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Investigating Alternative Network Structures for Operational Command and Control

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Introduction

- A Study of Command and Control (C2) processes of UK Police responses to Emergency Incidents

- Can Social Network Analysis be used to investigate alternative C2 structures for Police Operations?

- What are the implications of the new networks for the Distributed Cognition activities that are taking place within the C2 system?

- Part of wider HFI-DTC investigation into C4ISR for UK military

Rationale

- Issues with Network Centric Warfare (NCW): unclear how NCW C2 structures will be realised

- Operations Other Than War: analogous with emergency services activities

- Social Network Analysis allows examination of relationships between agents in networks, generating mathematical and graphical representations of interactions.

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Distributed Cognition

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Examines

- Systems-level cognitive processes of groups of individuals and artefacts

Assumptions

- Any unit – regardless of size – which is engaged in problem solving, can be defined as a cognitive entity (Perry, 2003)
- Artefacts (physical objects, language and people) act as representations of task relevant information
- Cognition takes place in the same way as cognition in the individual, through the creation, dissemination and transformation of representations of knowledge (Hutchins, 1995)

West Midlands Police (I)

Second largest Police Force in UK, serves a population of 2.63 million, covering 348 sq miles

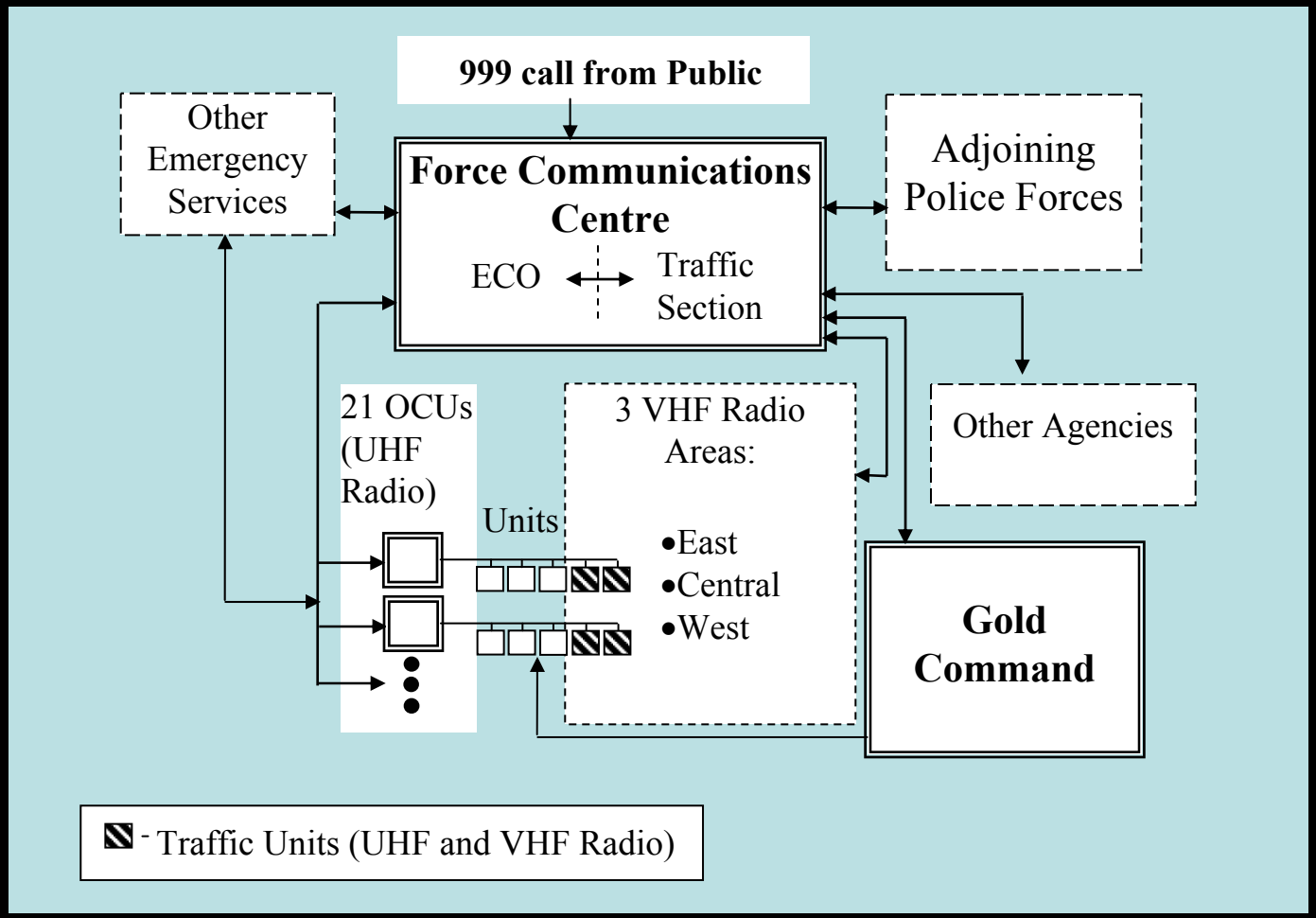
Three main levels of command; Bronze, Silver and Gold (HMSO, 1997):

