Evaluating the Impact of Network Delay and Loss in Distributed Auctions

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Introduction

Scenario:

- Good example of a wide-area network application with QoS constraints
- Assumes automated and distributed auctions
- Assumes large number of high-frequency and short-lived auctions
- Useful for resource allocation (e.g. cellular time)

Question: Does delay and loss affect such scenario?
(e.g. the expected seller's income under certain network delay/loss)

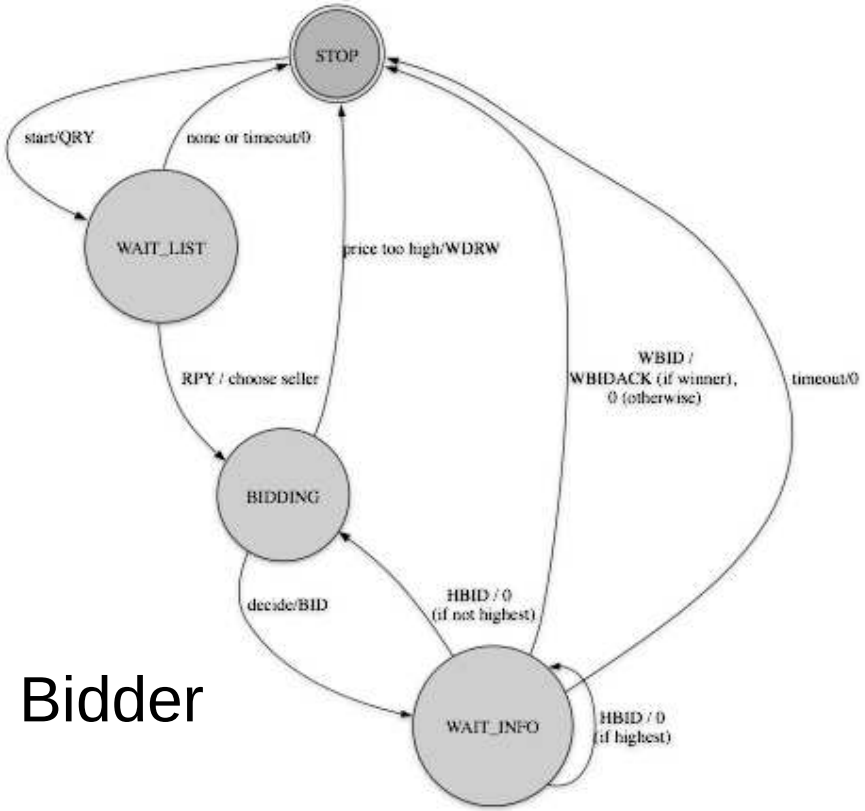
Parent projects:

- SAN: QoS-directed communications that use self-observation and self-adaptation to improve communications
- CASCADAS: Software architecture for the provision of autonomic and situation-aware communication services

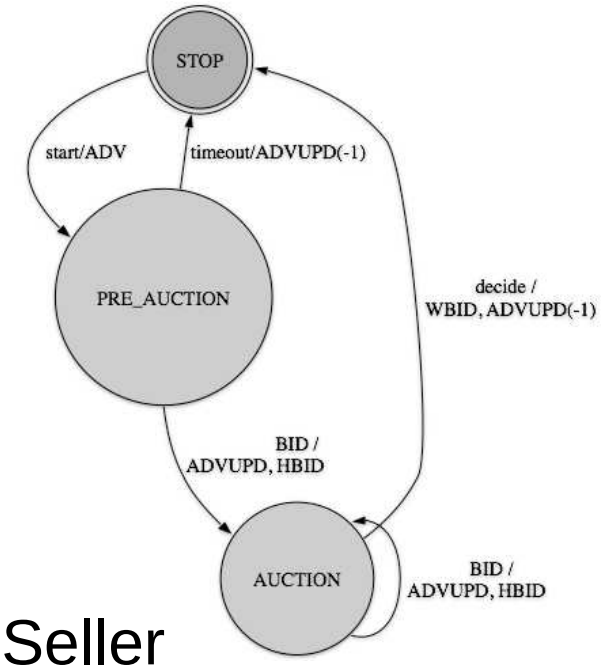
Distributed Auction System

- Basic elements:
  - sellers (auctioneers)
  - buyers (bidders)
  - auction centres
- Auction rules
  - This work assumes *English auction* rules
- Strategies for decision making
  - Assumes exponential decision times and bidding limits
  - No automatic bidding (unlike eBay)
- Communications protocol

