Don't Love Thy Nearest Neighbor

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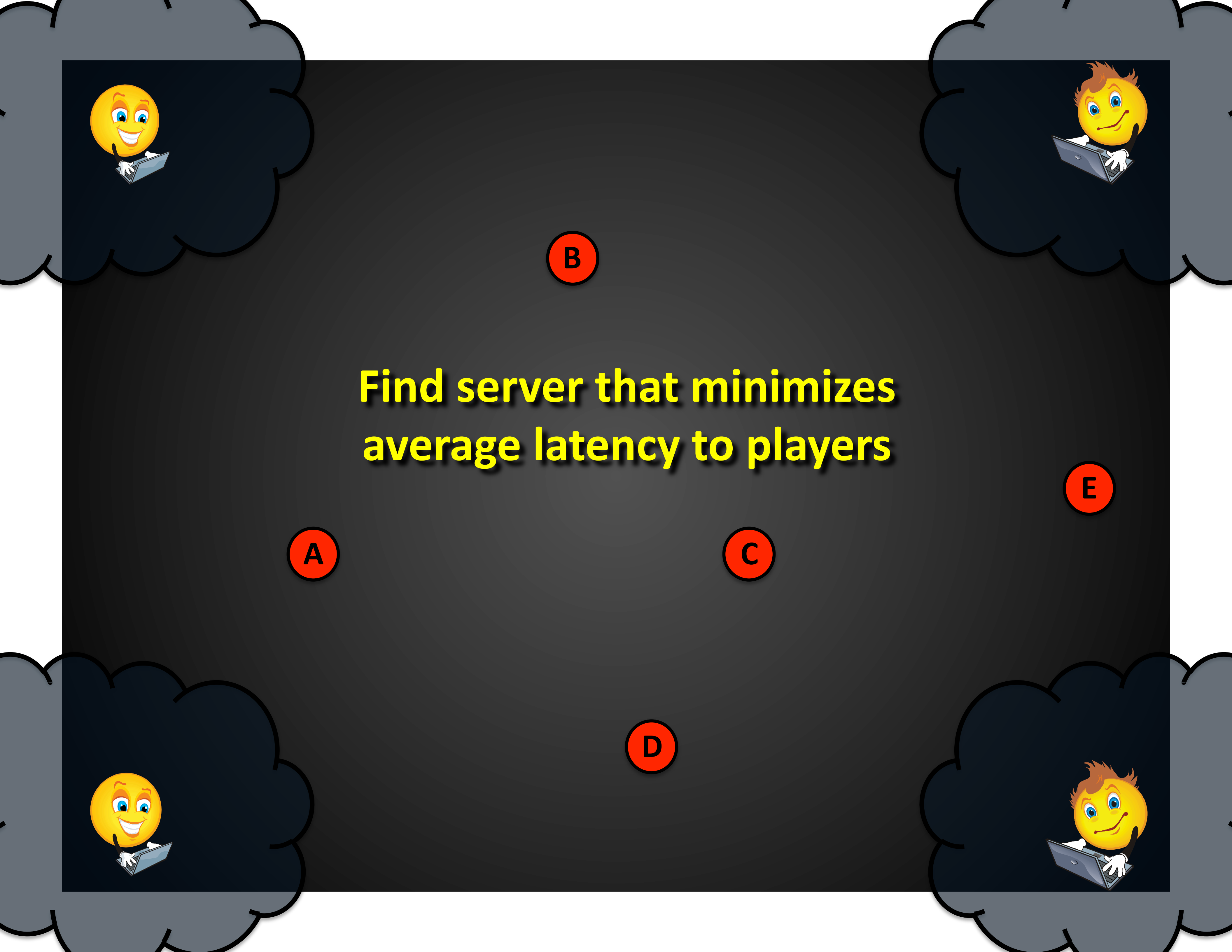
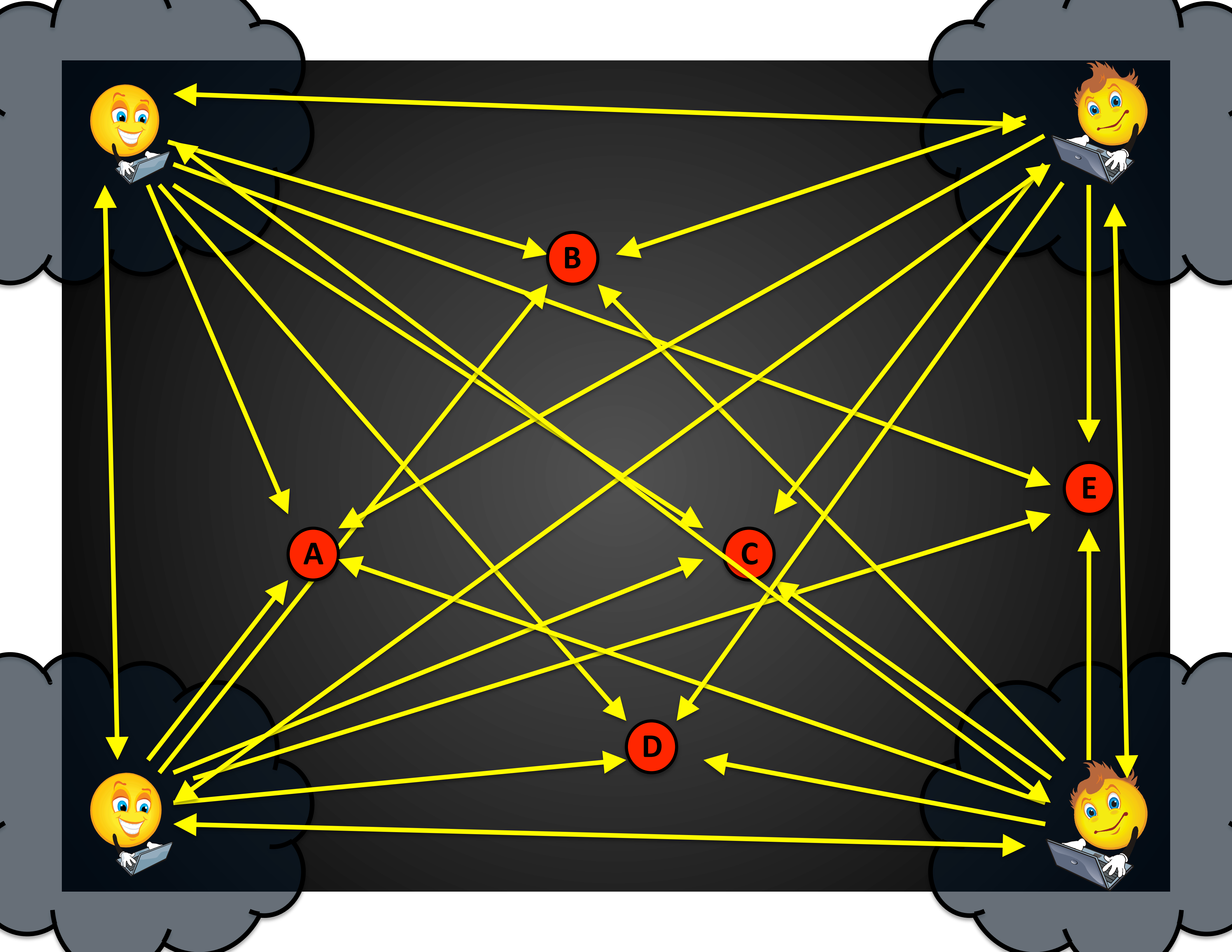
Distributed Internet applications need the ability to find nodes that satisfy latency constraints