- 21 local Operational Command Units – OCU (Operational)
- Force Communications Centre (Tactical)
- Gold Command (Strategic)

Rapid responses required (must attend Emergency Incidents within 10 minutes of 999 call)

West Midlands Police (II)

WMP communications during emergency responses



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Example 'Routine' Emergency Incident

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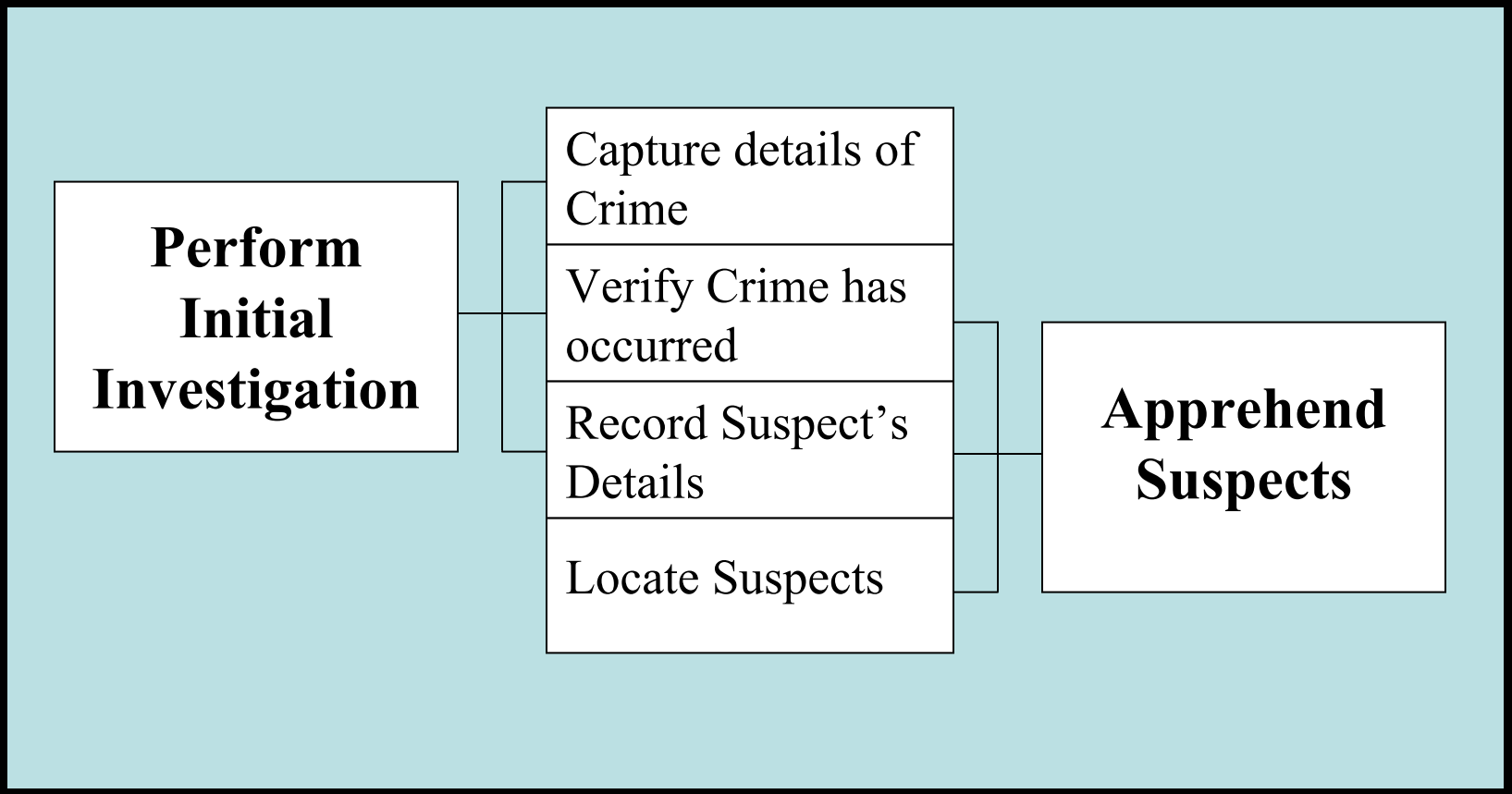
Theft from car caught on CCTV:

