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# Overview

This paper takes use cases that have previously been identified for the ASX extension definition, and breaks them into smaller, easier to manage use cases. Each of these is then examined for the C2SIM messages that are required to execute the use cases, to identify where the C2SIM standard needs to be extended to accommodate the messaging requirements for un-piloted vehicles, UxV.

## Sources

The high-level use cases were taken from the following papers:

* 6 Scenario-Level use cases
* Generic use cases
* \*\*\* To be filled out\*\*\*

## High Level Use Cases

This section lists the high-level use cases and the sub-use-cases they are broken into.

### Large Urban Area Hit By Earthquake

This scenario is broken into the following sub-use-cases:

* Search for survivors, infrastructure damage.
* Search for specific resource.
* Request specific resource.
* Deliver resources – Payload (medical supplies).
* Deliver resource – Vehicle with specific capability
* Extract survivor and deliver to hospital.

### Deploy Surveillance Swarm

* Deploy Swarm.
* Swarm Leader goes silent – new leader selected.
* Report Observations.
* Change Search Pattern.
* Return to base.

### Protect Troops / Population

* Request support.

### Deploy Resources

* Deploy fertilizer.

### Report Observed Swarm

* Patrol reports swarm of drones.

### Disrupt Law Enforcement

\*\* Give source for this observed behaviour.

### Detecting and Disrupting EW Signals

This is for communications and jamming IED signals.

# Use Case Descriptions

The use cases in this section were derived from use cases identified in the early stages of the ASX work. In some cases, the type of vehicle, or its function, may not be currently available, but they are included for the sake of ensuring the protocol extension accommodates them in future.

## Earthquake Aftermath: General Search via UAV

### Scenario Description

UAVs are deployed to survey an urban area that has been hit by an earthquake.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 1 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks Units, receives reports | N/A |
| UavSearch | UAV with visual | Scan for Survivors, Hazards, | Mobility or Platform type – Fixed Wing drone,  Mobility – Fan  Sensor Types:  Video Sensors  Mission-Related: On-Board Processing, Capability,  Target identification algorithms,  Target database (can be hostile entities, hazards, etc.) |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 2 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 3 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
| C2Unit | UavSearch | Order  Move To Location  Start Operation | Order | Operation types |
| UavSearch | C2Unit | Report arrival on scene | Report | Report Location |
| UavSearch | C2Unit | Report survivors | Report | Report  Observation |
| C2Unit | UavSearch | Order  Continue Operation | Order |  |

## Earthquake Aftermath: Search for Specific Resource

### Scenario Description

UAVs are deployed to survey an urban area for a specific resource.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 4 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |
| UavSearch | UAV with sensors | Scan for Survivors, Hazards, Broken Infrastructure, etc. | Mobility or Platform type – Fixed Wing drone,  Mobility – Fan  Sensor Types:  Video Sensors  Autonomy Type: Remote-Controlled, Self-Directed  Mission-Related: On-Board Processing, Capability,  Target identification algorithms,  Target database (can be hostile entities, hazards, etc.) |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 5 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |
| UavDelivery | InitializationConcept | Refill Depot Id |  |
|  |  | Payload Type |  |
|  |  | Payload Quantity |  |

### Scenario Messages

Table 6 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
| C2Unit | UavSearch | Order  Move To Location  Start Operation | Order | Operation types |
| UavSearch | C2Unit | Search Drone reports asset located | Report | Report Observation |
| C2Unit | UavSearch | Order  Search for next resource in target list / Assign new search target | Order | Deploy, payload |

