Assessing the impact of digital communications technology on existing C2 systems;

A distributed cognition perspective

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Introduction

- A study of the impact of new communications technology on the coordination of emergency incident responses
- Focus on systems-level cognitive processes
- Follow up to work presented at the 10th ICCRTS
- Part of wider investigation into C4ISR

Rationale

- An increase in technological support may not lead to performance improvements

- In 2005, all UK Police forces completed the move to digital radio communications

- Work environment, organisational structure and design of artefacts all impact on systems-level cognitive activity

- Previous research argued that changes to communications technology could negatively affect system performance

Distributed Cognition

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

- Any unit which is engaged in problem solving can be defined as a cognitive entity

(Perry, 2003)

- Artefacts act as representations of task relevant information

(Flor & Hutchins, 1991)

- Cognition takes place in the same way as cognition in the individual

(Hutchins, 1995)

Distributed Cognition (II)

- System achieves goal-state by performing transformations upon representations

(Norman, 1993; Hutchins, 1995)

- Coordination of work and flow of information leads to the development of systems-level cognition

(Perry, 2003)

- To study systems-level cognition, focus on:
    - Role of observable external representations
    - Flow of information
    - Environment in which the system operates

(Hutchins, 1995; Perry, 2003)

Approach

- Access was granted to West Midlands Police C2 facilities
- Concentrated on coordination of emergency response activity
- Observations of emergency incident responses, incident log data and Critical Decision Method interviews
- Data collected from before and after implementation of digital radio system

