

Human Agent Collectives:

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Human-Agent Collectives (HACs)

- Neither human nor agents always in control
- Humans and agents working together in teams and teams may change over time
- Actors may need to be incentivised to take a course of action
- Information and decisions are tracked and processed to guarantee the system is accountable

How do we **LOCATE** casualties and resources?

How to **ALLOCATE** resources?

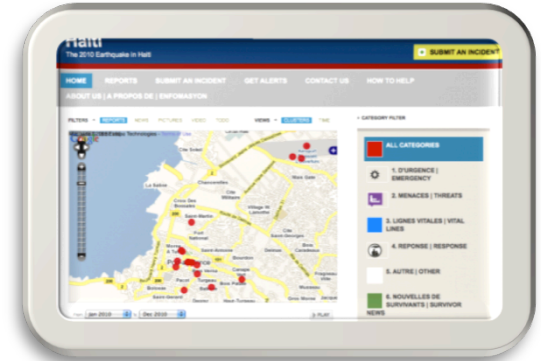
How to **DEPLOY** rescue teams across a large area?

How do we **TRUST** the information gathered?

Information Gathering and Coordination in Disaster Response



Haiti: Port-au-Prince



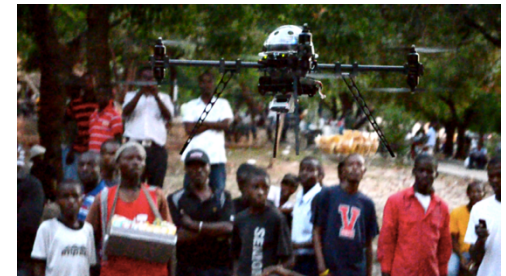
Crowdsourced Reporting and Response



Volunteers and Emergency
Responders from multiple
agencies (Bronze)

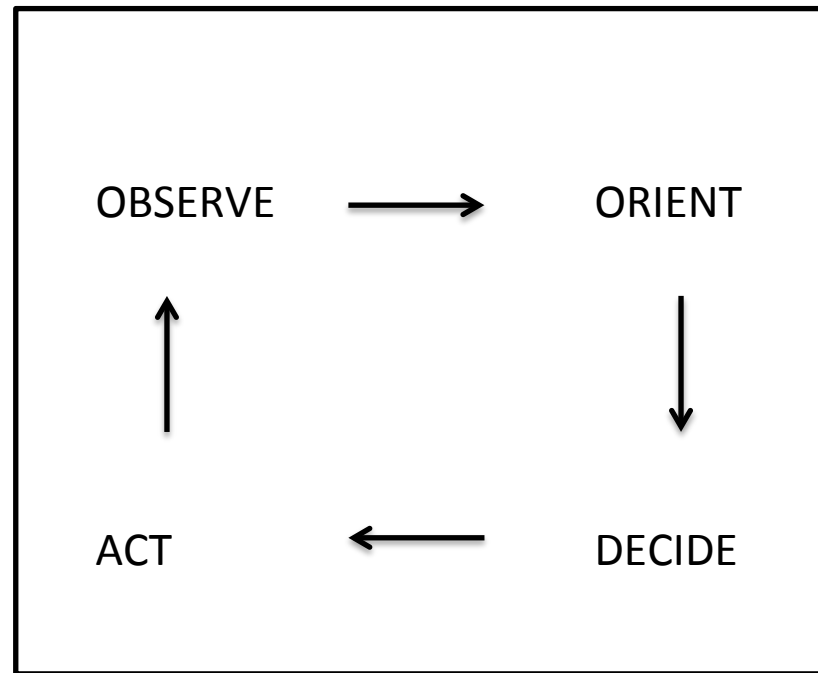


Command and Control Structures (Silver)

