International Technology Alliance in Network and Information Sciences

Tasking and Sharing Sensing Assets Using Controlled Natural Language

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MINISTRY OF DEFENCE

ISR task-asset assignment in a coalition context

"Decision-to-data"

- Make best use of scarce sensing assets by considering all ways to achieve an ISR task

  "Locate high value targets in an area"

  - imagery, acoustic, seismic….

- Help users utilise all suitable and available assets across the coalition – without requiring them to have sensing expertise
- Be agile in the face of changing task requirements and available assets

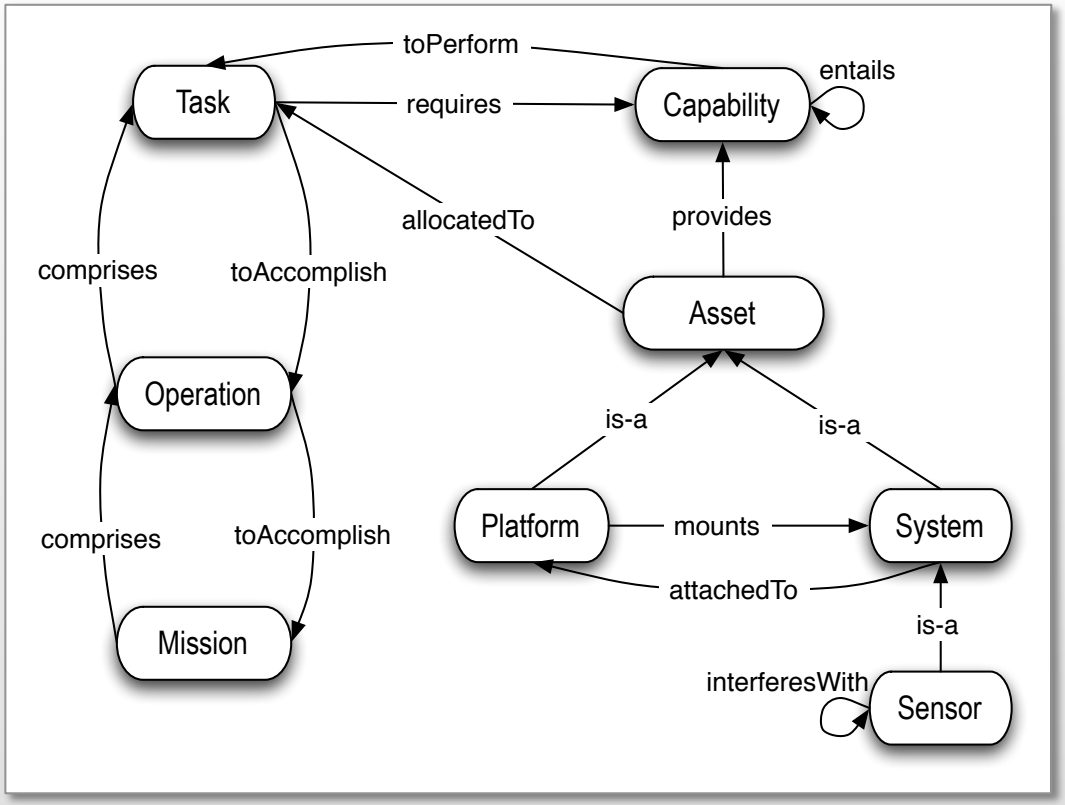
Users are decision makers in the network or at the edge of the network

Knowledge-based approaches

- **Sensor Web Enablement Sensor Planning Service** (Open Geospatial Consortium)
- **OntoSensor** (U Memphis/ Purdue)
- **Semantic Sensor Network WG** (W3C)

Previous work using the Military Missions & Means Framework (MMF)

Formalised MMF as a collection of ontologies defined using Web Ontology Language (OWL), for machine-processability



Extensible models

- Asset ontology based on OntoSensor
- Task ontology originally based on Joint Universal Task List
- MMF connects these:
  - tasks **require** capabilitites
  - assets **provide** capabilities

NIIRS-based approach

- Tasks are characterised by the data needed to achieve them
  - type of (imagery) data (visual, IR, radar, multispectral)
  - “quality” rating 0 to 9
- Assets are rated in terms of the data they can provide

Task-asset matching procedure

Definitions

- **Task type (TT):** a NIIRS interpretation task that characterises the given task, and requires a given NIIRS rating
- **Bundle type (BT):** a combination of platform and sensor(s) that provides a given NIIRS rating
- **Utility function (UF):** a means of assessing how effective a particular BT instance is likely to be in achieving a particular TT instance
- **KB Table (KBT):** a pregenerated set of triples of the form (TT, BT, UF) capturing all applicable BT/UF pairs for a given TT