## Earthquake Aftermath: Request & Deliver Resource

### Scenario Description

UAV detects injured survivors, requests medical supplies.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 7 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |
| UavSearch | UAV with sensors | Scan for Survivors, Hazards, Broken Infrastructure, etc. | Mobility or Platform type – Fixed Wing drone,  Mobility – Fan  Sensor Types:  Video Sensors  Autonomy Type: Remote-Controlled, Self-Directed  Mission-Related: On-Board Processing, Capability,  Target identification algorithms,  Target database (can be hostile entities, hazards, etc.) |
| UavDelivery | UAV with payload | Delivery: medical supplies, food, etc. | Deliverable Payload Type, Deliverable Payload Quantity,  Locations for delivery |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 8 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |
| UavDelivery | InitializationConcept | Refill Depot Id |  |
|  |  | Payload Type |  |
|  |  | Payload Quantity |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 9 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
| C2Unit | UavSearch, UavDelivery, etc. | Order  Move To Location  Start Operation | Order | Operation types |
| C2Unit | UavDelivery | Order  Move To Initial Location / Staging area | Order | Operation types |
| Deployable units | C2Unit | Report arrival on scene | Report | Report Location |
| UavSearch | C2Unit | Report survivor detected | Report | Report  Observation |
| C2Unit | UavDelivery | Order  Go To Location.  Deploy Payload | Order | Deploy, payload |
| UavDelivery | C2Unit | Report  Arrived on location  Payload deployed | Report |  |
| C2Unit | UavDelivery | Order  Go to Location (waiting area or next deployment) | Order |  |
| UavDelivery | C2Unit | Report  Payload Count 0 | Report |  |
| C2Unit | UavDelivery | Order  Go To Depot  Reload | Order |  |
| UavDelivery | C2Unit | Report  Reload complete | Report |  |

## Earthquake Aftermath: Deliver Resource – Vehicle

### Scenario Description

Passenger transport deployed to site of survivors.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 10 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |
| UavSearch | UAV with sensors | Scan for Survivors, Hazards, Broken Infrastructure, etc. | Mobility or Platform type – Fixed Wing drone,  Mobility – Fan  Sensor Types:  Video Sensors  Autonomy Type: Remote-Controlled, Self-Directed  Mission-Related: On-Board Processing, Capability,  Target identification algorithms,  Target database (can be hostile entities, hazards, etc.) |
| UgvTransport | UGV transport | Transport that can be loaded with casualties and move them to evac centers | Passenger Capacity |
| UgvExtractor | UGV transport with grabber arm | Retrieve physical items and load them for transport. | On-Board capabilities: Arms, etc. (see Robotics standards)  Types of Activities it can perform. |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 11 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |
| UavDelivery | InitializationConcept | Refill Depot Id |  |
|  |  | Payload Type |  |
|  |  | Payload Quantity |  |
| UgvExtractor | InitializationConcept | Initial Location |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 12 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
| C2Unit | UavSearch, UavDelivery | Order  Move To Location  Start Operation | Order | Operation types |
| Deployable units | C2Unit | Report arrival on scene | Report | Report Location |
| UavSearch | C2Unit | Search Drone reports survivor | Report | Report  Observation |
| UavSearch | C2Unit | Search Drone reports key asset located | Report | Report Observation |
| C2Unit | UavDelivery | Order  Go To Location.  Deploy Payload, e.g. MedKit | Order | Deploy, payload |
| C2Unit | UgvExtractor | Order  Go to location  Action: Extract survivor, transport to Medical Facility | Order | Action |
| C2Unit | Medical Facility | Order  Prepare for incoming ambulance | Order | Action |
| UavSearch | C2Unit | Report Hazard | Report | Report  Action |
| C2Unit | UgvExtractor | Order  Go to Hazard  Monitor | Order |  |
| UavSearch2 | C2Unit | Report  Action Event  Gas main explosion | Report |  |
| UavTransport1 | C2Unit | Report  Payload empty. |  |  |
| C2Unit | UavTransport | Order  Directed to nearest reload depot. |  |  |
| UavSearch | C2Unit | Report  Low fuel |  |  |
| C2Unit | UavSearch2 | Order  Directed to nearest fuel depot. |  |  |