Find server that minimizes average latency to players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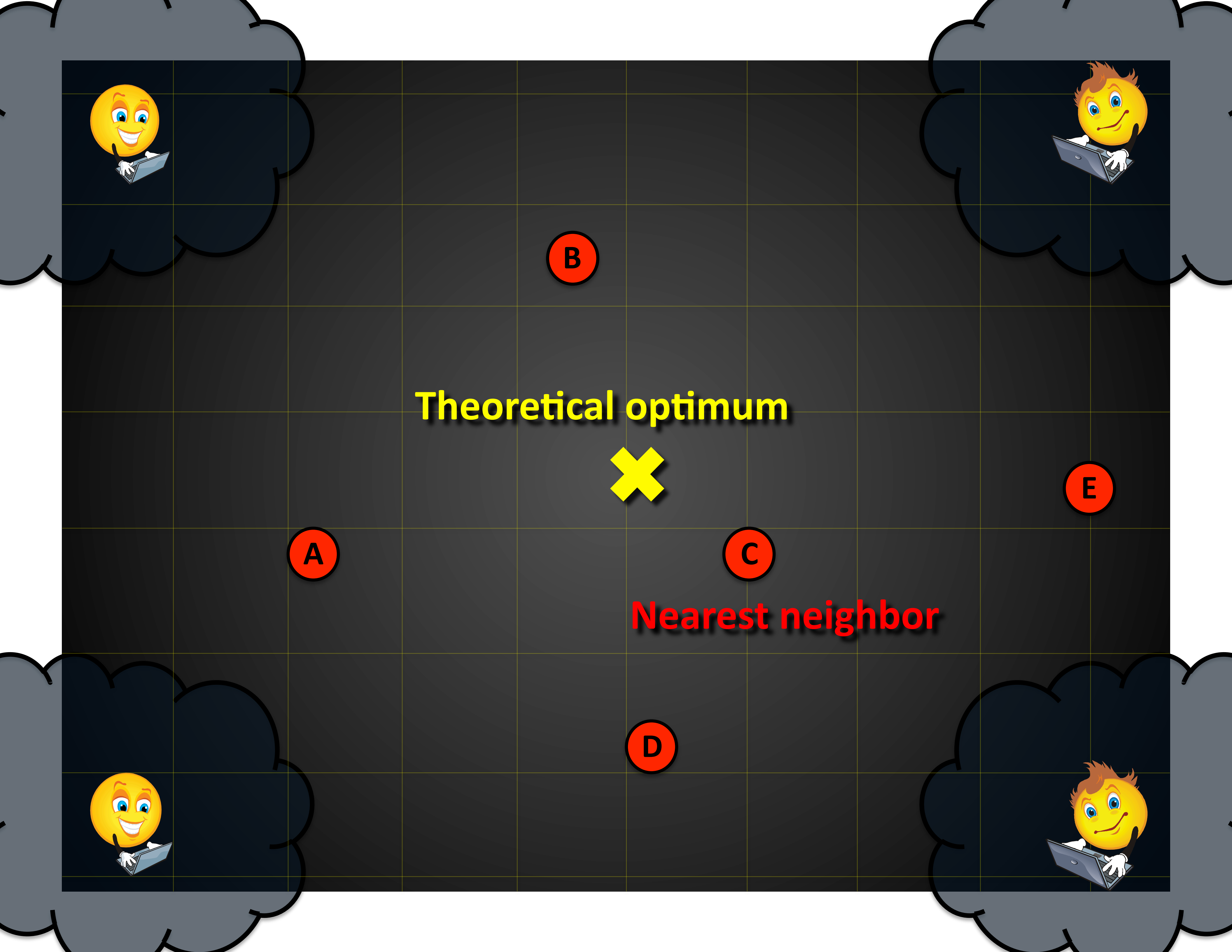
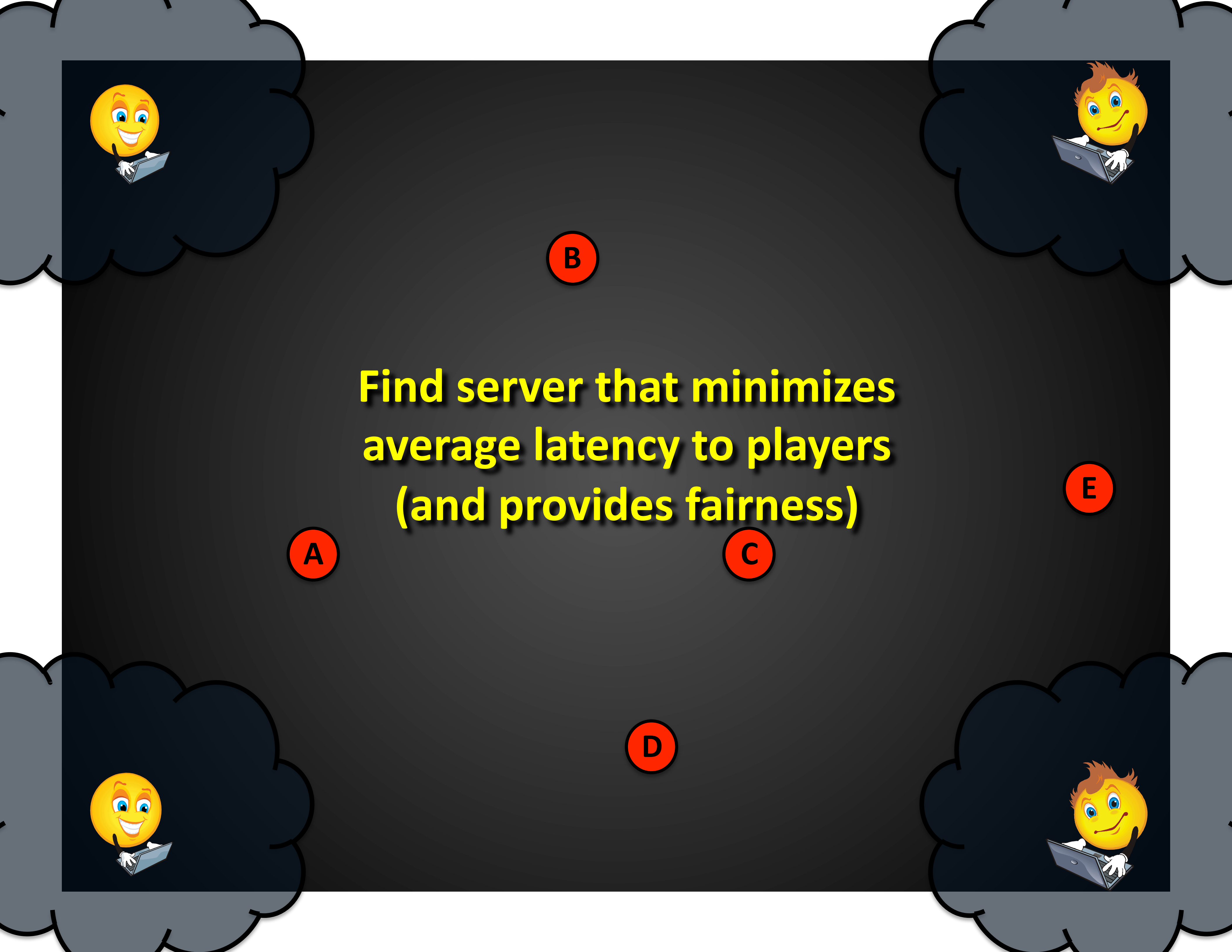


