



Australian Government

Department of Defence

Defence Science and
Technology Organisation

Agility in Networked Military Systems: A Simulation Experiment



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11TH ICCRTS — 2006

COALITION C2 IN THE NETWORKED ERA

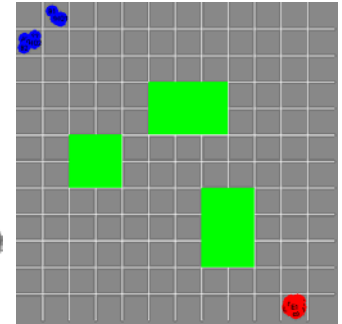


Outline of the Talk

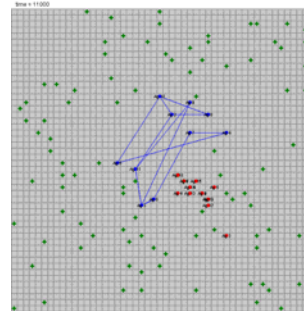
1. Agility



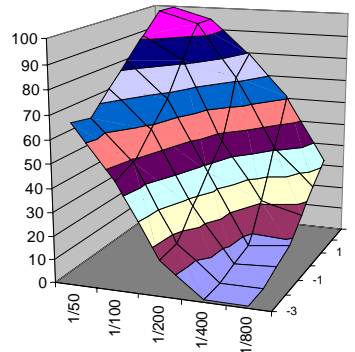
2. Project Albert & Agent Simulation



3. Design of this Experiment



4. Experimental Results





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Part 1: Agility





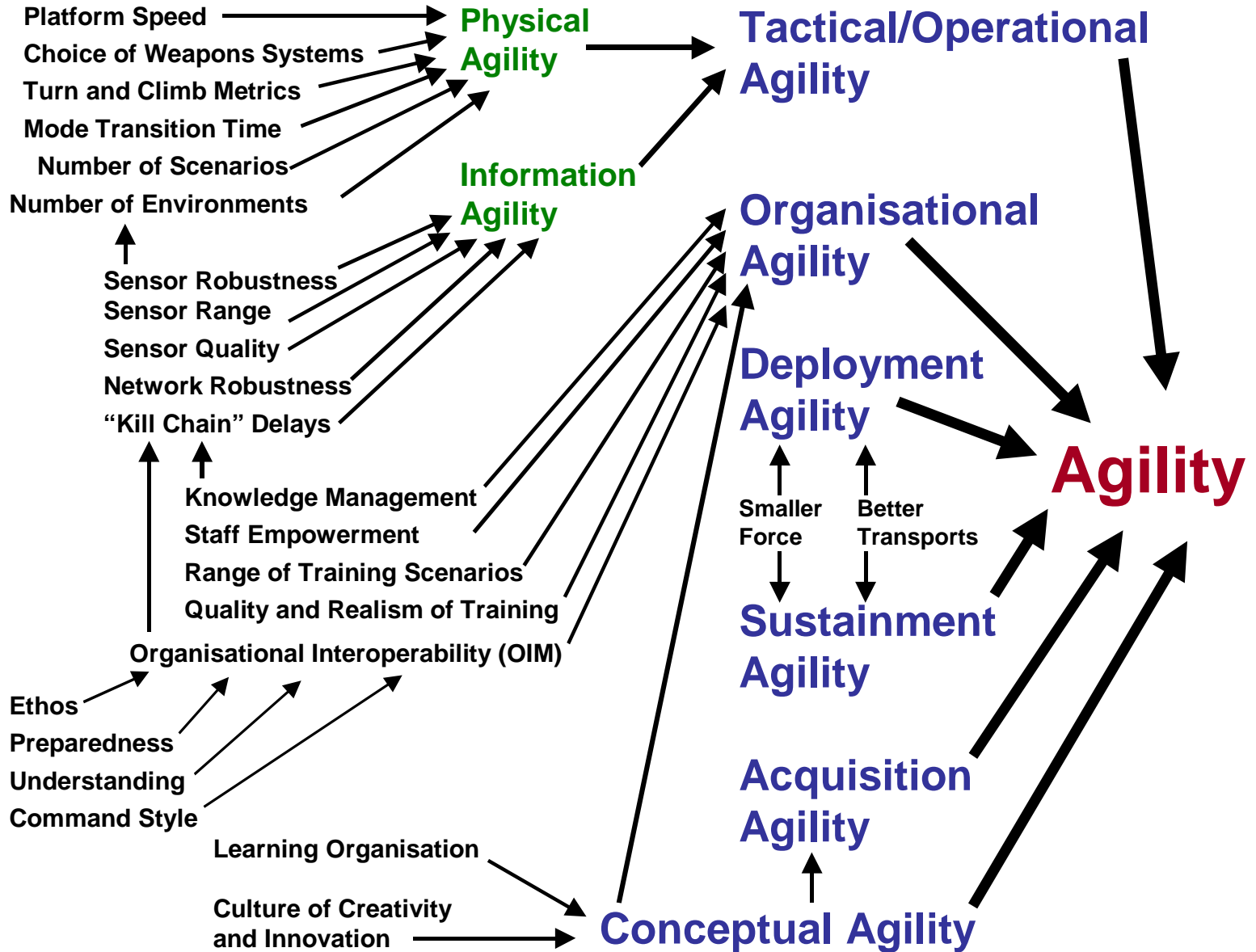
What is Agility?