- **Porter of Hotel sees break-in on CCTV – calls 999**
- **Emergency Call Operator (ECO) generates Incident log in OASIS**
- **Log passed to OCU and Traffic Ops who despatch Officers**
- **Offenders flee the scene**
- **Officers arrive at scene and perform initial investigation of crime**
- **Owner of damaged vehicle is located and statement taken**
- **Officers vacate scene and incident is closed**

Incident Analysis: Task Model

Task Model of WMP Incident Response



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Incident Analysis: Distributed Cognition

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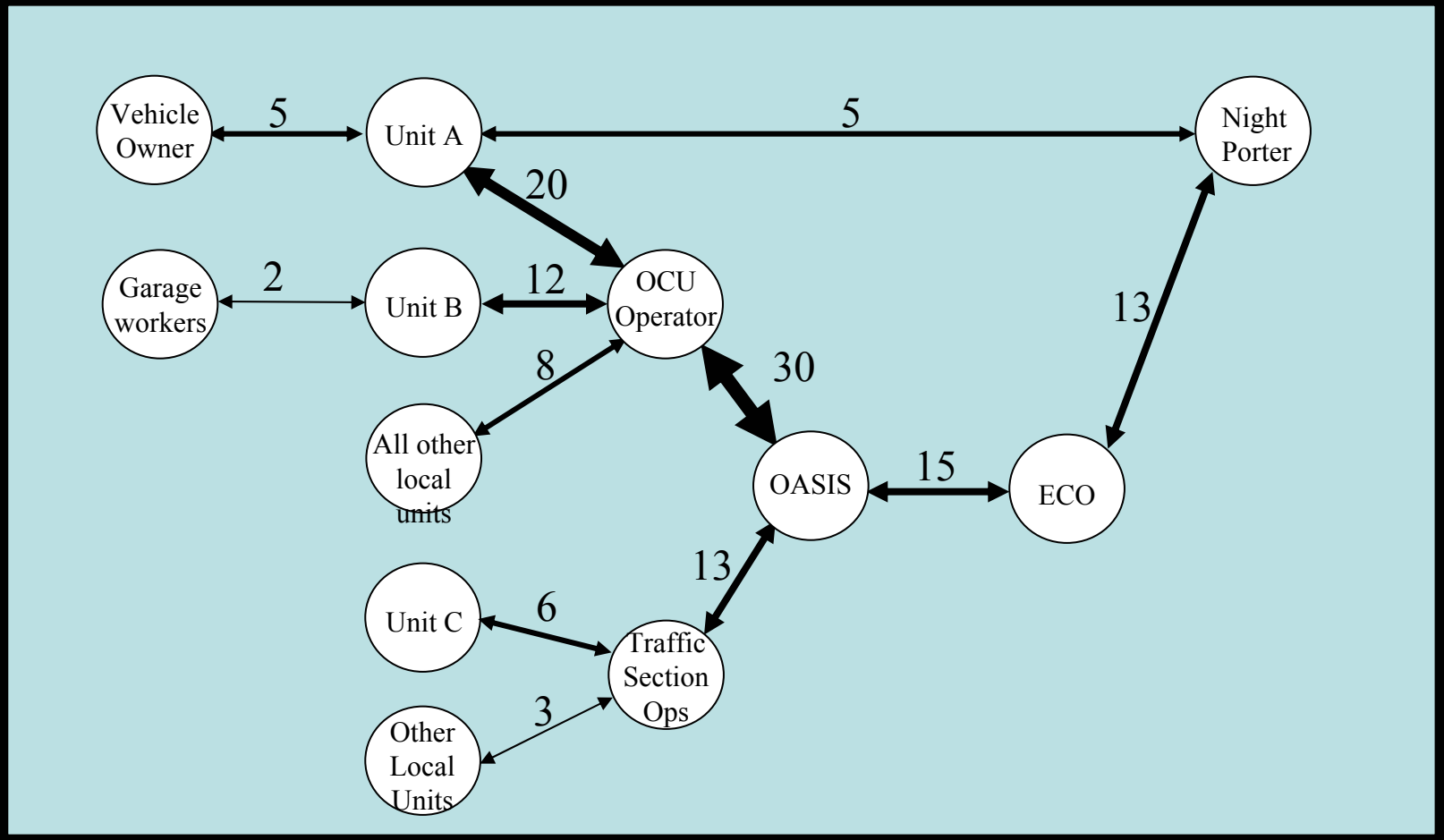
Cognitive activity is distributed across system – no single individual controls it