Theoretical optimum

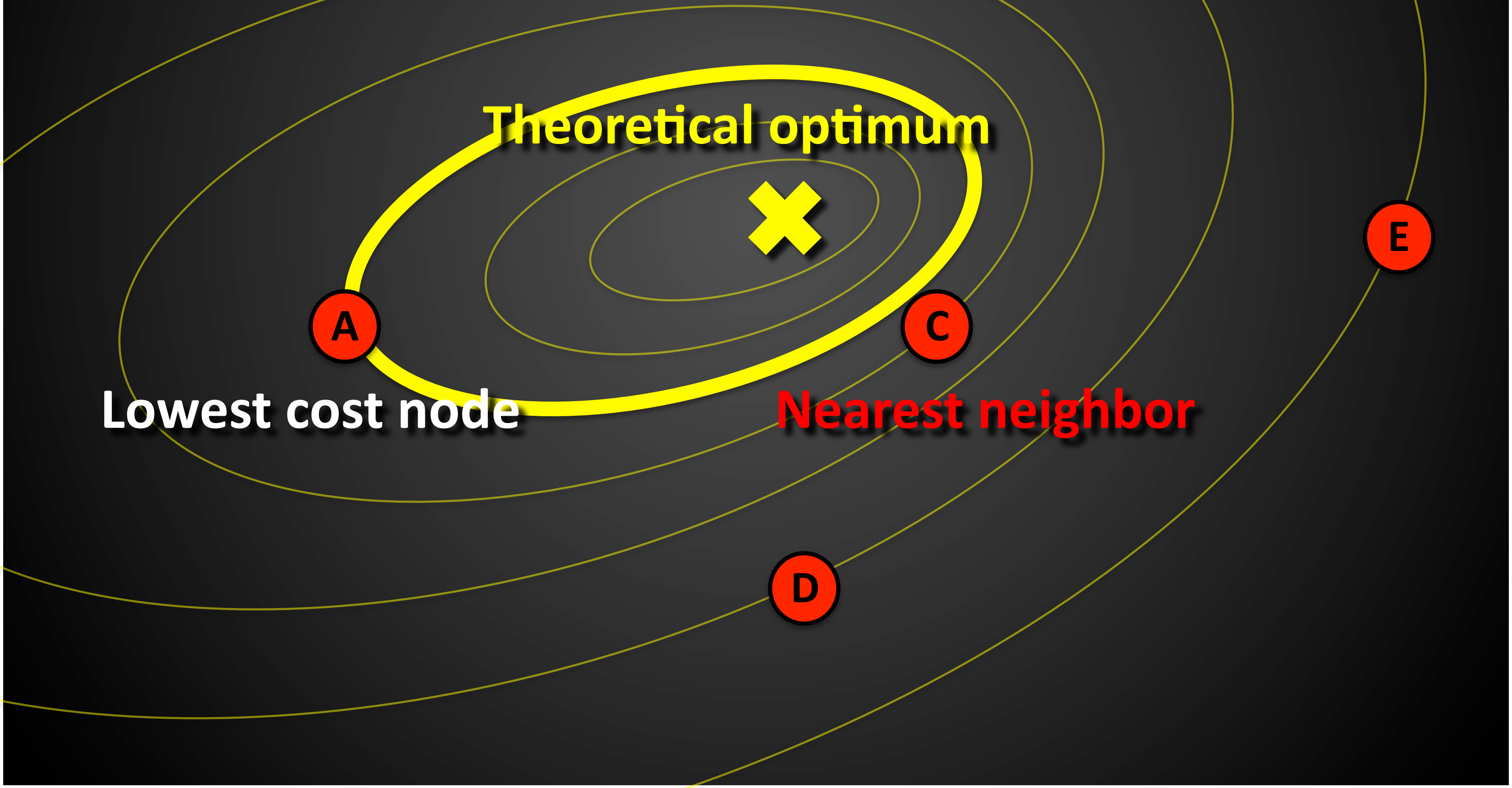
Nearest neighbor



Find server that minimizes average latency to players (and provides fairness)

