A Novel Multi-Agent and Multilayered Game Formulation for Intrusion Detection in Internet of Things (IoT)

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Abstract

The current era of smart computing and enabling technologies encompasses the Internet of Things (IoT) as a network of connected, intelligent objects where objects range from sensors to smartphones and wearables. Here, nodes or objects cooperate during communication scenarios to accomplish effective throughput performance. Despite the deployment of large-scale infrastructure-based communications with faster access technologies, IoT communication layers can still be affected with security vulnerabilities if nodes/objects do not cooperate and intend to take advantage of other nodes for fulfilling their malicious interests. Therefore, it is essential to formulate an intrusion detection/prevention system that can effectively identify the malicious node and restrict it from further communication activities. This study introduces a combined multi-agent and multilayered game formulation where it incorporates a trust model to assess each node/object, which is participating in IoT communications from a security perspective. The experimental test scenarios are numerically evaluated, and it is observed that the proposed approach attains significantly improves intrusion detection accuracy, delay, and throughput performance as compared to the existing baseline approaches.

Keywords

Author Keywords: Games; Intrusion detection; Throughput; Game theory; Internet of Things; Mathematical model; Internet of Things; intrusion detection; multi-layer games; security measures

Key Words Plus: SELFISH NODE DETECTION; COOPERATION

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Publisher
1. **A Fog based System Model for Cooperative IoT Node Pairing using Matching Theory**
   By: Abedin, Sarfarz Fakhrul; Alam, Md. Golam Rabil; Tran, Nguyen H.; et al.
   2015 17TH ASIA-PACIFIC NETWORK OPERATIONS AND MANAGEMENT SYMPOSIUM APNOMS Pages: 309-314 Published: 2015
   Times Cited: 31

2. **A comprehensive insight into game theory in relevance to cyber security**
   By: Anwar, F.; Khan, B. U. I.; Olanrewaju, R. F.; et al.
   Indonesian J. Electr. Eng. Inform. (IJEEI) Volume: 8 Issue: 1 Pages: 189-203 Published: 2020
   [Show additional data]

3. **That Internet of Things Thing**
   By: Ashton, K.
   RFID Journal Volume: 22 Pages: 97-114 Published: 2009
   Times Cited: 555

4. **TWOACK: Preventing selfishness in mobile ad hoc networks**
   By: Balakrishnan, K.; Deng, J.; Varshney, P.K.
   2005 IEEE Wireless Communications and Networking Conference, Vols 1-4: WCNC 2005: BROADBAND WIRELESS FOR THE MASSES READY FOR TAKE-OFF. Book Series: IEEE Wireless Communications and Networking Conference Pages: 2137-2142 Published: 2005
   Times Cited: 94

5. **Title: [not available]**
   By: Basar, T.; Olsder, G.J.
   Dynamic noncooperative game theory Volume: 23 Published: 1999
   Publisher: Siam, New York City
   Times Cited: 102

6. **Performance analysis of the CONFIDANT protocol (Cooperation Of Nodes: Fairness In Dynamic Ad-hoc Networks)**
   By: Buchegger, S.; Le Boudec, J-Y.
   MobiHoc 2002. Proceedings of the Third ACM International Symposium on Mobile Ad Hoc Networking and Computing Pages: 226-236 Published: 2002
   Times Cited: 133

7. **Stimulating cooperation in self-organizing mobile ad hoc networks**
   By: Buttyan, L.; Hubaux, JP.
   MOBILE NETWORKS & APPLICATIONS Volume: 8 Issue: 5 Pages: 579-592 Published: OCT 2003
   Times Cited: 374

8. **Outwitting smart selfish nodes in wireless mesh networks**
   By: Chang, Zan-Kai; Tan, Su-Wei; Goh, Bok Min; et al.
   INTERNATIONAL JOURNAL OF COMMUNICATION SYSTEMS Volume: 26 Issue: 9 Special Issue: SI Pages: 1163-1175 Published: SEP 2013
   Times Cited: 4