Example of Distributed problem solving in this incident - "Whose car is it?":

- Officer discovers vehicle has been broken into
- Officer locates individual who claims vehicle ownership
- Check registration in Police National Computer (PNC) via OCU
- OCU relay PNC vehicle description and name of registered owner
- Officer matches description to damaged vehicle
- Officer matches identity of individual to registered owner

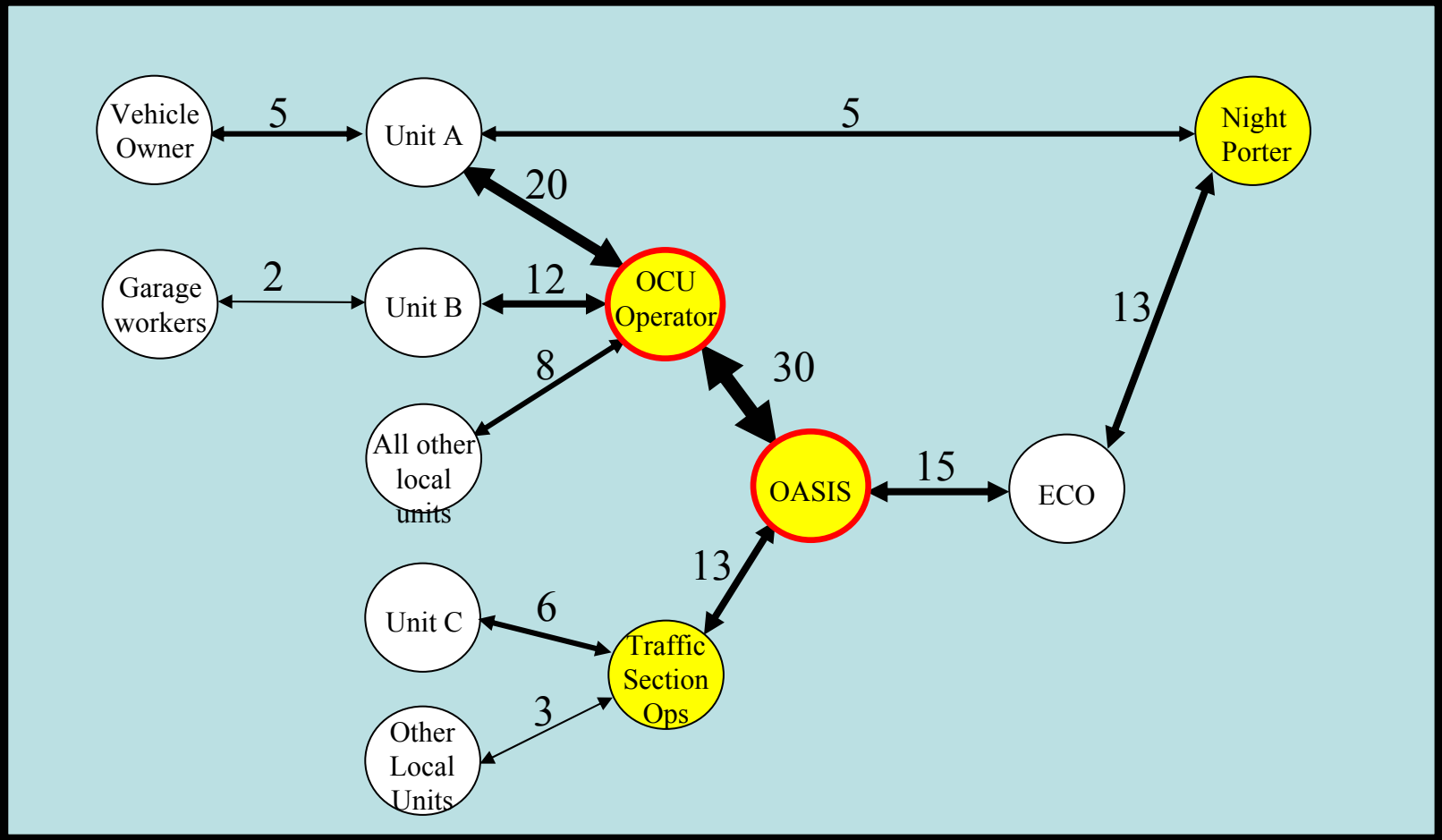
Incident Analysis: Social Network Analysis (I)

Social Network Diagram



Incident Analysis: Social Network Analysis (II)

Sociometric Status and Centrality



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Incident Analysis (IV): Network Description

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Police C2 network appears to be a Split Network (Dekker, 2002)

Split architecture is recommended where:

- Quality of information is high
- Speed of response is not critical

However for WMP emergency responses:

- Quality of information is often unreliable
- Nature of emergency is frequently in question
- Speed of response is critical

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Alternative Network Architecture for WMP (I)

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Issue of network efficiency for WMP with current Network Structure:

- Potential delays in responding to emergencies
- Risk of degradation of information as messages change format and are repeatedly summarised as they pass through network.