Cost optimization in the network coordinate space

Nearest neighbor is not enough



Sherpa

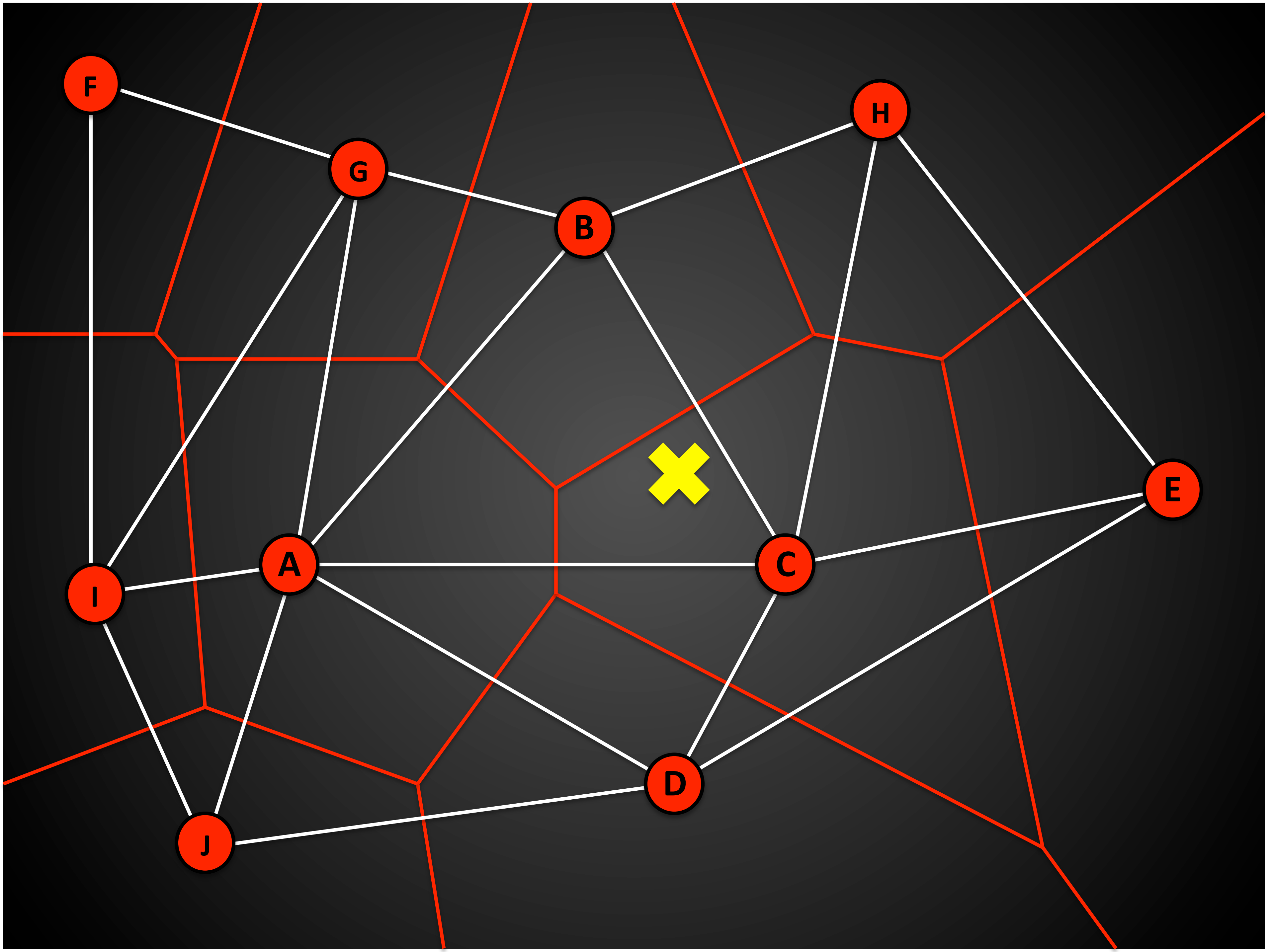
- Overlay network system that finds the lowest cost node under latency constraints
- Broad classes of latency-based cost functions, without knowing all the nodes that we are querying