1. **A user creates a task from which the system derives the corresponding TT.**
2. **The system retrieves all KBT entries (TT, BT, UF) for the given TT.**
3. **The system determines all possible *bundle instances* that conform to all retrieved BTs and uses the corresponding UFs to derive a utility for each.**
4. **A distributed allocation protocol attempts to assign a bundle instance, maximising overall utility in the face of multiple competing tasks.**

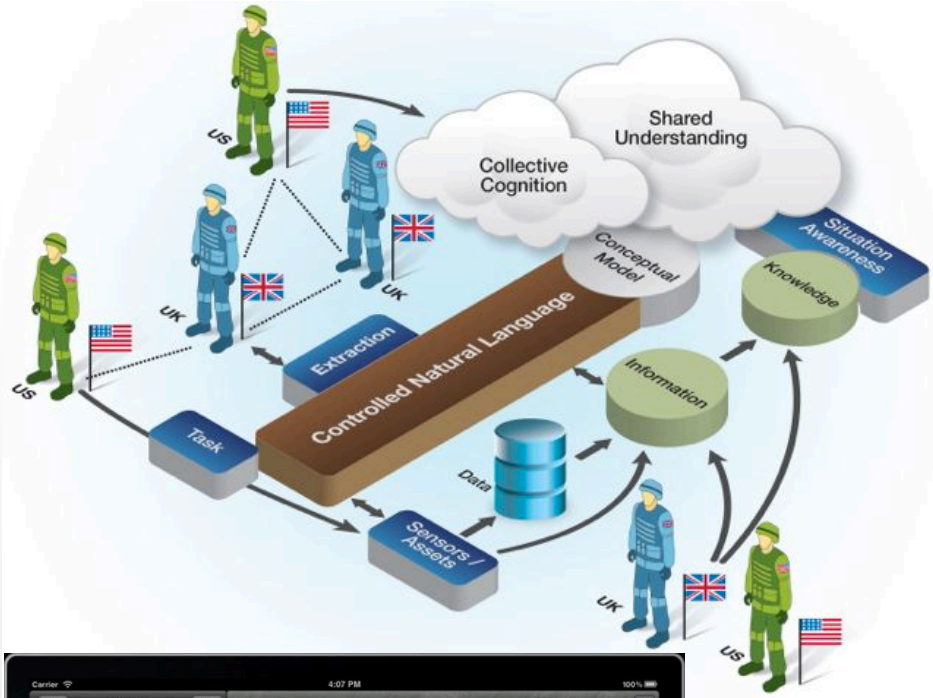
A new approach using Controlled Natural Language

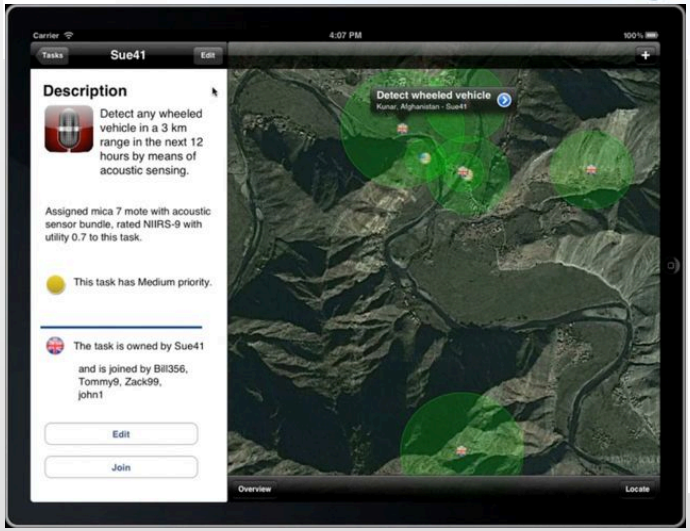
Controlled Natural Language

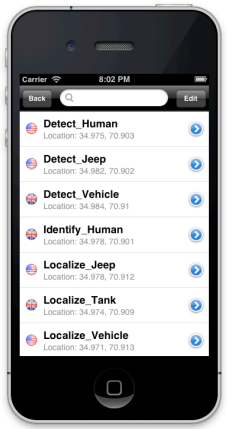
- A subset of a natural language with restricted syntax and vocabulary.
- Used to provide an information representation that is easily machine processable while also being human-readable.

Research questions

- Can our MMF-based knowledge base be expressed in CNL, with no loss of power to support automated asset-task matching?
- How can a CNL-based representation of tasks and their resourcing be used to create a human-understandable tool to promote task sharing among users?







Reformulating the ontology in ITA Controlled English

conceptualise a ~ capability ~ C.

conceptualise the mission M
~ comprises ~ the operation O.

conceptualise the operation O
~ comprises ~ the task T.

conceptualise the task T
~ requires ~ the capability C.

conceptualise the asset type A
~ is rated as ~ the NIIRS rating R and
~ provides ~ the capability C.

conceptualise a ~ system type ~ S that is an asset type.

conceptualise a ~ sensor type ~ S that is a system type.

conceptualise a ~ platform type ~ P that is an asset type.

conceptualise the platform type P
~ mounts ~ the system type S.

conceptualise a ~ UAV ~ U that is a platform type.

conceptualise a ~ MALE UAV ~ M that is an UAV.