Possible alternative network structures for WMP activity exist, smaller geodesic distances → faster information propagation

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Alternative Network Architecture for WMP (II)

Centralised Network:

- Allows rapid deployment of response units
- Hierarchical structure means Emergency can be 'owned' by OCU Operator
- Ensures accurate record of activity is captured

Distributed Network:

- Adopted in environments requiring rapid responses, but where information is limited
- Allows responding units to function independently

Alternative C2 networks may be simulated by modifying the data from the emergency incident

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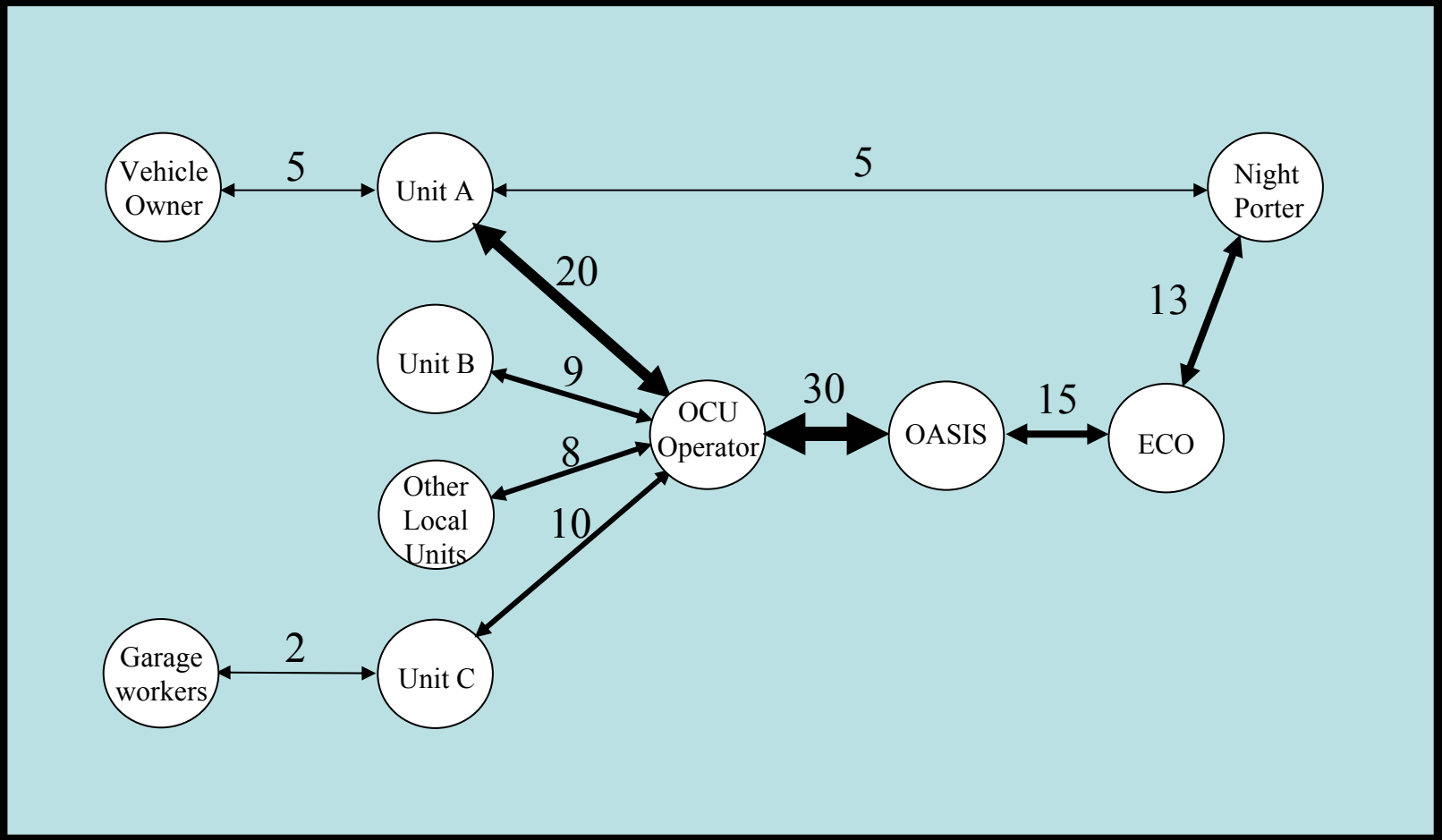
Social Network Analysis for Centralised Network

