Intelligent Agents And Distributed Models For Cooperative Task Support

R. Patel, R.J. Mitchell & K. Warwick

Department of Cybernetics

The University of Reading, UK

[R.Patel, R.J.Mitchell & K.Warwick]@reading.ac.uk

Introduction

- EPSRC / National Grid project done by Rak
- Began as investigation of interface issues – identified hole in current research – on-line support cooperative tasks
- work involves operations research, task modelling and intelligent agents
- applied to control room - though more generic

Operations Research

- Analysing work environments to effect changes to or to support work practices
- This work: Decision Support Systems
- Recent work: using Artificial Intelligence
  - may not be useful for on-line systems
  - can incur high development costs
- Computer Supported Cooperative work
  - growing field; seemed appropriate here

Application for Work

- National Grid Control Room
  - Engineers control flow of electricity across the country, cope with outages, maintenance
- (Real) Example Switching Scenarios
  - 10 outage and substation rearrangements
- Transmission Despatch Team
  - various engineers to perform tasks at appropriate times in correct sequence.
- Aim: provide system to speed up such tasks

The Agent Approach

- Agents : autonomous entities, interacting with environment and others, flexible.
- Generic agent model used
  - easier to scale system/tailor to environment
- So separate agent from domain knowledge
- System produced provides indirect management actions by agents to aid users
  - ensures user sees what is relevant

The Task Model

- Approach – analyse tasks and distribute knowledge as local task automata
  - Such state-based approach natural way of representing sequences of task activity
- Token passing to schedule task segments
  - many tasks supported at once
- Planned support actions embedded
  - connected agents process such instructions, deliver task support actions to human users

Interface Agents

- Interface agents - influence user behaviour
  - control information presented to user
  - control input permissions for different screens so only active tasks seen by user
  - by co-ordinating actions across all involved users, the group of users is synchronised
- Indirect management system
  - supports users without adding to workload