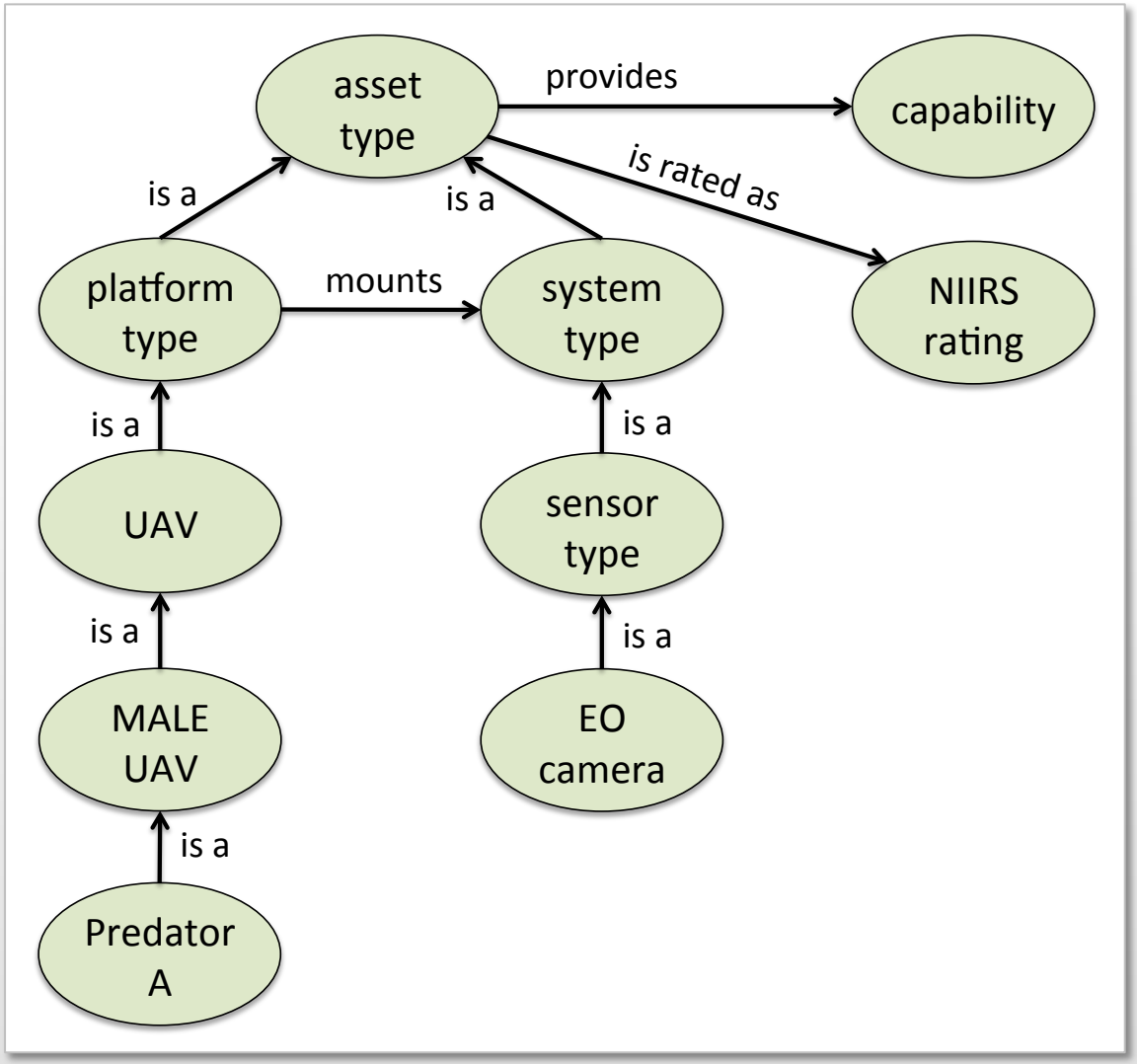
Note: MALE = Medium Altitude, Long Endurance.

conceptualise a ~ Predator A ~ P that is a MALE UAV.

conceptualise an ~ EO camera ~ E that is a sensor type.

Note: EO = Electro-optical.

Controlled English model and 'prototypical' instances



'Prototype' instances

there is an EO camera named **'EO camera sensor type'** that provides the capability 'visible sensing'.

there is a Predator A named **'Predator A platform type'** that mounts the sensor type 'EO camera sensor type' and is rated as the NIIRS rating 'visible NIIRS rating 6'.

