ASX Use Case Mapping

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# Overview

Have already defined:

* 6 Scenario-Level use cases
* Generic use cases

Next steps:

* Break Scenario-level use cases into sequence of generic use cases, plus any specialized use-cases.
* Identify entities involved in all use cases
* Map all entities from use cases to C2SIM entities.
* Model messaging between entities in use cases using C2SIM messages

Start by working through one scenario.

# Use Case Descriptions

## UC-001 Large Urban Area Hit By Earthquake

### Mission Overview

* Unit types involved
  + UAV
  + UGV
  + USV
* Mission Description:
  + Searching, locating – Locate missing persons or objects
  + Ensure immediate safety of survivors
  + Increase speed of response
  + Aid in property recovery
  + Collect valuable information: disaster site, environmental conditions, potential threats
  + Reduce risks for human rescuers
  + Help facilitate effective coordination among the rescue teams on the ground
  + Recover property where required
* Other entities:
  + Rescue Teams
  + Survivors
  + Objects

### Actions to model

* Start of scenario: calls for help received by Command Center.
* Deploy Units.
  + Units travel.
  + Units arrive on scene.
  + Units encounter obstacles as they travel.
* Perform mission:
  + Scan area using AI-based anomaly detection to analyze sensor data.
  + Search for survivors – search pattern.
  + Go directly to survivors – based on GPS from help request
  + Survivor(s) and/or Essential Property located:
    - Report location through network to all assets
    - Report survivor’s condition – mobile, needs assistance, un-responsive, deceased
    - Deliver medical supplies.
    - Extract survivor(s)
    - Report damage
    - Request additional units - Coordinating
  + Deliver medical equipment
    - Land/drop
    - Need to reload? If so, return to base for additional supplies.
      * Message back to HQ
      * Receive coordinates to reload.
  + Reload station
    - Get as close as possible to AOI
    - Report supply levels.
  + Extract survivor(s)
    - Self-driving or remote piloted large vehicle
  + Maintenance
    - Report maintenance needed – resupply deliverables, need refuel/new battery.

## UC-002 Surveillance and Information Gathering

### Mission Overview

* Deployment
  + Instructions – proceed to Area of Interest
  + Travel
  + Arrival at site.

### Actions to Model

* Perform mission
  + Report detections – signals.
  + Report events – on-site analyst? Or asset that can perform first-line analysis.
  + Stream information
  + Get assigned new locations.
  + Central node re-deploys local assets
* Maintenance
  + Request refuel
* Mission complete

## UC-003 Protecting Troops and populations against hostile UAX in modern urban environment

* Deployment
  + Assign missions, locations
  + Move to AOI.
  + Encounter Resistance – Engage hostile UAX (see Mission section)
* Perform Mission
  + Patrol
  + Report observations – signal detection, visual item
  + Signal detection – may be hostile or cry for help or ignorable transmission (yellow daisies)
  + Request support
  + Jam signals
  + Exchange fire – needs command/confirmation
  + Retreat
  + Detect loss of patrol unit
* Maintenance
  + Refuel/reload
  + Report damage
* Mission Complete

## UC-004 Patrol Group

* Deploy
  + Assign missions
* Perform Mission
  + Patrol

## UC-005 Deploy Resources – Fertilizer, Poison

* Deploy
  + Fuel – instructions to depot?
  + Assign location and deployment pattern
  + Go to AOI.
* Perform Mission
  + Swarm deployed in patterns
  + Report problems – equipment failure?
* Mission Complete

## UC-006 Disrupting Law Enforcement Team

* Deploy
  + Assignments
  + Location
  + Behaviour patterns
* Perform Mission
  + Monitor law-enforcement frequencies.
  + Deploy jammers.
* Mission Complete.

## UC-007 Observed Swarm

Forward unit observes arial drone swarm and reports back to HQ.

Entities:

* Observer
  + Visual observation?

Reporting Action-Events

* See swarm
* Report locations
* Report observed behaviour
* Report grouping – can this be done by existing grouping of vehicles? How do we report observation of a convoy?
  + Report multiple vehicles
  + Group them using context? Or report as organization with all associated entities.
  + How do we report engaging with an enemy force?