1. Network coordinates
2. Voronoi regions

Overlay setup

3. Compass routing
4. Gradient descent

Querying/Node discovery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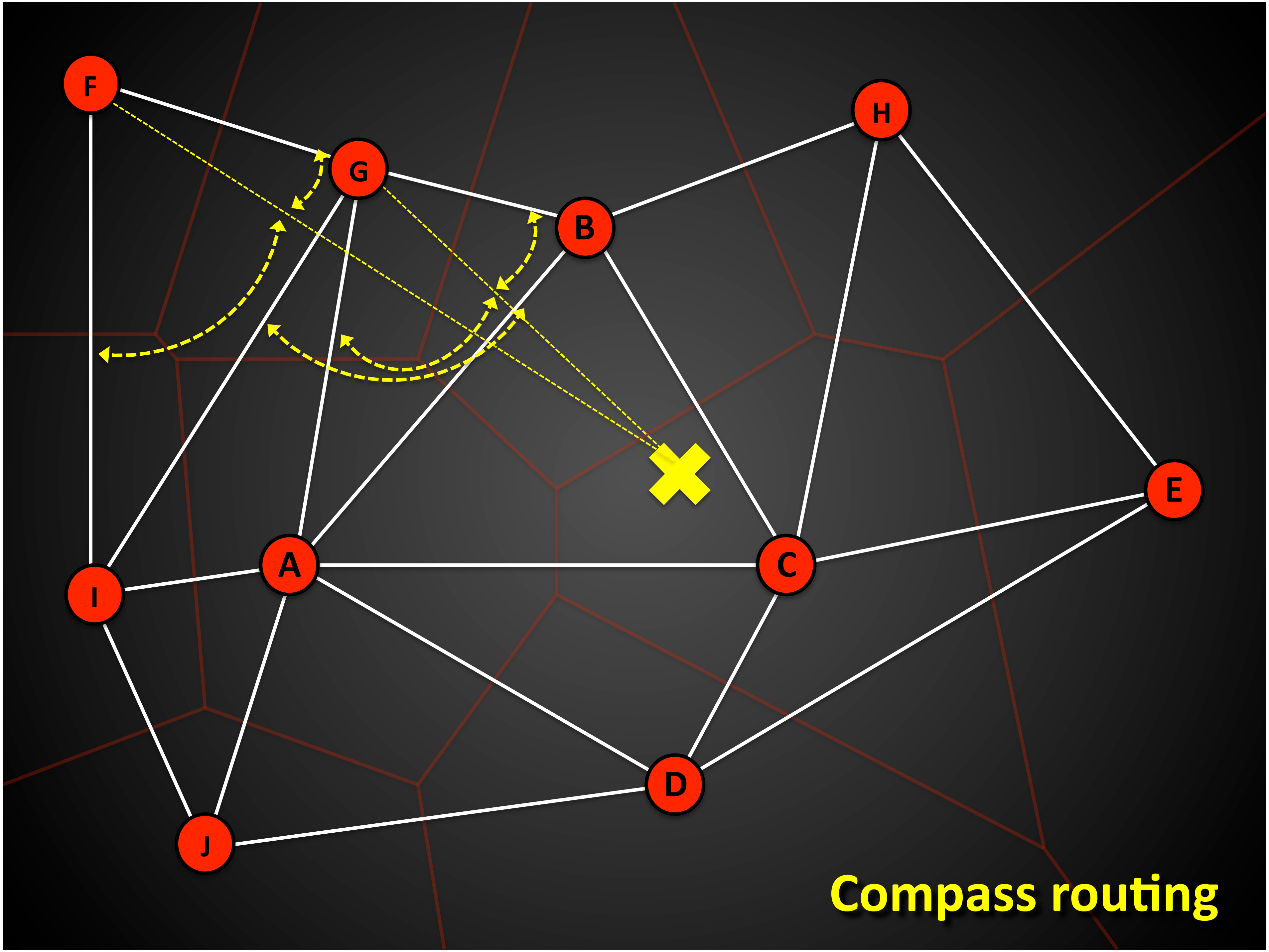
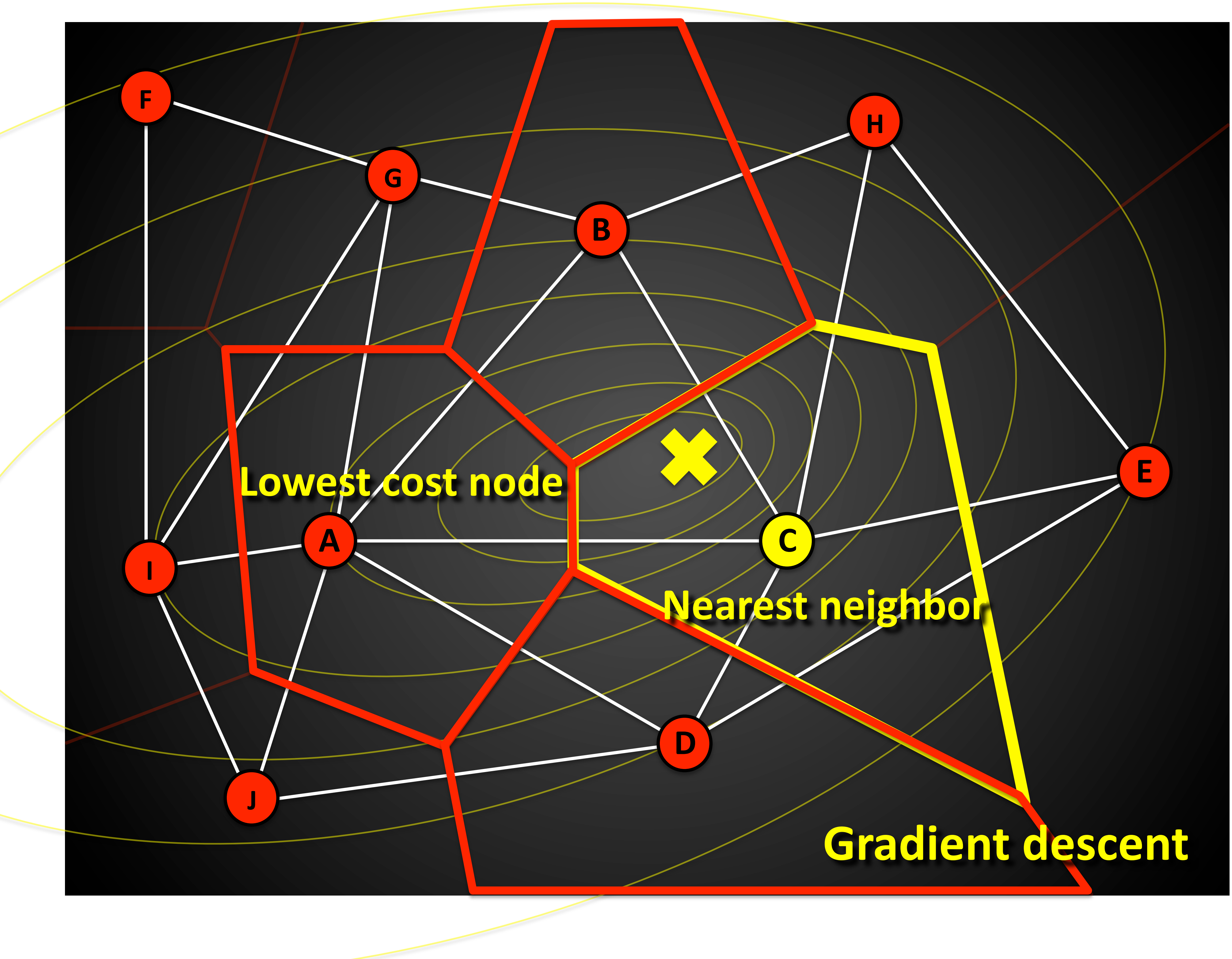