UK Emergency Response Policing

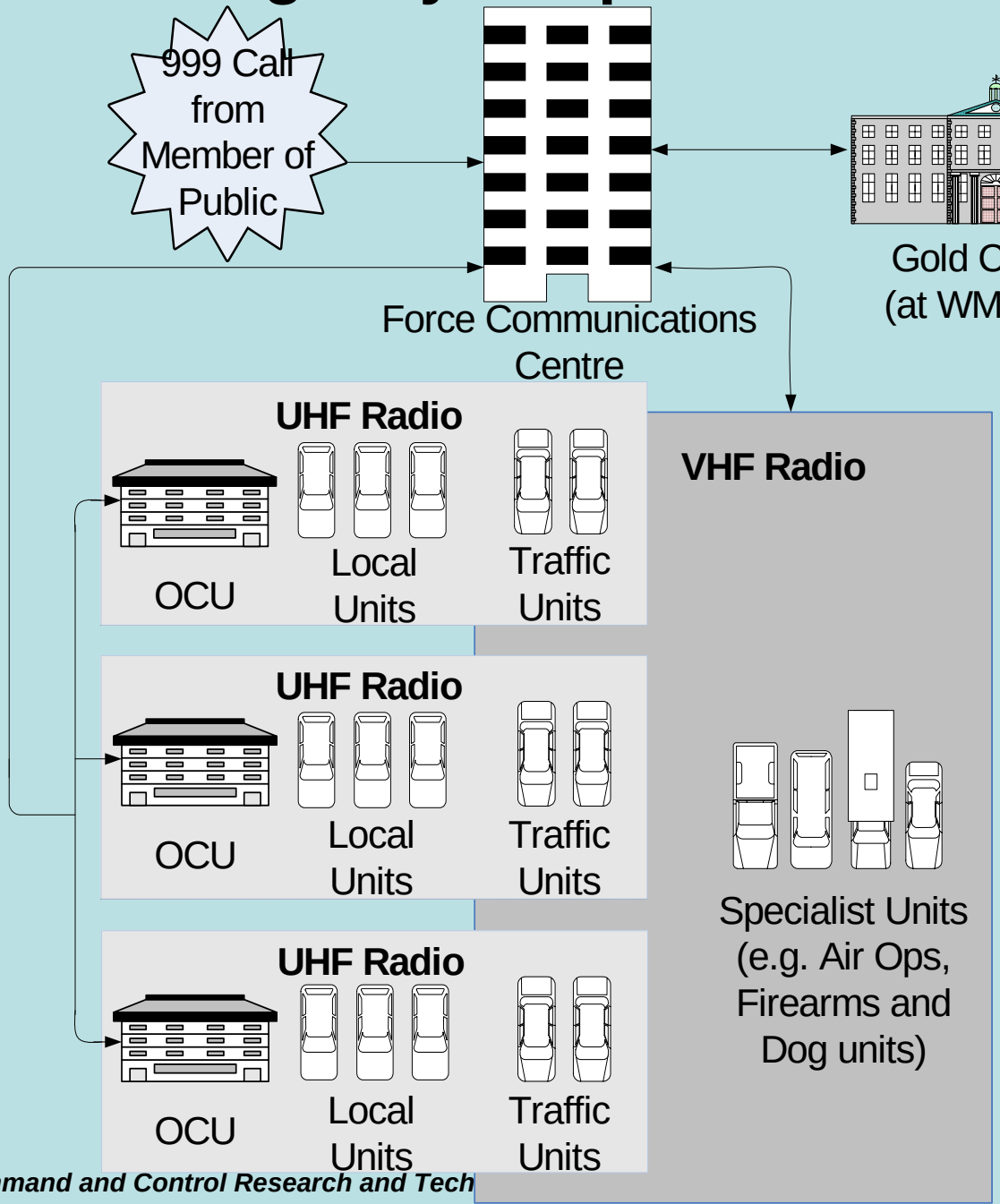
Force Structure

- 43 regional forces in England and Wales
- Police forces divided into Basic Command Units
- Several command centres

Emergencies

- Numerous incidents compete for limited resources
- Time-critical and uncertain nature of emergencies
- Require rapid collection, analysis and dissemination of information and coordination of an appropriate response

WMP Emergency Response C2 Structure



Changes to Emergency Service Radio Communications

Analogue

- Interoperability issues (VHF and UHF radios)
- One radio channel per OCU
- Officers unable to hear each others' broadcasts

Digital

- TETRA standard system
- Handset functions as radio, mobile phone and data terminal
- Talk groups, rather than radio frequencies (10 per OCU)
- Officers can join any talk group and hear all broadcasts

Distributed Cognition During Emergency Responses

McMaster, Baber and Houghton (2005)

- Cognitive activity is spread across the network, facilitated by artefacts

- RADs required to coordinate operations

- Data modified to represent alternative network structures – centralised vs. distributed

- Suggested that a distributed network could support more rapid flow of information and Officers self-organising activity