## Earthquake Aftermath: Extract Survivor and Deliver to Hospital

### Scenario Description

UAVs are deployed to survey an urban area that has been hit by an earthquake.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 13 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |
| UavSearch | UAV with sensors | Scan for Survivors, Hazards, Broken Infrastructure, etc. | Mobility or Platform type – Fixed Wing drone,  Mobility – Fan  Sensor Types:  Video Sensors  Autonomy Type: Remote-Controlled, Self-Directed  Mission-Related: On-Board Processing, Capability,  Target identification algorithms,  Target database (can be hostile entities, hazards, etc.) |
| UavDelivery | UAV with payload | Delivery: medical supplies, food, etc. | Deliverable Payload Type, Deliverable Payload Quantity,  Locations for delivery |
| UgvTransport | UGV transport | Transport that can be loaded with casualties and move them to evac centers | Passenger Capacity |
| UgvExtractor | UGV transport with grabber arm | Retrieve physical items and load them for transport. | On-Board capabilities: Arms, etc. (see Robotics standards)  Types of Activities it can perform. |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 14 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |
| UavDelivery | InitializationConcept | Refill Depot Id |  |
|  |  | Payload Type |  |
|  |  | Payload Quantity |  |
| UgvExtractor | InitializationConcept | Initial Location |  |
| UgvTransport | InitializationConcept | Initial Location |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 15 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
| C2Unit | UavSearch, UavDelivery, etc. | Order  Move To Location  Start Operation | Order | Operation types |
| Deployable units | C2Unit | Report arrival on scene | Report | Report Location |
| UavSearch | C2Unit | Search Drone reports survivor | Report | Report  Observation |
| UavSearch | C2Unit | Search Drone reports key asset located | Report | Report Observation |
| C2Unit | UavExtractor | Order  Go To Location  Action: Extract survivor | Order | Deploy |
| C2Unit | UavTransport | Order  Go to location  Action: Transport to Medical Facility | Order | Action |
| C2Unit | Medical Facility | Order  Prepare for incoming ambulance | Order | Action |
| UavTransport | C2Unit | Report  Arrived at Medical Facility | Order |  |

## Swarm Scenario: Deploy Swarm

### Scenario Description

UAVs are deployed to survey an urban area that has been hit by an earthquake.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 16 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 17 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 18 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

## Swarm Scenario: Swarm Leader goes silent

### Scenario Description

UAVs are deployed to survey an urban area that has been hit by an earthquake.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 19 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 20 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 21 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

## Swarm Scenario: Report Results

### Scenario Description

UAVs are deployed to survey an urban area that has been hit by an earthquake.

### Scenario Entities

The following table describes the types of entities deployed during the mission.

Table 22 Scenario Entity Types

|  |  |  |  |
| --- | --- | --- | --- |
| Label in Scenario | Unit Description | Role | ASX-related items |
| C2Unit | Headquarters Unit | Tasks UXVs and human units | N/A |
| UavSearch | UAV with sensors | Scan for Survivors, Hazards, Broken Infrastructure, etc. | Mobility or Platform type – Fixed Wing drone,  Mobility – Fan  Sensor Types:  Video Sensors  Autonomy Type: Remote-Controlled, Self-Directed  Mission-Related: On-Board Processing, Capability,  Target identification algorithms,  Target database (can be hostile entities, hazards, etc.) |

### Scenario Initialization Messages

The messages in the following table capture the Initialization messages required to set up the exercise.

Table 23 Initialization Messages

|  |  |  |  |
| --- | --- | --- | --- |
| Receiver | Msg Reference | Msg Details | ASX-related items |
| UavSearch | InitializationConcept | SearchPattern |  |
|  |  | TargetDatabase – People |  |
|  |  | TargetDatabase – Hazards |  |
|  |  | TargetIdAlgorithm |  |
|  |  | SwarmNetworkParameters |  |
|  |  | SwarmNetworkRole |  |

### Scenario Messages

The following table lists the messages that would need to be generated during the mission to complete it successfully. The list is representative, not exhaustive, so the table does not represent conversations.

Table 24 Scenario Messages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Description | Msg Type | Details |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

## UC-002 Surveillance and Information Gathering by Swarm

### 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

### 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 |  |
| 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. |  |  |
| UC01-12 | Swarm Lead | Rest of Swarm | Heartbeat  Build map of search area. |  | Not a C2SIM message? |
| UC01-20 | Swarm Member X | C2Unit | Report  Swarm Leader has gone silent.  New swarm leader ID is Member X. |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

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

### Mission Overview

* Deployment
  + Assign missions, locations
  + Move to AOI.
  + Encounter Resistance – Engage hostile UAX (see Mission section)

### Actions to Model

* Perform Mission
  + Recce UAV reports incident
  + Recce UAV tasked to site of incident
  + Report observations – signal detection, visual item
  + Request support
  + Exchange fire – needs command/confirmation
  + Retreat
  + Recce UAV reports damage
* Maintenance
  + Refuel/reload
  + Report damage
* Mission Complete

