Electronic contracting in aircraft aftercare: A case study

Felipe Meneguzzi[1]
felipe.meneguzzi@kcl.ac.uk
Simon Miles[1] Michael Luck[1]
Camden Holt[2] Malcolm Smith[2]
and others

[1]Department of Computer Science
King's College London

[2]Lost Wax

lost wax

KING'S College LONDON

An Aerospace Aftercare Use Case

- Simplified version of Lost Wax's use case (previous presentation)
- Aircraft engine manufacturers:
  - Need to maintain an operational engine pool
  - Receive hourly rates for engine usage
  - Need to provide minimum service levels
- Electronic contracts established between manufacturers and airlines

lost wax

KING'S College LONDON

Aftercare contracts

- Complex agreements
- Include provisions for:
  - Restricting provenance of engines
  - Specifying a minimum number of spare engines
  - Maximum idle time for aircraft waiting maintenance
  - Penalties for violations

lost wax

KING'S College LONDON

Background on Electronic Contracting

- Systems of self-interested agents:
  - Inherently unreliable
  - Require societal control
- We use norms to regulate agent behaviour:
  - Ensure compliance with societal goals
  - Usually expressed using deontic concepts
- Norms incorporated into a formal document $\longrightarrow$ *Contract*

lost wax

KING'S College LONDON

The CONTRACT Project

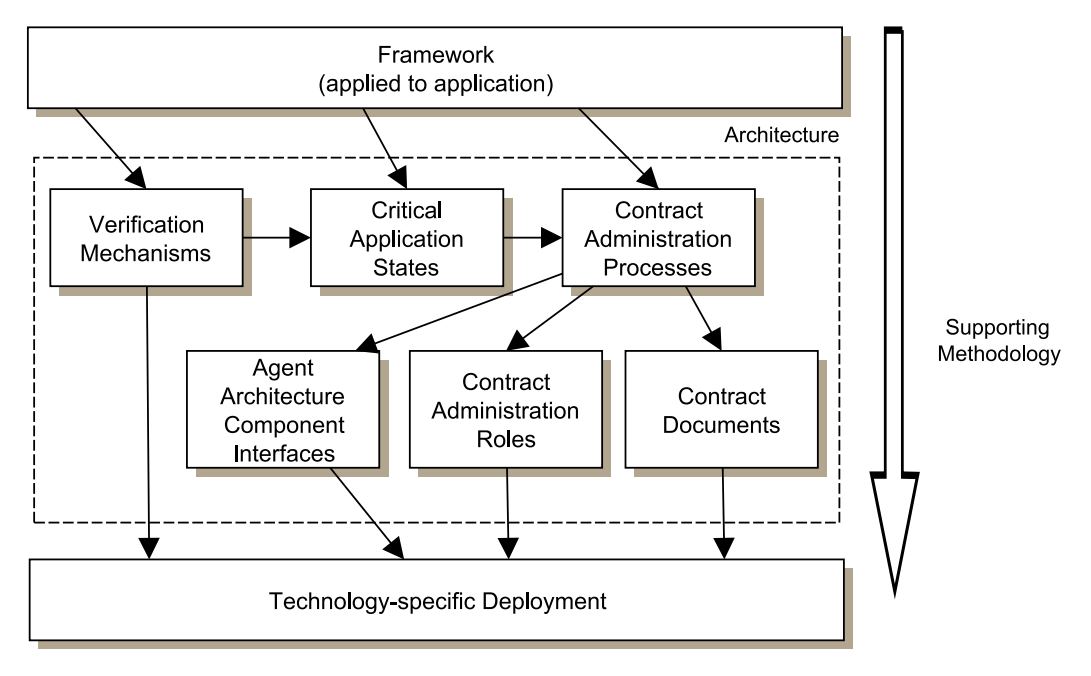
- Explore multiple aspects of contract-based systems
- Aiming at an electronic contracting framework:
  - Facilitates design, enactment and management of contracts
  - Includes critical aspects of a contract life cycle
  - Instantiated here for aerospace aftercare

lost wax

KING'S College LONDON

Structure

- Framework describes:
  - Contracts
  - Target agents (contract parties)
- Architecture provides for:
  - Verification mechanisms
  - Monitoring of critical states
  - Administration processes