BDI Model of Agent

- **B**eliefs of agent
  - models of / connections to work environment
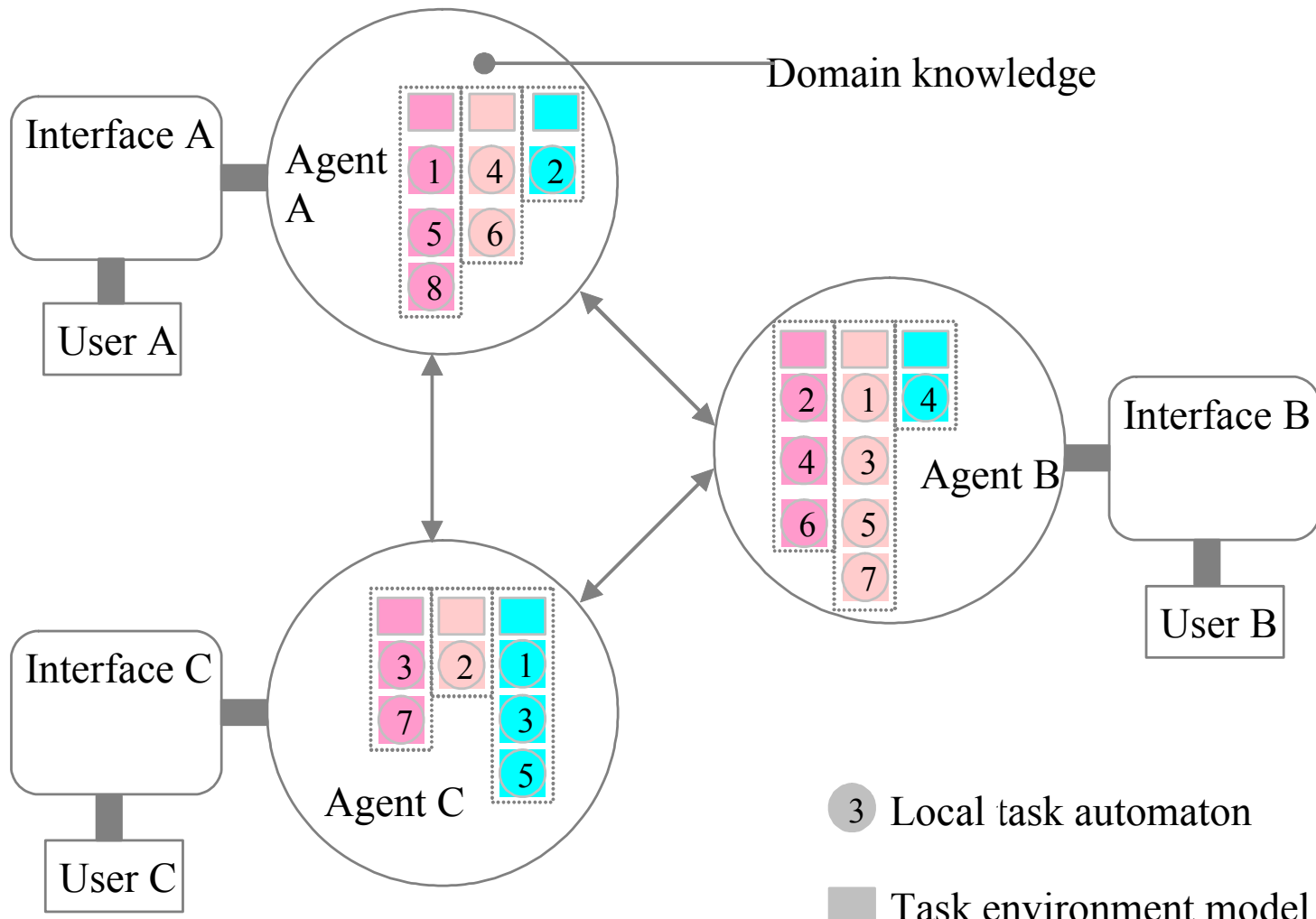 - substation settings, in the example
- **D**esires