Social Network Diagram



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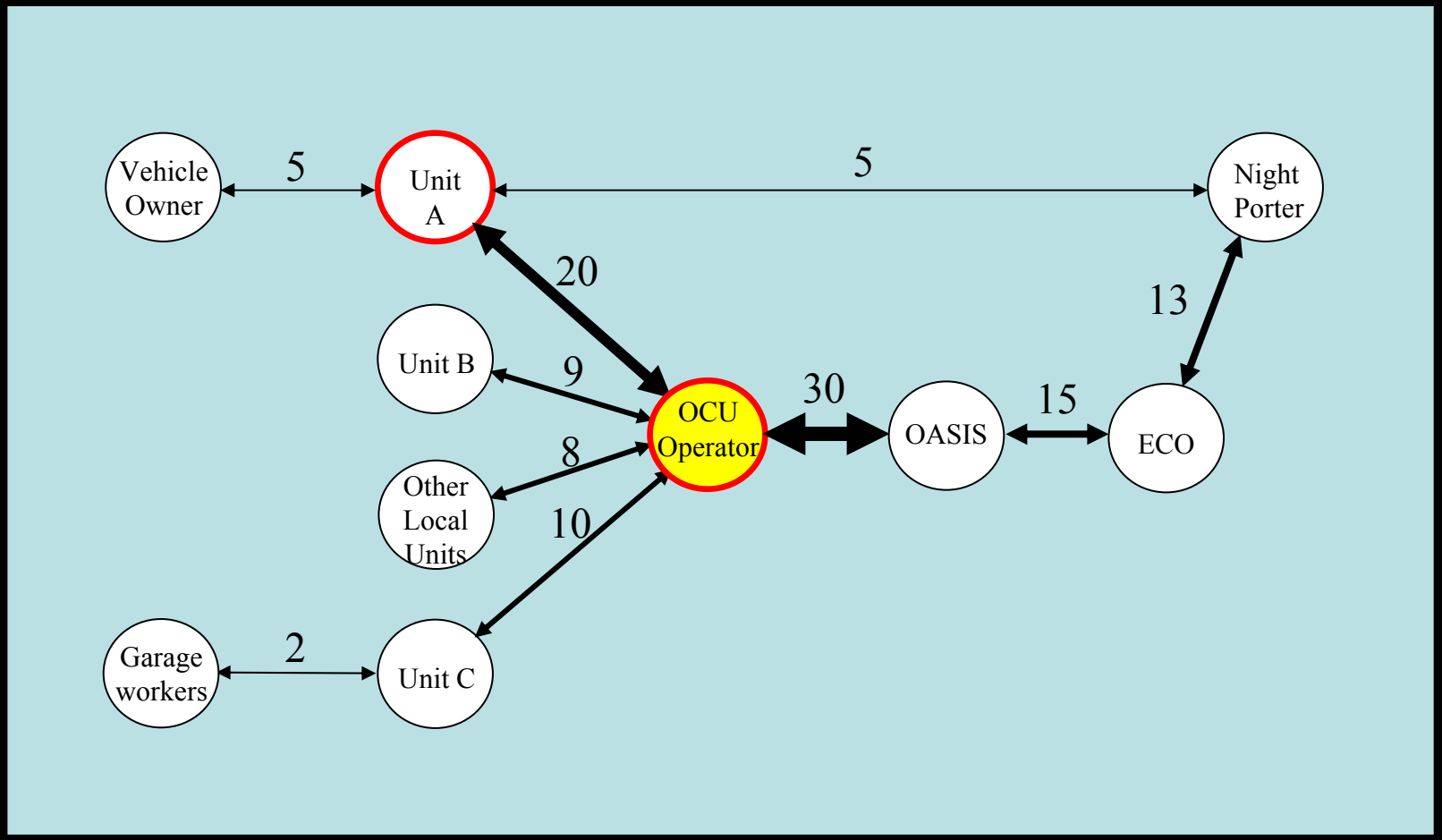
Social Network Analysis for Centralised Network

Sociometric Status and Centrality



Network Evaluation

Centralised Network

- Single agent supervising response → better coordinated response
- No increase in network efficiency
- Possible loss of freedom for Officers due to operational command role of OCU Operator