- **Agility** refers to the ability of an organisation, person, or military force to perceive an upcoming threat, and to respond quickly enough to it.
- This work focused on agility at the tactical military level — although agility also applies at higher levels.
- Agility requires **perceiving the threat from a sufficient distance**, and then **responding rapidly enough** to it.
- Ability to perceive and ability to respond quickly can be traded off against each other.
- Our experimental results demonstrate this.





Some Metrics for Agility

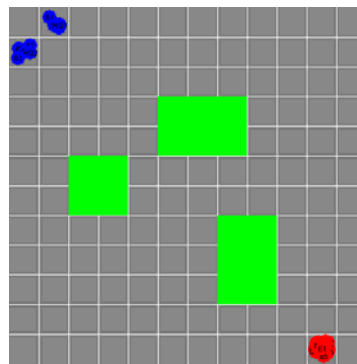




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Part 2: Project Albert & Agent Simulation

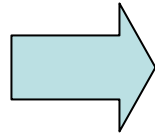




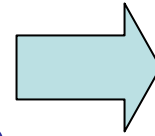
Data Farming in Project Albert



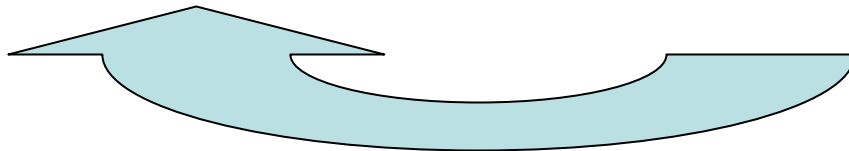
Choose Parameter
Ranges for x_1, \dots, x_n