# Use Case Breakdowns

## UC-001 Large Urban Area Hit By Earthquake

### Scenario Entities

Table 9 Scenario Entities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | Category | Equipment, other notes |
| Scenario Coordinator | N/A | Set up entities  Start scenario |  | Not modelled in scenario. |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | HQ |  |
| UavSearch1 | UAV with sensors | Scan for Survivors | Sensor | Video Sensors  AI Capability  Target identification algorithms  Programmable Target database |
| UavSearch2 | UAV with sensors | Scan for Hazards | Sensor | Video Sensors  Air Quality Sensors  Target identification algorithms  Programmable Target database |
| UavMedDelivery1 | UAV with payload | Deliver medical supplies; on call until given specific directive | Delivery | Refillable Payload  List of locations for delivery |
| UgvExtractor1 | UGV transport | Transport that can be loaded with casualties and move them to evac centers |  |  |
| UgvExtractor2 | UGV transport with grabber arm | Retrieve physical items and load them for transport. |  |  |
| UavTransport1 | UAV with payload capability | Deploy Med Kits |  |  |
| SwarmC2 | UAV | Automated Unit that coordinates all Automated units. |  | May be one of the other UXVs, or co-located with C2Unit |
| Survivor1 | Person | Call for help.  Get evacuated by air. |  | Injured |
| Survivor2 | Person | Call for help.  Get evacuated by ground. |  | Injured |
| Medical Facility | Building / Location |  |  |  |

### Scenario Initialization Messages

Set up the entities for the scenario. All of these messages are sent by Scenario Coordinator.

Table 10 Initialization Messages

|  |  |  |
| --- | --- | --- |
| Receiver | Msg Reference | Msg Details |
| C2Unit | InitializationConcept | Location.  List of resources. |
| UavSearch1 | InitializationConcept | SearchPattern |
|  |  | TargetDatabase – People |
|  |  | TargetIdAlgorithm |
|  |  | SwarmNetworkParameters |
|  |  | SwarmNetworkRole |
| UavSearch2 | InitializationConcept | SearchPattern |
|  |  | TargetDatabase – Hazards |
|  |  | TargetIdAlgorithm |
| UavMedDelivery1 | InitializationConcept | Refill Depot Id |
|  |  | Payload Type |
| UgvExtractor1 | InitializationConcept | Initial Location |
| UgExtractor2 | InitializationConcept | Initial Location |
| ?? | Initialization Concept | SwarmNetworkParameters |
|  |  |  |

### Scenario Messages

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Msg ID | From | To | Description | Notes / Details | Msg Ref |
| UC01-01 | Survivor1, Survivor2 | C2Unit | Request for help | Location, Damage, Injury |  |
| UC01-02 | C2Unit | UavSearch1, UavSearch2, UavMedDelivery, etc.  Search Swarm | Order  Move To Location  Start Operation | Operation types |  |
| UC01-03 | Deployable units | C2Unit | Report arrival on scene | Report Location |  |
| UC01-04 | UavSearch1 | C2Unit | Search Drone reports survivor | Report  Observation |  |
| UC01-05 | UavSearch2 | C2Unit | Search Drone reports key asset located | Report Observation |  |
| UC01-06 | C2Unit | UavTransport1 | Order  Go To Location.  Deploy MedKit | Deploy, payload |  |
| UC01-07 | C2Unit | UgvExtractor1 | Order  Go to location  Action: Extract survivor, transport to Medical Facility | Action |  |
| UC01-08 | C2Unit | Medical Facility | Order  Prepare for incoming ambulance | Action |  |
| UC01-09 | UavSearch2 | C2Unit | Report Hazard | Report  Action |  |
| UC01-10 | C2Unit | UgvExtractor2 | Order  Go to Hazard  Monitor |  |  |
| UC01-11 | UavSearch2 | C2Unit | Report  Action Event  Gas main explosion |  |  |
| UC01-12 | Swarm Lead | Rest of Swarm | Heartbeat  Build map of search area. | Not a C2SIM message? |  |
| UC01-13 | Swarm Lead | C2Unit | Report  Swarm member lost  \*\* Results in change to search pattern. Do we need to report this back to C2Unit?  \*\* May depend on program of units. |  |  |
| UC01-14 | Swarm Lead | C2Unit | Report  Damaged  New Swarm Lead required  \*\* Next step depends on Swarm behaviour – negotiate, or designated 2nd in command |  |  |
| UC01-15 | New Swarm Lead | C2Unit | Report  New Swarm Lead selected. |  |  |
| UC01-16 | UavTransport1 | C2Unit | Report  Payload empty. |  |  |
| UC01-17 | C2Unit | UavTransport1 | Order  Directed to nearest reload depot. |  |  |
| UC01-18 | UavSearch2 | C2Unit | Report  Low fuel |  |  |
| UC01-19 | C2Unit | UavSearch2 | Order  Directed to nearest fuel depot. |  |  |
| UC01-20 | Swarm Member X | C2Unit | Report  Swarm Leader has gone silent.  New swarm leader ID is Member X. |  |  |