  - process active automata to final state
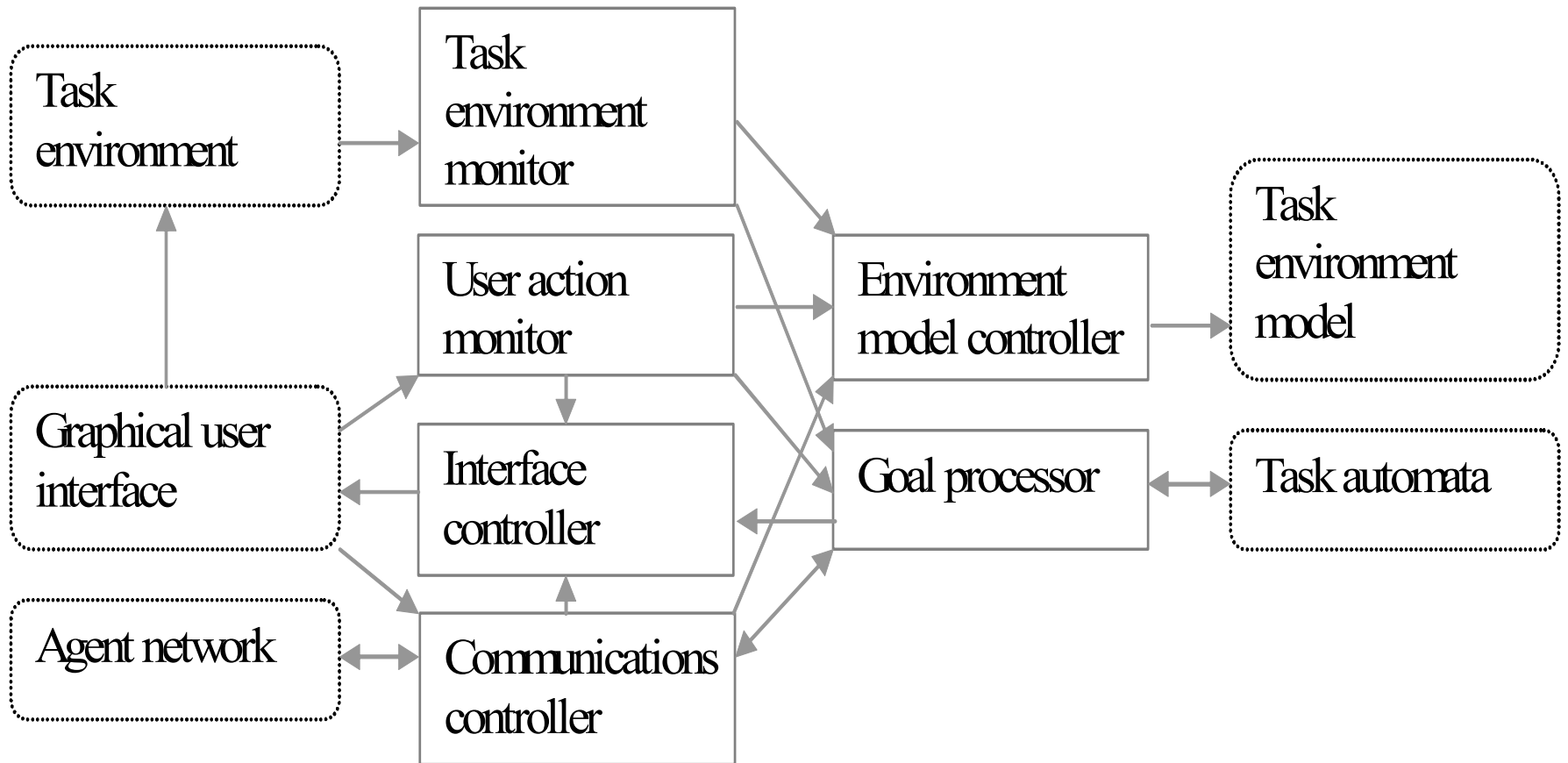 - (ie to finish the task)
- **I**ntentions
  - represented by support actions in local task automata

