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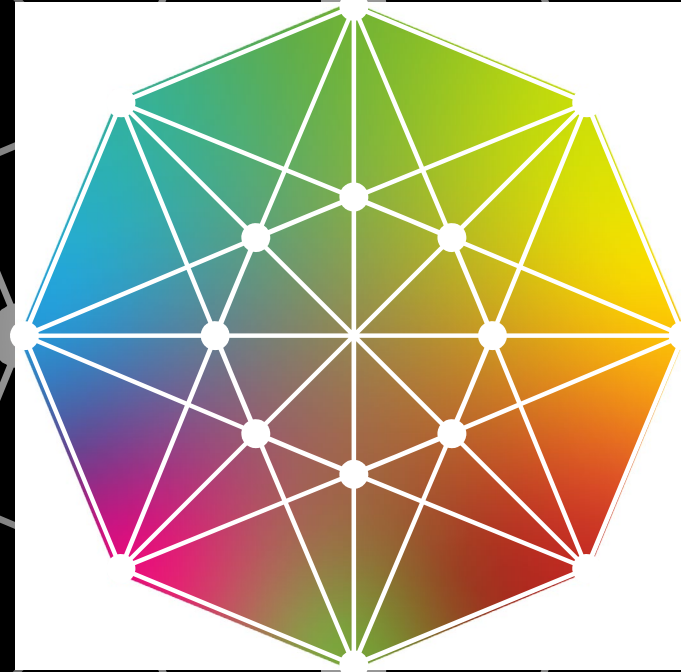
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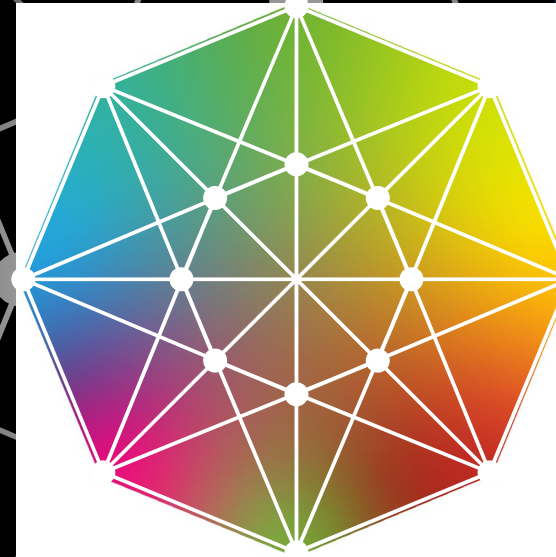
7-9 July 2026
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Hosted by  **AI for Good**
Global Summit



A Sequential Model Selection and Optimization Framework for Security in Zero Touch Network Environments

7-9 July 2026





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Session #S5.4



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Introduction & Security Challenges in ZTNs

- **The 5G/6G Vision:** Networks aim for fully automated, self-healing, and self-securing infrastructures (ETSI ZSM).
- **The Single-Learner Bottleneck:** Static mechanisms and single-model approaches fail against diverse autonomous traffic; relying on one algorithm creates inevitable security blind spots.
- **Concept Drift:** Rapidly evolving attack patterns make static security models obsolete.
- **Latency Constraints:** 6G requires sub-millisecond responses, rendering traditional manual SOC workflows too slow.
- **The Need:** An adaptive Intrusion Detection System (IDS) that integrates multiple models to operate with minimal human intervention.

Proposed Framework: SMSO

- **Core Strategy:** Integrates Online Learning with Automated Machine Learning (AutoML), featuring robust pre-processing and feature engineering.
- **Ensemble Synergy:** Overcomes the weaknesses of individual algorithms by screening a diverse pool of learners and integrating them to cover each other's blind spots.
- **Intelligence Plane:** Operates within the ZTN architecture to execute "Self-X" operations.