UC-002 Surveillance and Information Gathering

Scenario Entities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | Category | Equipment, other notes |
| Scenario Coordinator | N/A | Set up entities  Start scenario |  | Not modelled in scenario. |
| C2Unit | Headquarters |  |  |  |
| UavSwarm1,  UavSwarm2,  UavSwarm3,  UavSwarm4,  UavSwarm5,  UavSwarm6 | UAVs | Surveillance of Area of Interest |  |  |
| Emitter1, Emitter2 |  | Targets detected by sensors. |  | Locations,  Transmission Characteristics |

Scenario Initialization Messages

|  |  |  |
| --- | --- | --- |
| Receiver | Msg Reference | Msg Details |
| C2Unit | InitializationConcept | Location.  List of resources. |
| UavSwarm Units | InitializationConcept | Location. (Co-located with C2Unit.)  List of resources.  ID of Coordinator unit.  Search pattern |
| UavSearch1 | InitializationConcept | SearchPattern |
| Emitter1 |  |  |

Scenario Messages

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Msg ID | From | To | Description | Notes / Details | Msg Ref |
| UC01-01 | Survivor1, Survivor2 | C2Unit | Request for help | Location, Damage, Injury |  |
| UC01-02 | C2Unit | UavSearch1, UavSearch2, UavMedDelivery, etc.  Search Swarm | Order  Move To Location  Start Operation | Operation types |  |

Message Details

This section contains the details for messages for the scenarios. They are collected in one place as the same messages are expected to be used in multiple scenarios.

Mission Startup Messages

Msg1 Call for Help

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

Table 11 Search Drone Reports Survivor

|  |  |  |  |
| --- | --- | --- | --- |
| Sender | Receiver | Msg Reference | Msg Details |
| UavSearch1 | SwarmC2 | MessageConcept | Location  Number of Persons  Request for Medical Personnel  Request for Medical Drone delivery  Request for Extraction |
| SwarmC2 | All units of role Extractor | MessageConcept | Report Location |
| UgvExtractor1 | C2Unit, SwarmC2 |  |  |

*Table 1 UXV Description*

|  |  |  |
| --- | --- | --- |
| Category | Description | Notes |
| Identifier | UAV |  |
| Network ID | Name string – electronic address | Set when unit is configured |
| Equipment Type | Drone / Rover / Submersible |  |
| Mobility | Airborne, Tracked, Surface |  |
| Sensors | Video / EW / CBRN / Gas | Sensor type is related to Role |
| Autonomy | Operational Role – Search, Extract, Delivery |  |
|  | Autonomy Level – Full, Partial | Modelling with Partial Autonomy requires messaging back and forth with controller – Orders and Reports. |
|  | Network Role: Coordinator – Assign roles  Function Performer – Execute Mission  Back-up Coordinator – If Coordinator reports damage or goes dark.  Relay – repeat signals |  |
| Network Connection | Network ID, Frequency, Call Sign | Connection for swarm communication |
| Network Connection | Network ID, Frequency, Call Sign | Connection for partially-autonomous units communication back to human to get Orders. |
| Mission Data | Search Pattern, Anomaly library, |  |

Message Contents

Descriptions of message parts that need to flow and the values that appear in them.

