PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title page (p. 1): “A Systematic Review of Machine Learning-Driven Software-Defined Wireless Sensor Networks: Architectures, Security, and Routing Trends”.
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract (p. 1). The abstract identifies the report as a systematic review; states the review scope, 2024–2025 publication period, number of included articles (n = 46), thematic domains, descriptive quantitative synthesis, principal findings, and limitations related to heterogeneous studies.
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction, pp. 1–2; Section 1.1, “Motivation and Scope” (p. 2); Section 3, “Related Surveys: Comparative Analysis” (pp. 6–10).
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Section 1.1, “Motivation and Scope” (p. 2); Section 1.2, “Contribution and Organization” (pp. 2–3).
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Section 2.2, “Inclusion and Exclusion Criteria” (pp. 3–4). Study groupings for synthesis are described in Sections 4–11, which organize included studies across seven thematic domains.
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Section 2.1, “Search Strategy” (p. 3): IEEE Xplore Digital Library, ACM Digital Library, SpringerLink, and ScienceDirect; primary search conducted between March and December 2025, covering publications from January 2024 to December 2025; supplementary search conducted in early 2026.
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Section 2.1, “Search Strategy” (p. 3): full Boolean search query and search fields (titles, abstracts, and author keywords) are reported. Publication dates were restricted to January 2024–December 2025.
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Section 2.4, “Selection Process” (pp. 4–5); Figure 1 (p. 5). One reviewer conducted title/abstract screening and full-text eligibility assessment; uncertainties were discussed with the supervising author. No automation tools were used.
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Section 2.5, “Data Extraction” (p. 5). One reviewer extracted data from each included article. Extracted values were documented as reported in the original papers. No automation tools were used, and study investigators were not contacted for data confirmation.
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Section 2.5, “Data Extraction” (p. 5). Sought performance outcomes included accuracy, precision, recall, F1 score, latency/timing measures, and throughput. All available reported values relevant to the review domains were extracted; heterogeneous measurement definitions were retained and interpreted descriptively.
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Section 2.5, “Data Extraction” (p. 5). Other extracted variables included ML algorithm family, problem domain, evaluation datasets, experimental setup and platform, network scale and topology, baseline comparisons, key limitations,

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			and future-work statements. Missing or unclear information was not imputed; values were reported as available in the source articles.
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Section 2.6, “Quality Assessment” (pp. 5–6). A seven-criterion quality-assessment scheme scored problem significance, methodological rigor, novelty, baseline comparison, reproducibility, scalability analysis, and real-world applicability on a 0–2 scale. One reviewer performed the assessment; a ten-paper pilot re-evaluation was used for internal calibration. The limitation of no inter-rater agreement assessment is explicitly acknowledged.
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Section 2.5, “Data Extraction” (p. 5); Section 12, “Quantitative Trend Synthesis” (pp. 36–41). No formal effect measures or pooled effect estimates were used. Reported study-level performance measures include accuracy, precision, recall, F1 score, throughput, timing measures, packet loss, energy consumption, and resource-use measures. Values are synthesized descriptively.
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Section 2.2, “Inclusion and Exclusion Criteria” (pp. 3–4); Section 2.4, “Selection Process” (pp. 4–5); Section 2.6, “Quality Assessment” (pp. 5–6). Studies were eligible for the final synthesis if they met predefined criteria and achieved a quality score of at least 8 out of 14. Domain-specific syntheses are organized in Sections 5–11.
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Section 2.5, “Data Extraction” (p. 5); Section 12, “Quantitative Trend Synthesis” (pp. 36–37). Extracted values were documented as reported in original studies. No imputation or conversion to standardized effect sizes was performed. Heterogeneous timing definitions were retained as study-specific measures and were not pooled.
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Sections 3–14, Tables 1–9 and Figures 1–8 (pp. 7–50). Domain-specific comparative tables summarize study characteristics and reported findings. Figures visualize the PRISMA selection process, taxonomy, privacy trade-offs, cross-dataset patterns, temporal trends, deployment evolution, decision guidance, and research-gap prioritization.
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Section 12, “Quantitative Trend Synthesis” (pp. 36–41). A descriptive cross-study synthesis was used because studies differed substantially in datasets, tasks, network topologies, hardware resources, validation environments, and measurement definitions. No formal meta-analysis, pooled effect estimate, or controlled head-to-head comparison was performed.
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Section 12, “Quantitative Trend Synthesis” (pp. 36–41), especially the Methodological Note (pp. 36–37). Heterogeneity was described qualitatively across datasets, tasks, deployment conditions, validation platforms, hardware resources, workloads, and timing definitions. No formal subgroup analysis or meta-regression was conducted.
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Not applicable. No formal sensitivity analyses were conducted because this review used a descriptive synthesis of heterogeneous engineering studies rather than a statistical meta-analysis.
Reporting bias	14	Describe any methods used to assess risk of bias due to missing results in	Not assessed. No formal assessment of reporting bias or publication bias was

