\Theta(\log n)$ bits.