*Table 2 Setting up Assignment table - General*

|  |  |  |
| --- | --- | --- |
| Sender | Receiver | Message Description |
| C2 Unit (human programmer) | UAV | Order: Mission Type (Search, Delivery, Extraction, etc.) |
|  |  | Configuration: Swarm Network Information (Freq, ID, Role) |
|  |  | Initial Location |
|  |  | Depot: ID of refuel / reload / maintenance unit / depot. (will query for location when needed) |

*Table 3 Mission Description Data*

|  |  |  |
| --- | --- | --- |
| Mission Type | Required Information | Notes |
| Search | Start Location |  |
|  | Search Path/Pattern Information | Route type info? |
|  | Target Library | Types of things to look for. See Table. |
|  | Behaviour on Detection | Enum: Report and continue, request support, etc. |
|  | Type of sensor |  |
|  | Anomaly Detection Parameters | Threshold for reporting detection?  May be integrated into sensor. |
| Extraction | Start Location | Where to wait for request for extraction. |
|  | Types of Extraction possible |  |
| Deliver | Type of payload |  |
|  | Count of payload options |  |
|  | Final Location | Where is payload delivered |
| Directed Deployment | Location or list of locations to search | In the case where a person has phoned in and GPS information is available, or need to examine a specific target, e.g. Gas Depot, Power infrastructure items such as electrical stations. Expected behaviour is sending back sensor data, e.g. visual data or atmospheric readings. |

*Table 4 Search Pattern Data*

|  |  |  |
| --- | --- | --- |
| Value | Description | Notes |
| Start Location | Geographical Point | Lat/Long |
| Elevation | Above Ground (UAV), Below Surface (UUV) | Not needed for Ground Vehicles. |
| Search Pattern | Start Location,  Pattern Type, | \*\*\* Needs Definition |
| Pattern Type | Enum,  Parameters – length of laps, distance between laps, etc. | \*\*\* Needs Definition |

*Table 5 Target Library*

|  |  |  |
| --- | --- | --- |
| Value | Description | Notes |
| Person |  | Status of human (as detectable by sensors) |
| Key Equipment | ?? Need more information for what would be key |  |
| Hazard | Gas leak, CBRN detection, Flood |  |

*Table 6 Behaviour on Detection*

|  |  |  |
| --- | --- | --- |
| Value | Description | Notes |
| Report Location | Geographical Point | Lat/Long |
|  | Elevation (if needed) | People in buildings, or in sink holes |
| Report Target | Human or Equipment |  |
| Report Environmental Anomaly |  |  |
| Report Hazard |  |  |
| Report condition of found human |  |  |
| Report search complete | May result in order to repeat search or start search at new location. |  |

*Table 7 Network Configuration*

|  |  |  |
| --- | --- | --- |
| Value | Description | Notes |
| Network Identifier | Unique ID string | In case of large deployments with multiple UXV Networks |
| Frequency / Network Characteristics | Depends on network type. | See EW C2SIM extension. |
| Callsign | Unique ID for specific node |  |
| Role | Participant,  Coordinator,  BackupCoordinator |  |
|  |  |  |

Message Sequences for Typical Operations

*Table 7 Order for Extraction or Deployment of Payload*

|  |  |  |
| --- | --- | --- |
| Value | Description | Notes |
| Move Order | New Location |  |
| Behaviour Order | Extract, Deploy |  |
| Additional Location | Location | Point to which extracted target must be delivered. May depend on location of target, if there are multiple locations, or treatment facilities move throughout scenario. |

*Table 8 Maintenance Behaviour*

|  |  |  |
| --- | --- | --- |
| Value | Description | Notes |
| Report | My Platform Status | Damage Value, fuel level, payload depleted |
|  | My location | Geolocation |
|  | Whether I can continue | Measured by level of damage |
| Order | Location | Location of nearest depot |
| Report | My Platform Status | Damage repaired, payload level, fuel level. |
|  | My Platform Status | Report from Depot – too damaged to resume mission |
| Order | Return to previous location, or deploy to new location |  |
| Order | Task another unit to take over damaged unit’s function | Remove from list of available Extraction or Deployment units. |
|  | Trigger new C2 unit | If damaged unit is a C2 unit |

# Findings – New Concepts

## Entities and Attributes

* Roles

## Orders

* Swarm-related Actions:
* Action Events

## Reports

* Swarm-specific operations

# Areas for Future Investigation