Stage A: Online Candidate Screening

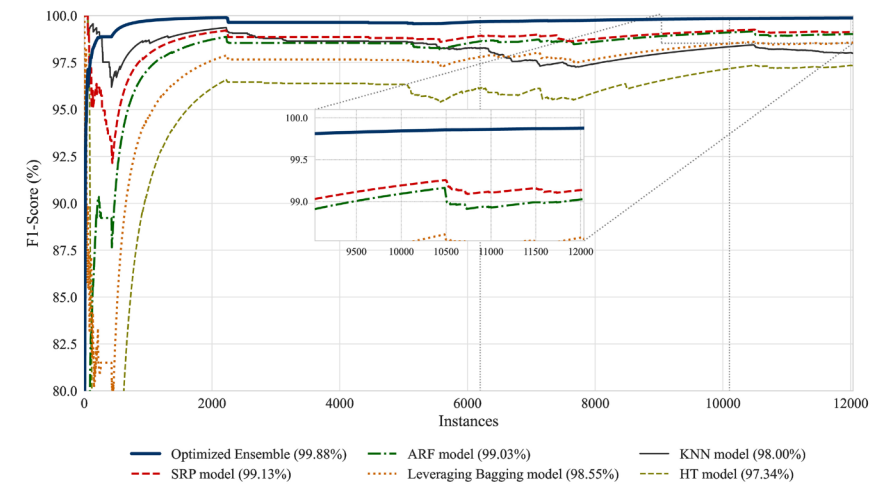
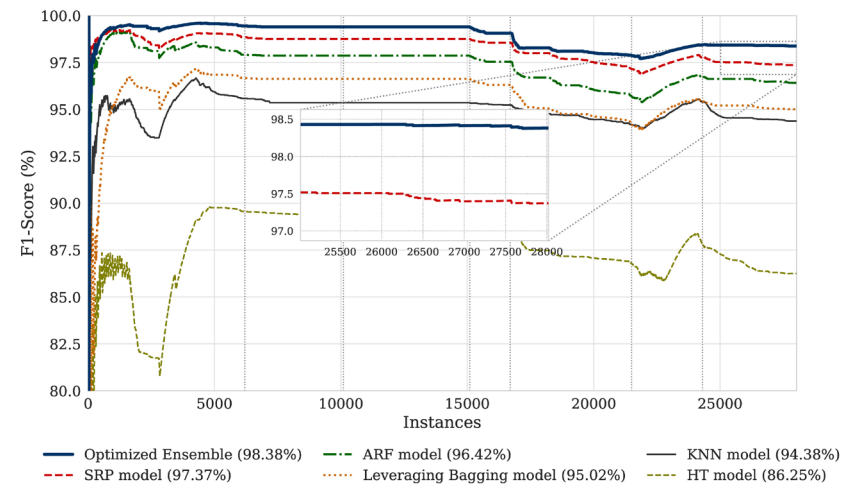
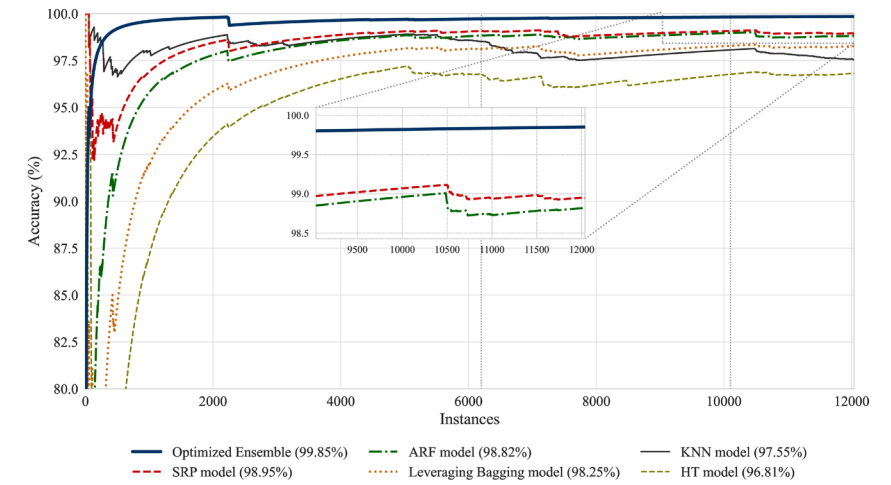
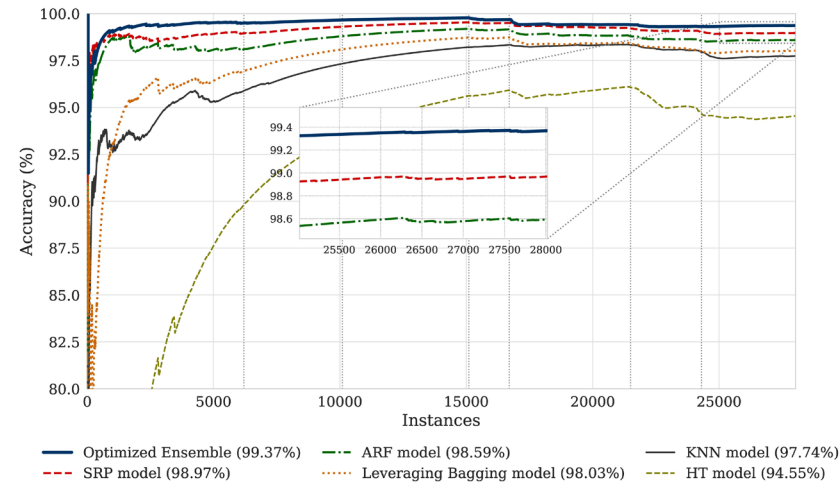
- **Learner Pool:** Includes Hoeffding Trees (HT), Adaptive Random Forest (ARF), and Streaming Random Patches (SRP).
- **Test-Then-Train:** Every sample is used for prediction first, then for updating the model.
- **Real-time Ranking:** Models are ranked dynamically based on their running F1-Score and Accuracy.

