Dynamic Networks: Robots, Agents, and Topology Manipulation

David Ko

April 30, 2009

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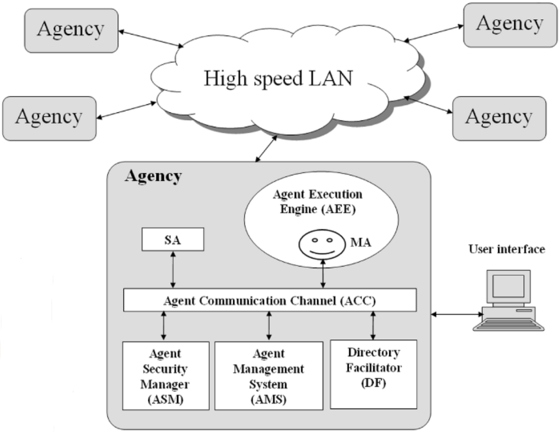

Figure: Agency Overview

Why use mobile agents?

Some commonly cited reasons to use the mobile-agent paradigm of computation: (from Wikipedia)

- Reduce network load: Processing on data may be done in place, rather than collecting data at a central location.
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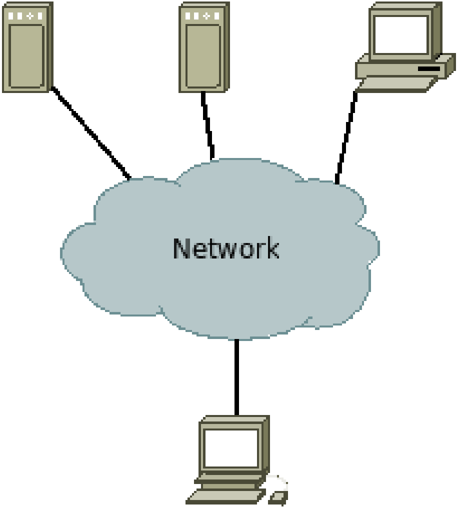

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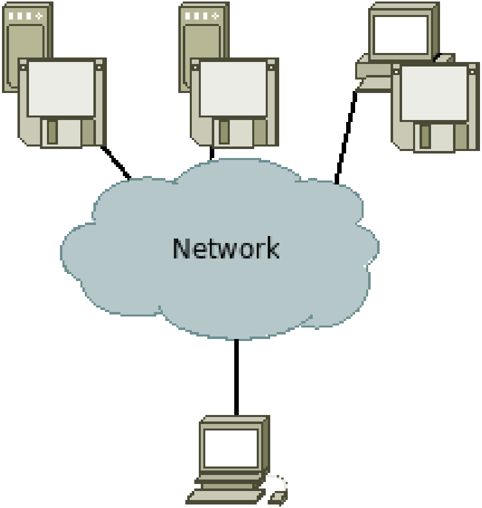

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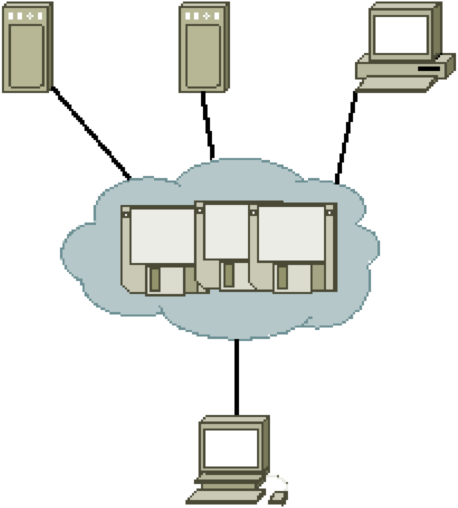

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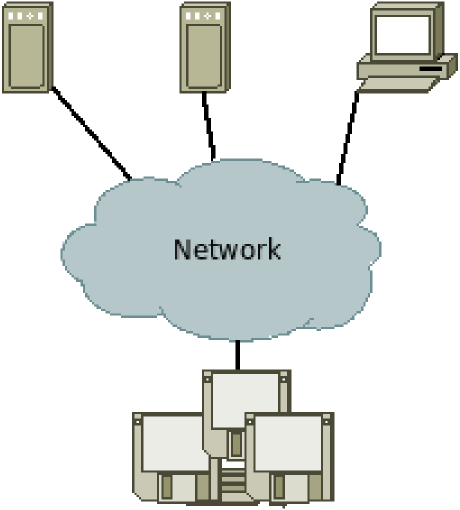

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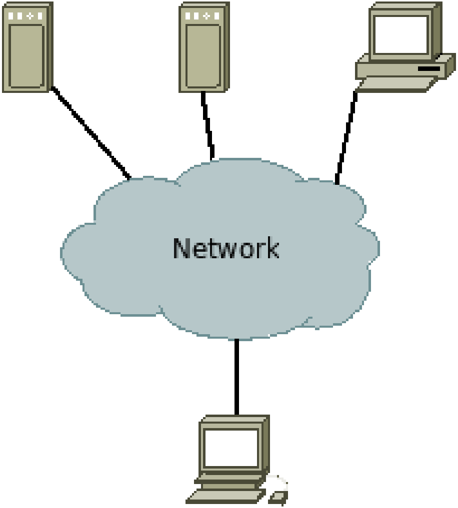