Communications Protocol



Bidder

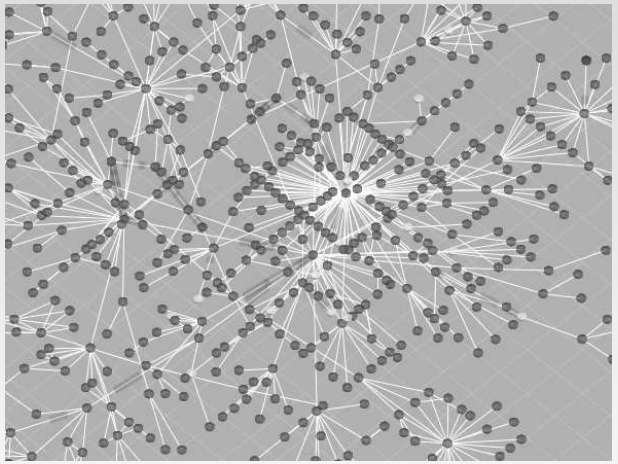


Seller

Example

- Simulation of a single auction running on IP network (UDP/IP)
  - Seller (red node)
  - Auction centre (yellow node)
  - Up to 20 bidders (light blue and blue when highest bidder)
- Packets:
  - Green: new advertisement
  - Blue: bid
  - Red: new price and highest bidder
  - Black: other messages
- Topology: Government national research lab: 448 routers and 203 attachment points

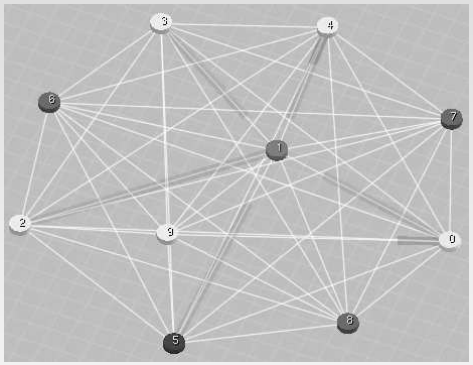
(source: http://www.crhc.uiuc.edu/~jasonliu/projects/topo)



Video clip available at:
http://san.ee.ic.ac.uk/~rlent/clips/

Simulation

- Packet-level simulation of a single distributed auction (1 seller, up to 10 bidders randomly joining the auction)
- As with the analytic model:
  - Seller waits exponential time to accept a bid, which is reset if another bid is received before expiration
  - Bidders (other than higher bidder) place bids after an exponential time of receiving a high bid notification unless the price has reached their limit
  - Bids are in unit increments
  - Price limits are selected randomly in the interval [80,120]
- Simulation recreates the application-level connections of auction participants
- Bandwidth and end-to-end loss are controlled to obtain networks of different characteristics



