Multi-agent Simulation Approach to Development of Applications for Decentralized Tactical Missions

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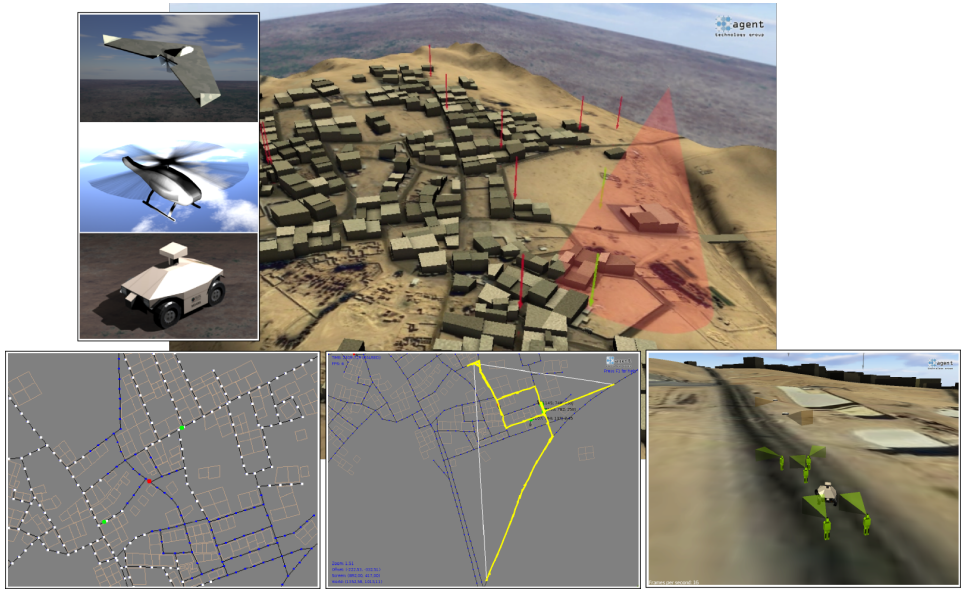

KSCO 2012 - February 16th 2012

agent technology center

Czech Technical University

Sponsored by
U.S. Army CERDEC
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Motivation

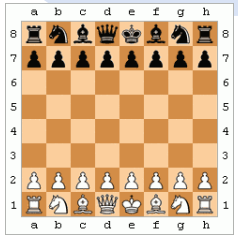
AI algorithms
in synthetic environments

Control mechanisms
in high-fidelity simulations

- Virtual Battle Space 2 - Bohemia Interactive

Problem

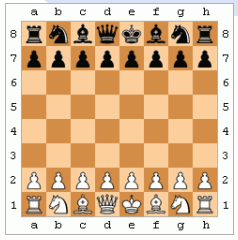
AI algorithms
in synthetic environments



Control mechanisms
in high-fidelity simulations

Problem

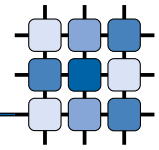
AI algorithms
in synthetic environments



Control mechanisms
in high-fidelity simulations

a gap

Agenda

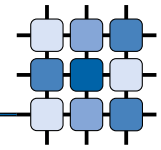


1. Simulation-aided Design
2. Environment & Simulation
3. Tactical Mission Scenario
4. AI Algorithms
5. Q&A

Simulation-aided Design (SAD)

Michal Pěchouček, Michal Jakob, and Peter Novák. Towards simulation-aided design of multi-agent systems. *In Post-proceedings of the eighth international workshop on programming multi-agent systems, ProMAS 2010*, LNAI, Vol. 6599. Springer-Verlag, 2010. (in print).