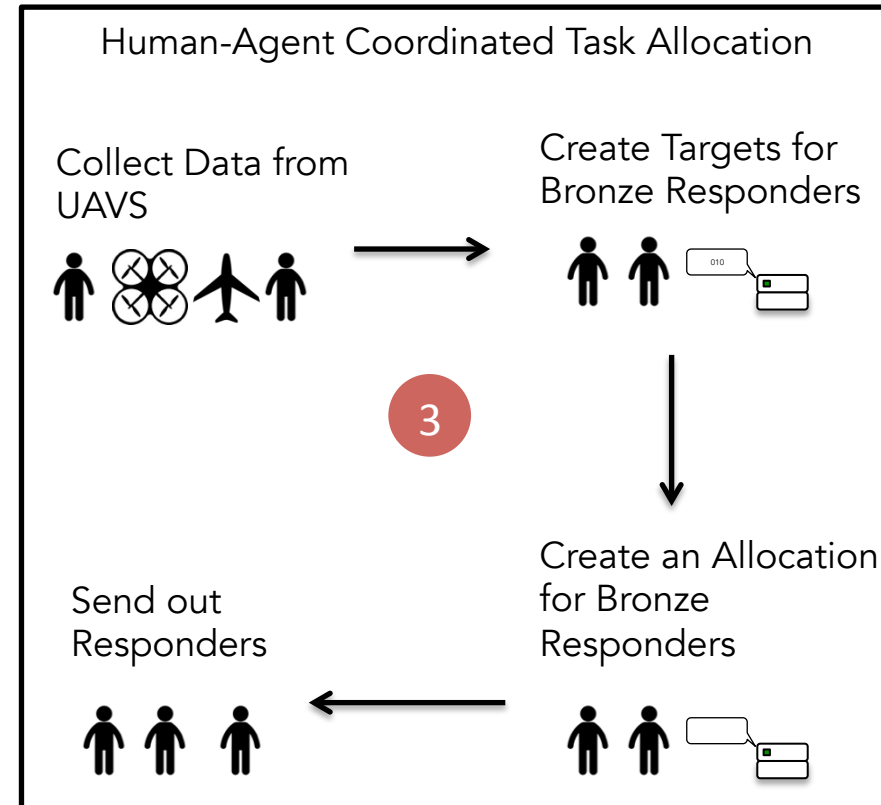
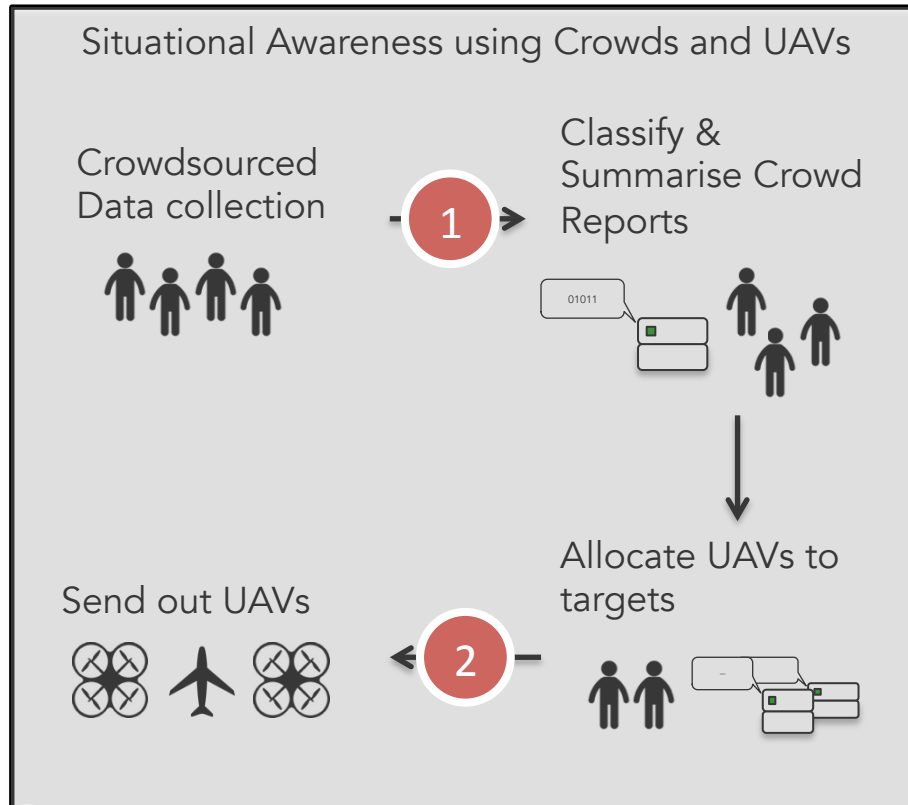


UAVs for situational awareness

Information Gathering and Decision Making Loop

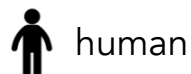
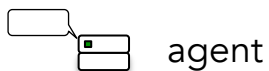