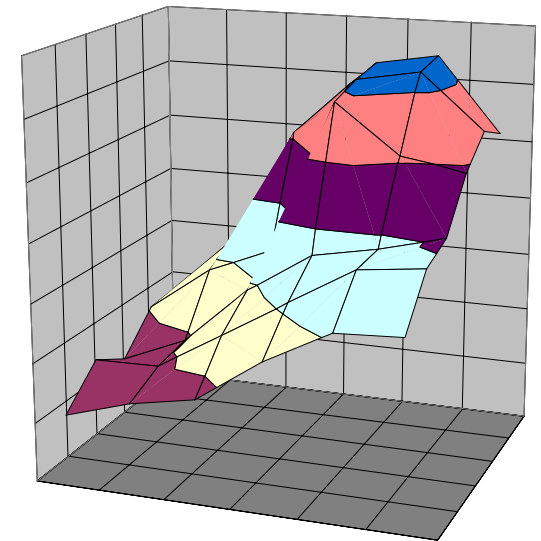
Simulate
Process
 $P(x_1, \dots, x_n)$



Analyze &
Visualize Results



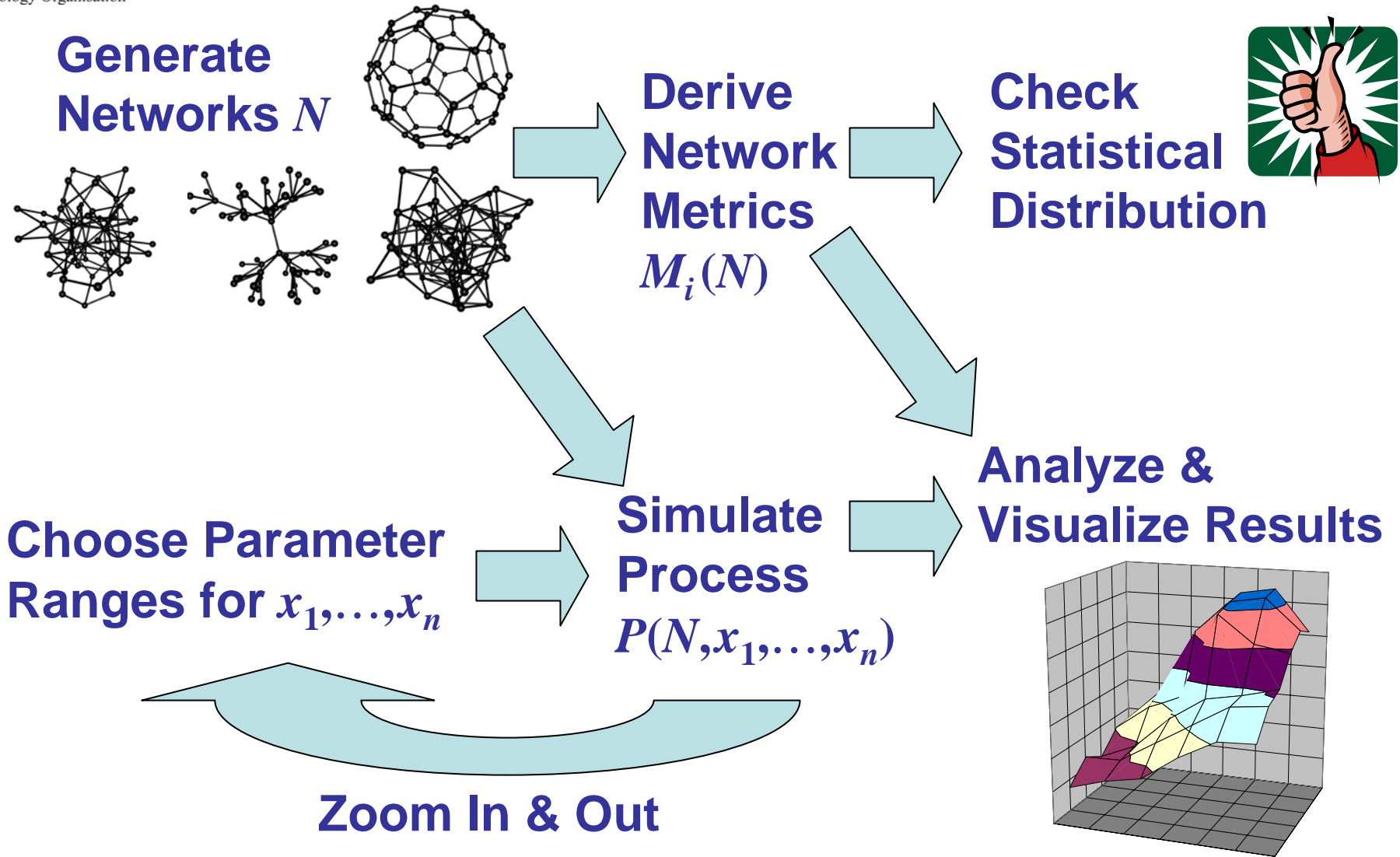
Zoom In & Out



*Mission: "... collaboratively explore the vast space of possibilities inherent in the **questions** that our decision makers face ..."*



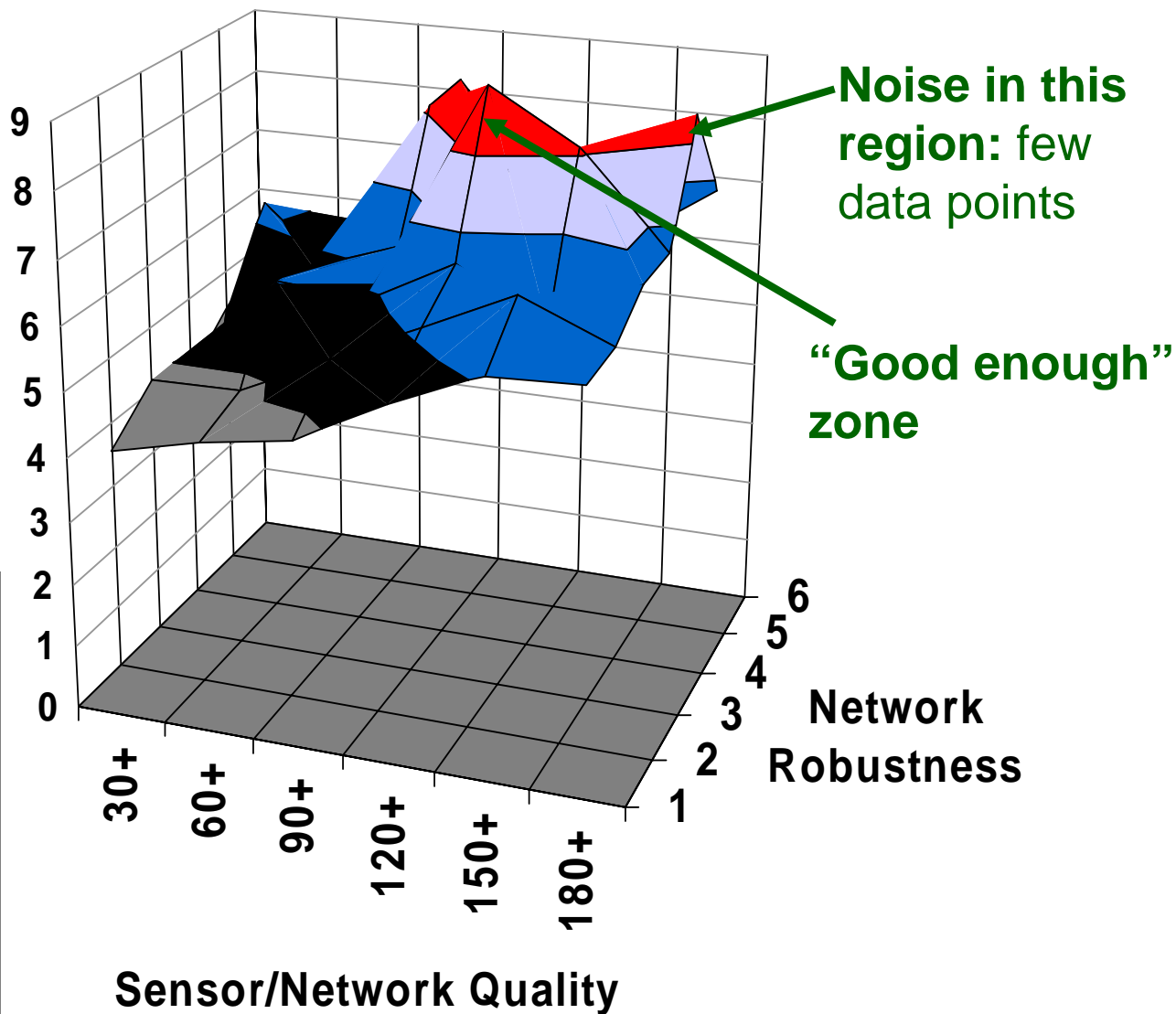
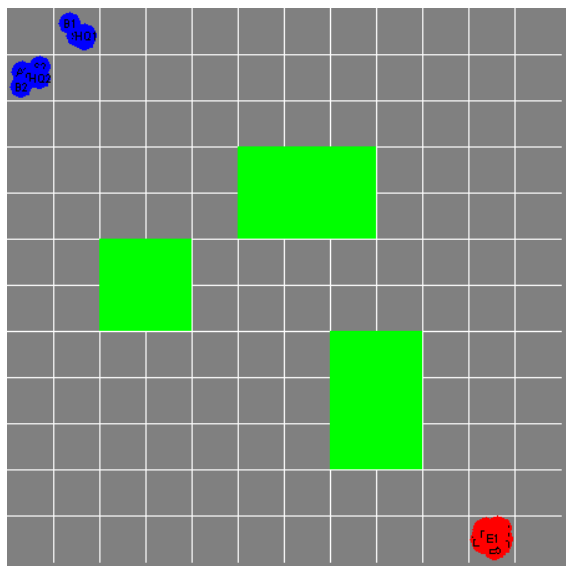
Network Farming extends Data Farming