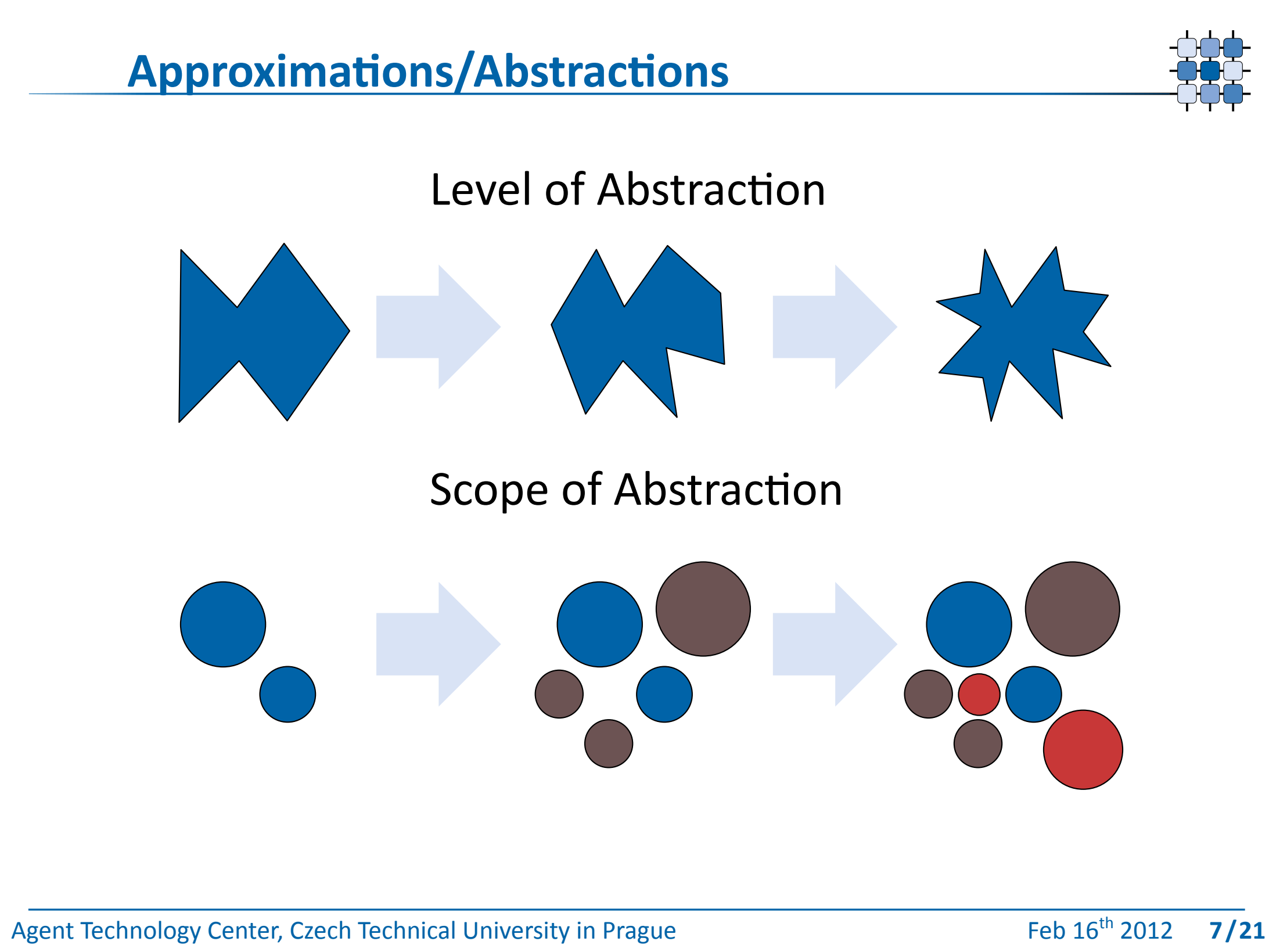
Iterative Process



An **iterative process** of an approximated validation using testbeds of increasing fidelity.