Example Agent Model (3 user/task)

Interface A

User A

Agent A

Domain knowledge

1	4	2
5	6	
8		

Agent B

2	1	4
4	3	
6	5	
	7	

Interface B

User B

Interface C

User C

Agent C

3	2	1
7		3
		5

Each user works via single interface controlled by agent; all agents interface with each other

(3) Local task automaton

Task environment model

The Generic Agent Model

Task environment → Task environment monitor

User action monitor

Graphical user interface → Interface controller

Agent network ↔ Communications controller

Environment model controller → Task environment model

Goal processor ↔ Task automata

Interface   Agent Processor Modules   Models

Testing of System

- 10 tasks presented to volunteer teams
- Completion times measured for supported and unsupported test runs
- Run for all tasks in *pre-planned* order
- And *ad-hoc*, where task order up to user (except for safety aspects)
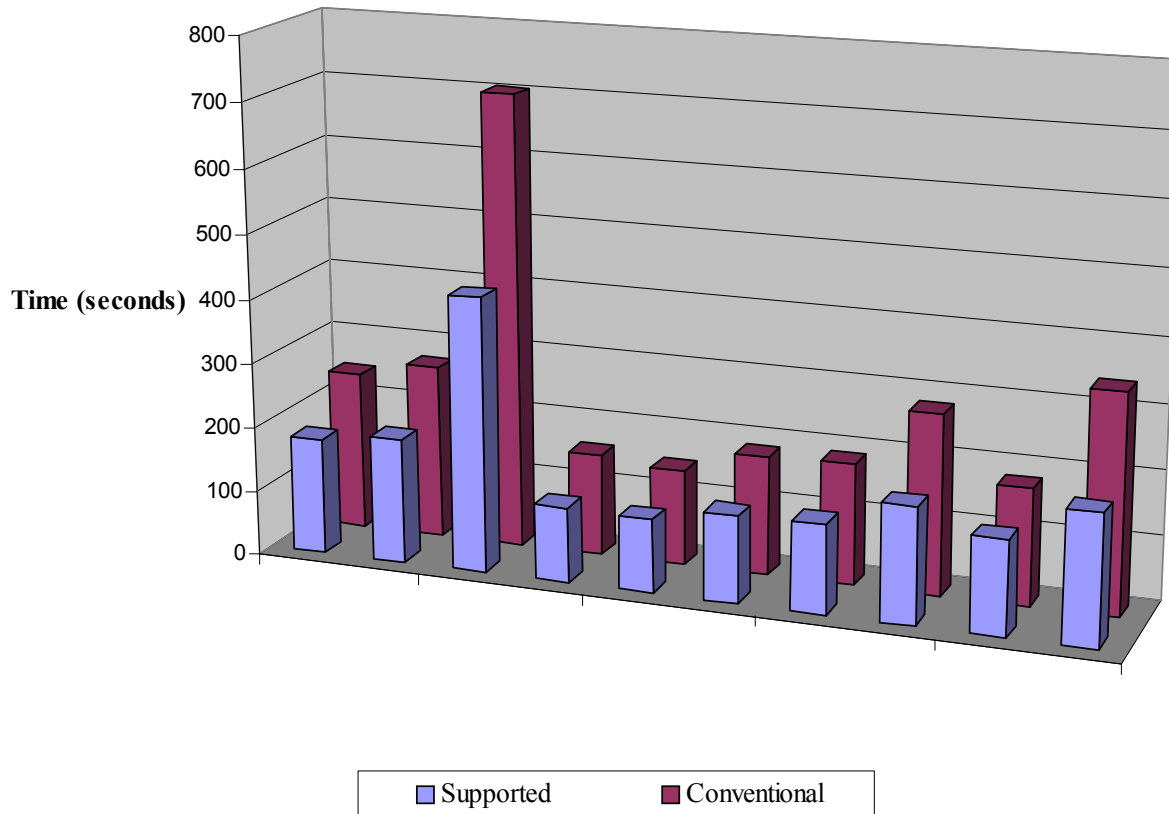 - the latter tests flexibility of system when dealing with random nature of ad-hoc cooperative environments