lost wax

KING'S College LONDON

Contracts

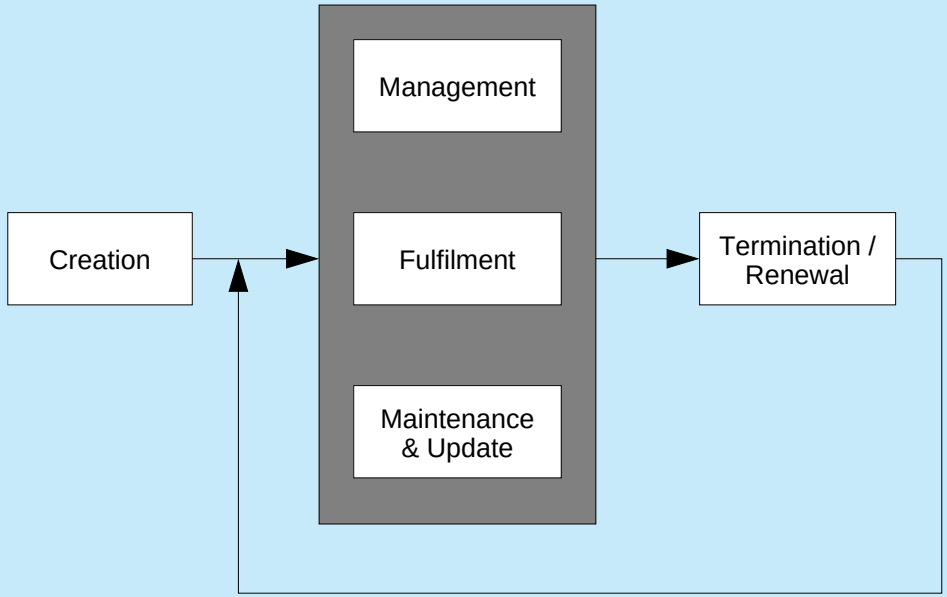
- A contract contains clauses:
  - Obligations
  - Permissions
  - Prohibitions
- *Contract parties* bound by clauses
- *Contract roles* are fulfilled by contract parties

lost wax

KING'S College LONDON

Contract Life Cycle

- Five stages:
  - Creation, finding partners, negotiating terms
  - Maintenance and update of a contract in a repository
  - Fulfilment of clauses by participants
  - Management, overseeing fulfillment, taking action
  - Termination or renewal when expired or violated



lost wax

KING'S College LONDON

Contract Parties

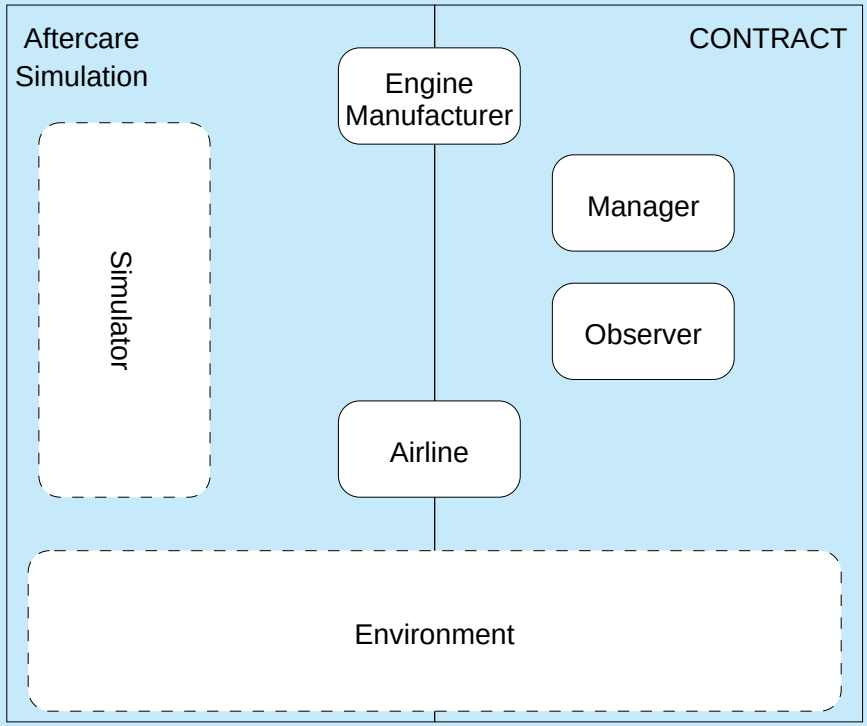
- Business contract parties:
  - Agents targeted by the contract
  - Obligations largely concerned with *business* objectives
- Administrative contract parties:
  - Required to maintain system integrity:
    - Observer monitors critical state
    - Manager responds to notifications by observer
  - Obligations concerned with *administering* the system