Example of single auction with up to 8 bidders

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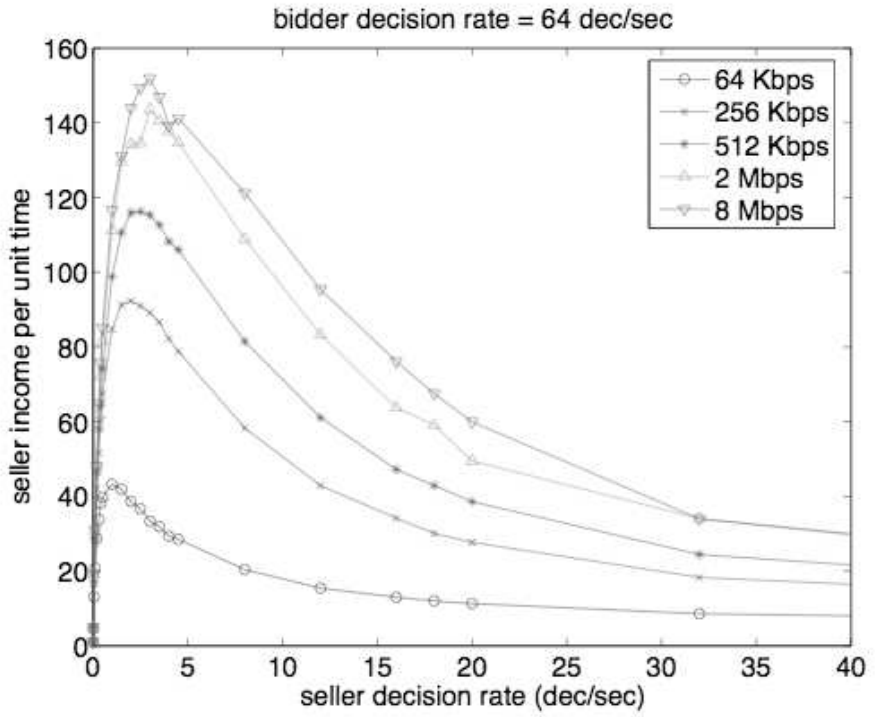
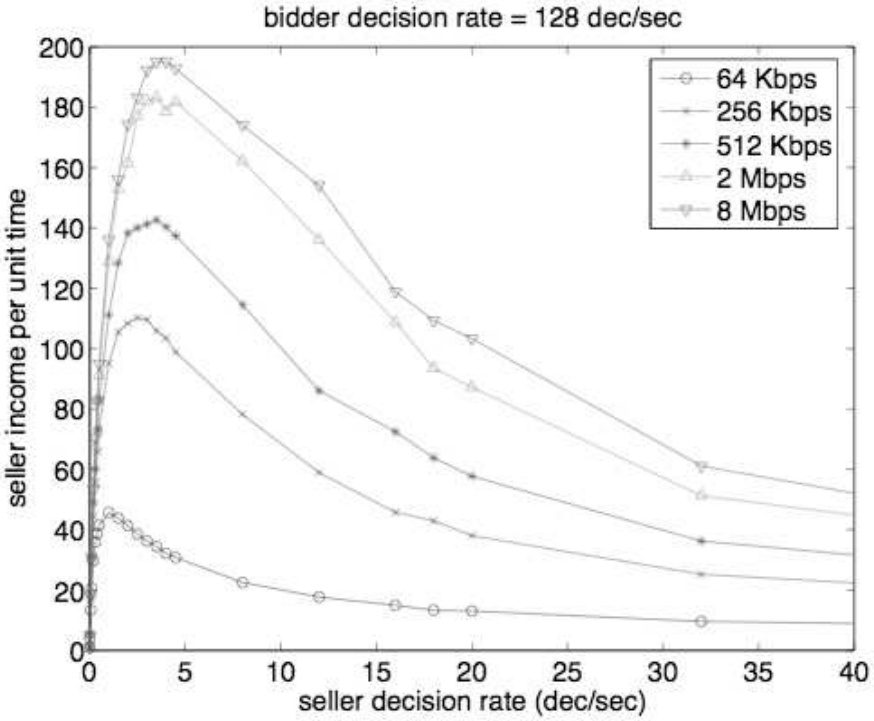
Income/time and RTT