Information gathering and coordination loops



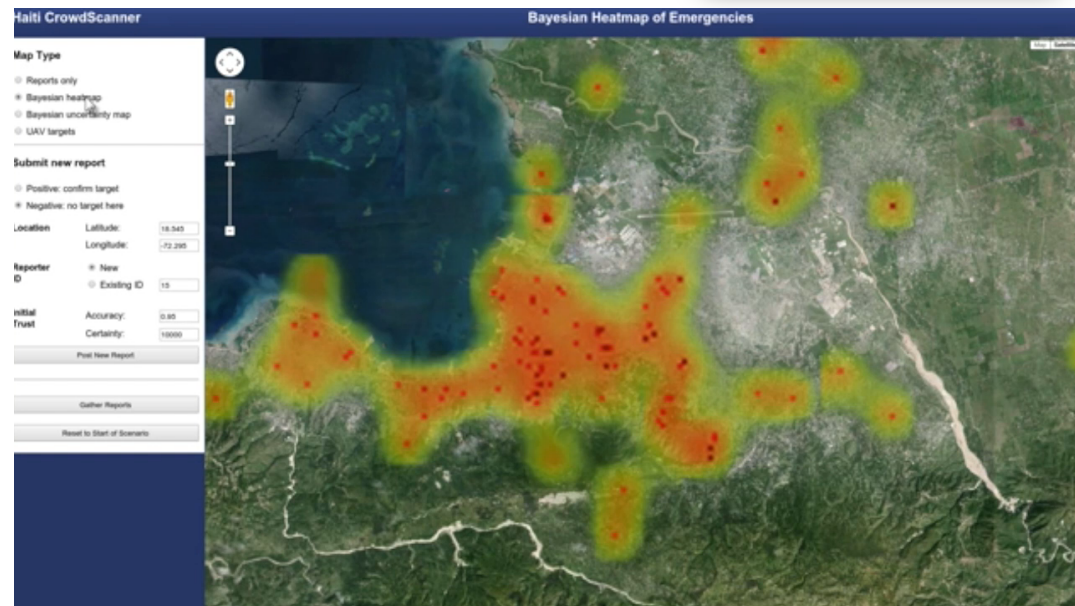
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Provenance of Decisions and Information



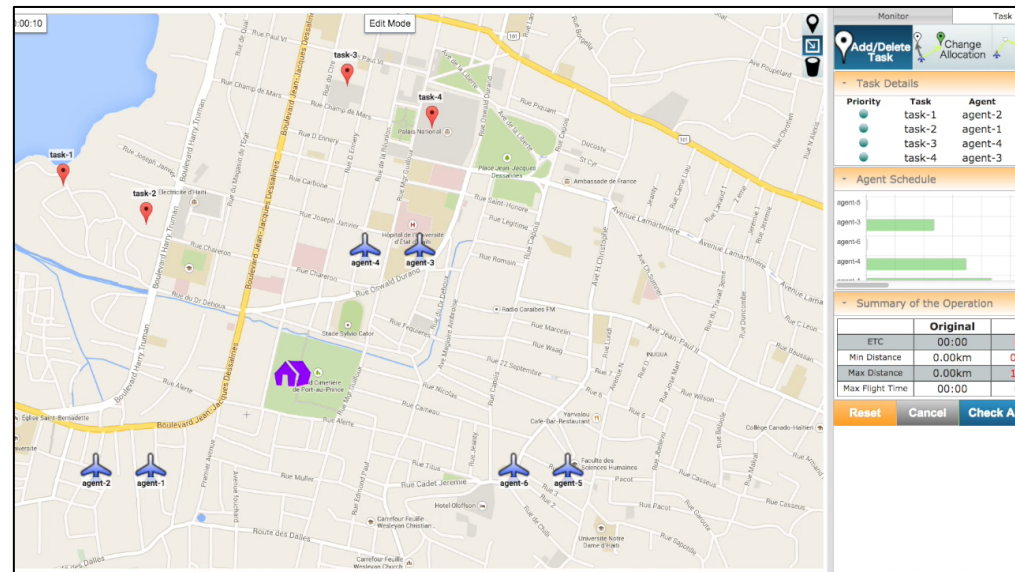
CrowdScanner: making sense of crowd reports using human and machine intelligence

- Interpretation
 - Online (imperfect) Crowds + Machine Learning (BCC+ NLP)
 - Hire+Fire algorithm to recruit the best workers and get the best interpretation
- Heatmap creation
 - Gaussian Process to model disaster
 - Fold in trusted reports
 - Use classification output to generate intensity
- Generate targets for UAVs