lost wax

KING'S College LONDON

Agent Roles

- Airline operator
- Engine manufacturer
- Observer
- Manager



Role: Airline Operator

- Goals:
  - Perform flights according to schedule
  - Notify manufacturer of unscheduled events
  - Schedule maintenance ahead of time
- Responsibilities:
  - Manage a fleet of aircraft
  - Clock engine cycles as flights are carried out
  - Inform observer of all communication

lost wax

KING'S College LONDON

Role: Engine Manufacturer

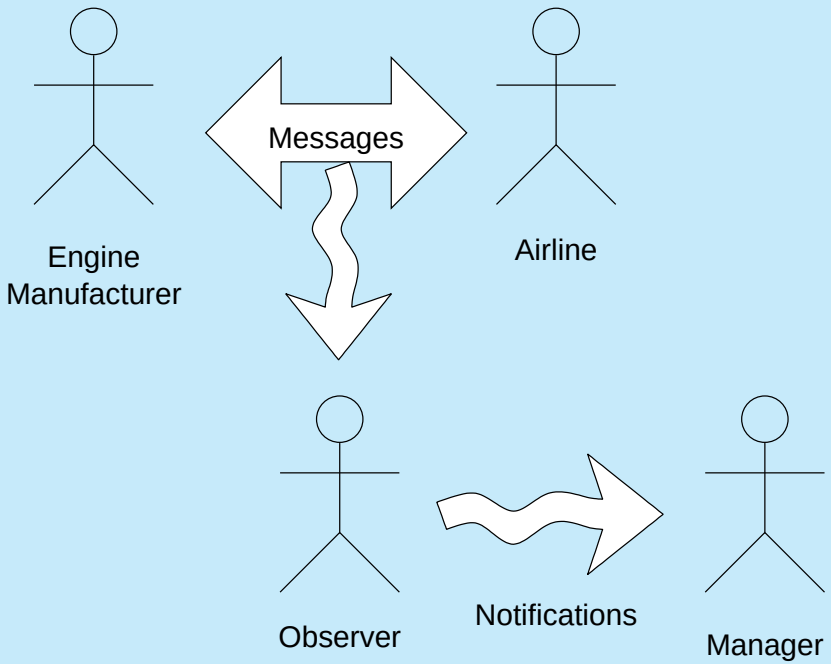
- Goals:
  - Perform scheduled maintenance before deadlines
  - Perform unscheduled maintenance ASAP
- Responsibility:
  - Inform observer of all communication

lost wax

KING'S College LONDON

Role: Observer

- Monitors activities of contract parties
- Detects whether or not violations take place
- In our system, intercepts communication between parties
- Notifies manager of violations



Role: Manager

- Receives violation notifications from Observer
- Takes action to remedy them
- In our system, informs human operator of violation