Network Farming Example: Robustness

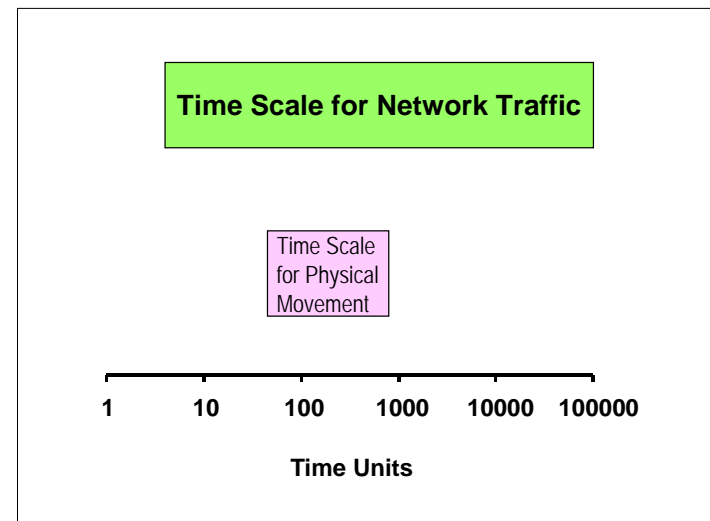
Adjusted Loss
Exchange
Ratio





Recently Added Simulation Features

1. **Event Queues:** Because message traffic can be very slow or very fast compared to movement, time-step simulation is not appropriate for networked forces.



2. **Neural-network Learning:** Saves on the time required to fine-tune behaviour parameters — reinforces successful behaviours
(avoids some problems with MANA etc.)

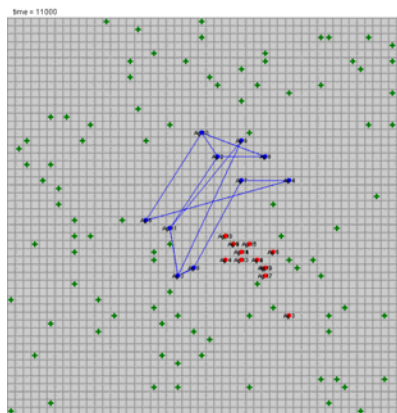


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Part 3: Design of this Experiment