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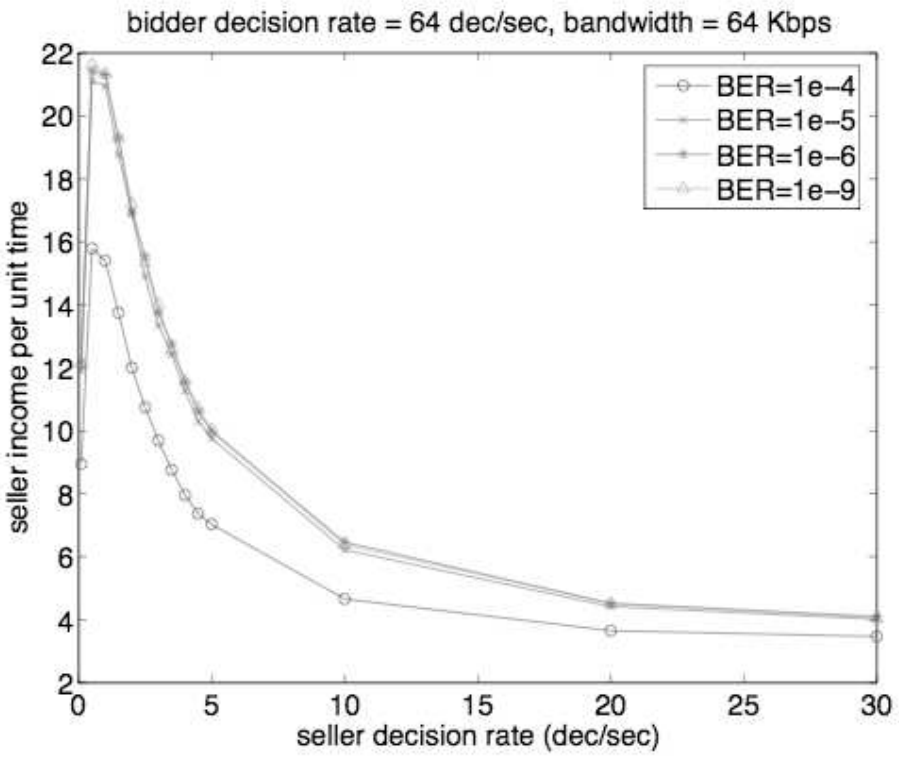
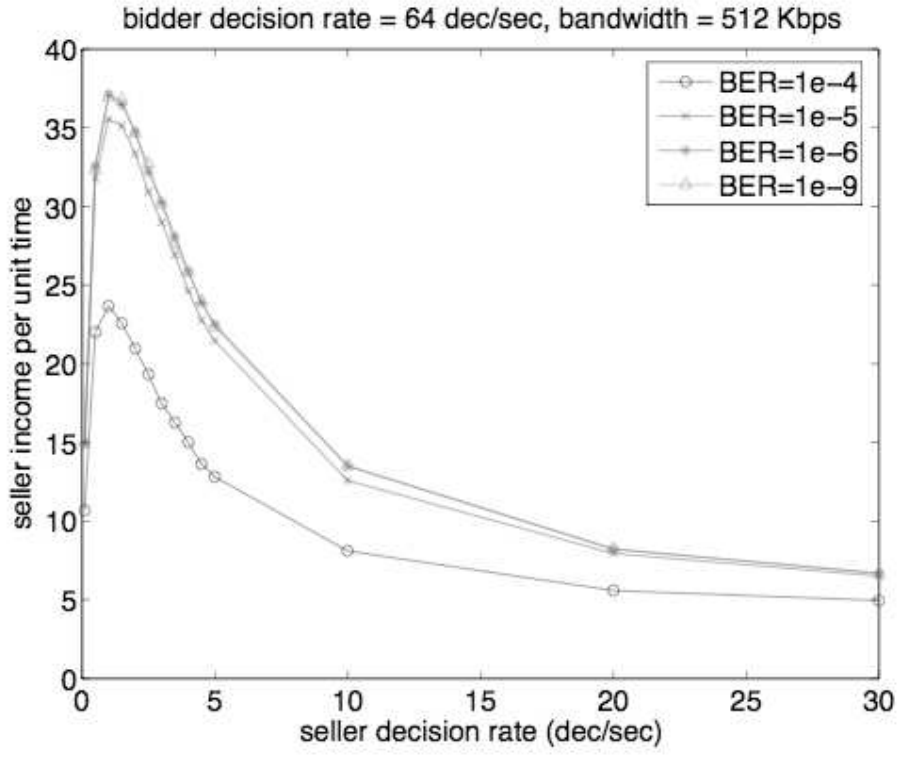
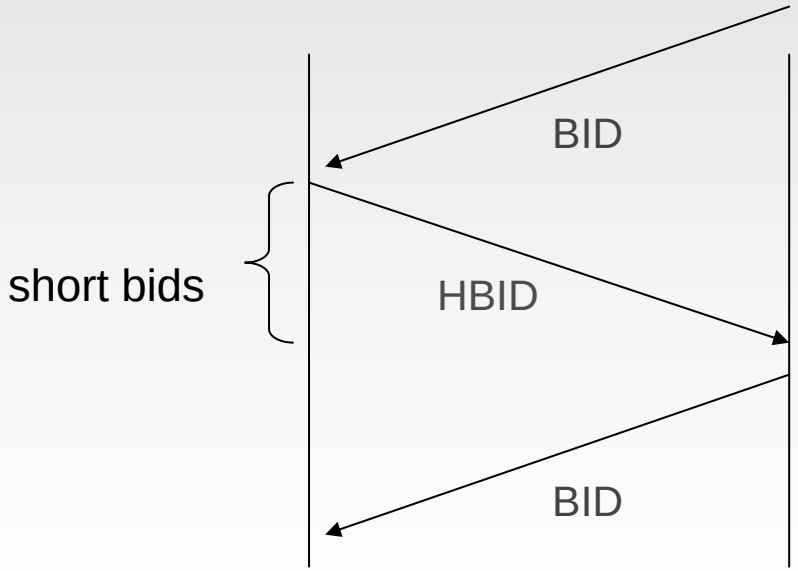
Income/time and Loss