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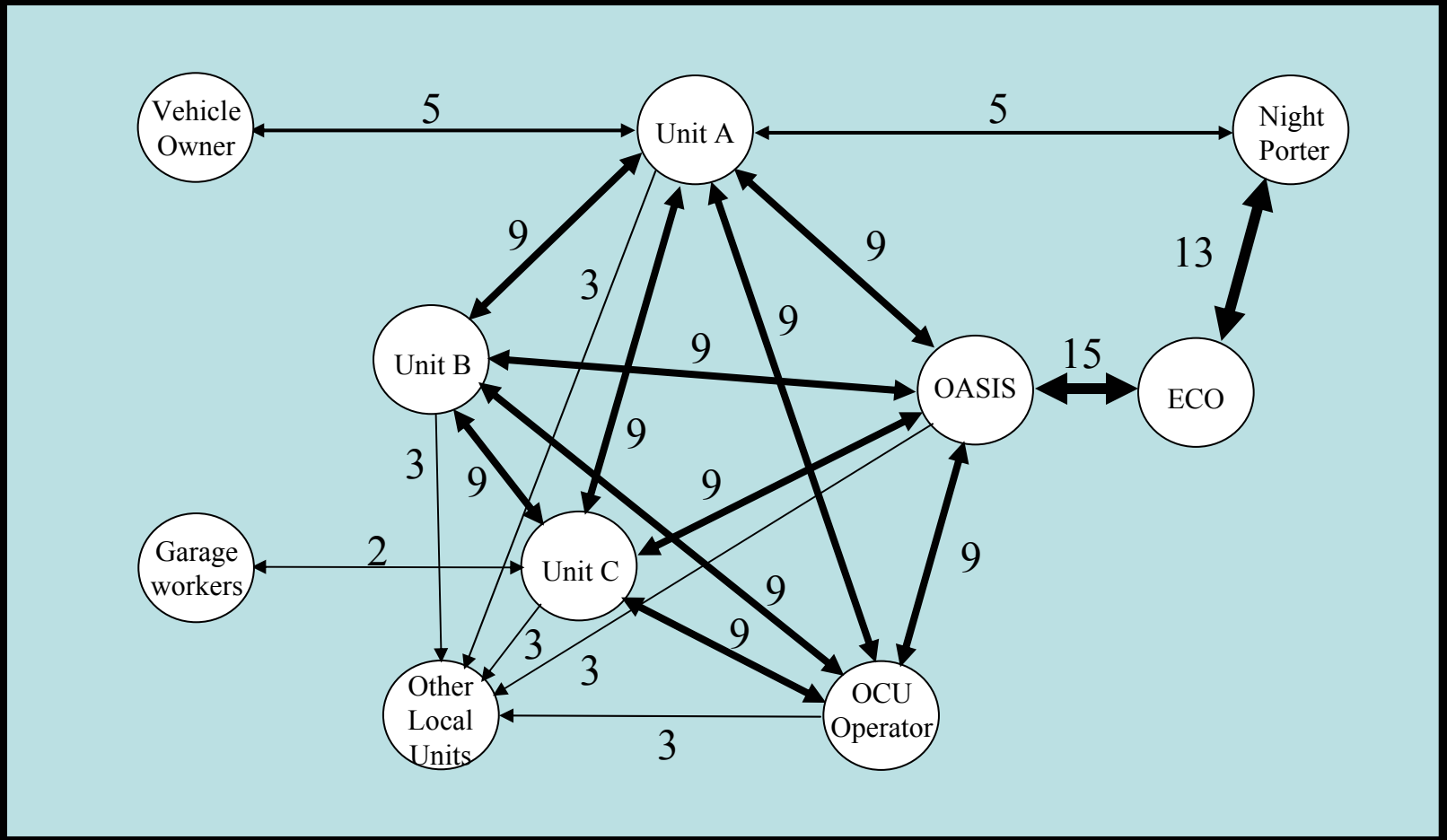
Social Network Analysis for Distributed Network