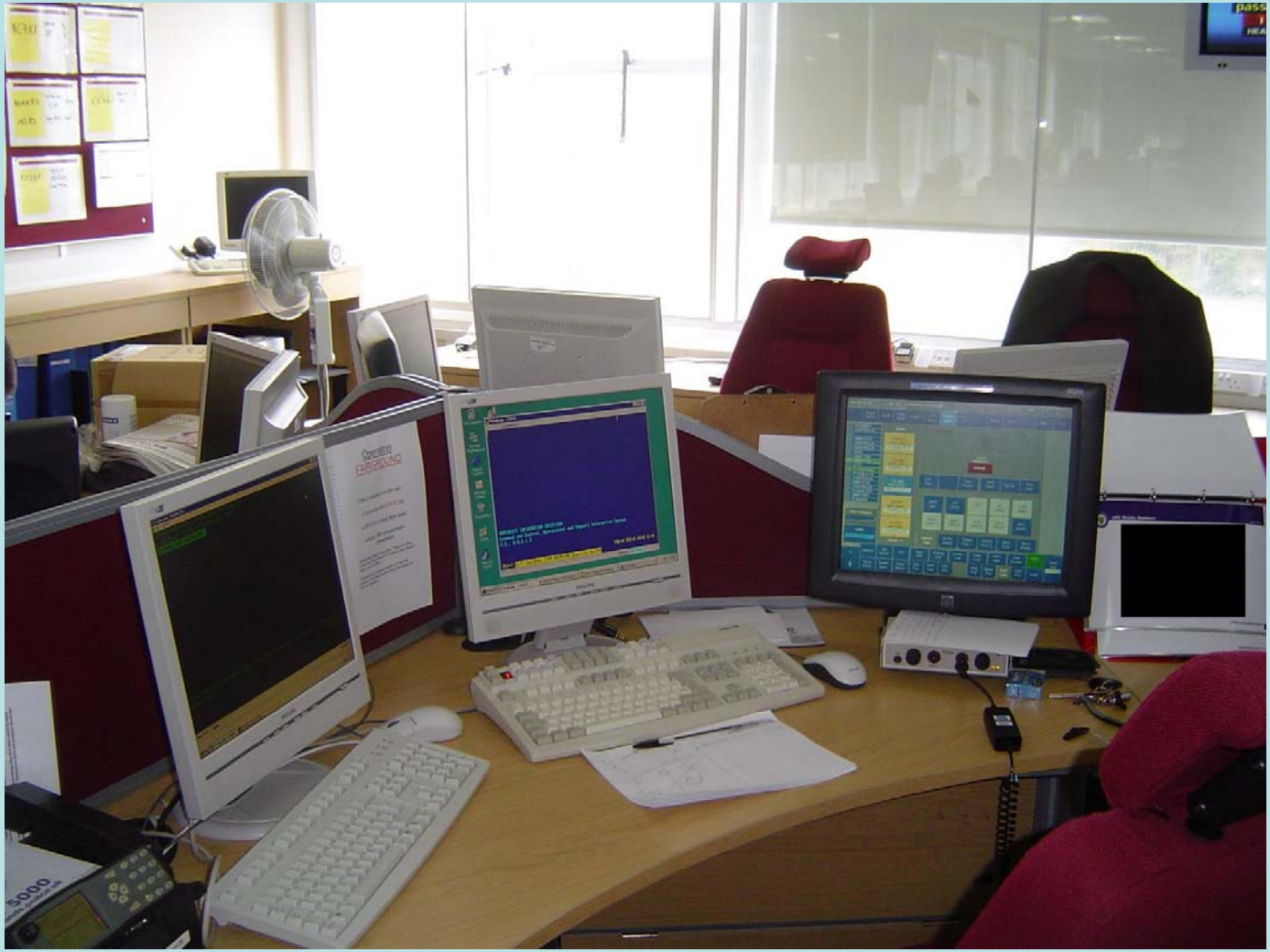
- Digital radio enables a more distributed network

Analysis of WMP Command and Control

Comparing analogue and digital radio operations

- Control room environment
- OASIS record of incident response
- Impact reported by staff
- Decision-making
- Role of artefacts
- Incident response process flow

Control Room Environment



WMP FCC Workstation

OASIS Record of Incident Response

OASIS Log Contents

Entries indicate similar responses to comparable incidents using analogue and digital communications:

- Call from member of public
- 999 Operator captures details in OASIS, routes to OCU
- OCU RAD reviews incident and despatch resources
- Officers update RAD on progress in resolving incident
- Additional resources allocated as required

…but this merely means that similar information is being recorded

Impact Reported by Control Centre Staff

- Increase in communications between responding Officers
- Increase in workload - need to filter communications
- RADs unable to monitor all talk groups
- Improved situation awareness of RADs and Officers
- No difference to speed of incident response or resolution
- RADs still coordinate incident responses
- RADs follow same decision-making processes

Role of artefacts

OASIS

• Remains main method of communication between control rooms and central storage mechanism for incident data

• Supports and cues C2 activities

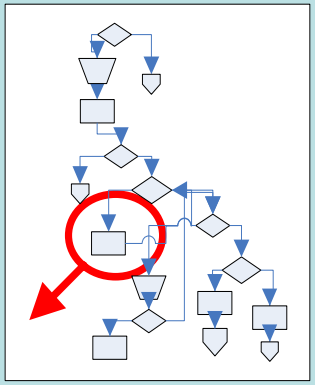
Map system

• Relied upon by responding Officers (via RADs)

