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Power Auctioning in Resource Constrained Micro-Grids: Cases of Cheating

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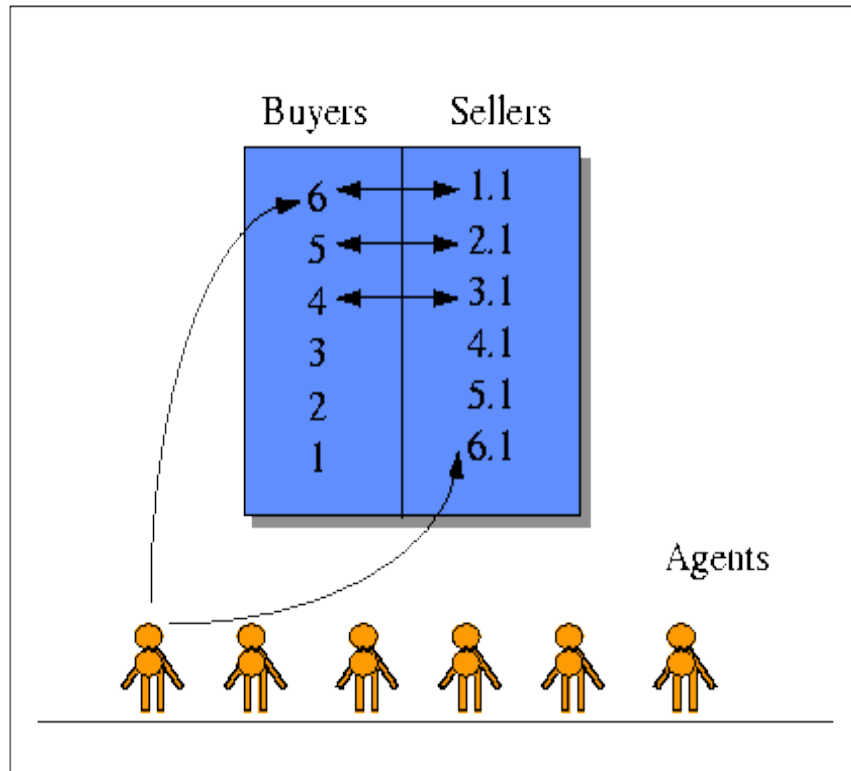
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Background – Continuous Double Auctioning



Continuous Double Auctioning (CDA):

- market mechanism supporting power trading in resource constrained (RC) smart micro-grids

Advantages:

- coordination of distributed components on incomplete and imperfect information
- incur minimal computational cost
- ensure robust, reliable and fair energy allocation

Background – Resource Constrained Micro-grid



Resource Constrained Micro-Grids (MG):

- small, integrated energy systems intelligently managing distributed load and energy resources.
- capable of autonomous operation in case of failure of national grids, (islanded mode)
- operate on resource limited information technology infrastructure.
- we conform to a MG model specified in other work



2) Anesu M C Marufu, A V D M Kayem, and S. Wolthusen (2016). Fault-Tolerant Distributed Continuous Double Auctioning on Computationally Constrained Microgrids. In Proceedings of the 2nd International Conference on Information Systems Security and Privacy, ICISSP 2016, pages 448–456. SCITEPRESS, 2016.