Social Network Diagram



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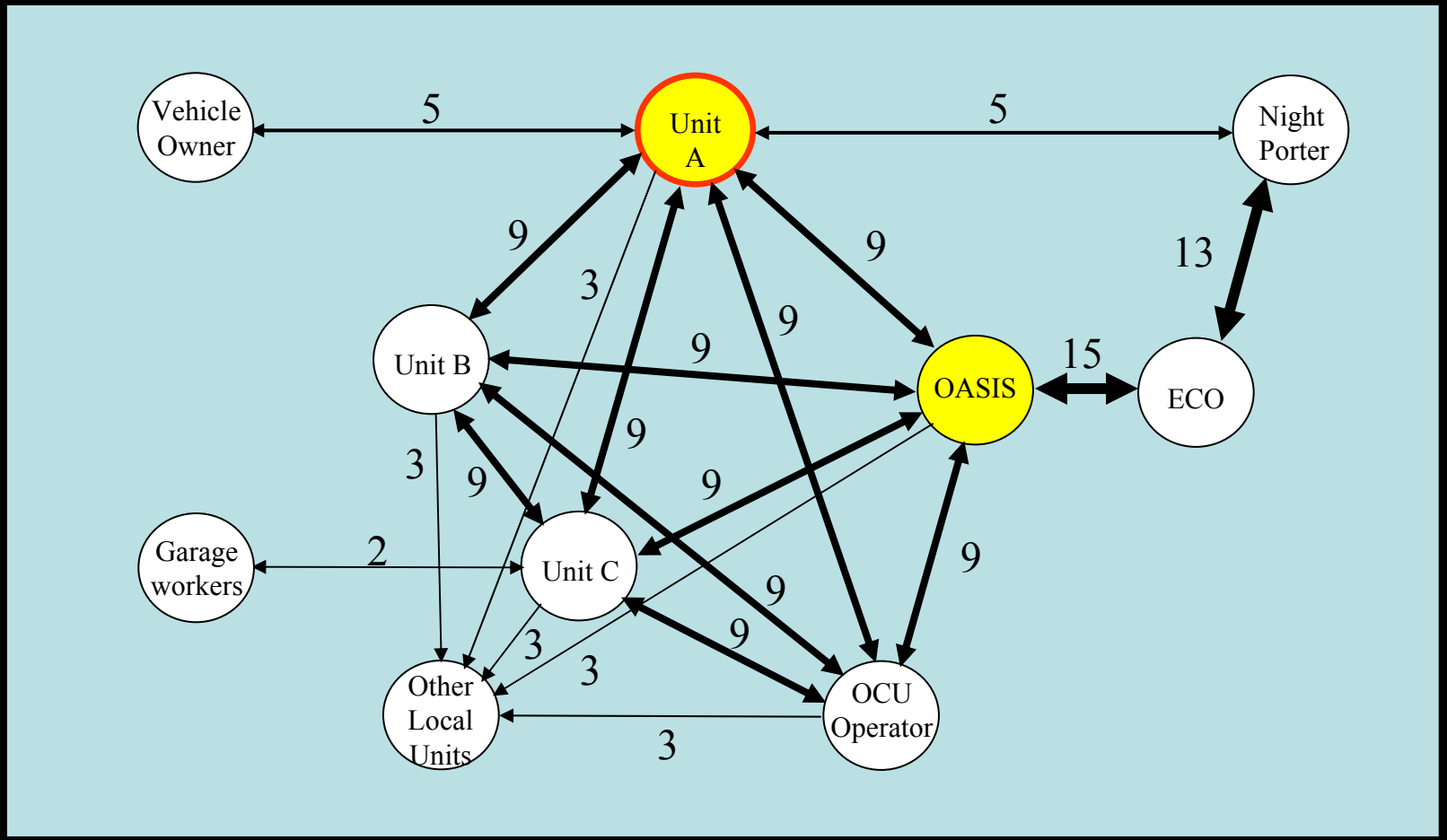
Social Network Analysis for Distributed Network

Sociometric Status and Centrality



Network Evaluation

Distributed Network

- Rapid acquisition, analysis and dissemination of information
- Geodesic distances have been reduced, increasing network efficiency and reducing risk of information degradation
- Self organisation of responding Officers allows effective coordination of activity
- Officers retain autonomy, as OCU Operator is strategic / tactical command level

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Findings from Network Simulations

- Distributed network may offer advantages to WMP

- Could form ad hoc networks as required, rather than formal distributed architectures, for example: Search activities involving ground units and helicopter

- Move to digital radio technology may require adoption of distributed networks

Distributed Cognition

- System achieves its goal-state through the coordination and communication of agents; agents need to know 'who knows what' and 'who does what'

- Relatively straightforward in Centralised Network – single point of contact (OCU Operator)

- More difficult in Distributed Network – many potential information sources, roles may be less well defined, less sure who to pass information to.

- Potential solution is to give all agents access to information repository, such as WMP 'OASIS' system.

Summary

It is possible to simulate new network structures using network communications data, allowing the exploration of different C2 architectures using Social Network Analysis

However, an in-depth understanding of the context of the system is required in order to describe, compare and evaluate potential network architectures

Ongoing Activities

- We are currently investigating the effects of the new Digital radio system on WMP C2 structure

Any Questions?

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