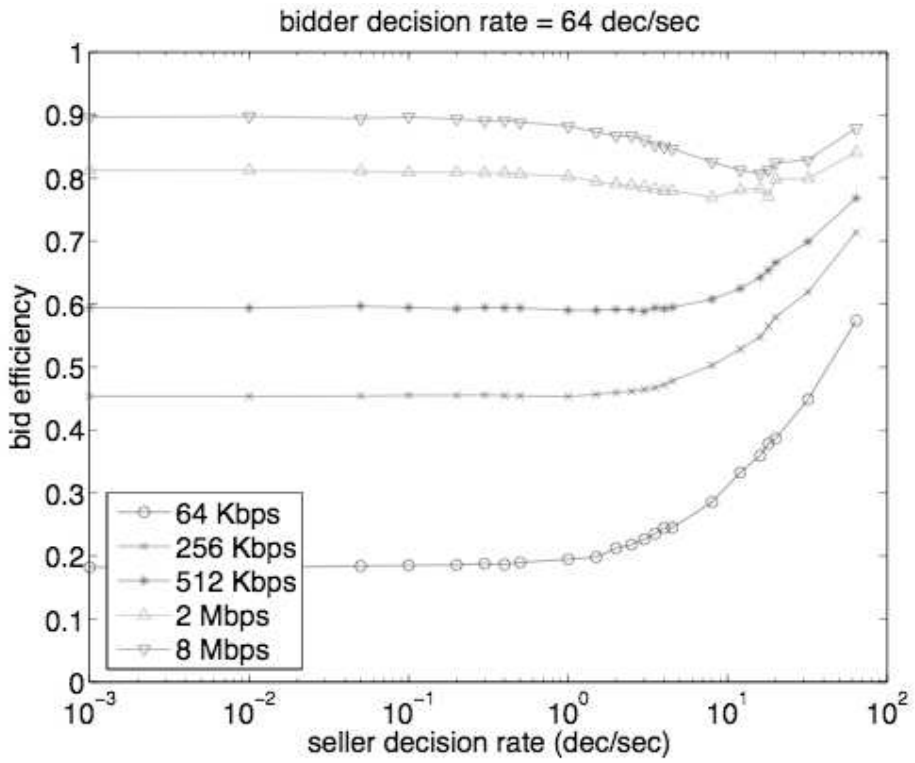


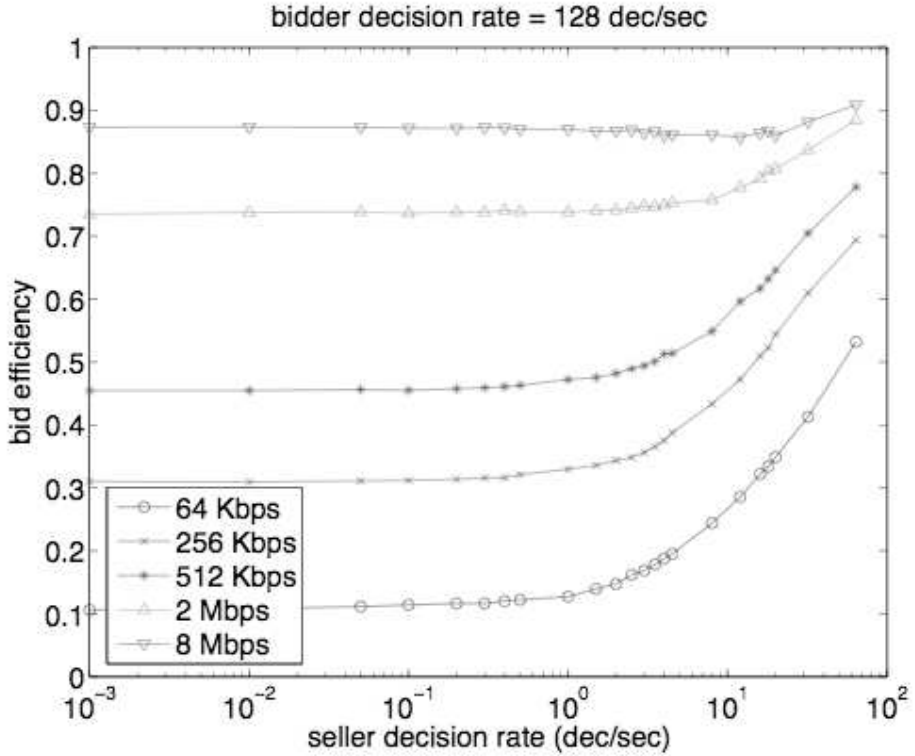
Short Bids and Bid efficiency

- Because of delayed HBID messages, bidders may place bids with a lower value than required by the seller
- Let us call K the bid efficiency: the ratio