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Requirements for Countermine Simulations

- A very large number of mines with Entity State(heartbeat) distribution is not feasible.
- Mines in a countermine environment cannot be treated as static objects.
- Simulation of individual mines requires the maintanence of thousands of entities in even modest exercises.
- In any scenario most entities never need to know any mine information. Even the active countermine detection systems only sample a small and temporally limited set of mine data.
- Emissions PDU should be expanded to allow countermine systems defeat mines by either spoofing or electronically overwhelming their sensor/detonation systems.
- Mines can be emplaced both before and during the exercise therefore responsibility for the management and the simulation of the mines after they are emplaced needs to be transferred from the initiating simulator to a mine simulator.

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Minefield Related DIS PDUs

In DIS, there are four proposed PDU types related to Minefields.

Minefield State PDU (MSPDU)

- a minefield sequence number
- minefield presence and border
- the basis for a local minefield coordinate system
- identifies the minefield current state
- lists the types of mines contained in the minefield

Minefield Data PDU (MDPDU)

- a minefield sequence number
- location of individual mines

- characteristics of individual mines(optional)
    - burial depth
    - orientation
    - thermal and dielectic contrast
    - location of detonation and trip wires
    - fusing types
    - emplacement age
    - color

Minefield Query PDU (MQPDU)

- region
- mine types
- mine characteristics

Response NACK PDU (RNACKPDU)

- identifies any missing response packet.

A client sends MQPDU to the minefield simulator. Minefield simulator extract region, mine types and characteristic information and sends a bunch of MDPDU to the client. Client responds with RNACKPDU to inform the minefield whether there is a lost package or not.

A minefield sequence number field in MDPDU and MSPDU tries to identify the state change in the minefield. This number is updated upon any change of state of any mine within the minefield.

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HLA Compliant Design

There are several models for designing countermine simulation in HLA framework.

- Representing each mine as an individual simulation object.

  Pros:

    - DDM can easily filter unnecessary state updates.

- The region of interest of a countermine sensor is very small.

Cons:

- Huge number of objects which has to be taken care of by RTI. An object id assignment can easily be a problem.
- Very long start-up time for object registration since there will be at least two calls to RTI per created object (get object id and register).
- RTI does not use the same object ID and mines can easily exhaust all the available object IDs when they are detonated.

  Sol: *This problem occurs because that RTI behaves like a central authority to provide this service. But the required unique key can be obtained by using GUIDs as an object id and obtaining this information from RTIAmbassador does not require central verification(Object Manager).*

- DDM. There will be huge number of publishing regions.
- There will be huge number of state updates because of the number of mines.

  Sol : *Actually, if DDM is on and there is no federate interested in its state, individual mine does not put its state update information on the RTI bus.*

- Representing each minefield as an individual simulation object.
  Mine data can be an attribute of the simulated minefield.

  Pros:

  - There will be less number of minefield objects than mines so that RTI will not be overwhelmed with the number of simulated objects.

  Cons:

  - Lost individual mine information.
  - A huge data representation for attribute updates. This means the size of the package will be very large. For example: 84 bytes on average to describe a mine and if there are 1000 mines in the minefield then this means that the length of the attribute data is 84KBytes.
  - Attribute based filtering can not be supported unless an attribute is defined for each attribute of mines. Such as thermal characteristic of each mine can be concataneted and build a thermal attribute for the minefield. This will automatically reduces the length of data to K*KBytes where K<5. But, a little change in one mine causes the retransmission of this state information.

    Sol: *This problem can be solved by transmitting only changed state information related to mines. But, this assumes that the other federates in the subscribe region knows this information. They actually knows that.*

- Query/Response approach. Minefields will be a simulated entities but information about individual mines will be provided through interactions.

  Pros:

  - Given mine's data may never be published unless it is encountered by another object capable of detecting the mine.

  - The minefield attribute include some basic information about the minefields location and a list of contained mine types, etc.(MSPDU)

  Cons:

  - Query/Response approach is point-to-point communication.

    Sol : *RTI communication is based on subscribe-publish pattern and subscribers and publishers do not know each other. Although, point-to-point communication between two federates can be accoplished by defining a region on the fly and passing this information to the publisher so that subscriber will receive the information.*

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Advantages of HLA for CMS

- Interactions of an object can easily be defined without trying to established an agreed standard message definion such as in DIS. This requires a lot of time(meetings) and money to upgrade the current systems to handle this new message.

- Attribute ownership and transfer simplifies the major issue in CMS because after mines are emplaced their ownership can be easily transferred to a mine simulator object. This also makes it possible to continue simulation in another host such as Origin2000.

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