Associating tasks with asset bundles

Model

conceptualise the task T
~ requires ~ the intelligence capability IC and
~ is looking for ~ the detectable thing DT and
~ operates in ~ the spatial area SA and
~ operates during ~ the time period TP and
~ is ranked with ~ the task priority PR.

conceptualise the assignment template AT
~ fulfills ~ the intelligence capability IC and
~ is looking for ~ the detectable thing DT and
~ can be satisfied by ~ the bundle type BT and
~ is ranked by ~ the utility function UF.

conceptualise the bundle type BT
~ is deployed on ~ the platform type P and
~ uses ~ the sensor type S.

Sample instances

there is a task named t1265 that
requires the intelligence capability detect and
is looking for the detectable thing
'wheeled vehicle' and
operates in the spatial area r942 and
operates during the time period t1789 and
is ranked with the task priority medium.

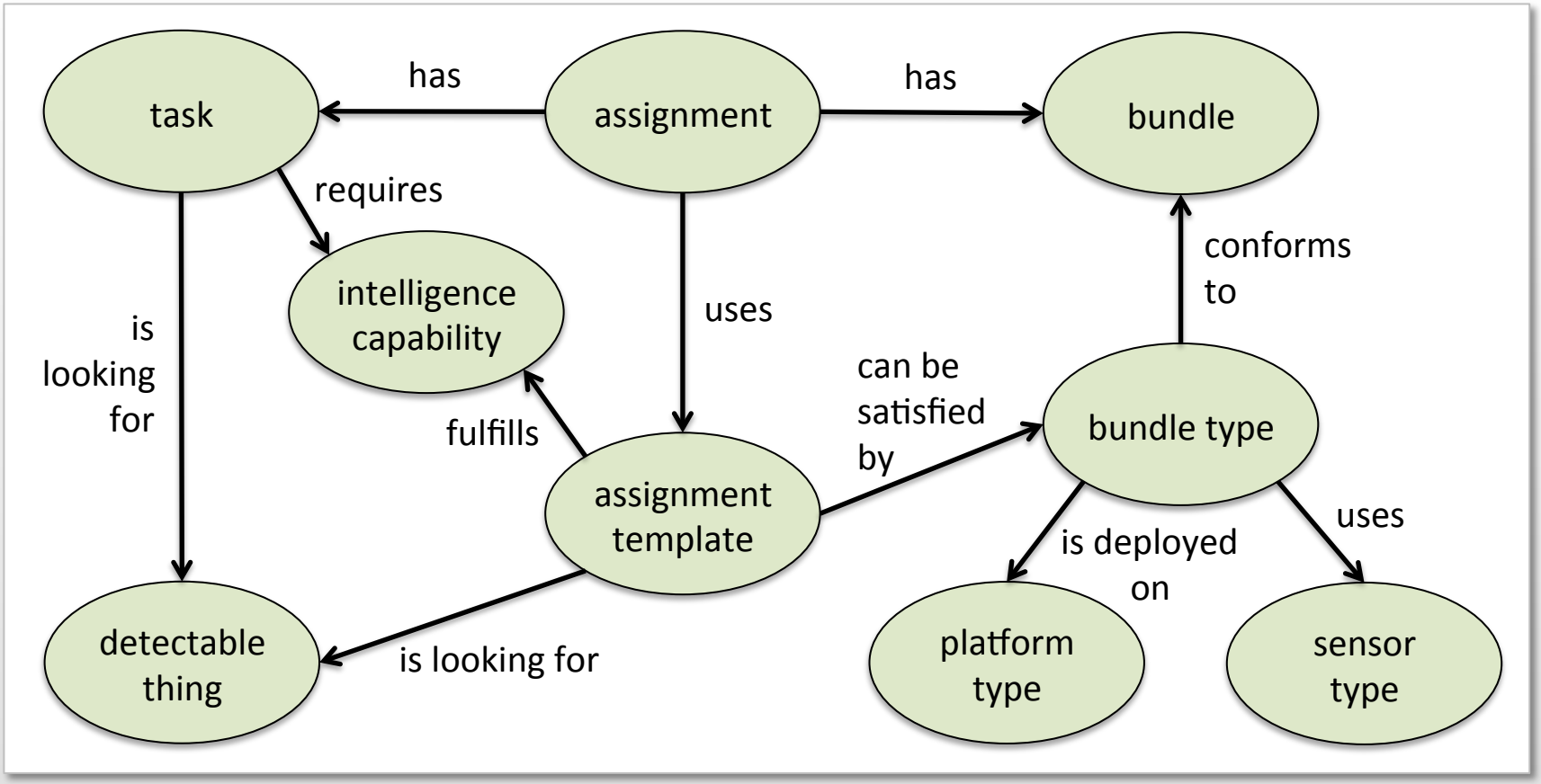
there is an assignment template named at349 that
fulfills the intelligence capability identify and
is looking for the detectable thing
'wheeled vehicle' and
can be satisfied by the bundle type bt312 and
is ranked by the utility function CDP.

there is a bundle type named bt312 that
is deployed on the platform type
'Predator A platform type' and
uses the sensor type 'EO camera sensor type'.

