Nine complications to consider (or not) when you construct your adversarial problem formulation

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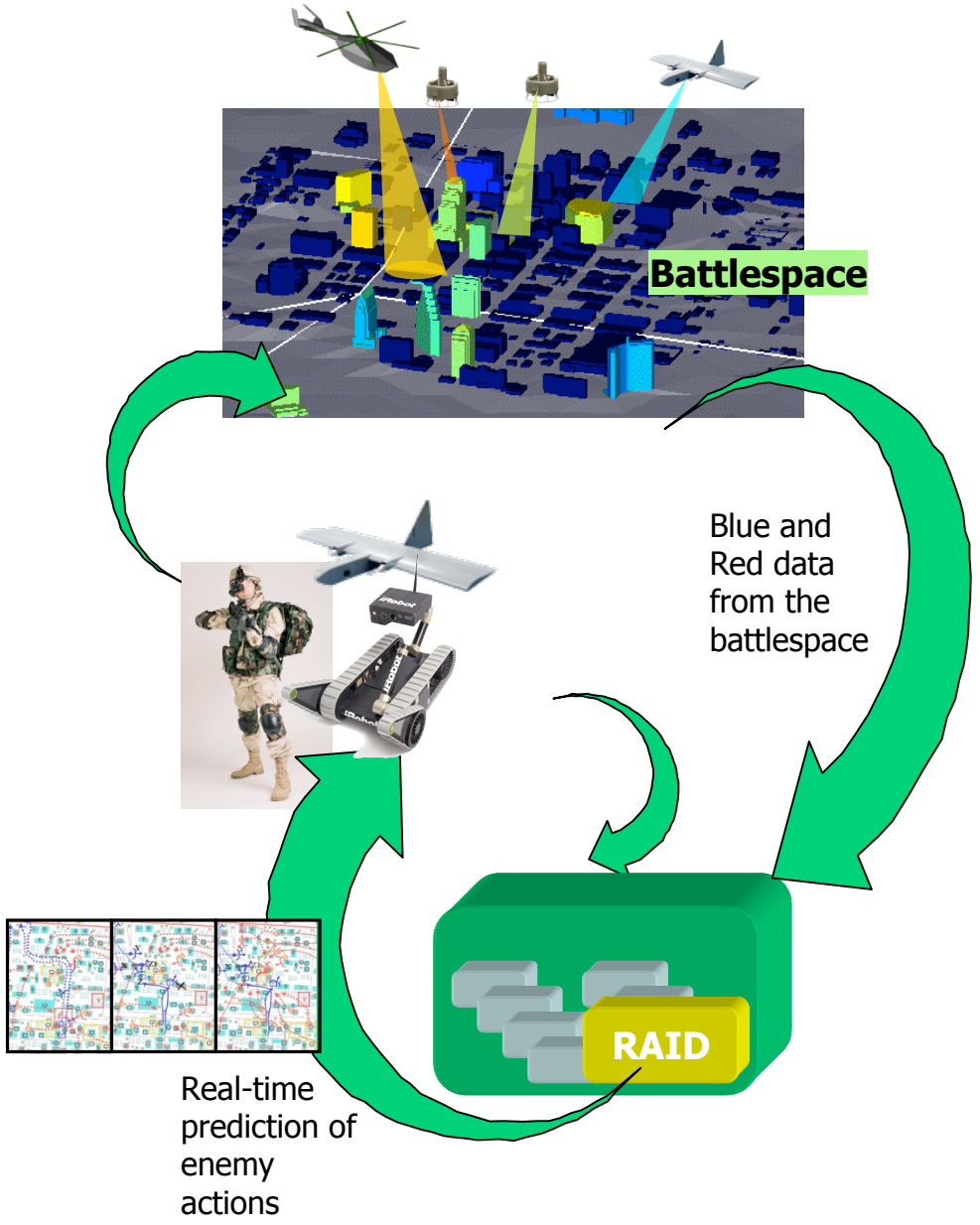
Illustrative problem: adversarial reasoning in urban firefight

- A company of friendly warriors (including machines) against a force of insurgents in a city
- Physical scale: ~25 sq km, ~10,000 buildings
- Terrain: complex, broken
- Temporal scale: minutes-to-hours
- Active, intelligent entities: 100-1000
- Observability: < 10%
- Potential autonomous entities: UAVs, missiles, ground robots



The first 8 complications

- Large problem scale: ~10^6 terrain points, ~10^3 actors, ~10^3 moves/actor
- Uncertainty (initial conditions of board, actors, goals)
- Partial observability
- Dynamics (board, pieces change, goals change)
- Stochasticity (movements, effects, observations)
- Social effects (even robots influenced by superiors, peers)
- Communications (explicit or stygmergic)
- Bounded rationality (limited cycles, heuristics, behaviors, training/learning, emotions)

…plus deception

Deception works

- Pervasive and dominant: “all warfare is based on deception”
- Methods of performing a deception:
  - concealment (most common)
  - emulation
  - confusion
- Mechanisms of deception (bounded rationality):
  - recognition of presumed enemy situation,
  - paralysis/indecision,
  - timing of decision
- Mechanisms of deception (perfect rationality)
  - perfectly rational agent with can still be subject to deception?

…plus deception (cont.)

When deception does not work

- Mechanisms of failure of deception:
  - unnoticed
  - misunderstood
- N-th order deception
  - rare in humans,
  - may be ok for autonomous systems?
- Costs of deception:
  - commitment of resources,
  - self-confusion,
  - reveal much to enemy,
  - (and still may not be noticed or understood)
- Planning for failure of deception during execution:
  - When will opponent recognize my deception?
  - To what extent?
  - How will he react?
  - What do I do?
- Planning for post-deception: will the enemy learn, and what?

In conclusion

What is to be done:

- consider,
- exclude,
- assess bounds

More on the topic:

Kott and McEneaney (eds.) “Adversarial Reasoning”, chapters 1.2, 1.3, 2.1, 2.3, 2.4, 3.2, 3.3