### 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 |  |
| UavRecce1 | UAV with visual/audio sensors | Provide video feedback to C2Unit | Recce | Visual/audio sensor |
| UavArtillery1, | UAV with artillery | Engage hostile forces | Artillery | Guns  Ammo  Target Recognition |
| UavArtillery2 | UAV with artillery | Report Status | Artillery | Guns  Ammo |
| UavEw1 | UAV with EW Sensors | Intercept audio signals, request Jammer | EW Sensor | EW Sensor(s) |
| UavEw2 | UAV with EW attack devices | Respond to request for Jammer | EW Attack | EW Jammer |

### Scenario Initialization Messages

|  |  |  |
| --- | --- | --- |
| Receiver | Msg Reference | Msg Details |
| C2Unit | InitializationConcept | Location.  List of resources. |
| UavArtillery1 | InitializationConcept | Location. |
| UavRecce1 | InitializationConcept | Patrol Route |

### Scenario Messages

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Msg ID | From | To | Description | Notes / Details | Msg Ref |
| UC03-01 | C2Unit | UavRecce1 | Order  Start Patrol |  |  |
| UC03-02 | UavRecce1 | C2Unit | Report Incident | Location, Entities Involved: Target, Entities to protect |  |
| UC03-02 | C2Unit | UavArtillery1 | Order  Move To Location  Fire on Target |  |  |
|  | UavArtillery1 | C2Unit | Arrived |  |  |
|  | UavAudio1 | C2Unit | Report  Audio signal  Reporting |  |  |
|  | C2Unit | UavEw1 | Order  Move to location  Jam signal |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

## UC-004 Patrol Group

### Mission Overview

* Deploy
  + Assign missions

### Actions to Model

* Perform Mission
  + Patrol

### Scenario Entities

### Scenario Initialization Messages

### Scenario Messages

## UC-005 Deploy Resources – Fertilizer, Poison

### Mission Overview

* Deploy
  + Fuel – instructions to depot?
  + Assign location and deployment pattern
  + Go to AOI.

### Actions to Model

* Perform Mission
  + Swarm deployed in patterns
  + Report problems – equipment failure?
* Mission Complete

## UC-006 Disrupting Law Enforcement Team

### Mission Overview

* Deploy
  + Assignments
  + Location
  + Behaviour patterns

### Actions to Model

* Perform Mission
  + Monitor law-enforcement frequencies.
  + Deploy jammers.
* Mission Complete.

## UC-007 Observed Swarm

### Mission Overview

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

Entities:

* Observer
  + Visual observation?

### Actions to Model

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?

## UC-008 Detecting and Disrupting EW Signals

### Mission Overview

* Deployment
* Assign missions, locations
* Move to AOI.

### Actions to Model

* Perform Mission
  + Signal UAV reports incident
  + Report observations – signal detection
  + Signal detection – may be hostile or cry for help or ignorable transmission (yellow daisies)
  + Request support
  + Jam signals
* Maintenance
  + Refuel/reload
  + Report damage
* Mission Complete

# ASX Needs

This section captures the features of UXVs that need to be communicated to execute the missions defined in the previous section.

## Initialization – UxV-Specific Attributes

Table 25 UxV Attributes

|  |  |  |  |
| --- | --- | --- | --- |
| Attribute | New / Extisting | Range of Values | Parent (Class that Attribute belongs to) |
| Mobility | Enum Extension | HoverFans  Jet |  |
| VehicleType | Enum Extension | Drone – Fixed Wing  Drone - Hover |  |
| Payload |  | SensorType,  Armiture,  Supplies (Medical),  Supplies (Food),  Ammunition  Fuel | (see Robotics presentation for details) |
| Payload Quantity | Integer | Positive Integers | Platform type that takes Payload. |
| Passenger Capability | Integer (Count or Max. Load by weight) | Positive Integers |  |
| SensorType |  | Visual,  EW,  Counter EW (Jammer),  Audio | \*\*\*Check Robotics Standard for categories of sensor types |
| Control Function | New on Vehicle | Piloted,  Unpiloted – Autonomous  Swarm | See Robotics notes |
| Swarm Parameters | New entity | Leader – Boolean  Network – Network Parms (See Network entities in base standard; see EW Extension) |  |
| Autonomous Parameters | New entity | Algorithm/Type |  |
| Mission Function | New enum | Search General,  Search Targeted,  Retrieve Resource,  Deliver Resource |  |
| Mission Parameters | Construct from existing capabilities | Route,  Target Database,  Hostility Database,  Identification Parameters |  |

