Systems Engineering for Autonomous Systems
Defence Technology Centre

SEAS DTC

Development and virtual network demonstration of future communication architecture

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It is generally accepted that use of unmanned vehicles in military systems will increase in the coming years. It is assumed that the different UxV (and other) networked systems will form discrete mobile ad-hoc networks (MANETs), partly to maintain scalability. Allowing interconnection between ad-hoc networks increases the scope for co-operative operation as a system-of-systems, and can extend the range of communications by allowing traffic to be routed through another system. This work (CC018) is based on the research challenge of inter-MANET communication as identified in CC011 – a previous DTC architectural analysis. Inter-MANET routing is a difficult problem to address that raises many challenges including: address management, interconnecting reactive and proactive MANETs, and dealing with topology changes. The aim is to design an overall architectural model for the interconnection of MANETs and to provide a demonstration of inter-system networking running on a testbed of virtual nodes.

Aim

To derive an overall architectural model for the interconnection of mobile ad-hoc networks.

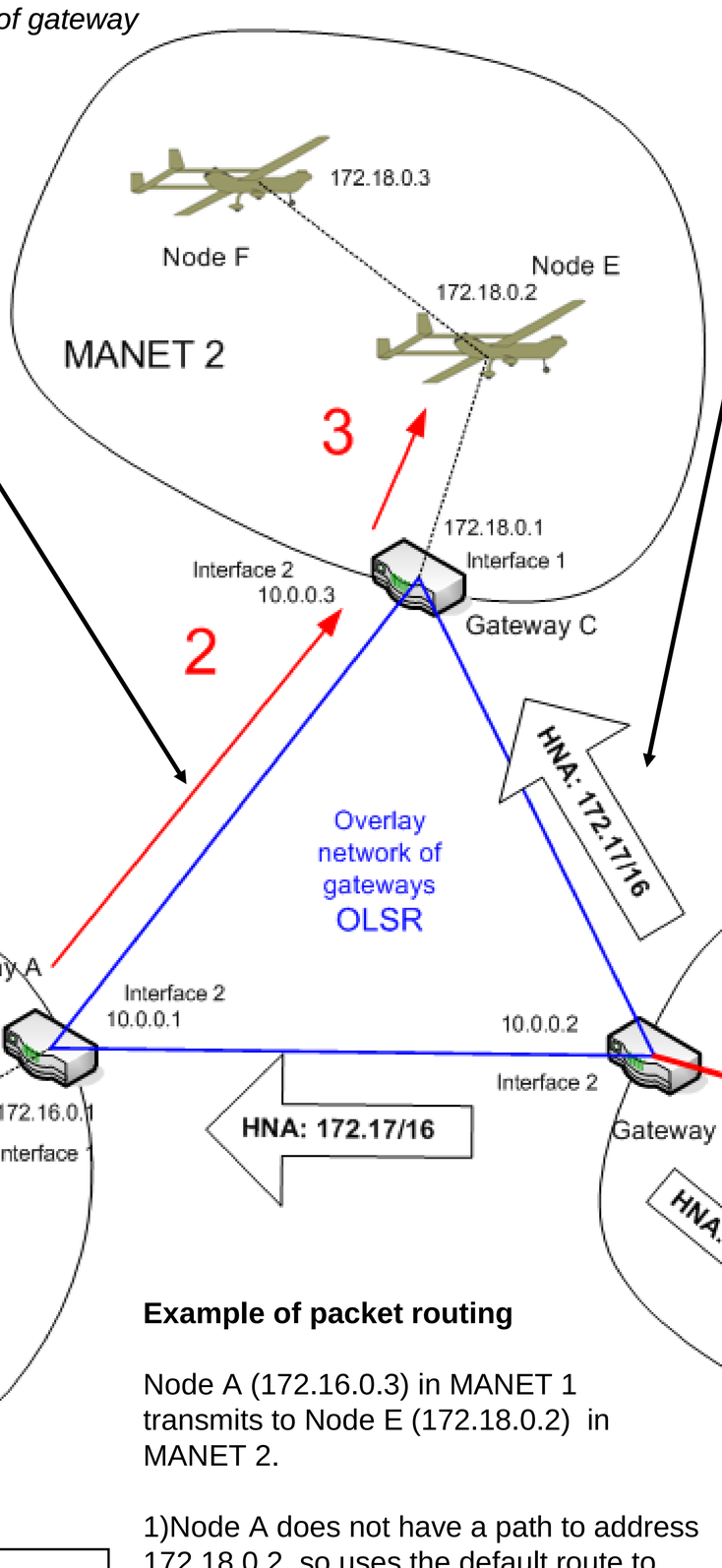
Approach

Identify state of the art technology for system interconnection; design an overlay network solution; implement a simple overlay network on a testbed; plan the next phase of work**.**

Outcomes

A practical demonstration of interconnecting ad-hoc networks. The virtual network testbed supports further experimentation, which will be proposed as part of this task.

The figure shows the architecture of a scenario interconnecting three MANETs by means of gateway nodes.



Inter-MANET routing

An overlay network of gateway nodes provides inter-domain routing between the MANETs. OLSR has been chosen as the inter-domain routing protocol for this work. Each gateway node has two interfaces: an internal interface to perform intra-domain routing and an external interface for inter-domain routing.

Intra-domain routing

Nodes within the same MANET communicate using an intra-domain routing protocol (in this case OLSR). The gateway nodes run the same protocol on their local interface. Intra-domain routing is independent from inter-domain routing; as a result each MANET could run a different intra-domain routing protocol (such as AODV) and still be able to interconnect.

Gateway peer discovery

The gateway nodes in the overlay network discover routes to external MANETs by transmitting OLSR gateway advertisements, known as HNA messages. Each gateway advertises to its peers the prefix of the MANET address space that it is connected to.

Host discovery of gateways

Regular nodes need to discover gateways and therefore each intra-MANET routing protocol needs to have a gateway discovery mechanism. Alternatively, an independent gateway discovery mechanism could be used across all MANETs.
This example shows gateway nodes advertising a path to external routes by transmitting OLSR HNA (host network attachment) messages. The HNA messages associate the default route (0.0.0.0/0) with the local gateway address. Regular nodes wishing to send data to an external address not in their routing table will use the default route to transmit to the nearest gateway.

Example of packet routing

Node A (172.16.0.3) in MANET 1 transmits to Node E (172.18.0.2) in MANET 2.

1)Node A does not have a path to address 172.18.0.2, so uses the default route to send data towards interface 1 on gateway A1 via node B.

2)Gateway A is aware of the 172.18/16 address space advertised by gateway C on interface 2 and routes towards this gateway on the overlay network.

3)Gateway C transmits the data to node E using a route from the intra-domain protocol

Further work

- Address management – routing currently assumes non-overlapping address space - this is a particular issue when domains partition and merge
- Look at the interaction between proactive and reactive MANETs in more detail
- Discovery of optimal gateways – a generic discovery mechanism that selects the best gateway
- A mechanism for gateways within the same MANET to automatically discover each other and set up tunnels between gateways across MANETs
- Boundary establishment – how to define the boundary (thus membership) of a MANET.

Multiple gateway problem

Using the OLSR gateway discovery mechanism, regular nodes choose the closest gateway to them to route to external networks. The closest gateway to the source node is however, not always on the best path to the external MANET.

A gateway discovery mechanism that chooses the most appropriate gateway to use would be more efficient. Data would need to be tunnelled across the MANET to the other gateway.

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