Anomaly Transmitter Recognition and Tracking

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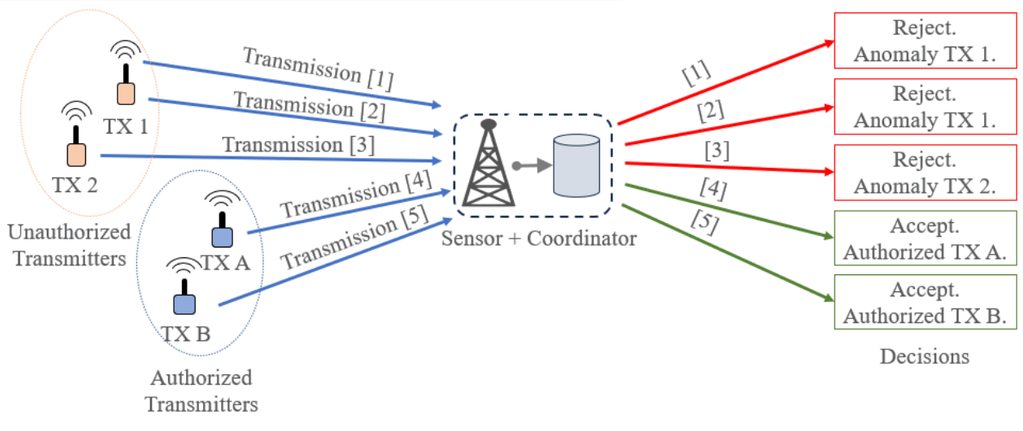
BACKGROUND

The number of wireless devices is increasing drastically in modern society, urging the need to promote coexistence by ensuring efficient mechanisms to secure and protect spectrum rights.

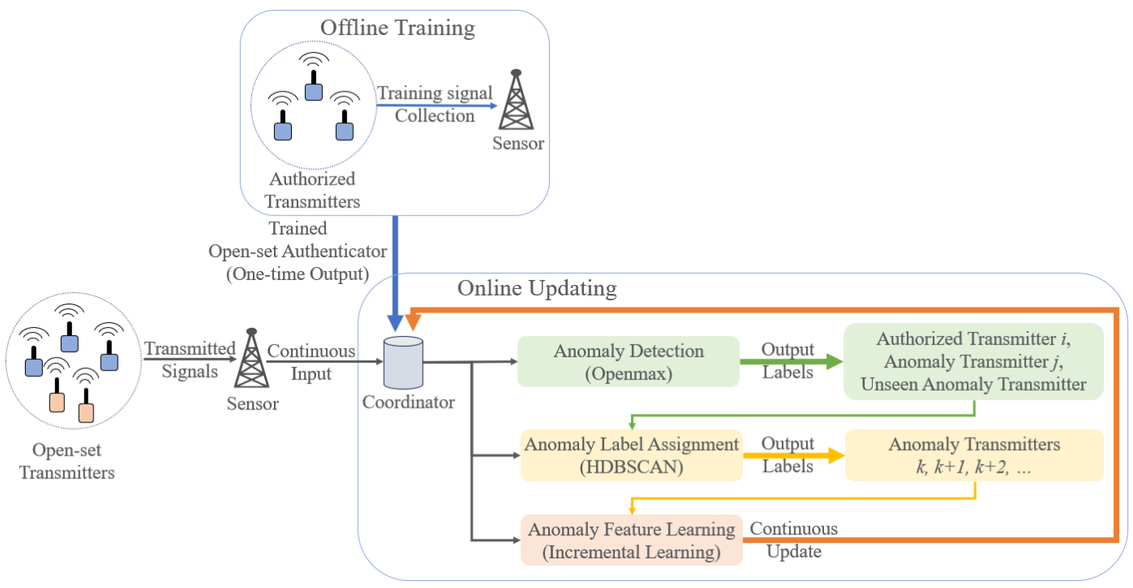
- Authorized and non-authorized device recognition is needed.
- RF fingerprinting performs physical layer authentication utilizing transmitter hardware imperfections.