Effects On Task Times – Ad-Hoc
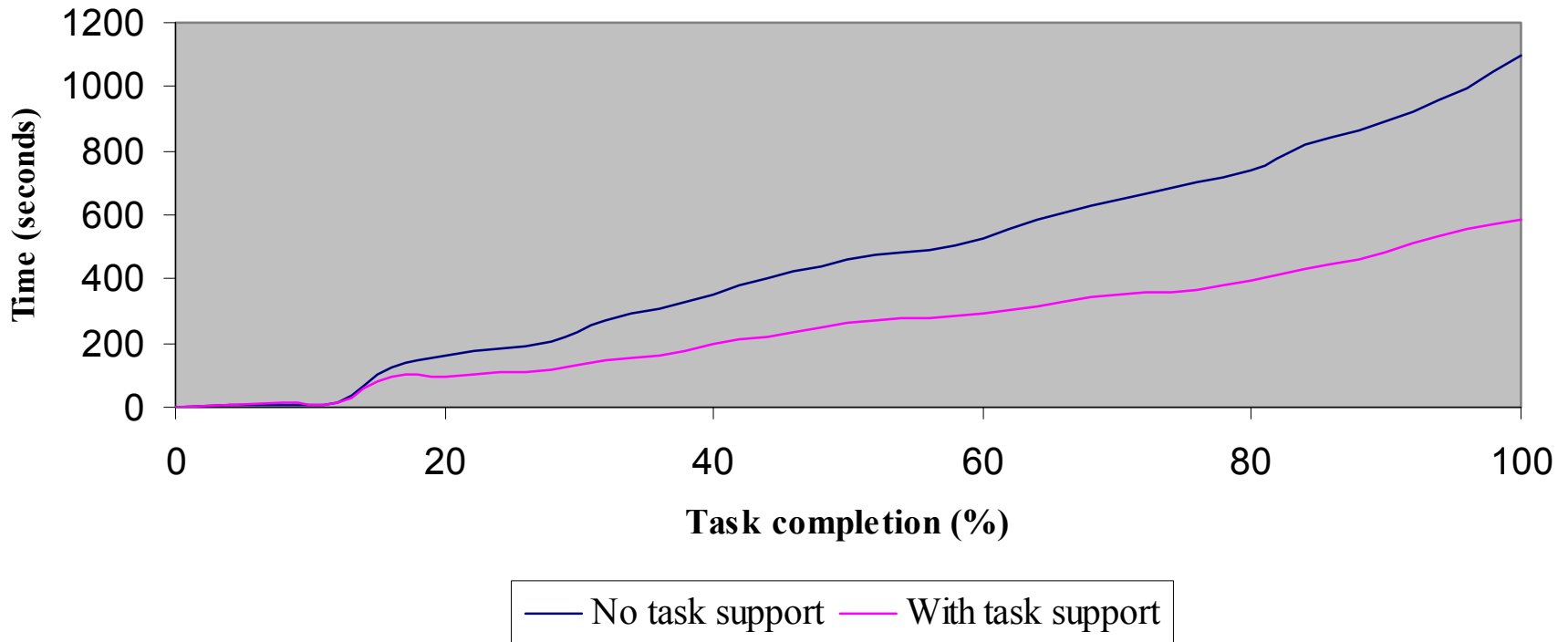
Individual task performance (ad-hoc process schedule)
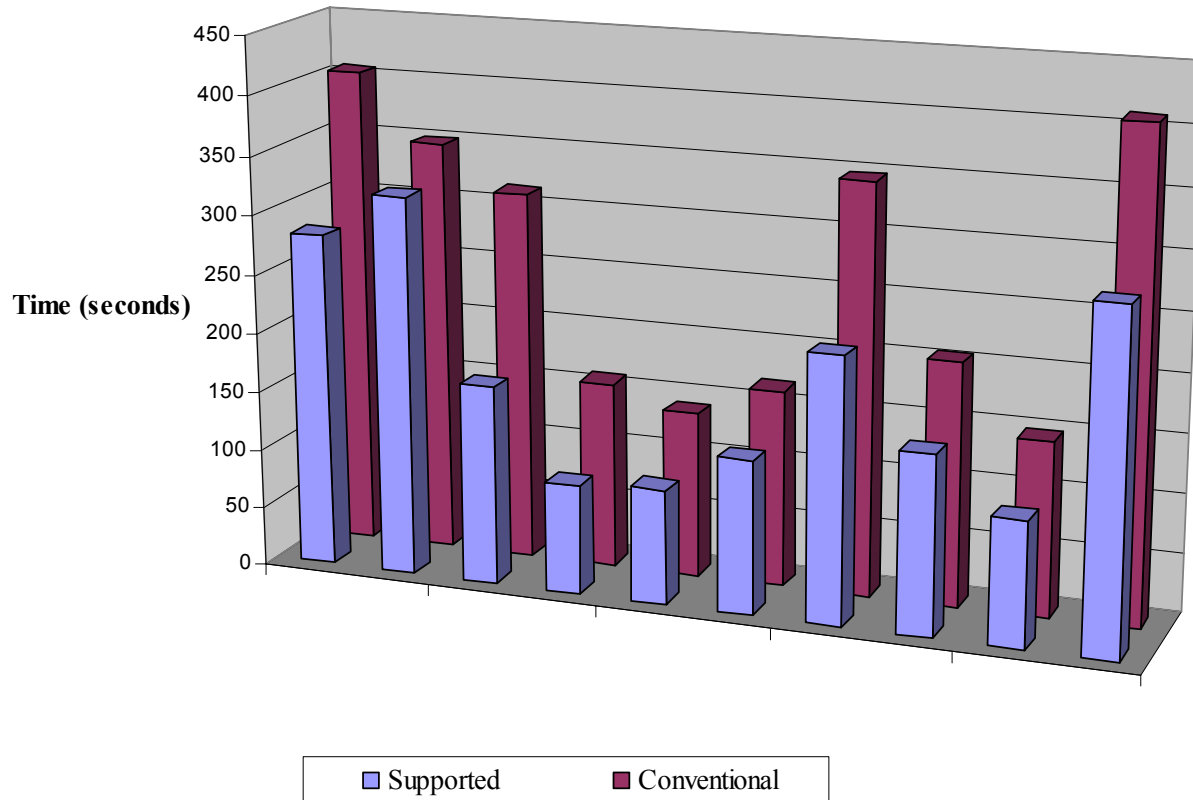
Effects on Times - Pre-Planned