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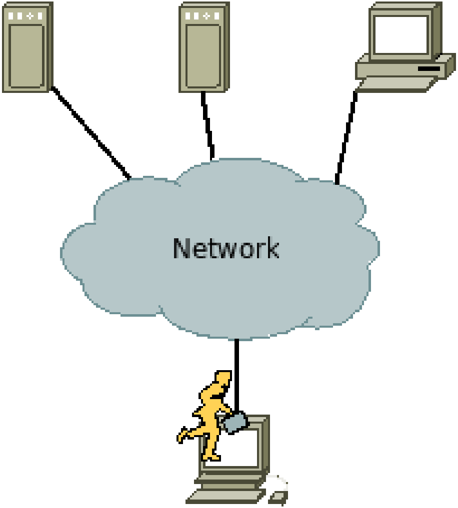

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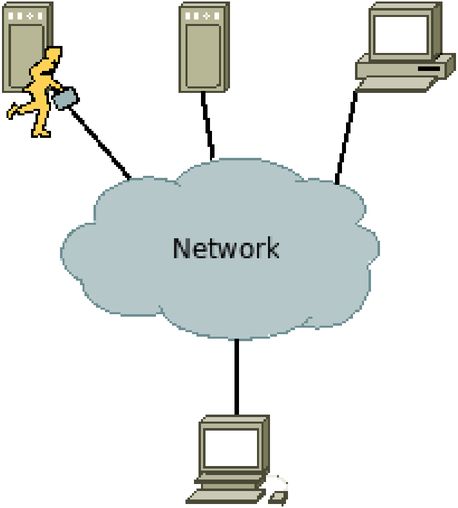

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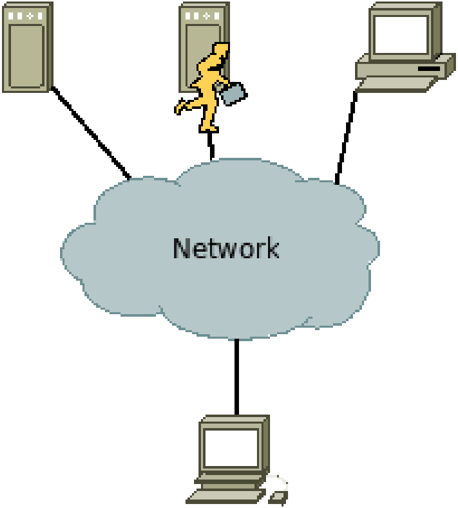

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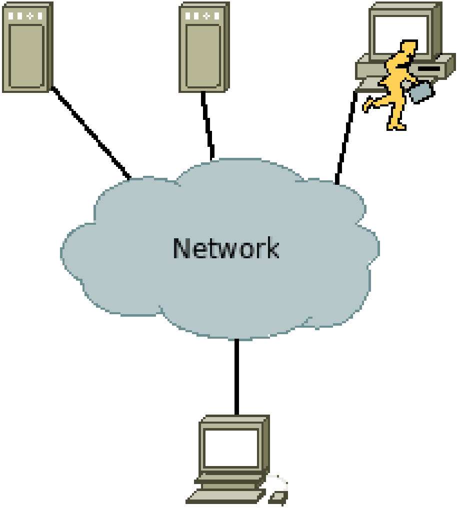

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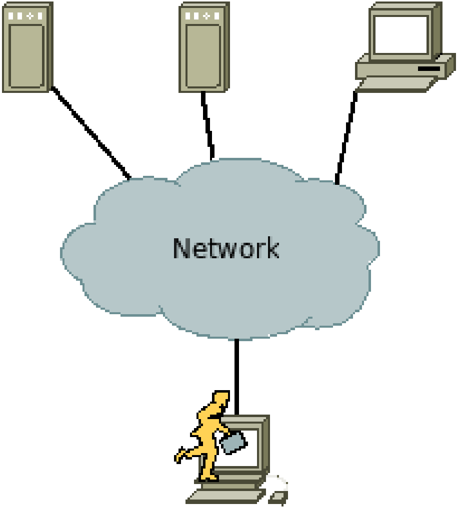

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Preliminary work done by Basu

- Proposed that in order to be fault tolerant, a robot network should be biconnected. In other words, the network should contain no cut vertices.
- Robot connectivity determined by limited communication range.
- Robots in a robot network may physically move to ensure a biconnected network.
- Cases presented by Basu include:
  - Linear contraction case.
  - Two dimensional contraction case.
  - Two dimensional block movement case.

Linear Contraction Case

Minimize

$$D_{total} = \sum_{i=1}^{N} |x_i - p_i| \tag{1}$$

With the following constraints:

$$x_1 \geq p_1 \tag{2}$$

$$x_N \leq p_N \tag{3}$$

$$x_i - x_{i-1} \geq 0, \ 2 \leq i \leq N \tag{4}$$

$$x_i - x_{i-2} \leq 1, \ 3 \leq i \leq N \tag{5}$$

2-D Contraction Case

2-D analog of the linear case.