lost wax

KING'S College LONDON

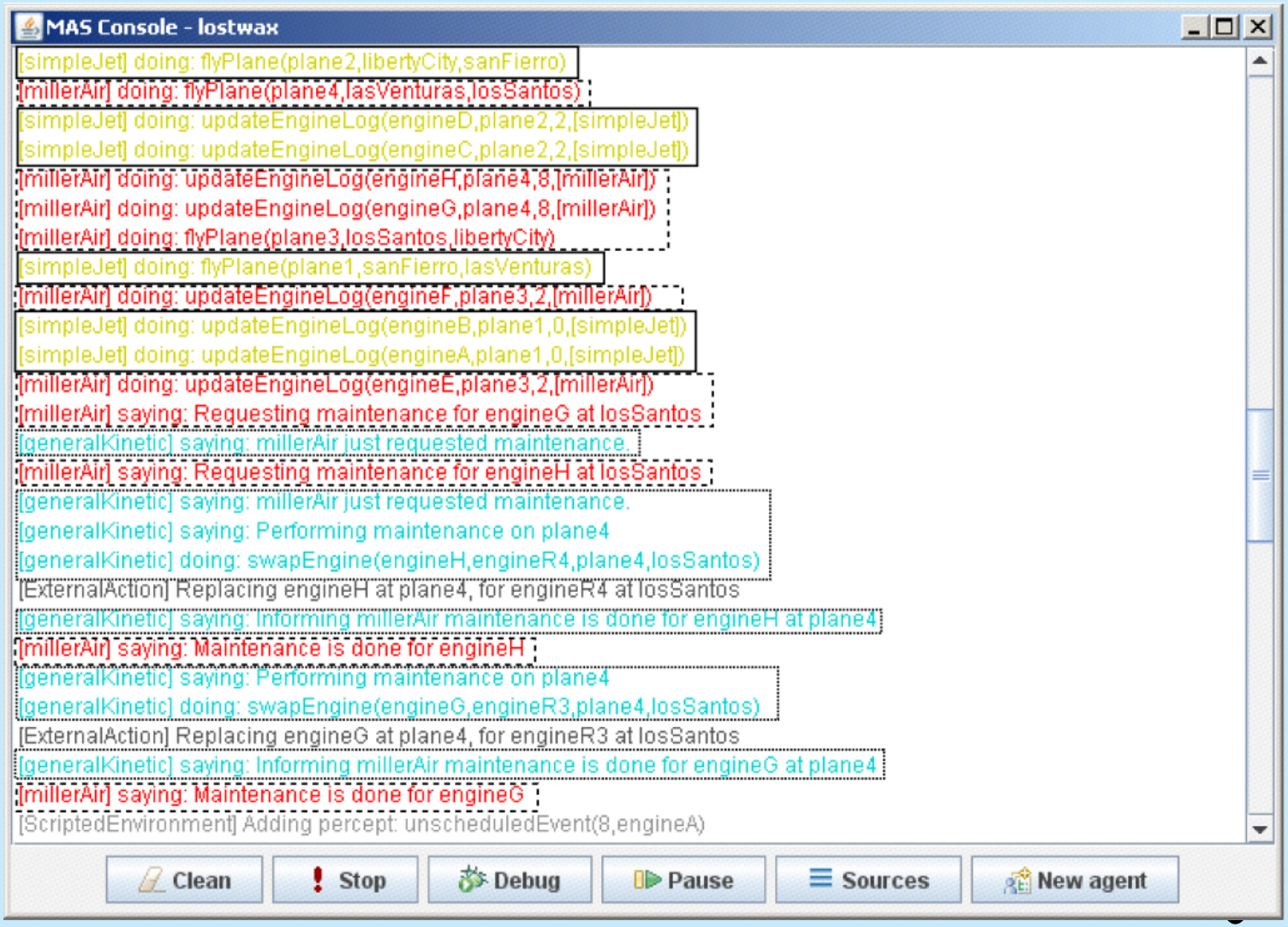
AgentSpeak(L) and Jason

- AgentSpeak(L) is a *procedural* agent language
- Based on the BDI model
- Designer specifies plans in a library:
  - Plans encode procedures
  - Plans are characterised by trigger and context conditions
  - Goals are implicit in the plans
- Lends itself well to state-based monitoring mechanism
- Prototype implementation in the Java-based *Jason*

lost wax

KING'S College LONDON

Screenshot



lost wax

KING'S College LONDON

Summary

- Shown an instantiated system based on the CONTRACT framework
- Examples of concrete Observer, Manager and Contract Parties

Conclusions

- Provide an observation mechanism that can be reused
- Linked a flexible agent model to an explicit contracting mechanism
- Proof of concept for a contracting architecture

lost wax

KING'S College LONDON

Future Work

- Expand the prototype
- Integrate XML contract format
- Incorporate monitoring

lost wax

KING'S College LONDON

Questions?