of effective bids to total bid rate arriving at the seller



Bid Efficiency (K) and RTT





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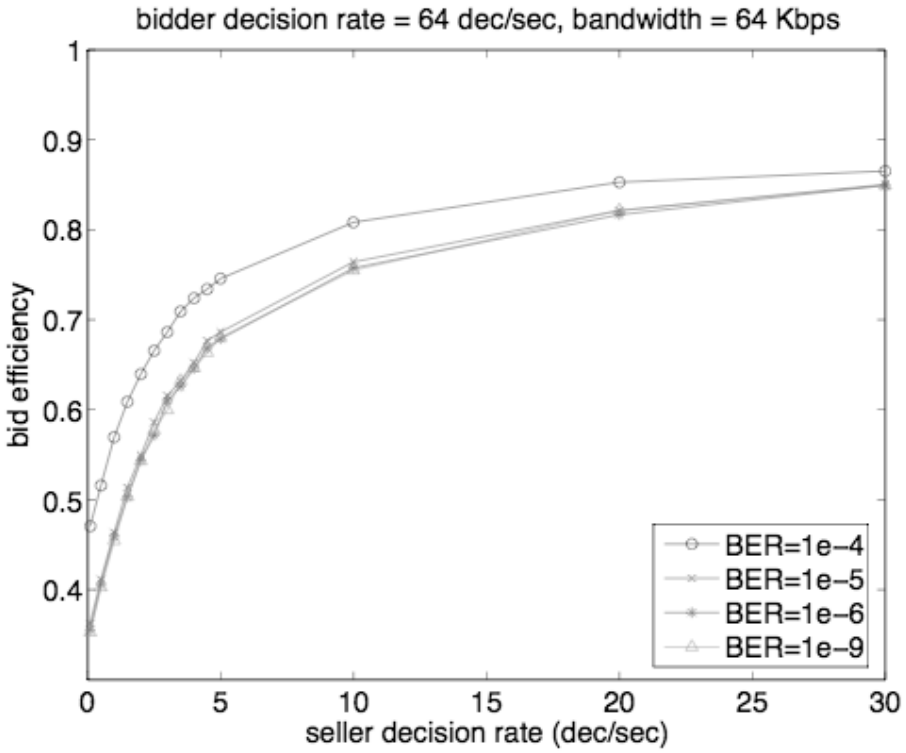
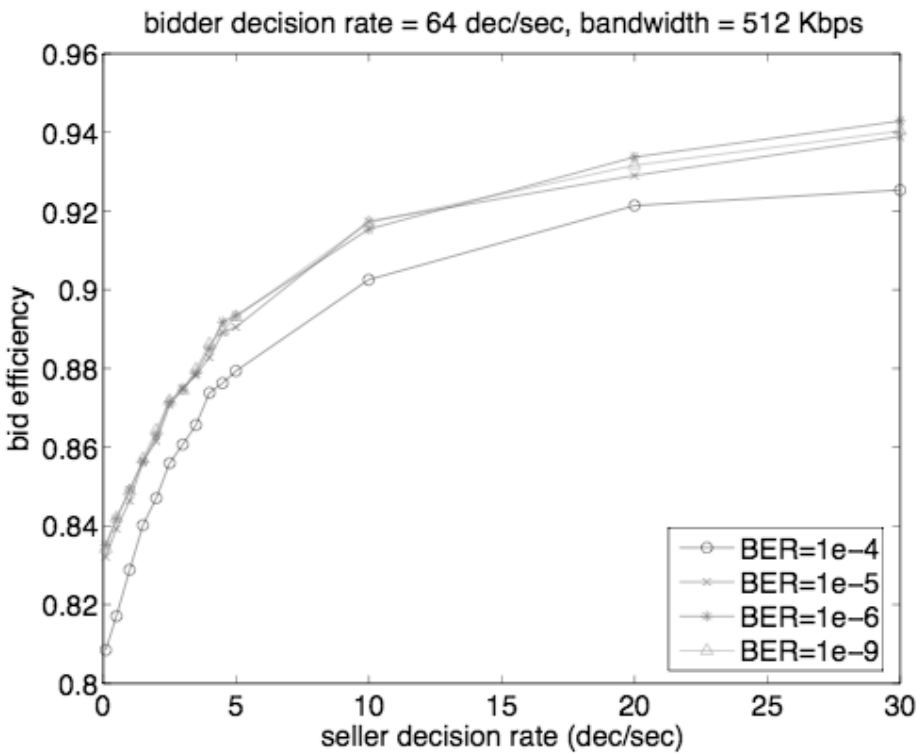
Bid Efficiency (K) and Loss