Compass routing



Lowest cost node

Nearest neighbor

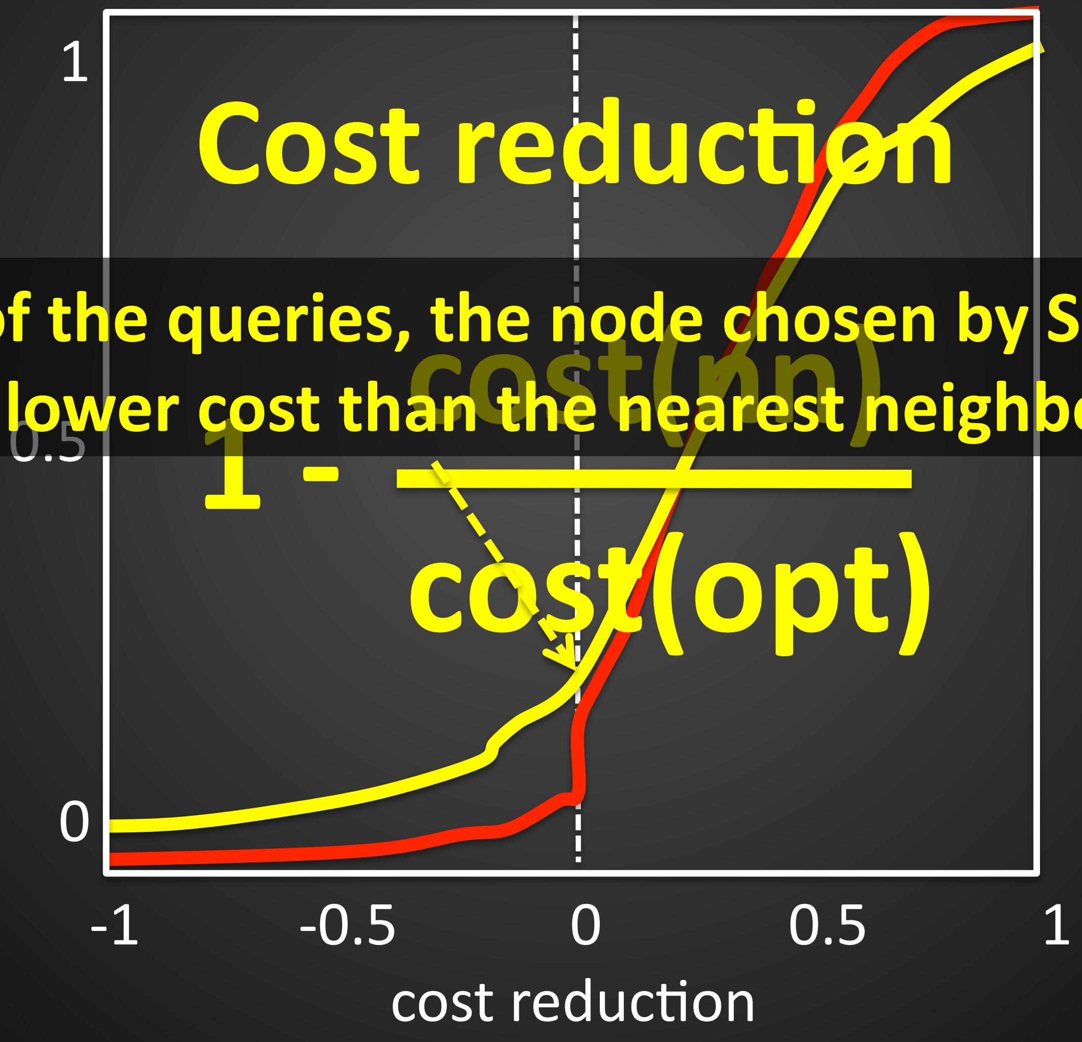
Gradient descent

Evaluation

- Two latency data sets:
  - – 1715 DNS servers, 213 PlanetLab nodes
  - – network coordinate system: Vivaldi
- 1,000 queries: “find centroid of 30 nodes”

$$\operatorname{cost}(m) = \frac{\sum_{i=1}^{N} d(m,p_i)}{N} + \\ +(\max_i(d(m,p_i)) - \min_i(d(m,p_i)))^2$$