Background – Resource Constrained Micro-grid

Control Centre Sentinel



Shared Smart Meters



Neighbourhood Area Network

Trading Agents



Household Area Network



Sentinel

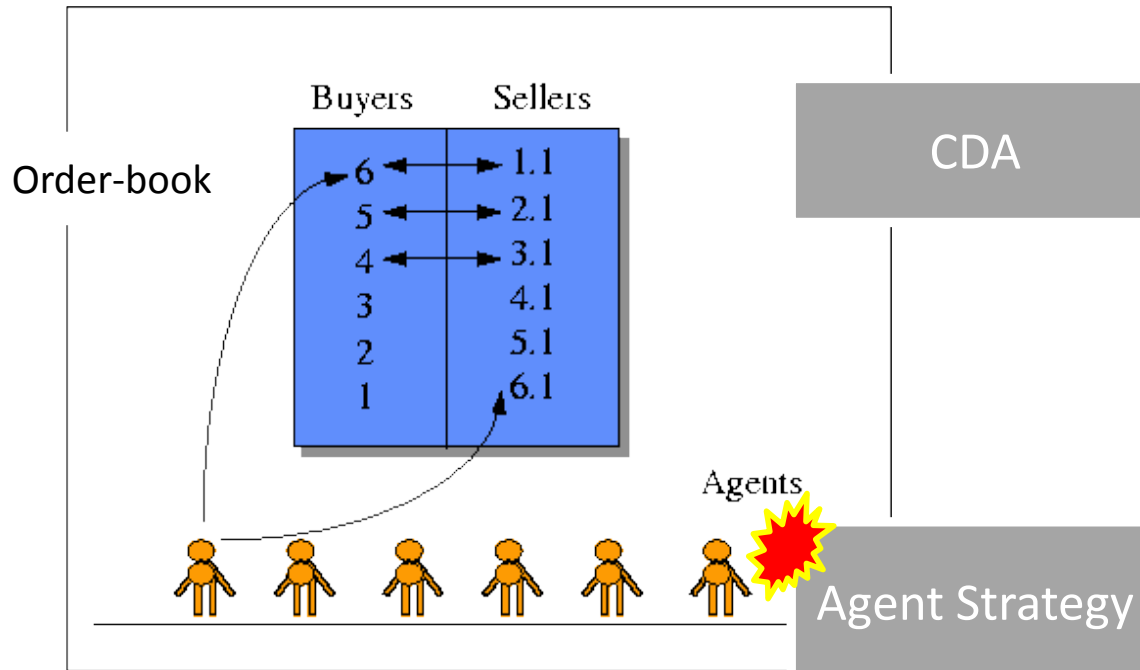


Buyer



Seller

Problem – Realisation of Cheating



-Fairness important in ensuring trust

- CDA [2] is ideal – Fairly robust to traditional cheating forms:

e.g. Multiple bidding; Bid shading, Shill bidding

Strategy Manipulation Attacks

-Victim Strategy Downgrade

-Collusion Attack

-operate on resource limited information technology infrastructure.

Support of Cheating Attacks

- Superior strategies = more surplus vs. inferior counterparts
- Superior strategy: *Adaptive Aggressive (AA)*
- Inferior strategy: *Zero Intelligence (ZI)*
- *Gjerstad-Dickhaut Extended (GDX)* challenges supremacy of AA.
- GDX gains more surplus vs. AA sometimes

3) Marco De Luca and Dave Cliff (2011). Human-agent auction interactions: Adaptive-aggressive agents dominate. In IJCAI Proceedings-International Joint Conference on Artificial Intelligence, volume 22, page 178. Citeseer, 2011

4) Perukrishnen Vytelingum (2006). The structure and behaviour of the Continuous Double Auction. PhD thesis, University of Southampton, 2006.

5) Daniel Vach and Ales M. A. Maršal (2015). Comparison of double auction bidding strategies for automated trading agents, 2015.

Cases of Cheating

1) Victim Strategy Downgrade

- One adversary uses a tool (e.g. malware) to control other participants' trading agents.
- dynamic 'downgrade' of victim trading strategy.
- Adaptive Aggressive (AA) \succ Zero Intelligence ZI strategy

2) Collusion Attack

- a number of traders collude to change bidding strategy
- K colluders coordinate agent strategy change: AA-GDX
- Adversary population ratio to victim population must ensure max. surplus

Proposed Countermeasure 1

- Cheating is auction specific – likewise countermeasures
- Current security measures are inadequate:
 - Absence of central auctioneer
 - Different clearing mechanisms
- Cheating gives rise to **exceptions**,
- *Exception handlers* adopting a citizen approach are proposed
- Make use of *allocative* efficiency & # of messages