Task-assignment-bundle model

conceptualise an ~ assignment ~ A that
has the task T as ~ task ~ and
has the bundle B as ~ bundle ~ and
has the value US as ~ utility score ~.

conceptualise the assignment A
~ uses ~ the assignment template AT.



Associating assignments with users

Model

conceptualise a ~ user ~ U.

conceptualise a ~ coalition partner ~ CP.

conceptualise the assignment A
  ~ is provided by ~
    the coalition partner CP and
  ~ is owned by ~ the user UO and
  ~ is joined by ~ the user UJ.

Sample instances

there is an assignment named a43288 that
  has the task t1265 as task and
  has the bundle b17352 as bundle and
  has '0.7' as utility score and
  uses the assignment template at349.

there is a bundle named b17352 that
  conforms to the bundle type bt312.

the assignment a43288
  is provided by the country UK and
  is owned by the user Sue41 and
  is joined by the user Bill356 and
  is joined by the user Tommy9 and
  is joined by the user Zack99.

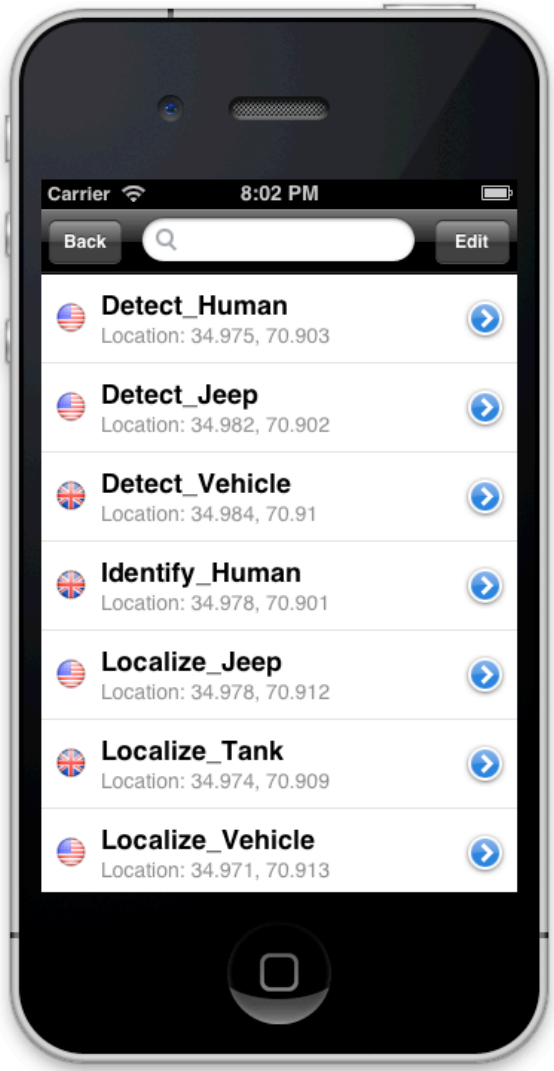
Concept illustration via mobile apps

Aims of original smartphone app

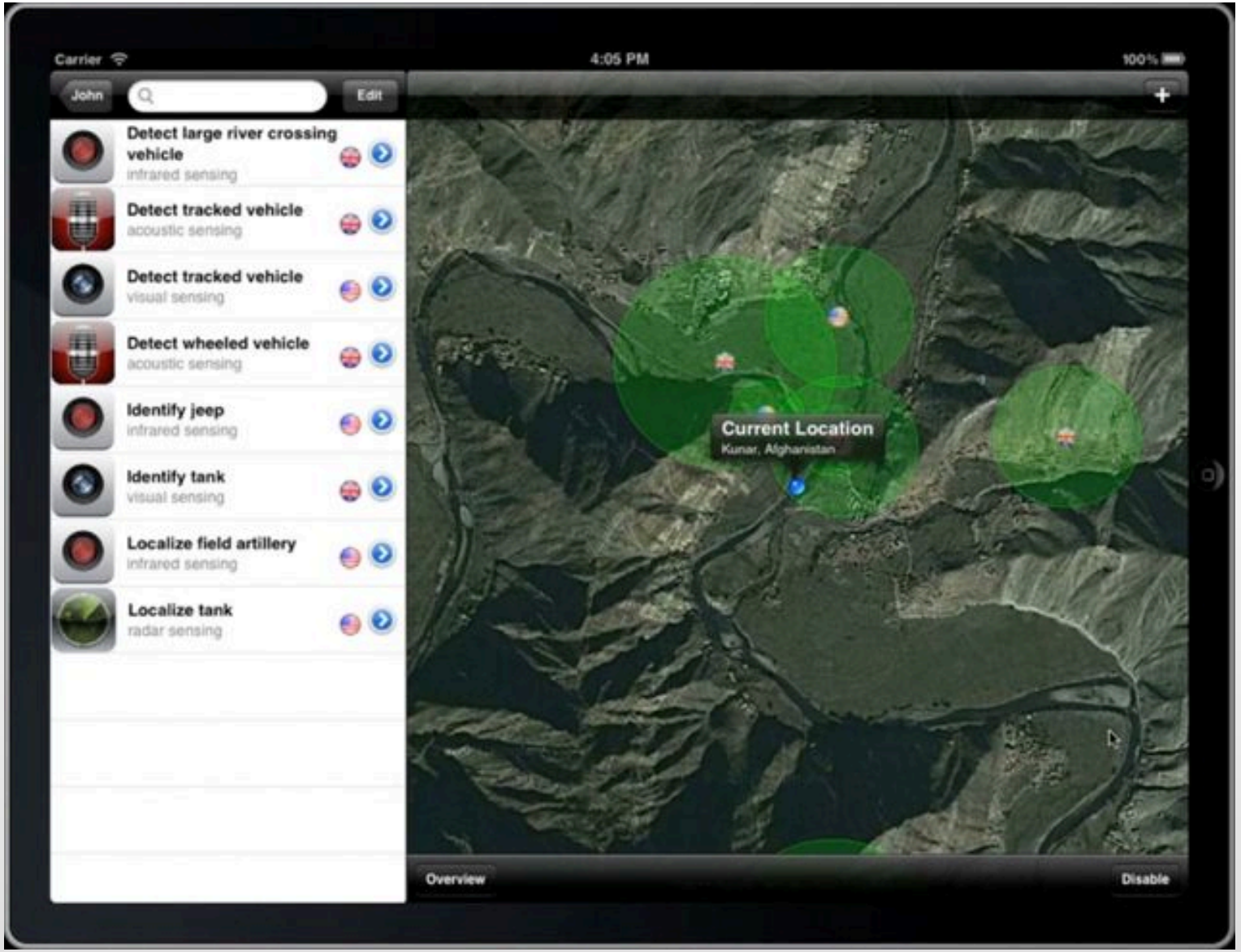
- Allow a user to create an ISR task in an area-of-interest, by means of a convenient user interface, and submit the task for asset assignment.
- Achieve separation between **what** information the user requires and **how** the information is obtained.

Aims of enhanced tablet app

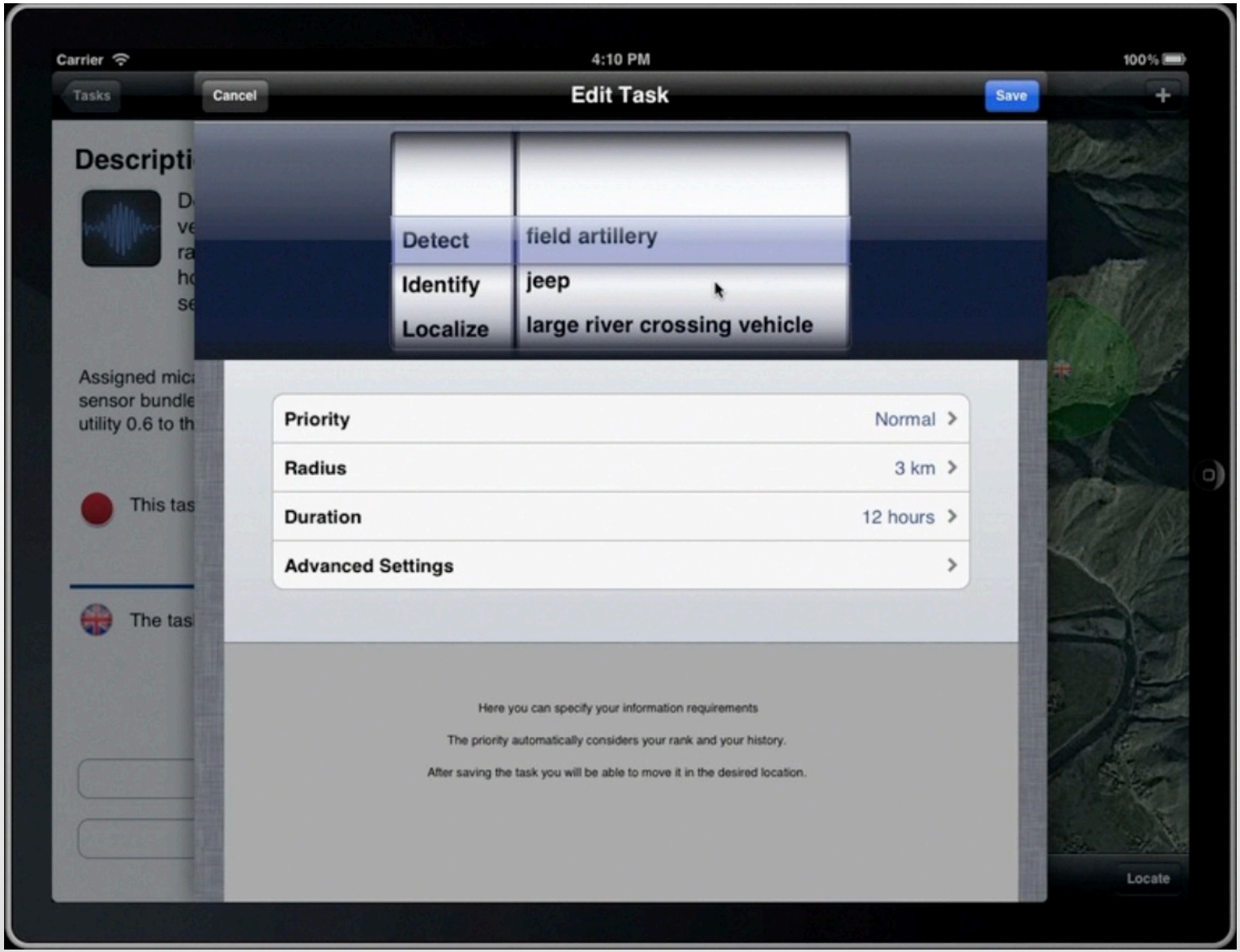
- Allow a user to view all tasks with assigned assets in an area of interest (subject to access policies).
- Allow the sharing of tasks among users (again, subject to access policies).