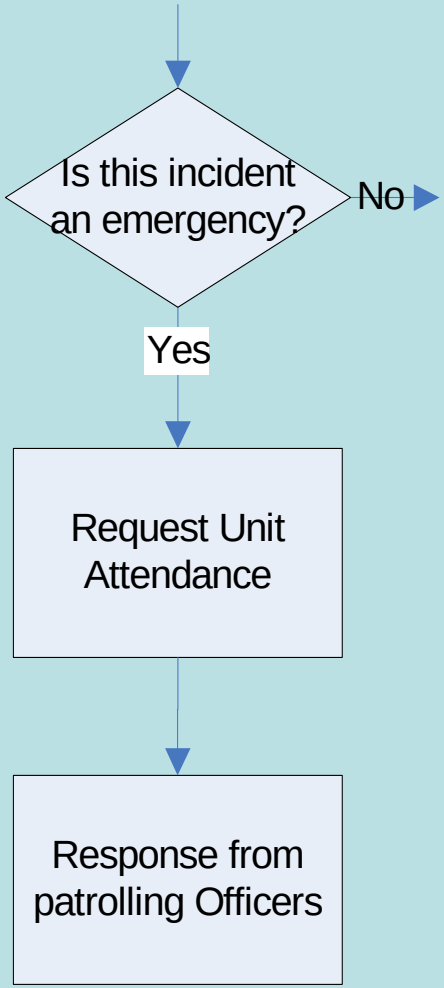
Digital Handsets

• Tendency to treat handsets as radios

Incident Response Process Flow

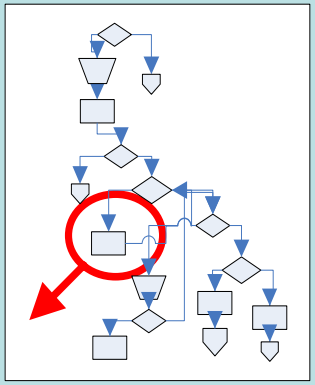


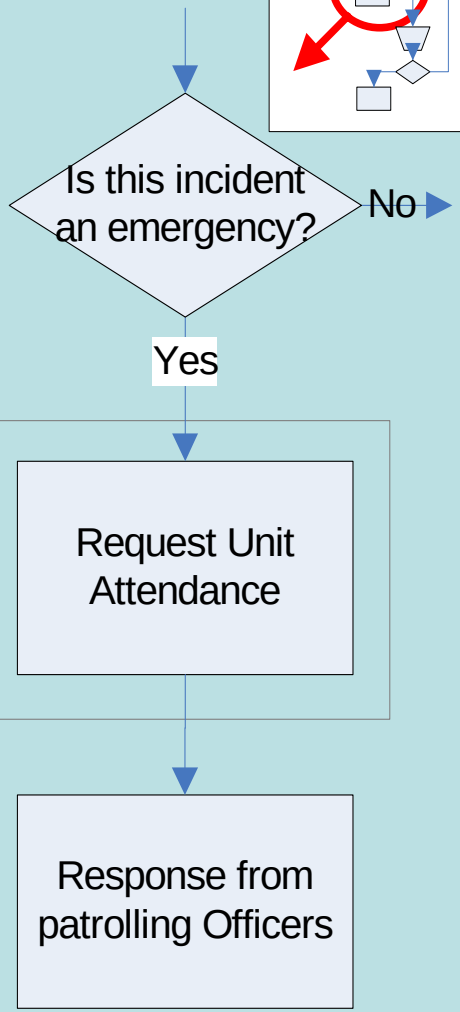
Operation from the Emergency Response Process