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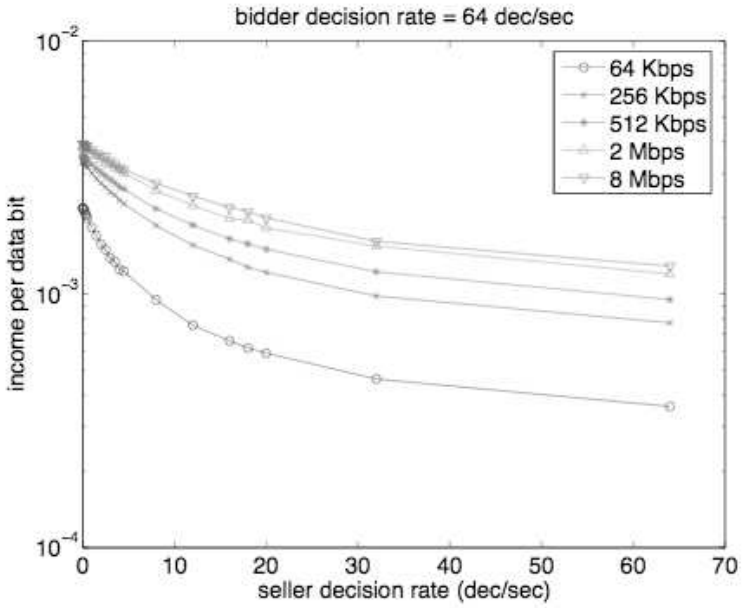
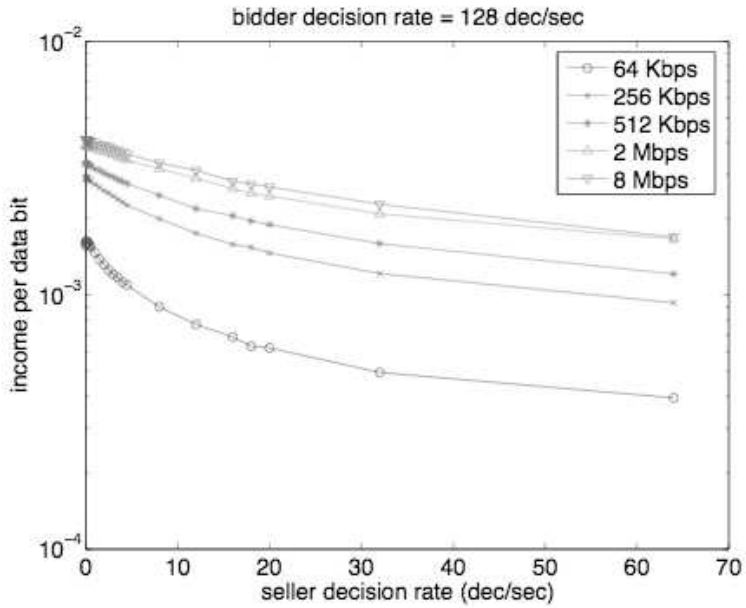
Income/Data sent (Delay)