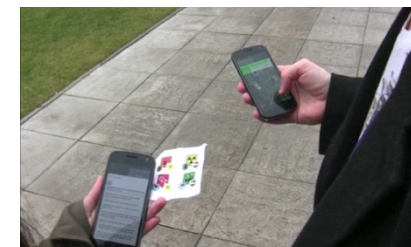
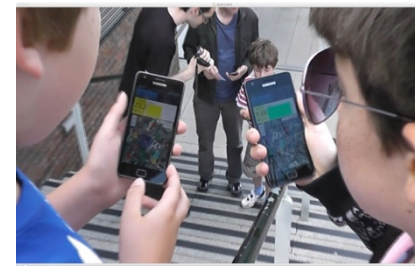
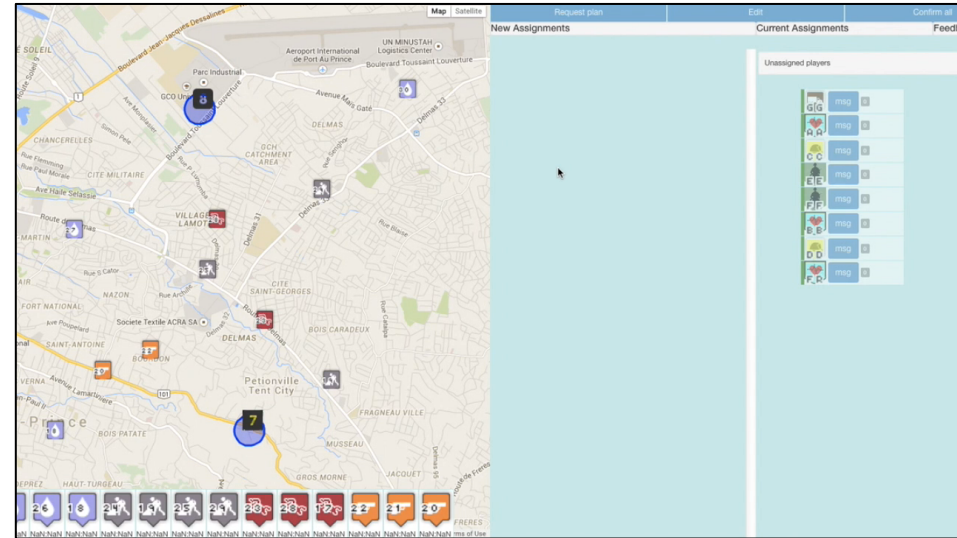
Mixed Initiative Multi-UAV Coordination

- 1 pilot -> 3+ UAVs
- Heterogeneous UAVs running max-sum
- Flexible Autonomy
 - 'Adjust' max-sum plans
 - React to UAV drop-outs
 - Transfer of control between Silver, UAVs, and Bronze operators
- Validated on real UAVs
- Tested with 40 users
- UAVs Targets confirmed for Responders to be deployed



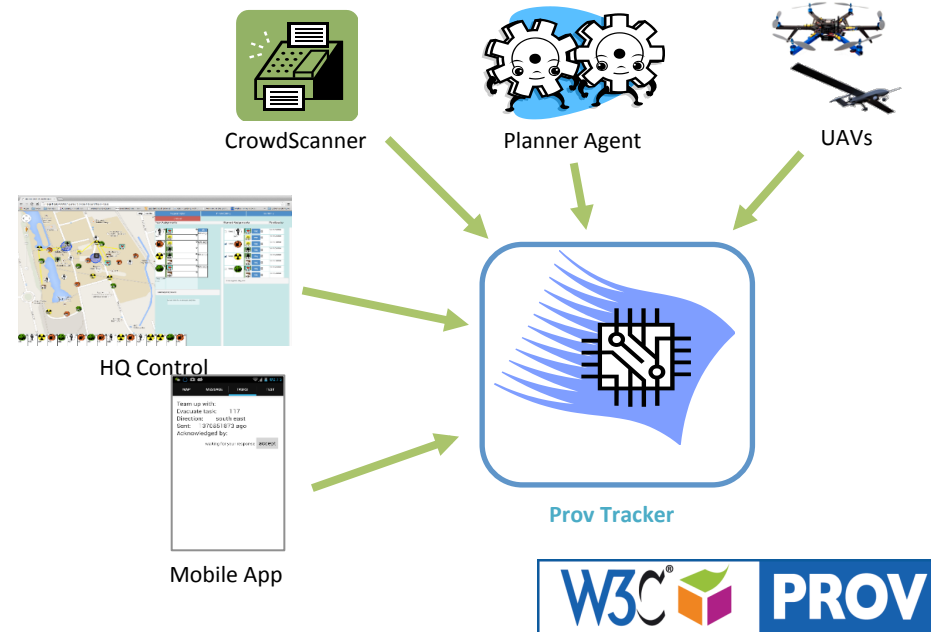
Human-Agent Collaboration for Task Allocation