Proposed Countermeasure 2

Central Sentinel



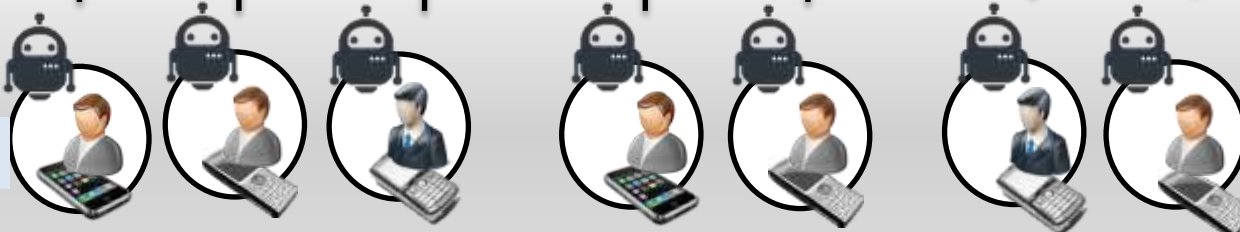
Shared Smart Meters



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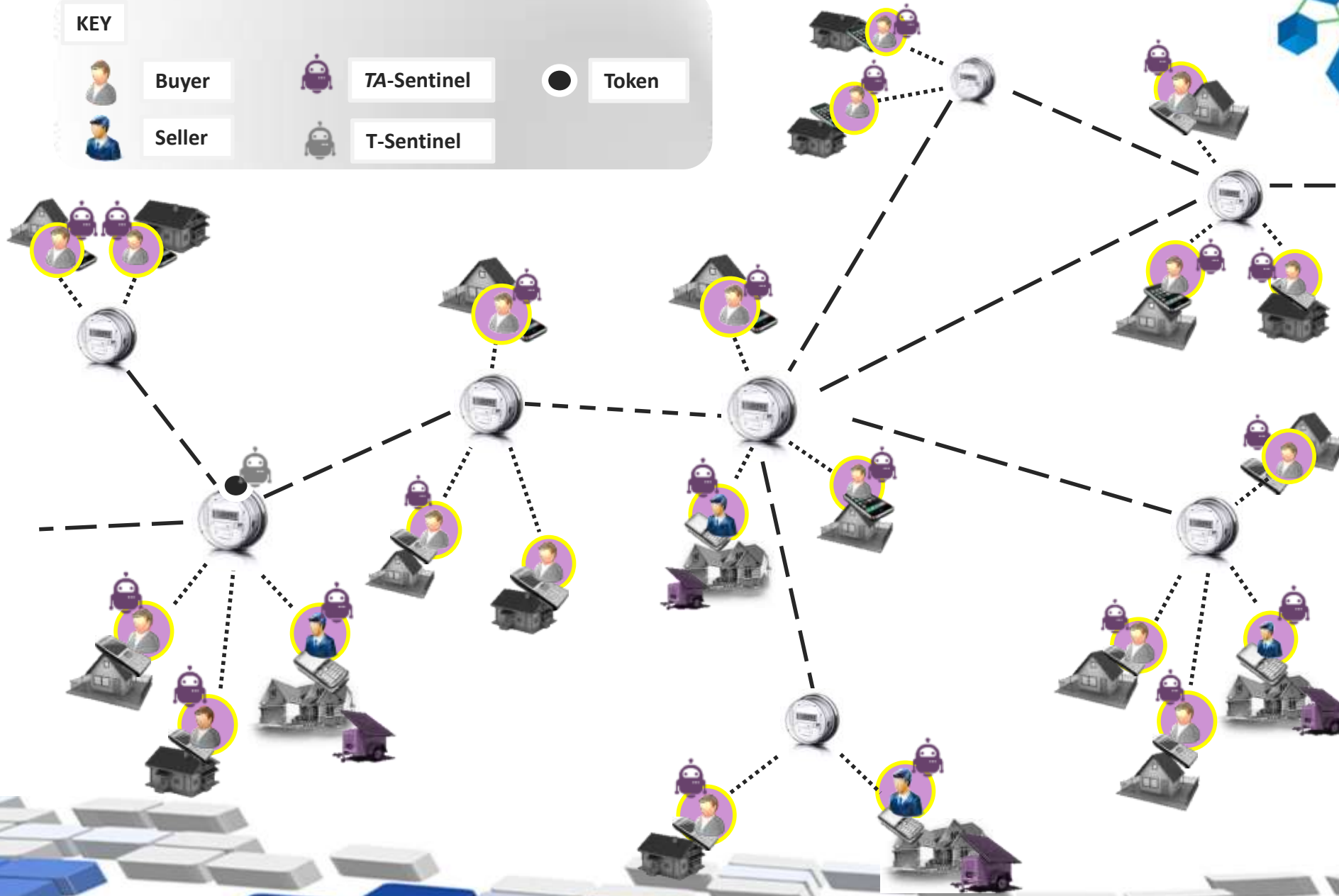
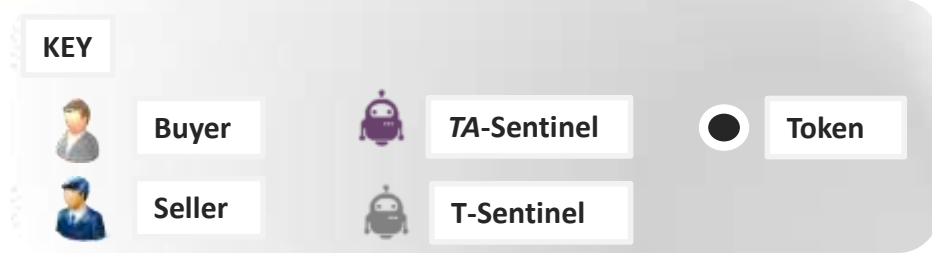
Sentinel



Buyer



Seller



Acknowledgements



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Conclusion

- Continuous Double Auctioning ideal for power allocation
- Automated Cheating is possible
- Exception handling mechanism using a citizen approach can be used
- Future work: validate and evaluate the exception handling protocol



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