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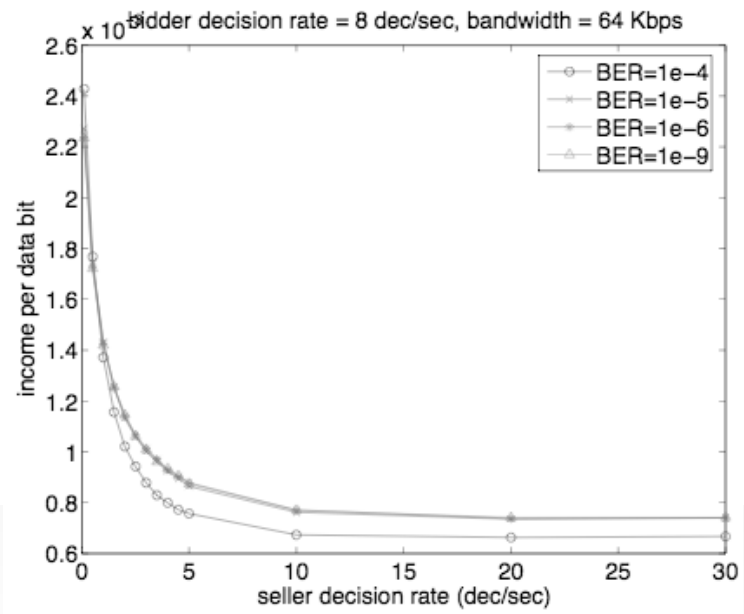

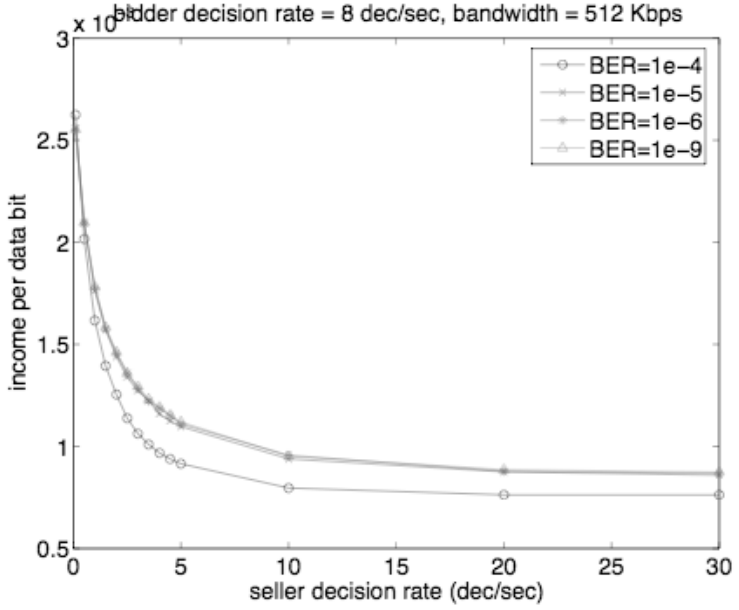

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Summary

- This work has quantified the influence of network delay and loss in the selling prices of goods in automated distributed auctions
- It has also shown that an important amount of ineffective traffic (short bids) can be generated in proportion to network delay
- The strategy of both sellers and bidders should depend on network state
- A future work will evaluate the benefits of network self-adaptation in auction outcomes and the bidder's side.