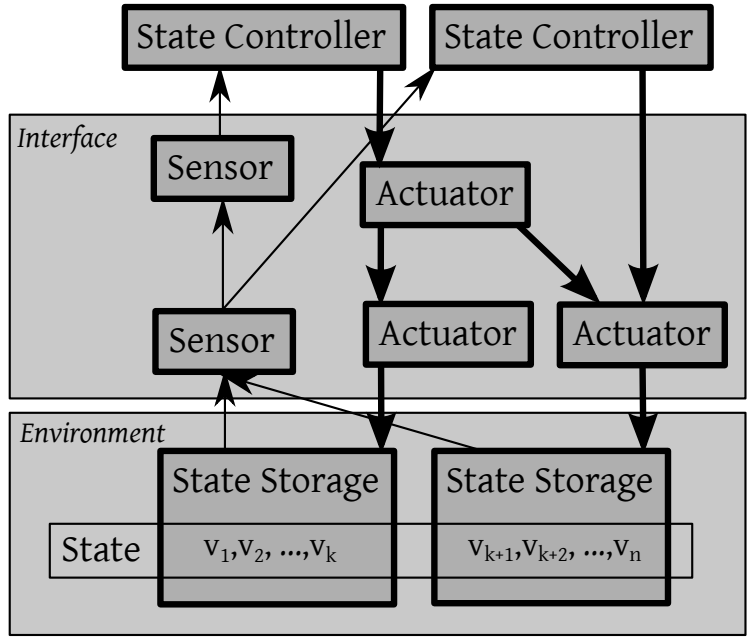
1. Choose an appropriate approximation reduction.
2. Build a mixed simulation upon the previous iteration.
3. Develop an application for the prepared simulation.
4. Test, debug, and validate the application.
5. Repeat 3 and 4 until requirements are met.
6. Go to 1.

Approximations/Abstractions

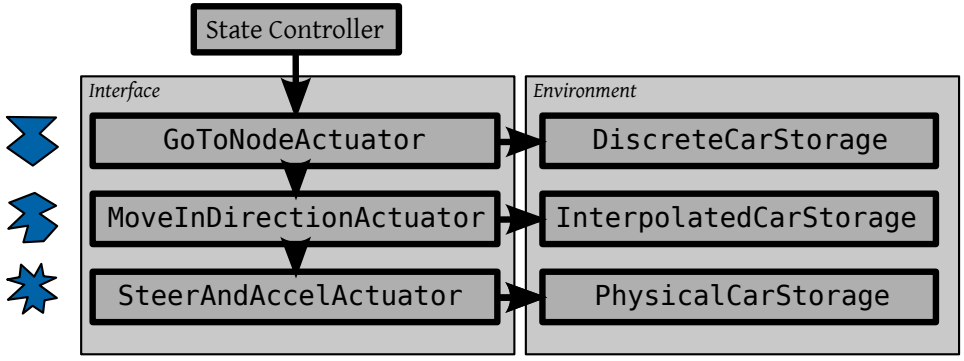


Environment & Simulation

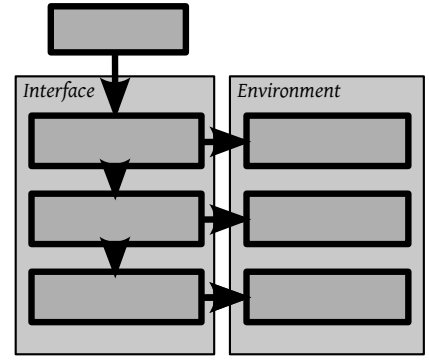
Environment Modeling



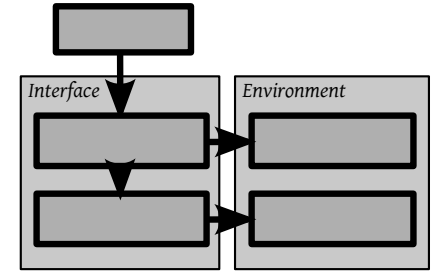
a car



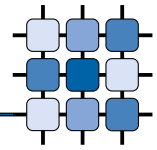
a helicopter



a trooper



Simulation Assurances



Deterministic*

Synchronous*

Independent on simulation HW

Reproducible experiments

in vitro simulation concept

Efficient development, testing, debugging

elaboration tolerant

* vs. simulated non-determinism/asynchronicity

Tactical Mission Scenario

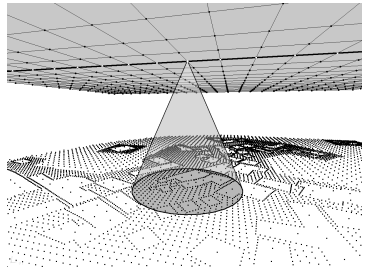
A rescue mission in an urban area:

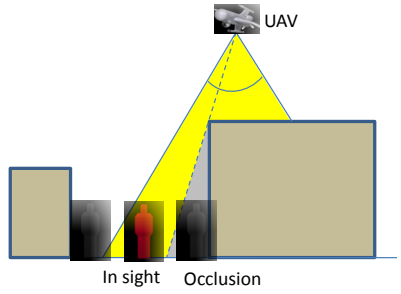
- move to a safehouse
- extract a VIP
- capture a high-valued target evading from the safehouse
- move to an extraction point

