Law Governed Peer-to-Peer Auctions

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Agenda

- Online auctions
- Limitations of centralized auction services
- Law governed interaction
- Law governed interaction and auctions
- Sample auction law
- Related work
- Conclusions and future work
Online auctions

- Buyers and sellers scattered across the globe interact to close deals
- Faster and less expensive transactions with no geographical barrier
- Forecast Research expects that in 2003 there will be a market of 14 million consumers and $19 billion in sales
Limitations of centralized auction services

- The auction algorithm
  - Several types of such algorithms can be used (like open-cry, sealed, variations, etc.)

- Certification
  - How to compute reputation and trust information about the auction participants

- Auditing
  - What needs to be audited, and by whom

- The treatment of complaints
  - How to handle inappropriate behavior of auction participants
Law governed interaction (1/4)

- LGI is a message-exchange mechanism that allows an open group of distributed agents to engage in a mode of interaction governed by an explicitly specified policy, called the law of the group.

- The group of agents interacting via L-messages is called a community C.

- For each agent x in a given community has a control-state CS(x).

- Agents are black box components.
Law governed interaction (2/4)

- Although the law $L$ of a community $C$ is global it is enforceable locally at each member of $C$
  - $L$ only regulates local events at individual agents
  - The ruling of $L$ for an event $e$ at agent $x$ depends only on $e$ and the local control-state $CS(x)$ of $x$
  - The ruling of $L$ at $x$ can mandate only local operations to be carried out at $x$, such as an update of $CS(x)$
Law governed interaction (3/4)

Legend:
- a regulated event
- a primitive operation
Law governed interaction (4/4)

- Some LGI primitives
  - t@CS returns true if term t is present in the control state, and fails otherwise
  - +t adds term t to the control state;
  - -t removes term t from the control state;
  - forward(x,m,y) sends message m from x to y; triggers at y an arrived (x,m,y) event

- A law is represented as “Prolog” in Moses
Law governed interaction and auctions (1/4)

- **Auction registry**
  - The auction registry is a separate agent that holds the selling offers as a tuple \{ProductName, Description, SellerAddress, AuctionLaw, Timeout\}

- **Sellers and Buyers**
  - All the interaction between sellers and buyers is governed by LGI according to the auction policies (laws) specified in the registry tuples
  - The actual exchange of product and money between the buyer that wins the auction and the seller is handled offline
Law governed interaction and auctions (2/4)

- Sellers send messages to the auction registry to insert or delete auction tuples
- Buyers make requests for offers that meet some conditions
- When a buyer discovers about an interesting auction, it can join the community that is conducting the auction
- Buyers and sellers exchange messages according to the law specified in the auction tuple
- They interact directly, in a peer-to-peer communication model
Law governed interaction and auctions (3/4)

- Interaction among sellers, buyers, and the auction registry

1. Register auction
2. Find about auctions
3. P2P interaction
Law governed interaction and auctions (4/4)

Auction registry

Register auction K: open-cry law
Register auction L: sealed-bed law

Find about auctions

P2P interaction on auction K
P2P interaction on auction L
P2P interaction on auction L

Buyer 1
Seller 1
Seller 2
Buyer 2

Auditor X
Auditor Y
Complaints agent Z
Sample auction law (1/5)

Initializations
R1. Directory(auditor, auditor@enterprise.com)
R2. Authority(ca, URL(http://aramis.cs.rutgers.edu:9020))
R3. InitialCS([])

Certification
R4. certified(X, certificate(issuer(ca), subject(Y), attributes([seller(N)]))) :-
    do(deliver(X, certificate(issuer(ca), subject(Y), attributes([seller(N)])), X)),
    do(+certified), do(+role(seller)), repealObligation(endCertified(X)),
    imposeObligation(endCertified(X), 100),
    do(deliver(X, attributes([seller(N)], auditor))
Sample auction law (2/5)

**Seller starts the auction**

R5. `sent(X,start(P,T),X) :-`
    `certified@CS, role(seller)@CS, do(+P), do(+max(P,0)),`
    `do(+winner(P,X)), do(imposeObligation(timeout(P),T)),`
    `do(deliver(X,start(P,T),auditor))`
Sample auction law (3/5)

The “open cry” auction

R6. sent(X,offer(P,M),Y) :-
    certified@CS, role(buyer)@CS, do(forward(X,offer(P,M),Y)),
    do(deliver(X,offer(P,M,Y),auditor)

R7. arrived(X,offer(P,M),Y) :-
    role(seller)@CS, max(P,Q)@CS, winner(P,Z)@CS, M>Q, not
    role(buyer)@CS, do(-max(P,Q)), do(+max(P,M)), do(-winner(P,Z)),
    do(+winner(P,X)), do(forward(Y,accepted(P,M),X)),
    do(deliver(Y, accepted(P,T,X),auditor),
    do(forward(Y,outbid(P,M),Z)), do(deliver(Y,outbid(P,T,Z),auditor)
Auditing

- Auditor is an agent that is not involved in the auction but that receives copies of the messages that were exchanged.
- Agents can request copies of the messages exchanged during the auction.
- An auction can have more than one auditor.
- An agent can choose not to participate in an auction if it does not trust its auditors.
- The law imposes no restrictions in the way auditors handle the messages they receive.
Sample auction law (5/5)

- **Treatment of complaints**
  - An agent can complain about another agent (A) if he or she thinks that A did not have a correct behavior.
    - Not sending the item once the auction is over

- **Prevention of the artificial increase of the price by the seller**

- **The complaints agent can talk to the auditor to retrieve copies of all the exchanged messages and the real IDs (as are written in the certificates) of the agents**
Related Work

- Centralized auction services
  - B2B
  - B2C
- AuctionBot
  - Configurable auction policy
- UDDI
  - Auction registry
Sellers can set up their own auction policies and these policies are explicitly stated, readable by everybody, and strictly enforced by the LGI mechanism.

Auctions are conducted in a totally distributed manner, through a peer-to-peer communication protocol.

There is no centralized authority that can act as a trusted mediator.

Third parties, such as auditors and complaints agents, can participate on the auctioning process under a given law.

This architecture is not limited to auctions, but it can be applied to any online trading model.
Conclusions and Future Work (2/2)

- Definition of laws for other types of negotiation
  - Especially interested in studying the behavior of agents in the presence of several optional (and conflicting) laws

- Integration with Web services
  - UDDI and WSDL

- Web-based user interface for the system