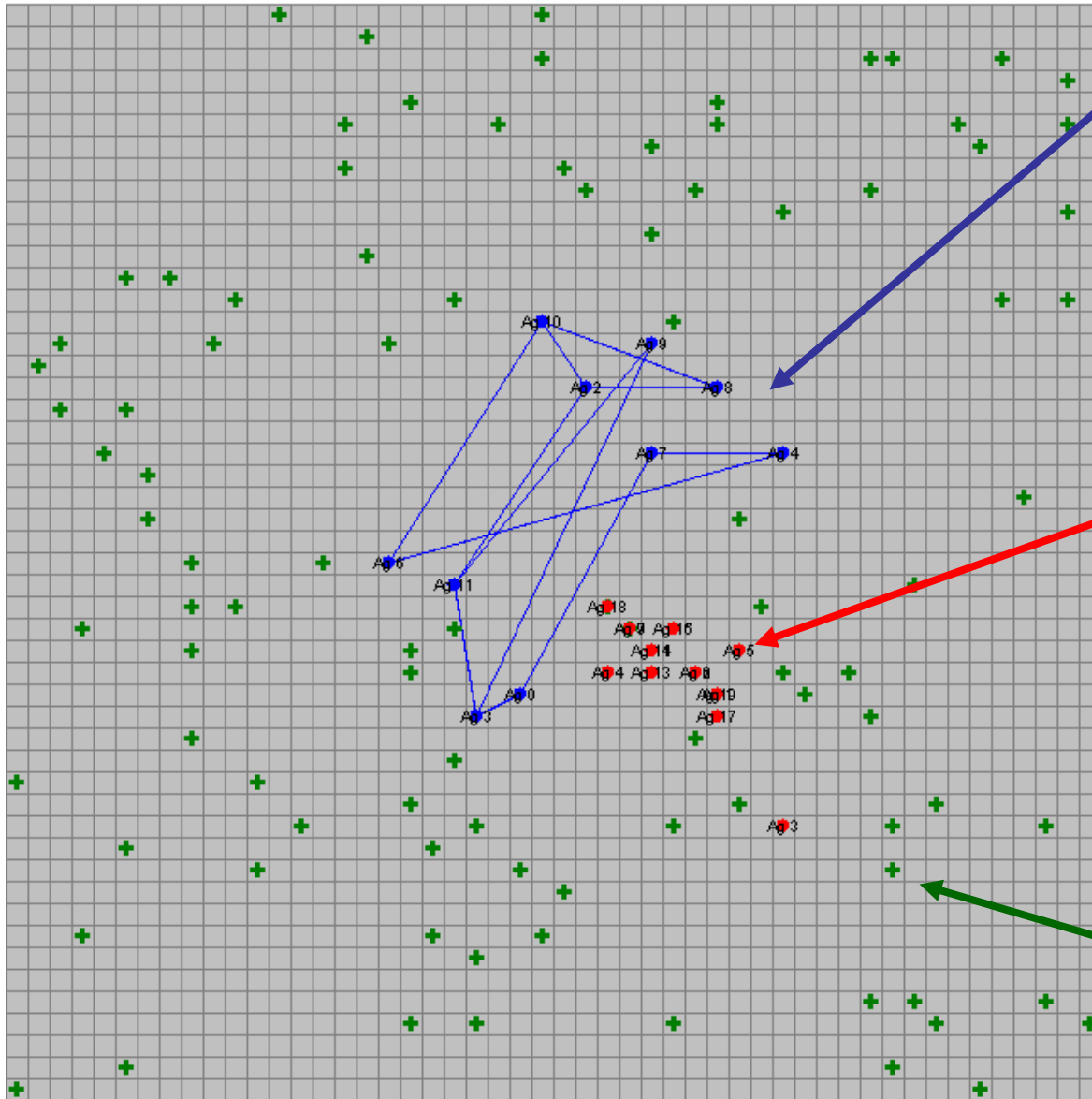
Design

- Simple abstraction of military activities — mission carried out under fire.
- In this case, **100 “items” to pick up** on a 50×50 grid.
- Networked friendly “Blue” force of 12 agents.
- 20 non-networked hostile “Red” agents.
- Agents have **sensors** and a **weapons**.
- Blue agents broadcast sensor information across network.
- Study performance for varying:
 - sensor quality
 - network quality
 - movement speed