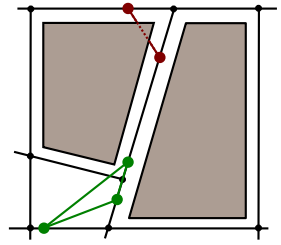
Urban Area

Shaped Ground

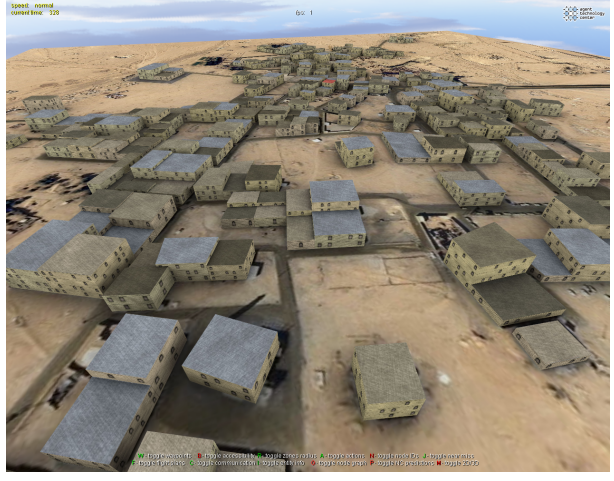
Occlusions



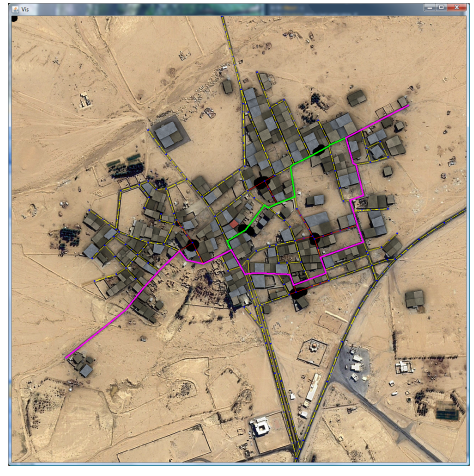




Buildings

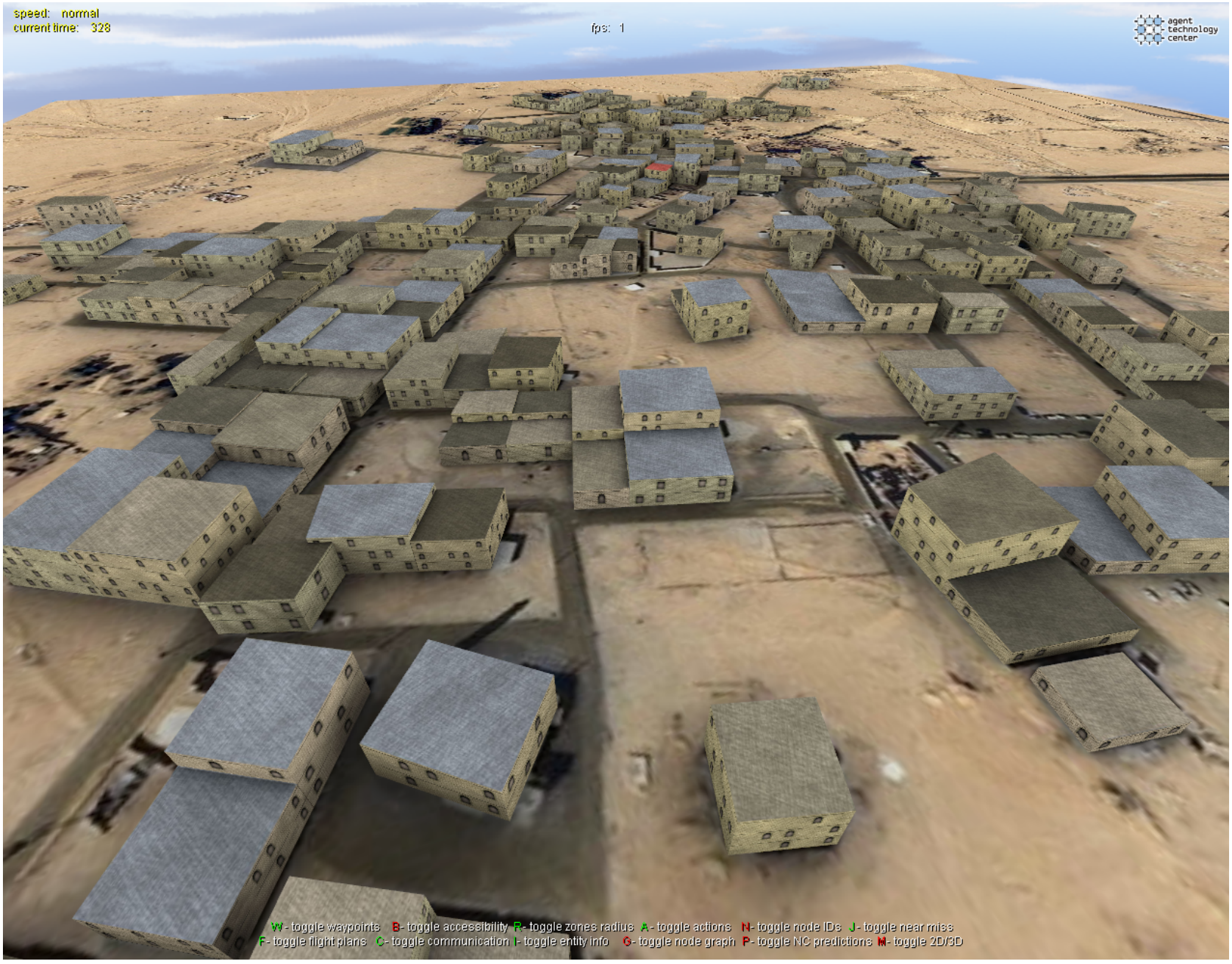