* + 1. Initialize – Start Location

Hierarchy of base type:

* Owl:Thing
* InitializationConcept
  + InitializationDataFile
  + ObjectDefinitions
  + ScenarioSetting
  + SystemEntityList

Message:

|  |  |  |  |
| --- | --- | --- | --- |
| Type | Attribute | Value | Notes |
| InitializationConcept (sub-type of owl:Thing) | InitializationDataFile |  |  |
|  | ObjectDefinitions |  |  |
|  | ScenarioSetting |  |  |
|  |  |  |  |

## Mission Execution – UxV-Specific Attributes

During a mission, the following table contains UxV-specific information that needs to be included in the messaging.

|  |  |  |  |
| --- | --- | --- | --- |
| Attribute | New / Extisting | Range of Values | Parent (Class that Attribute belongs to) |
| Mobility | Enum Extension | HoverFans  Jet |  |
| VehicleType | Enum Extension | Drone – Fixed Wing  Drone - Hover |  |
| Payload |  | SensorType,  Armiture,  Supplies (Medical),  Supplies (Food),  Ammunition  Fuel | (see Robotics presentation for details) |
| Payload Quantity | Integer | Positive Integers | Platform type that takes Payload. |
| Passenger Capability | Integer (Count or Max. Load by weight) | Positive Integers |  |
| SensorType |  | Visual,  EW,  Counter EW (Jammer),  Audio | \*\*\*Check Robotics Standard for categories of sensor types |

### Scenario Progress

The following messages are broken out in this section.

1. Request for assistance. Includes Location, type of assistance required, own status (Damage / injury)
2. Order – Move to Location, start operation – operation type may already have been included in Initialize message.
3. Report – Arrived at scene of request for aid.
4. Report – Survivor detected.
5. Report – Hazard detected.
6. Order – Move to location and deploy resource – MedKit.
7. Report – Arrival at location and deployment of resource.
8. Report – Low on resource (fuel, deployable resource).
9. Order – Report to depot for refill.
10. Report – Arrived at depot. Successful refill. Ready for re-deployment.
11. Report – Action Event – Explosion of Gas Main.

### Swarm-Specific Messaging

1. Order – report current location and status.
2. Report – Location and status.
3. Order – Request for specific unit to report status.
4. Order – Change of search pattern / other change to orders.
5. Report – Swarm Lead damage report. Negotiate new Swarm Lead.
6. Order – ID of new swarm lead.

Table 26 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 27 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 28 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 29 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 30 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 31 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 32 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 33 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 34 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 35 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 |

# Ontology Elements

## C2SIM Concepts Used In Messages

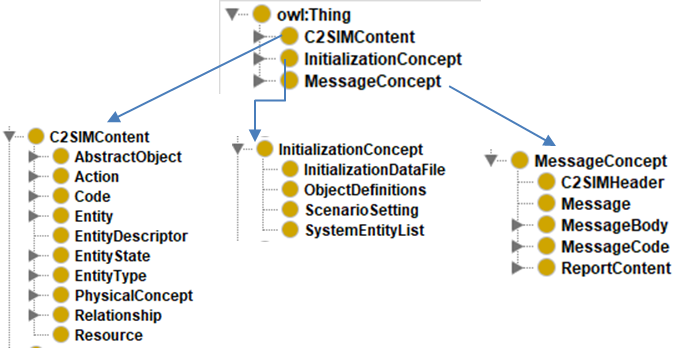


Figure 4‑1 C2SIM Standard Hierarchy

## New / Modified Entities and Attributes

* Roles

## Orders

* Swarm-related Actions:
* Action Events

## Reports

* Swarm-specific operations

# Areas for Future Investigation

## Robotics Standard

* Code for Attachments – arms, sensors, etc.