RESEARCH QUESTIONS



- Closed-set classification: classify authorized transmitters
- Open-set recognition: recognize and reject anomaly signals
- Anomaly tracking: track anomaly (unauthorized) transmitters

METHODS AND MATERIALS



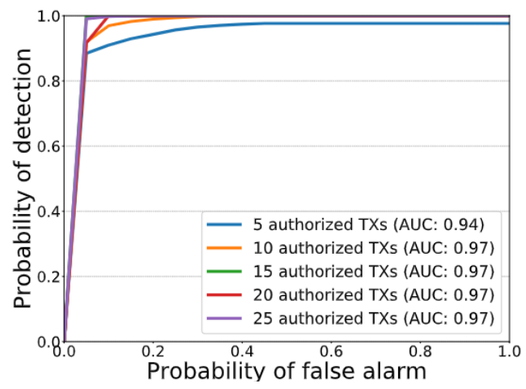
We proposed an Anomaly Recognition and Tracking (ART) Framework.

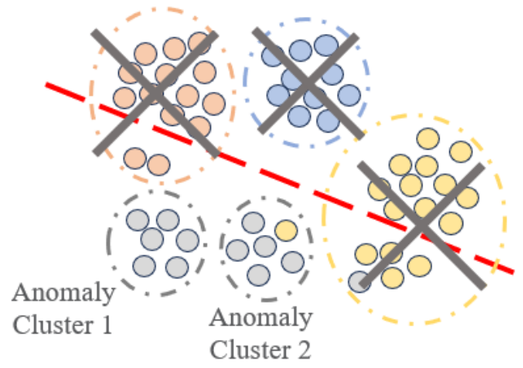
- **Offline training**:
  - Deep learning based open-set authenticator trained using authorized transmitters
- **Online updating**:
  - Anomaly Detection: classify authorized transmitters and detect anomaly signals.
  - Anomaly Label Assignment: assign labels for the anomaly transmitters by unsupervised clustering.
  - Anomaly Feature Learning: learn the features of the anomaly transmitters and update the open-set authenticator accordingly.

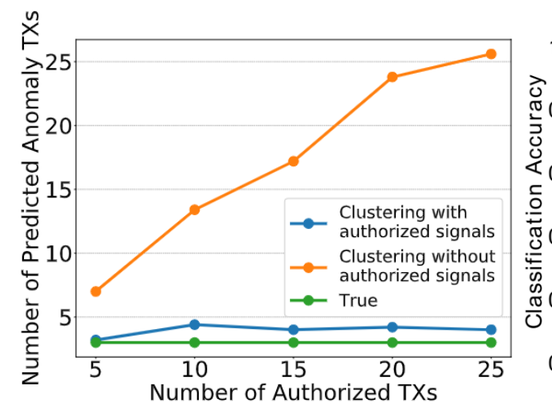
We evaluated the proposed approach on a large-scale WiFi dataset [1].

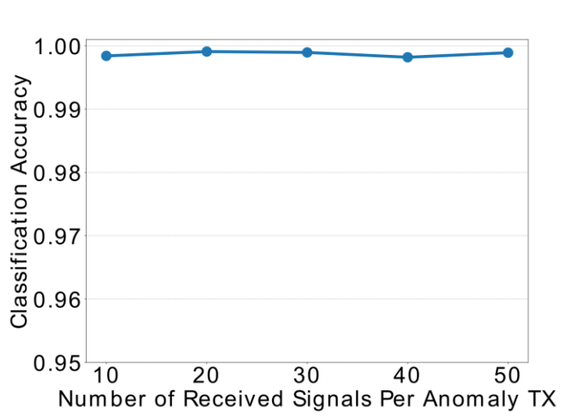
RESULTS

- The ART framework [2] can effectively recognize anomaly signals, achieving >0.93 AUC ROC regardless of the number of authenticated transmitters n and anomaly transmitters k.
- With the proposed anomaly label assignment method, ART can effectively remove misclustered signals.
- ART can learn the features of an anomaly transmitter using 10 signals, and reliably classify the transmitters with 99% overall accuracy.









CONCLUSION

- We considered a practical problem in RF fingerprinting authentication and anomaly detection.
- We proposed a deep learning based framework to reliably recognize and track anomaly transmitters.
- The ART framework can achieve good performance when the transmitter features are consistent, and more work needs to be done to ensure the robustness of the model against variations in the features due to random factors such as wireless channels.

ACKNOWLEDGEMENTS

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REFERENCES

[1] S. Hanna, S. Karunaratne, and D. Cabric, “Wisig: A large-scale wifi signal dataset for receiver and channel agnostic rf fingerprinting,” IEEE Access, vol. 10, pp. 22808–22818, 2022.
[2] T. Zhao, S. Sarkar, Y. Tian and D. Cabric, “Anomaly Transmitter Recognition and Tracking,” in IEEE DySPAN 2024.