Building and Street Topology



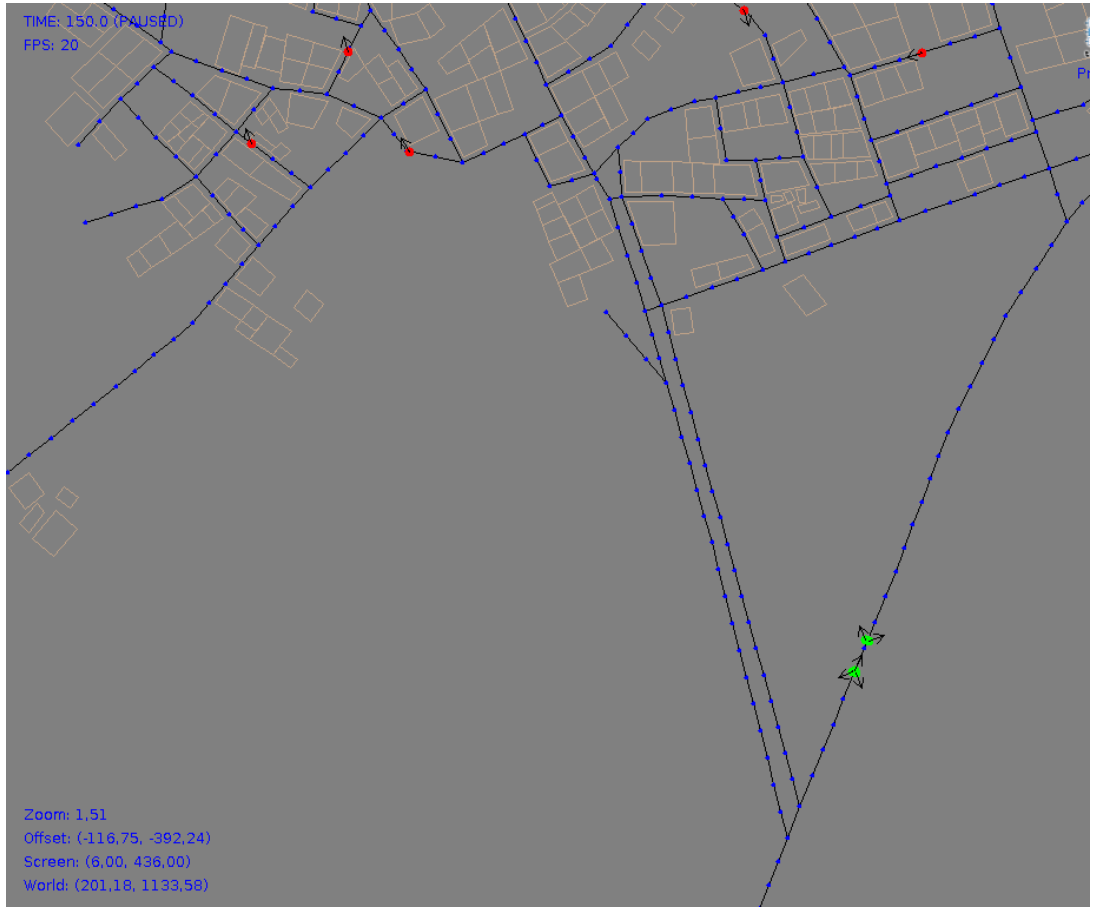
Shaped Ground

Buildings

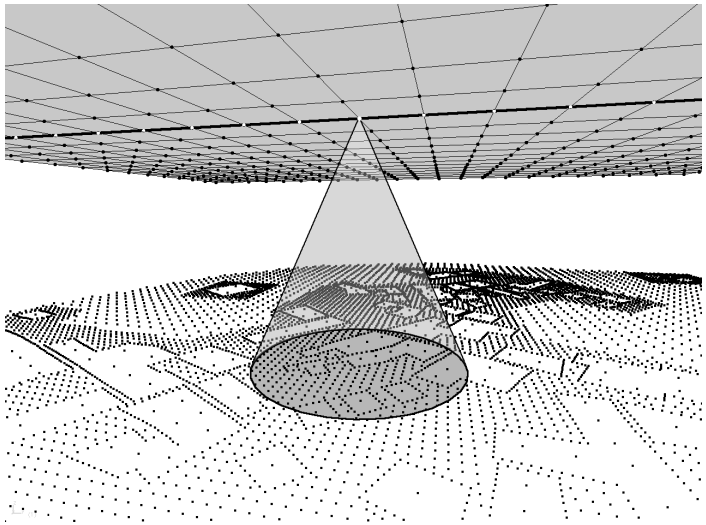

speed: normal
current time: 328
fps: 1
agent technology center
W - toggle waypoints B - toggle accessibility R - toggle zones radius A - toggle actions N - toggle node IDs J - toggle near miss
F - toggle flight plans C - toggle communication I - toggle entity info G - toggle node graph P - toggle NC predictions M - toggle 2D/3D

