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Software Engineering Institute

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Applied Computational Mechanism Design

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Recall from Mark Klein's Talk...

“Theories and constructs from the field of economics can endow the notion of architecture with new meaning and consequently offer structuring principles for Ultra-Large-Scale Systems.”*



We put this idea to the test to allocate scarce bandwidth in an emulated tactical data network based on the US Navy's LINK-11.

ULS Research Area

6.2 Computational Emergence

6.2.1 Algorithmic Mechanism Design
Computational

Mark Klein, Panel slides, SMART Ultra-Large-Scale Systems Forum



Did you know that...

- 98%+ of Google's \$6.7B revenue in 2006 has been attributed to an auction mechanism?
- the FCC has conducted auctions of licenses for electromagnetic spectrum since 1994?
- in 2007 three Nobel prizes in economics were awarded for work in mechanism design?



What is Computational Mechanism Design?

- A **mechanism** is an institution, such as a market or an auction, that defines the rules for how humans are allowed to interact, and governs the procedures for how collective decisions are made.
- A **computational mechanism** uses computational processes to act on behalf of humans, and/or uses computers to determine decision outcomes.
- **Computational mechanism design** is the art of designing computational mechanisms
- Computational mechanism design straddles **microeconomics**, **game theory**, and **computer science**



Why Study Tactical Data Networks?

A tactical data network will serve diverse needs of diverse users in a highly dynamic, performance-critical environment

Many systems communicate only minimal information to conserve bandwidth and to minimize latency

Mechanisms may provide a principled way to **trade scarce bandwidth** for **value-driven improvements** in data quality

We will regard the system as a virtual economy, where bandwidth is *scarce* and information has *value*





Our approach to studying mechanism design

Develop an environment to study mechanisms at scale

- tactical data network (LINK-11)

Study one mechanism in-depth in this environment

- Vickrey-Clarke-Groves auction

Evaluate engineering potential

- mechanism engineering as a peer of, for example, performance engineering?





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demonstration...



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Takeaway Point

“Since computation has moved over the past twenty years decisively closer to people, interfaces with social sciences such as Psychology and Sociology, besides Economics, have become increasingly important”

– Christos H. Papadimitriou, in “Algorithms, Games, and the Internet”