Incident Response Process Flow

Distributed Cognition Features



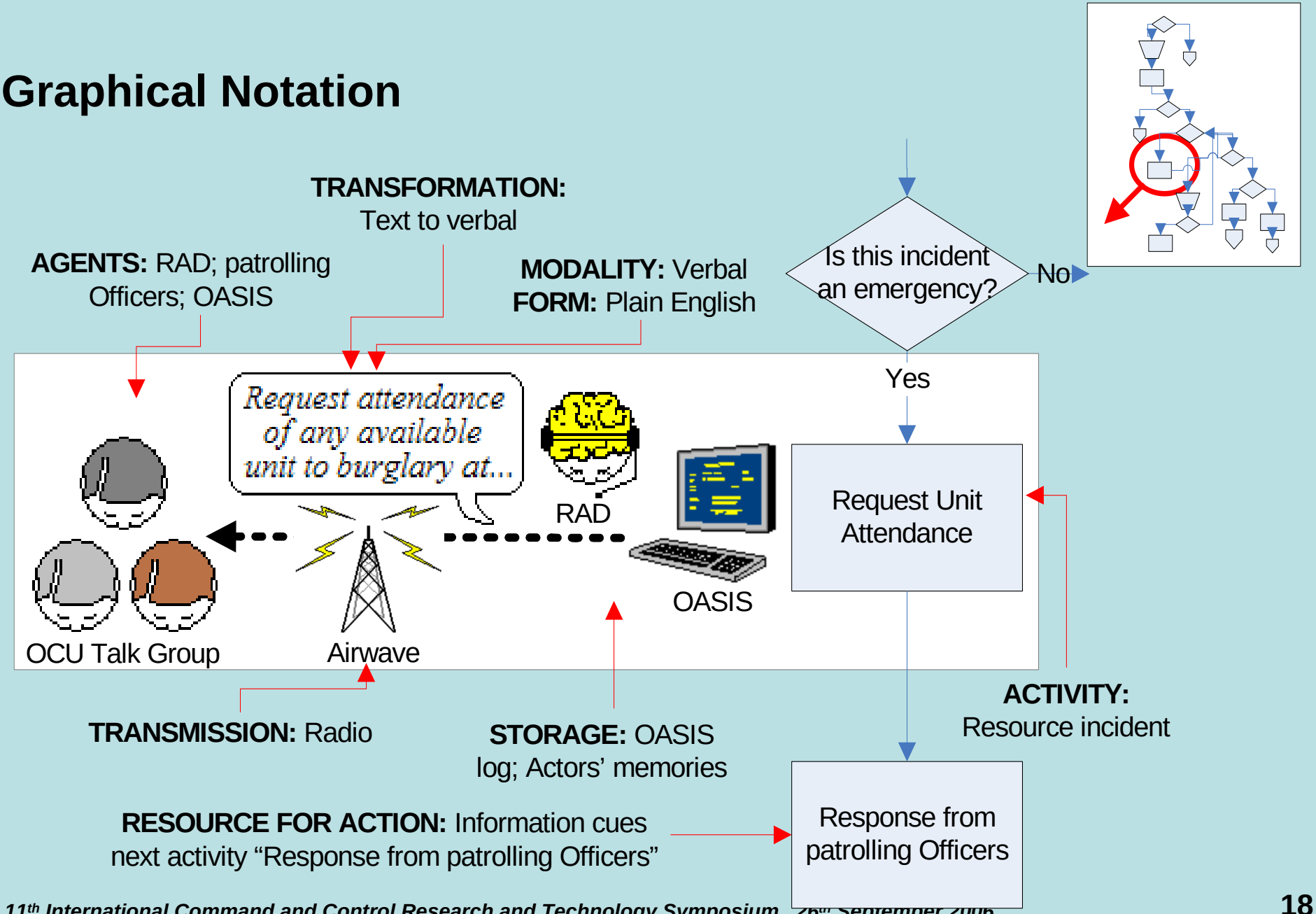


Process 1.2: Coordinate Local Response

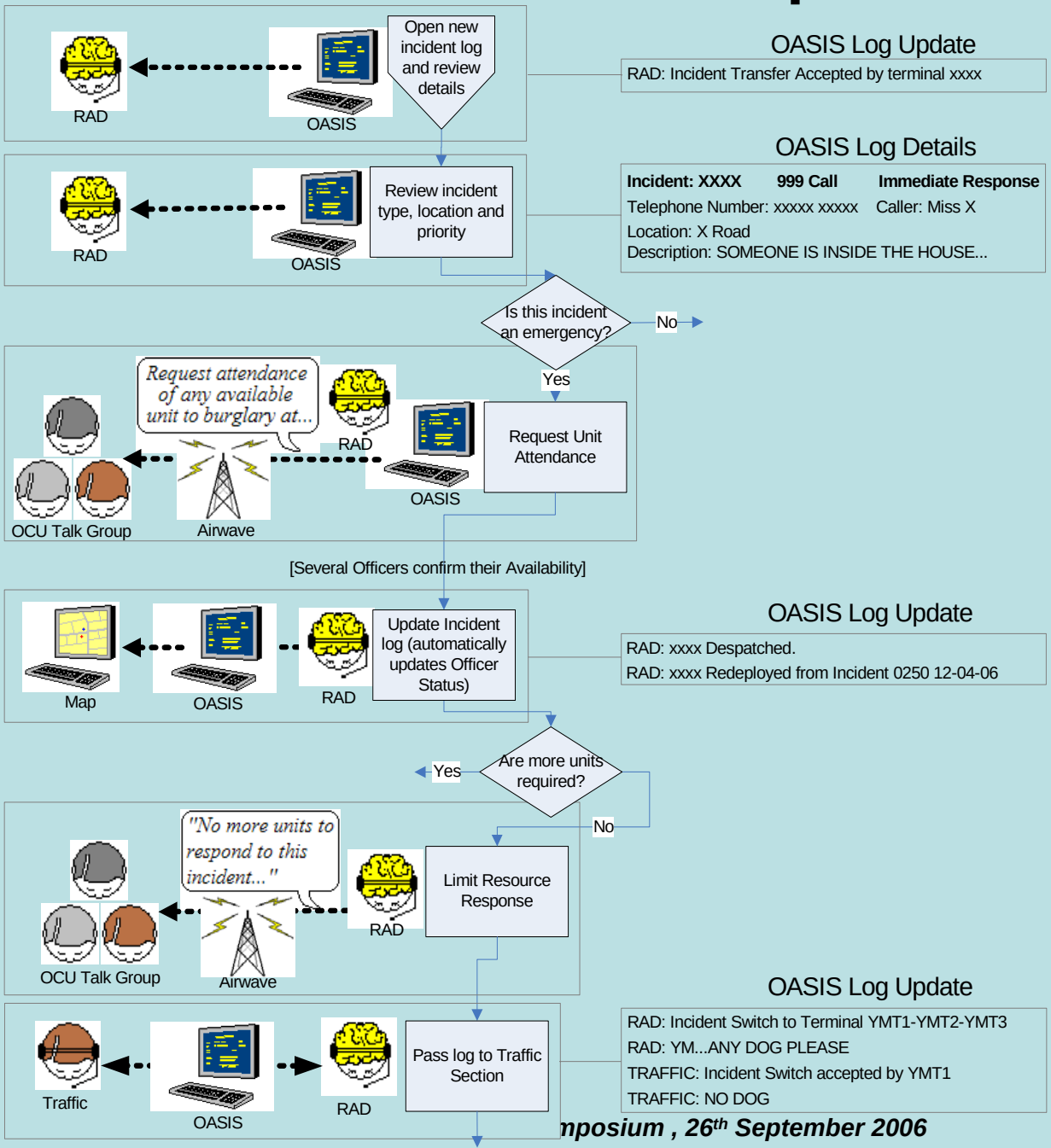
AGENTS:	RAD; patrolling Officers; OASIS
ACTIVITY:	Resource Incident
MODALITY:	Verbal
FORM:	Plain English
TRANSMISSION:	Radio
TRANSFORMATION:	Text to verbal
STORAGE:	OASIS log; Agents' memories
RESOURCE FOR ACTION:	Information cues next activity - "Response from patrolling Officers"

Incident Response Process Flow

Graphical Notation



Annotated 'Coordinate Local Response' Process



Findings

- Digital radio has not had a significant impact on WMP incident response performance

- WMP C2 system undertakes the same activities in the same way

- Full capability of digital system is not being exploited

- Future developments may require adaptation of C2 work practices

Discussion

- Distributed cognition provides a rich description of C2 systems from a macroergonomic perspective

- Changes in the wider work system are required when new technologies are implemented

- Implications for expansion of Airwave system

- Lessons for other domains

- Further Work: inter-force and multi-agency operations

Any Questions?

For further information, contact the authors

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Or see the website: www.hfidtc.com