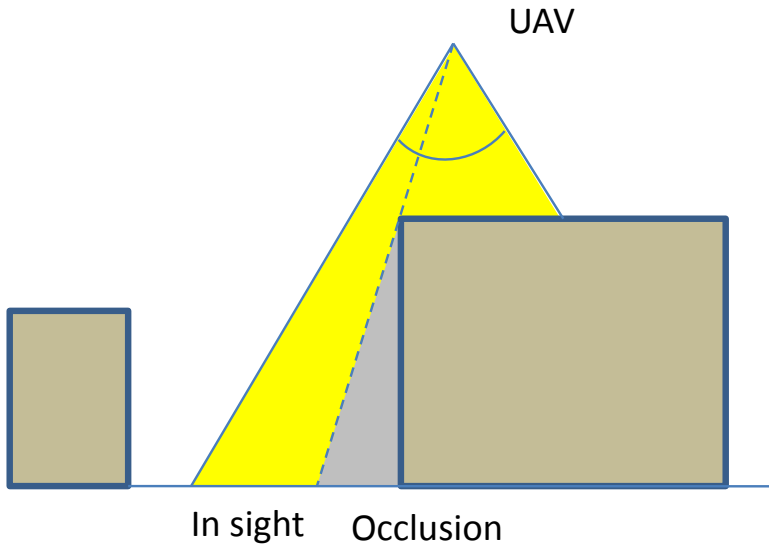

Vis

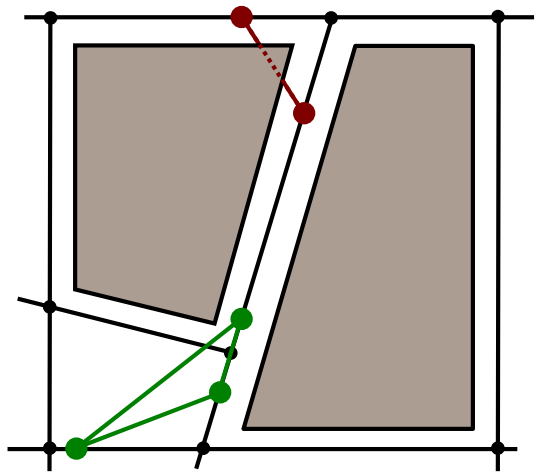
Building and Street Topology



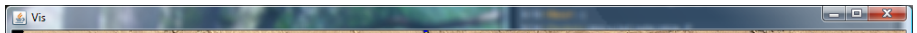
Occlusions







Building and Street Topology



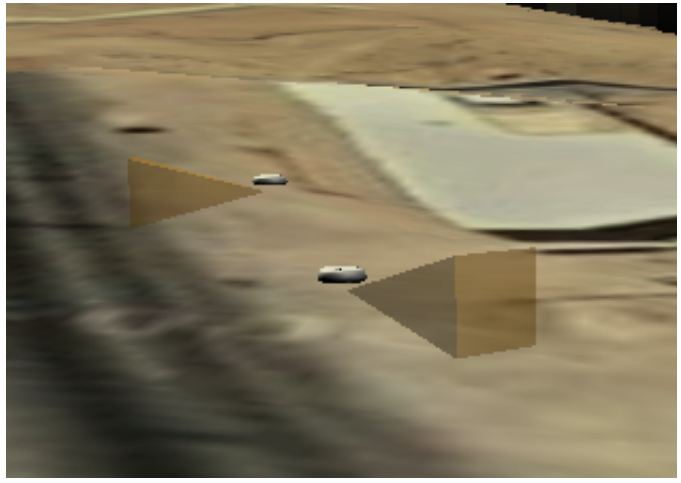
Assets

MDARS (US Army)

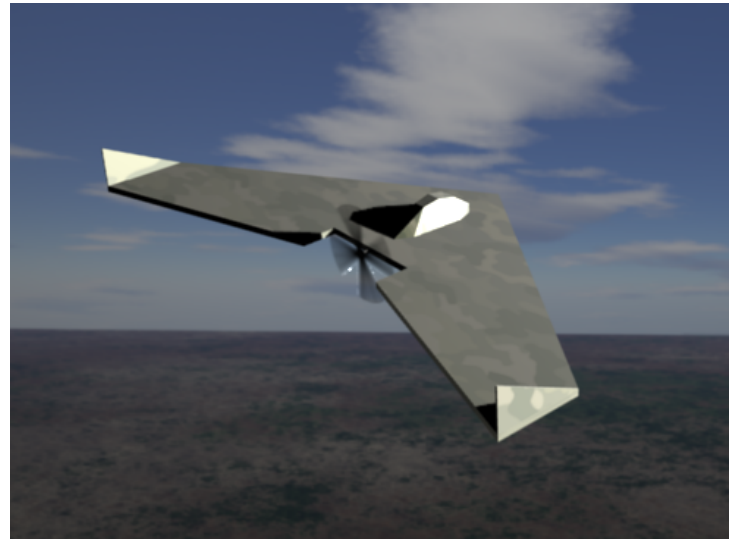
Skeldar (Saab)