Stages B & C: TPE & Weighted Ensemble

- **Bayesian Optimization:** Uses Tree-structured Parzen Estimator (TPE) to tune hyper-parameters on the fly.
- **Dynamic Integration :** The system calculates a proportional weight (ω_k) for each of the top 3 models based on their real-time validation performance. The final prediction is a mathematically weighted sum, allowing the strongest model for a specific attack type to drive the decision..
- **Explainability:** Decisions are transparent through explicit model weights (ω_k) allowing operator verification.

Performance & Results

- **Top Accuracy:**
Optimized Ensemble achieved **99.37%** (CIC-IDS-2017) and **99.85%** (5G-NIDD).
- **Robust F1-Score:**
Maintained **98.38%** (CIC-IDS-2017) and **99.88%** (5G-NIDD) despite Concept Drift.



Operational Viability

- **3GPP Compliance:** Average per-packet latency of **1.47ms** (CIC-IDS-2017) and **2.02ms** (5G-NIDD) respectively.
- **URLLC Ready:** Operates safely within the strict sub-5ms latency requirement for 5G/6G.

5G-NIDD

Model	Avg Latency (ms)
Hoeffding Tree	0.09
k-Nearest Neighbors	3.62
Leveraging Bagging	0.33
Adaptive Random Forest	0.22
Streaming Random Patches	0.33
SMSO Ensemble	2.02

CIC-IDS-2017

Model	Avg Latency (ms)
Hoeffding Tree	0.09
k-Nearest Neighbors	3.27
Leveraging Bagging	0.30
Adaptive Random Forest	0.26
Streaming Random Patches	0.32
SMSO Ensemble	1.47

Conclusion & Future Outlook

- **Key Contribution:** A fully automated, closed-loop security framework (SMSO) for ZTN.
- **AI for Good (Humanity Impact):** Securing 6G infrastructure ensures the reliability of critical societal services, such as healthcare and emergency response.
- **Alignment:** Supports ITU-T SG13 (2025-2028) objectives for trustworthy and autonomous networks.
- **Future Work:** Live validation via NWDAF interfaces in production 5G core environments.

Thank you!