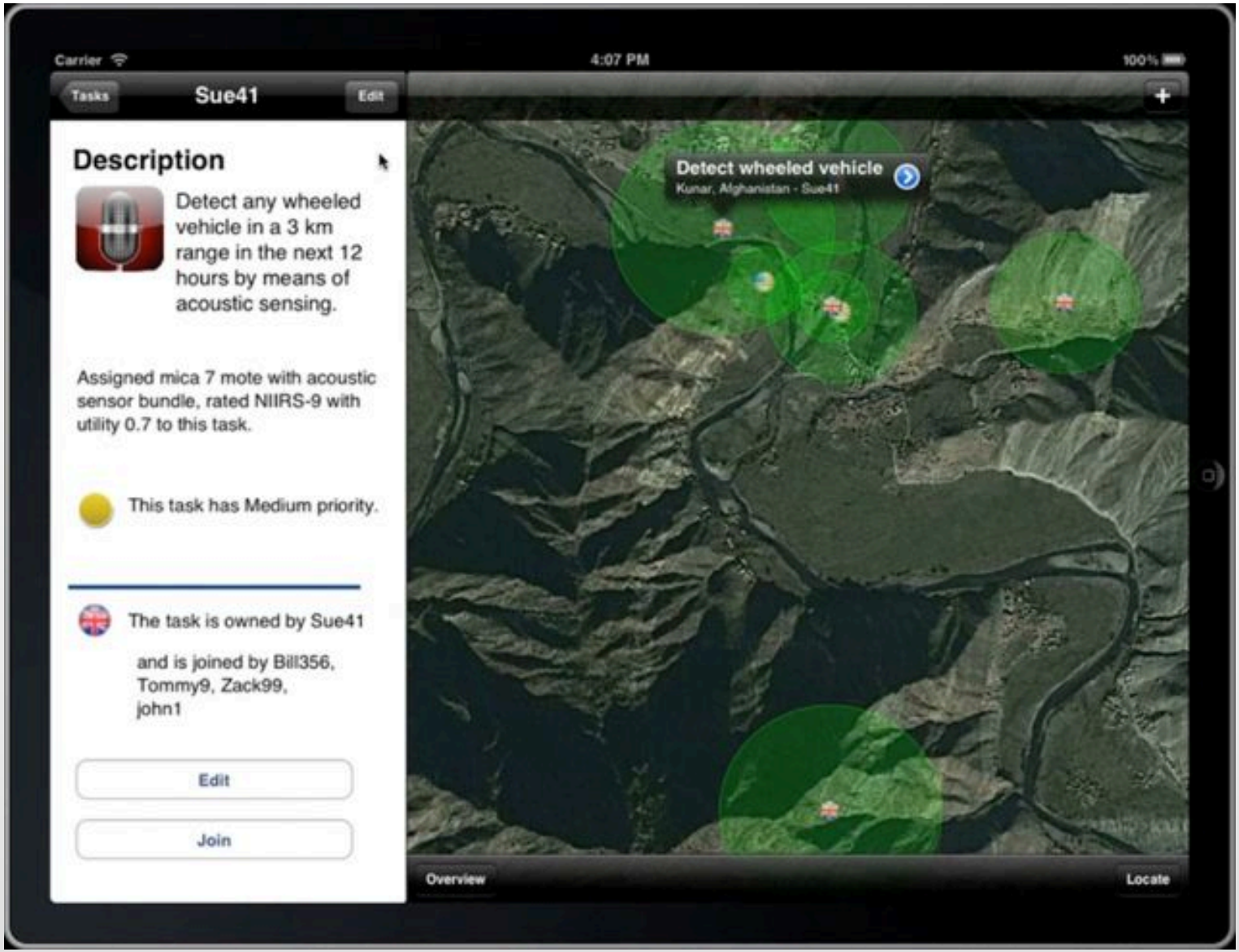
Tablet-based app: task panel



Tablet-based app: task editing panel

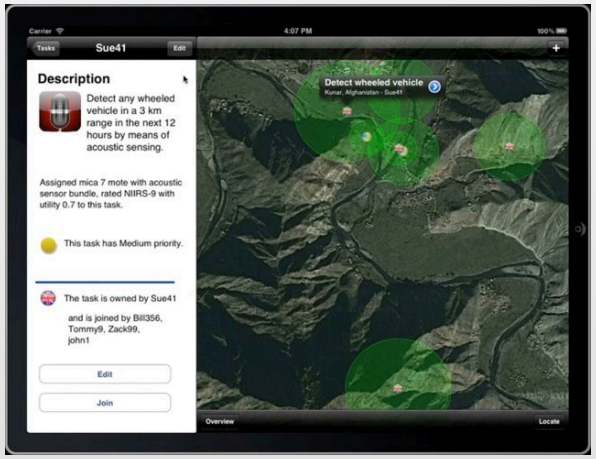


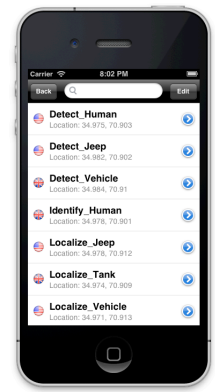
Tablet-based app: task assignment panel

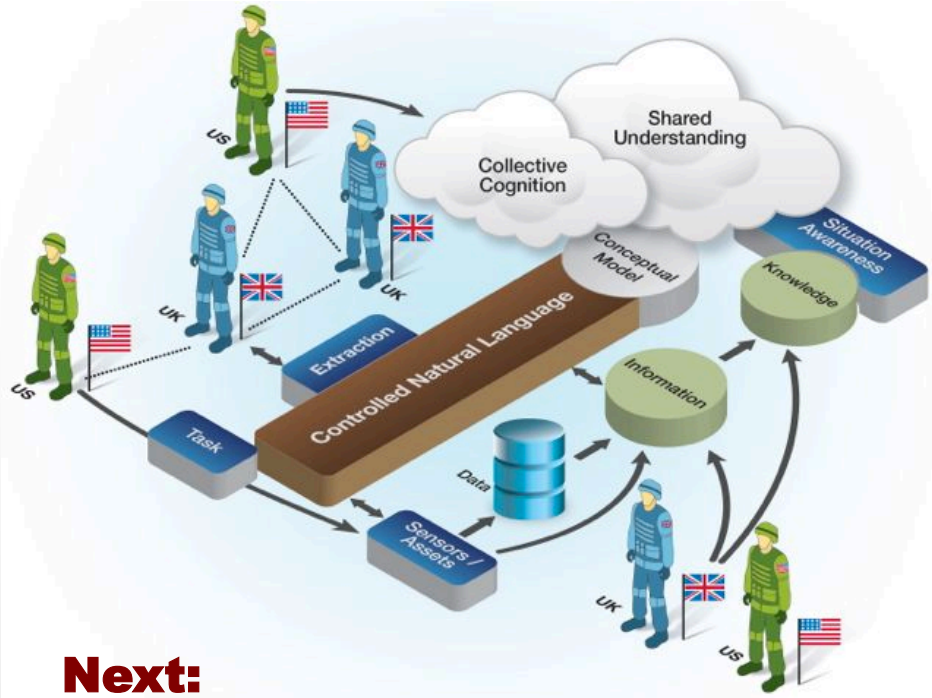


Conclusions & future work

- Our apps demonstrate how a multi-modal interface can be driven by underlying CE-based information.
- If a user wishes to go outside the designed scope of the apps they can contribute CE sentences if required.
- We believe that the current form of ITA CE appeals to non-technical users.







Next:

- Invest further in refinement of the syntax and increased expressivity.
- Explore opportunity for “local knowledge” to be added (new facts, model refinements/extensions).
- Evaluate as piece of end-to-end experimentation.