Small Assets

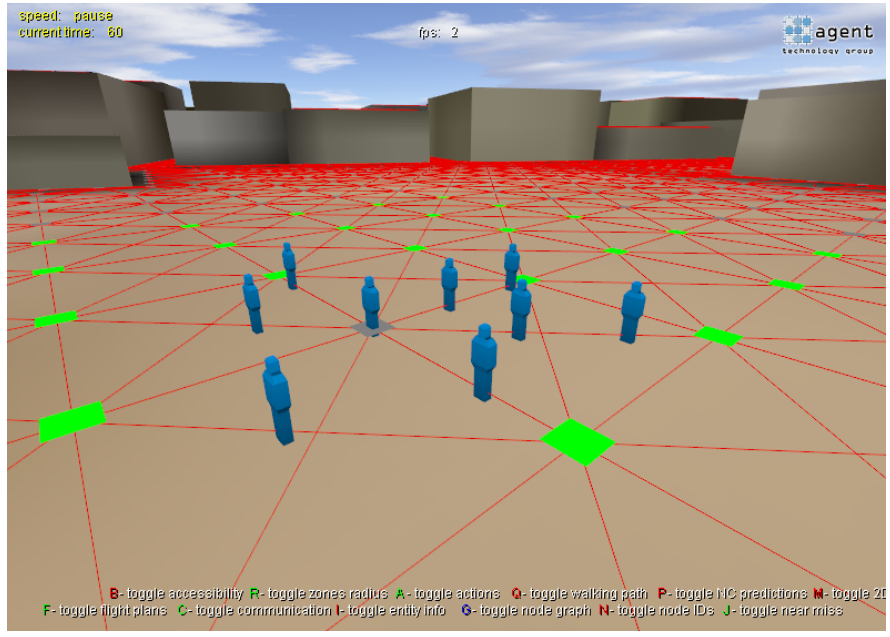
Vidar (Aesir)



Procerus Tech.

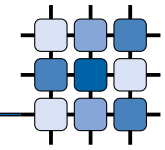


Troops, Insurgents, and Civilians



AI Algorithms

Multi-agent Smart Patrolling

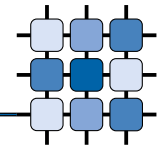


Problem: Patrol a moving targets considering smart opponents

Solution:

- define patrolling problem as a patrolling game
- compute optimal strategy
- execute the strategy by the assets

Multi-agent Smart Capturing

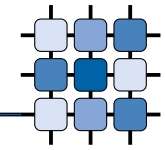


Problem: Capture an smart evading target by a set of cooperating assets

Solution:

- define problem as a pursuit-evasion game
- compute capturing strategy
- execute the strategy by the assets
- continuously observe state of the game
- dynamically update the strategy

Multi-agent Mission Performing

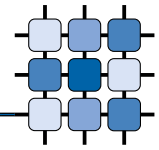


Problem: Carry out a high-level mission

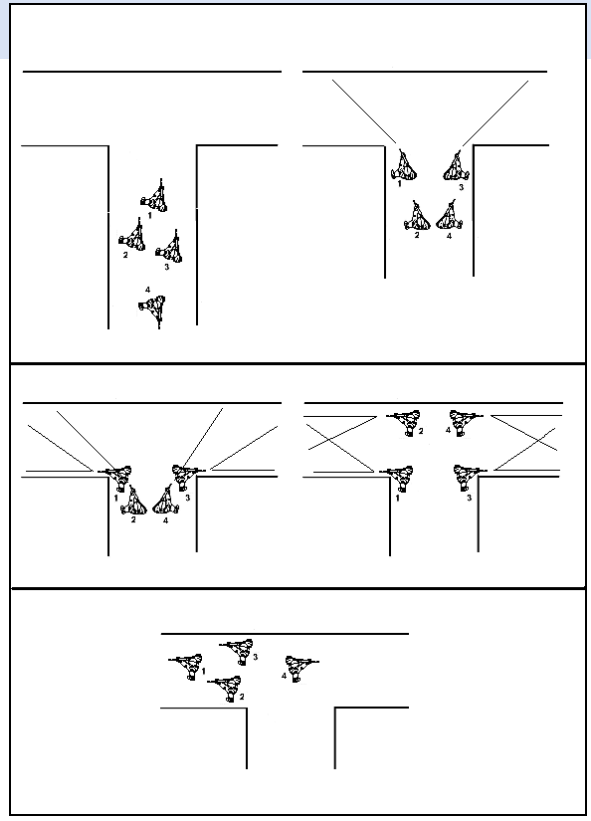
Solution:

- use mission planning domain
- define mission as planning problem
- plan a coordinated multi-agent plan
- execute and monitor multi-agent plan
- prospectively use multi-agent plan repairing to recover from execution failures

Multi-agent Coordinated Movement



Problem: Hold an adaptable formation of assets during movement



Solution:

- define formations as reactive behavior
  - Commitment Machines
  - Jazzyk language
- define robust programs for formation transitions
- execute programs

Q&A