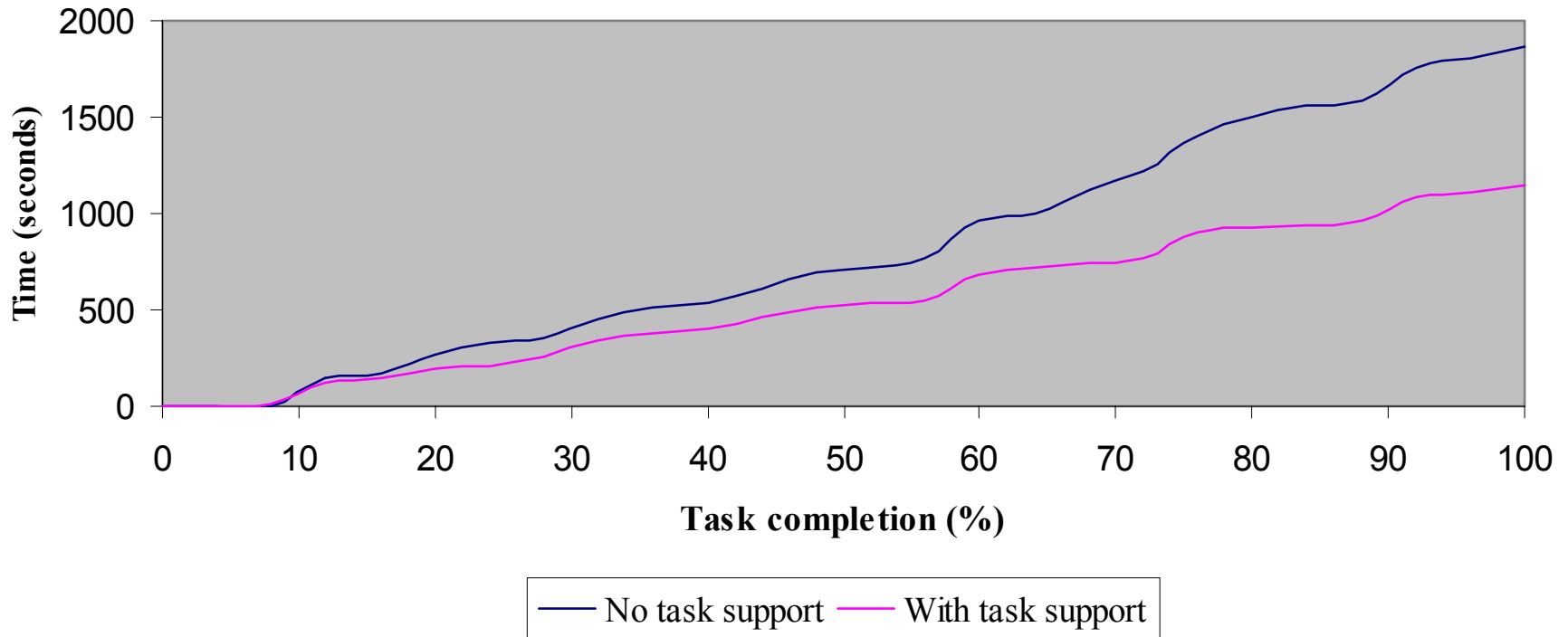**Individual task performance (pre-planned process schedule)**

Time (seconds)

Legend: Supported, Conventional

Average Times Taken - Ad-Hoc

Group performance (Ad-hoc process schedule)

— No task support   — With task support

Average Times – Pre-Planned

Group performance (Pre-planned process schedule)

Conclusion

- Various methods applied to cooperative supported work
  - enhanced automata structure for distributed task model
  - plus flexible interface agent community
- Solution successfully reduces time taken for completion of cooperative tasks

Thanks to EPSRC and National Grid