Nearest neighbor is not enough

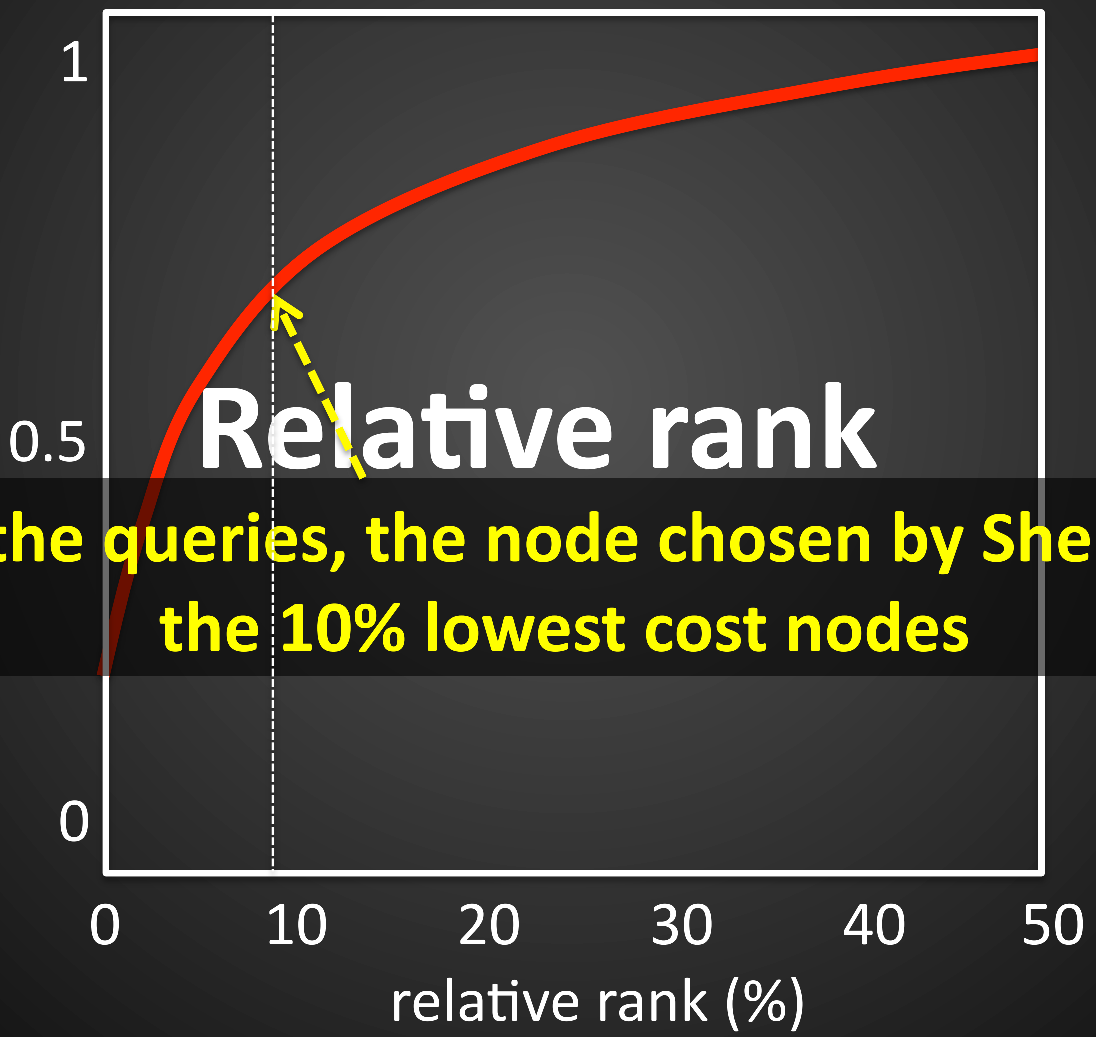


Cost reduction

$$1 - \frac{\mathrm{cost(nn)}}{\mathrm{cost(opt)}}$$

For 80% of the queries, the node chosen by Sherpa has a lower cost than the nearest neighbor

Relative ranking



For 65% of the queries, the node chosen by Sherpa is among the 10% lowest cost nodes

Conclusions and Future Work

- Generalized node selection with network coordinates
- Sherpa finds the lowest cost node

- Implementation
- Cost functions
- Other applications: split TCP, route avoidance