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AI-Driven Zero Trust Architecture: Adaptive Intrusion Detection Using Federated and Self-Supervised Learning- Conclusion

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Abstract: *Zero Trust Architecture (ZTA) has emerged as a fundamental security paradigm to address the limitations of traditional perimeter-based defenses in modern distributed, cloud, and IoT environments. With the increasing sophistication and volume of cyberattacks, conventional intrusion detection systems (IDS) struggle to adapt to dynamic and previously unseen threats. This paper proposes an AI-driven Zero Trust Architecture that integrates Federated Learning (FL) and Self-Supervised Learning (SSL) to enable adaptive, privacy-preserving intrusion detection. Federated learning facilitates collaborative model training across multiple organizations without centralizing sensitive network data, thereby ensuring data privacy and regulatory compliance. Self-supervised learning enhances the model's ability to learn robust representations from unlabeled data, improving the detection of zero-day and evolving attacks. Experimental evaluation demonstrates that the proposed framework achieves higher detection accuracy, significantly reduces false positive rates, improves zero-day attack detection, and enhances privacy preservation compared to traditional IDS solutions. The results validate the effectiveness of combining FL and SSL within a Zero Trust framework to deliver scalable, trustworthy, and resilient cybersecurity defenses for modern enterprise networks.*

Keywords: Zero Trust Architecture, Intrusion Detection System, Federated Learning, Self-Supervised Learning, Adaptive Security, Cybersecurity, Privacy-Preserving Artificial Intelligence

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