1. Calculate “center of mass” of all robots.
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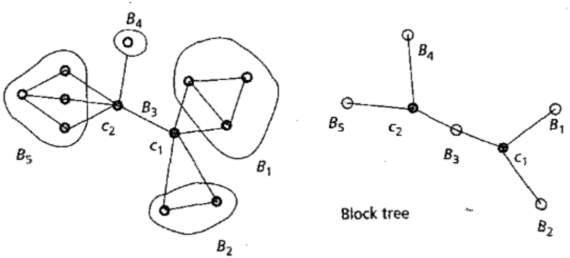

Figure: Basu's decomposition of a graph into a bipartite block tree.

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A Better Algorithm

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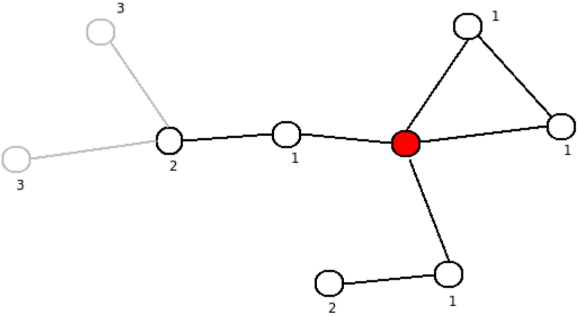

Figure: The 2-hop network of a certain node.

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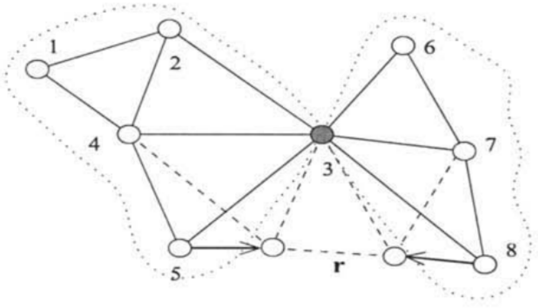

Figure: Node movement for a critical node with no critical neighbors.

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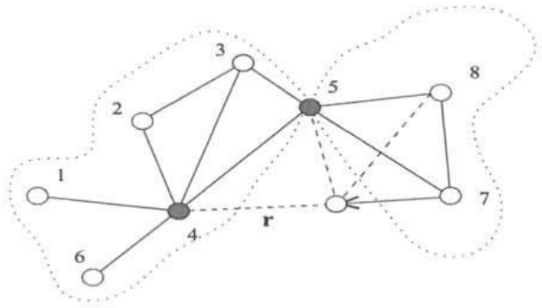

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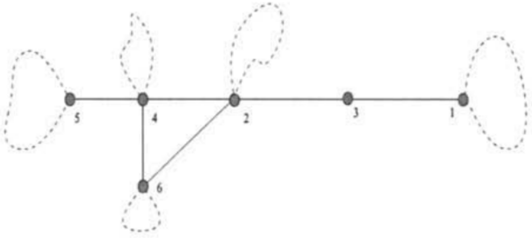

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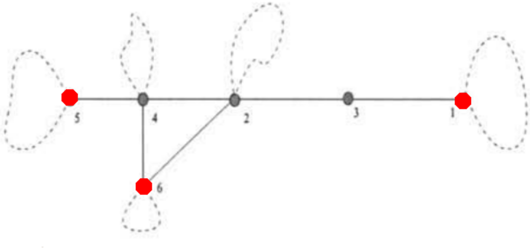

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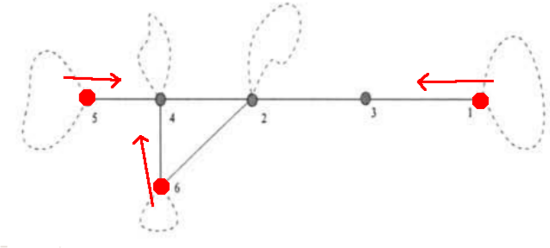

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Leader Agent/Bot

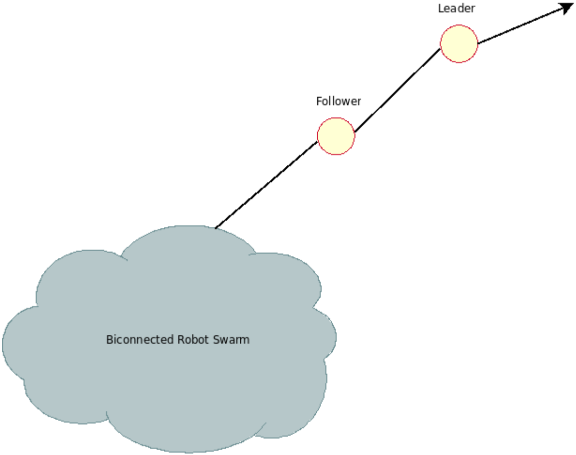

Figure: Conceptual drawing of a leader bot “dragging” a biconnected robot network.

The End

Questions? Comments?
Thanks for your time!