- Human-Agent Silver team allocate tasks to Bronze responder team
- Agent uses Multi-agent Markov Decision Process
 - Computes best task for each responder, and best path for each task
 - Models environment (buildings and lakes are obstacles)
- Responders get instructions via mobile app
- Tried in the AtomicOrchid Mixed Reality Game with 100+ users including emergency responders.
- **Available as a testbed for research**



Supporting Human and Agent Decision Makers using Provenance

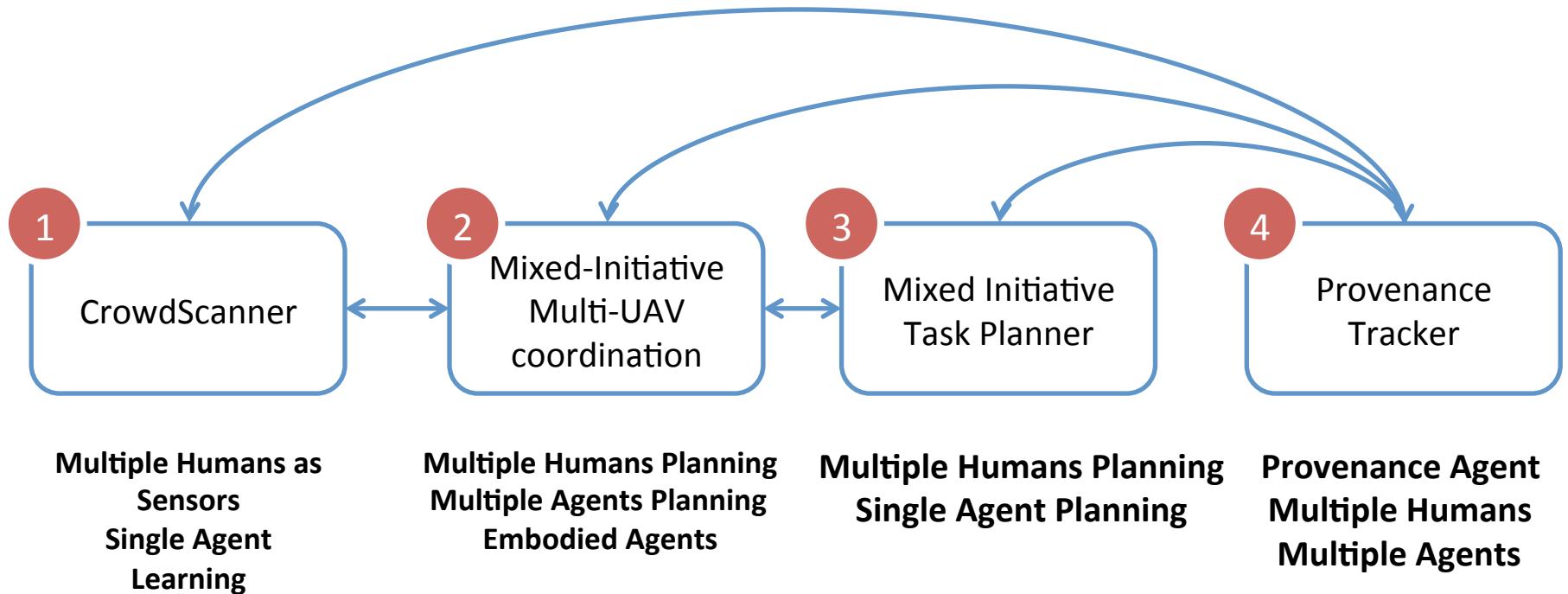
- Timely Decision Support
 - Live monitoring of provenance for changes
 - Ensures the whole system reacts to changes
- Post-hoc analysis



Example:

- During the operation, UAVs invalidate targets,
- Prov tracker immediately notifies Silver commanders at HQ
- Prov tracker identifies impacted rescue missions

HAC Interactional Arrangements



Emergency Response organisations we work with

- Nepal Earthquake Mapping with Zooniverse/Verily/SBTF
- Hampshire LRF crowdsourcing platform
- Training tool
- Table-Top Planning for Rescue Global



Disaster Risk Reduction and Response



More info/videos:

- www.orchid.ac.uk

Best Paper: Innovative Application Track AAMAS 2015

HAC-ER: A Disaster Response System Based on Human-Agent Collectives