Experiment in Progress

time = 11000



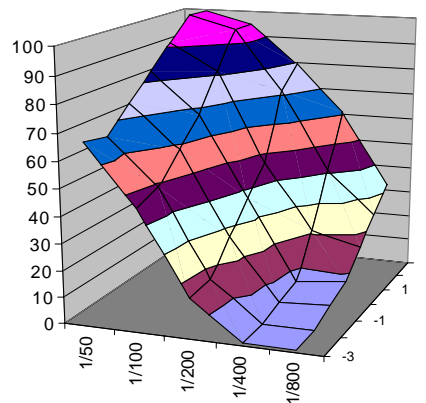
Networked
Blue force

Hostile Red
force

“Items” to be
picked up

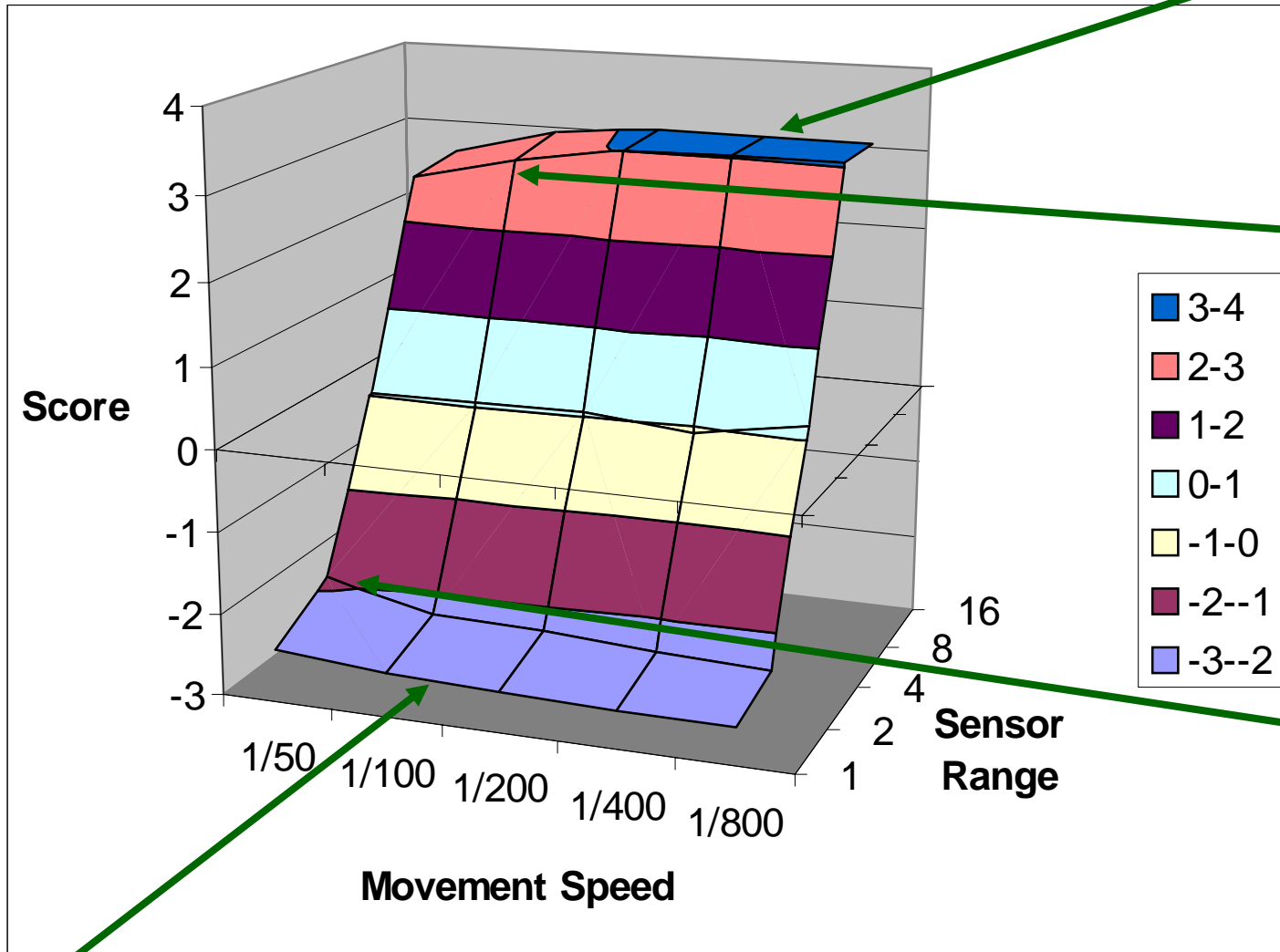


Part 4: Experimental Results





Combat Scores (log of ALER) — *a*



Big Blue advantage:
 sensor range > Red's 4

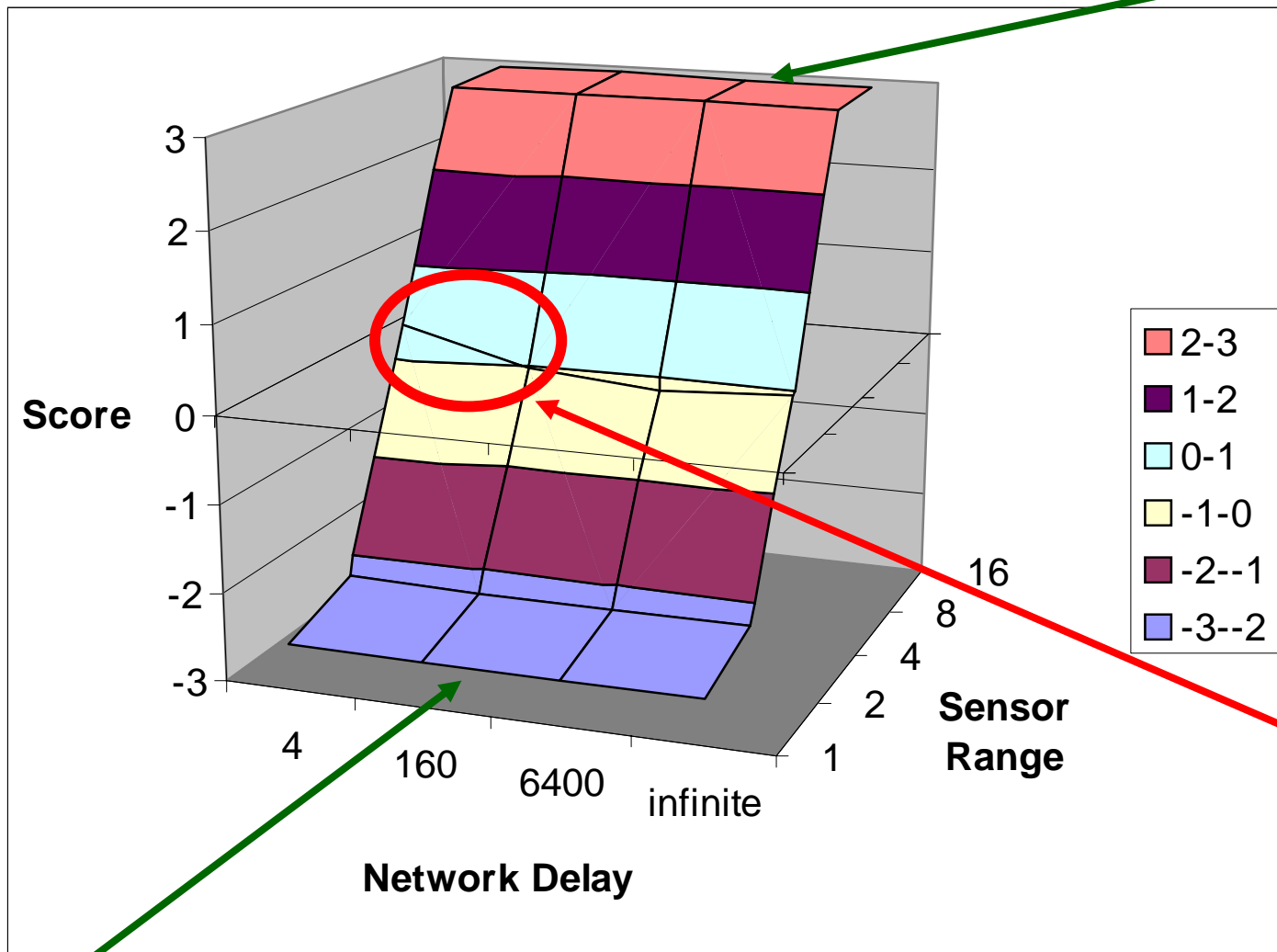
Slight Blue losses: due to fast movement

Slight Blue improvement:
 due to fast movement

Big Blue disadvantage: sensor range < Red's 4



Combat Scores (log of ALER) — *b*



Big Blue advantage:
 sensor range > Red's 4

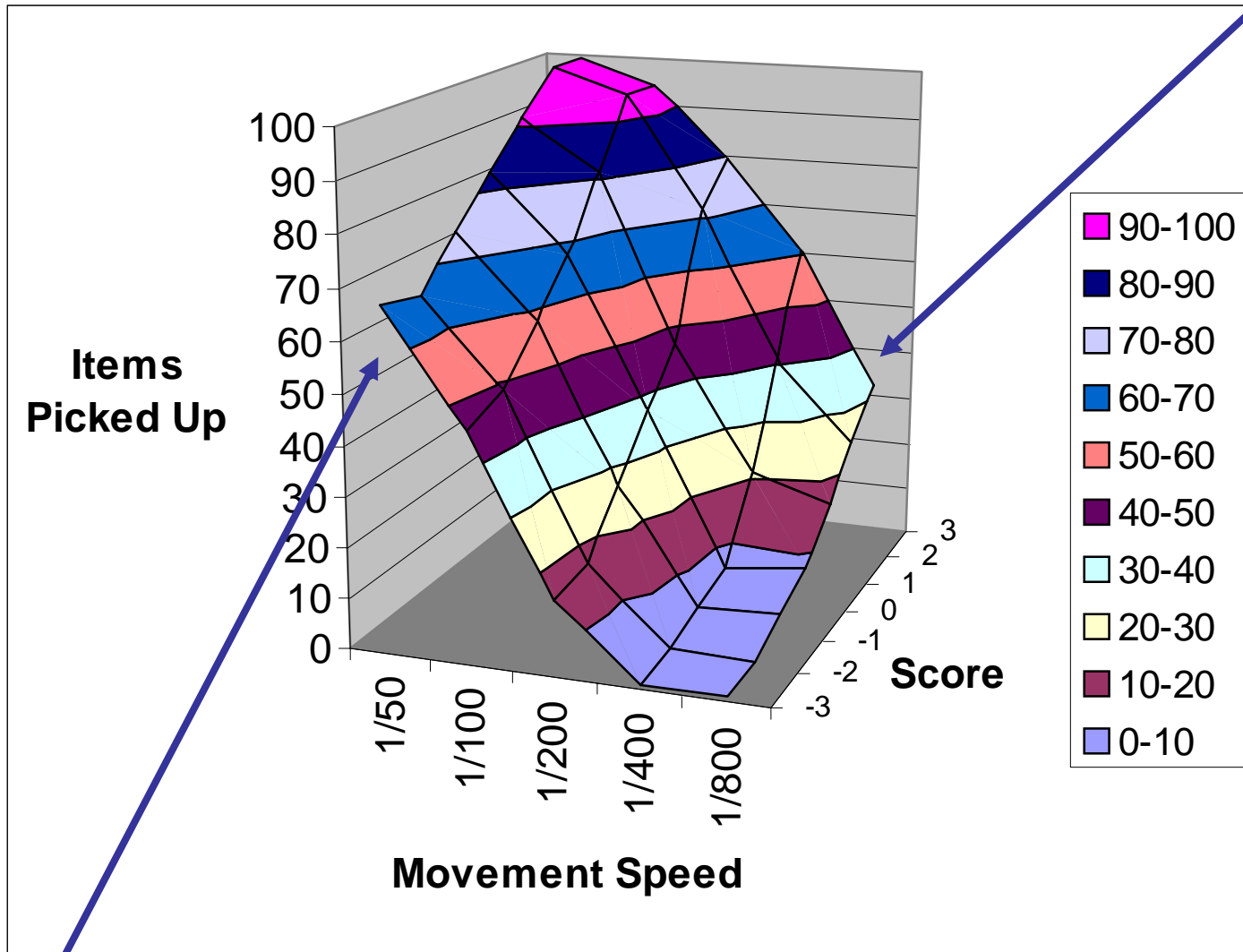
Network advantage:
 occurs when Blue has information worth sharing

Big Blue disadvantage: sensor range < Red's 4



Mission Success: Items Picked Up

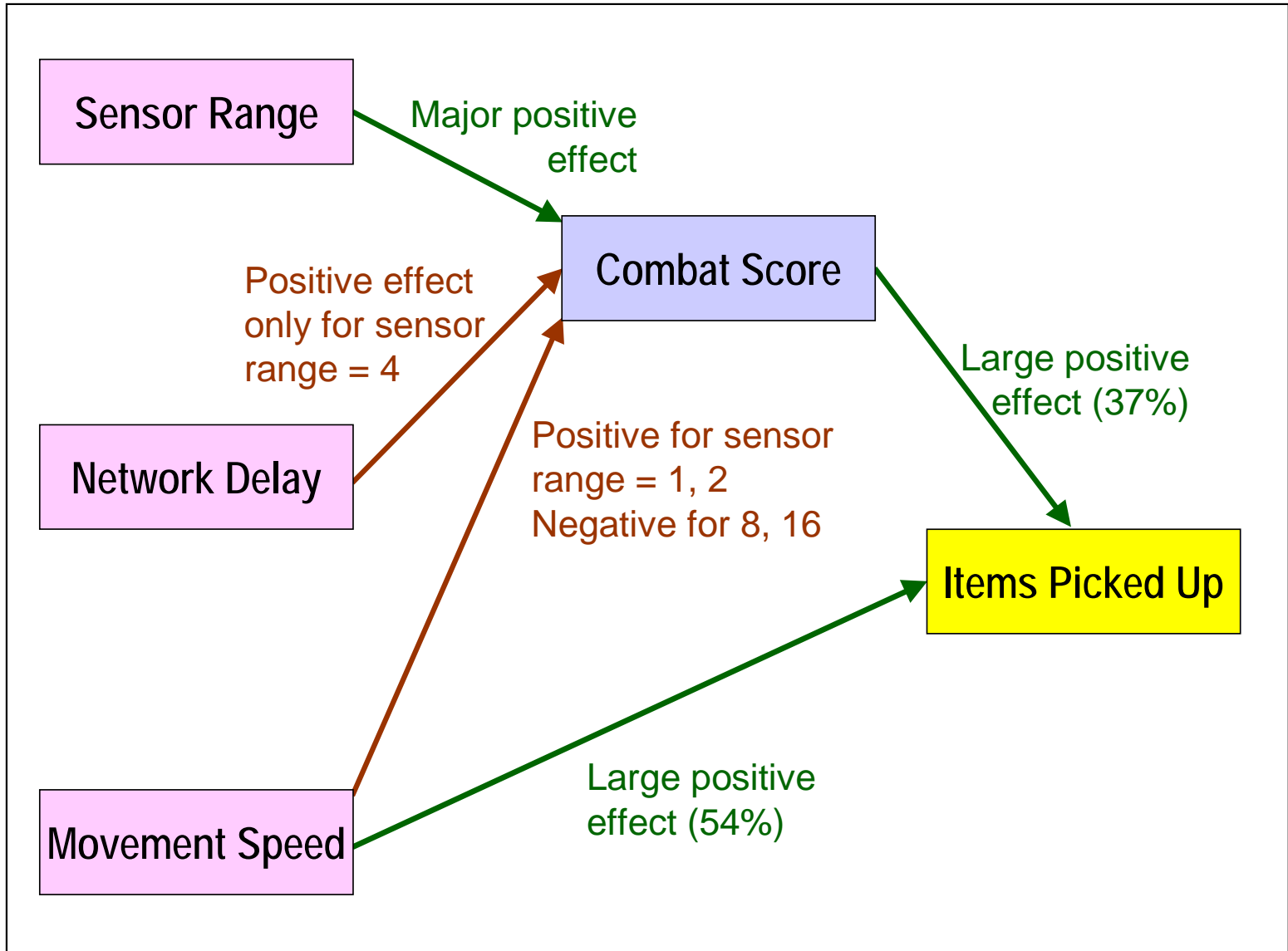
Increases with
Combat Score



but Movement Speed is an even bigger positive



Items Picked Up: Statistical Relationships





Five Principles Illustrated



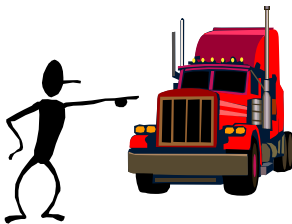
Agents with limited information of purely local relevance gain **no benefit from networking**.



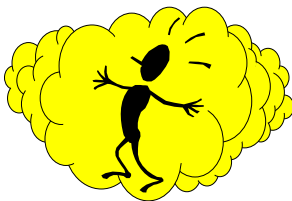
Agents with sufficient information of their own gain **no benefit from networking**.



Agents with **moderate** amounts of information gain a **competitive advantage by sharing information**.



Agents require **either** early awareness of upcoming threats, or the ability to respond to them very rapidly.

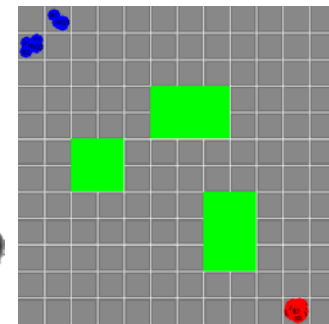


High-quality information creates a situation where motion causes risk – but if this breeds risk averseness, overall mission success may suffer.

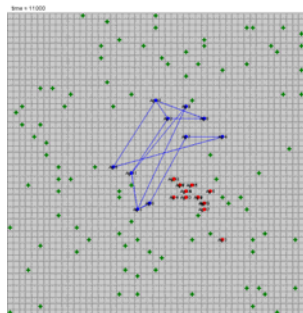


Any Questions?

1. Thoughts on Agility



2. Project Albert & Agent Simulation



3. Design of this Experiment

4. Results Illustrating 5 Principles