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assessment		a synthesis (arising from reporting biases).	conducted. The review acknowledges limitations arising from heterogeneous evaluation settings, database restrictions, English-language eligibility, limited real-hardware validation, and single-reviewer screening and quality assessment; see Sections 2.2, 2.4, 2.6, 12, and 14 (pp. 3–6, 36–41, and 45–50).
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Not assessed using a formal certainty-of-evidence framework. Section 2.6, “Quality Assessment” (pp. 5–6), evaluates the methodological quality of included studies; Section 12, “Quantitative Trend Synthesis” (pp. 36–41), explains why the heterogeneity of the evidence prevents formal comparative certainty judgments.
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Section 2.4, “Selection Process” (pp. 4–5); Figure 1, PRISMA 2020 flow diagram (p. 5). Records identified: n = 243; duplicate records removed: n = 9; records screened: n = 234; records excluded during title/abstract screening: n = 145; full-text reports assessed for eligibility: n = 89; full-text reports excluded: n = 27; studies assessed using quality criteria: n = 62; studies excluded after quality assessment: n = 16; included studies: n = 46.
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Section 2.2, “Inclusion and Exclusion Criteria” (pp. 3–4); Figure 1 (p. 5). Full-text exclusions are reported in aggregate in the PRISMA diagram (n = 27), and studies excluded after quality assessment are reported as scoring below 8 out of 14 (n = 16). The eligibility reasons correspond to the predefined exclusion criteria in Section 2.2.
Study characteristics	17	Cite each included study and present its characteristics.	Sections 3–11, Tables 1–6 and associated narrative descriptions (pp. 7–36). Included studies are cited individually and characterized by domain, ML approach, dataset, deployment setting, reported performance measures, network context, and study-specific limitations.
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Section 2.6, “Quality Assessment” (pp. 5–6). Quality assessment is reported at the review level, including scoring criteria, score threshold, score range (9–13), and mean score (10.7). Individual study-level quality scores are not separately tabulated.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Sections 5–11 and Tables 2–6 (pp. 13–36). Reported performance values and study-specific findings are presented for DDoS mitigation, intrusion detection, privacy preservation, data integrity, routing, QoS management, and network efficiency. Formal effect estimates and confidence intervals were not applicable because no comparative statistical meta-analysis was conducted.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Section 12, “Quantitative Trend Synthesis” (pp. 36–41). The Methodological Note summarizes heterogeneity in datasets, tasks, deployment conditions, validation platforms, and timing definitions. Section 2.6 (pp. 5–6) describes study quality assessment and its limitations.
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Section 12, “Quantitative Trend Synthesis” (pp. 36–41). No formal statistical meta-analysis was conducted. Descriptive reported-value aggregates are presented, including observed performance ranges, study counts, dataset-use patterns, timing-measure discussion, validation methods, scalability patterns, and temporal trends.

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	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Section 12, “Quantitative Trend Synthesis” (pp. 36–41). The review qualitatively identifies heterogeneity related to datasets, tasks, topologies, hardware, workloads, deployment architecture, validation platform, and timing definitions. No formal subgroup analysis or meta-regression was conducted.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Not applicable. No formal sensitivity analyses were conducted because the review did not perform a statistical meta-analysis.
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Not assessed. The review did not conduct a formal reporting-bias or publication-bias assessment. Limitations relevant to possible bias and incomplete evidence are discussed in Sections 2.4, 2.6, 12, and 14 (pp. 4–6, 36–41, and 45–50).
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Not assessed using a formal certainty-of-evidence framework. Section 2.6, “Quality Assessment” (pp. 5–6), and Section 12, “Quantitative Trend Synthesis” (pp. 36–41), provide the review’s structured assessment of study quality, evidence heterogeneity, and interpretive limitations.
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Section 15, “Conclusions” (pp. 50–51); Section 13, “Design Guidelines for Practitioners” (pp. 41–45). Findings are interpreted in relation to security, routing, deployment architecture, privacy preservation, practical design guidance, and methodological heterogeneity.
	23b	Discuss any limitations of the evidence included in the review.	Section 12, “Quantitative Trend Synthesis” (pp. 36–41); Section 14, “Research Gaps and Future Directions” (pp. 45–50); Section 15, “Conclusions” (pp. 50–51). Limitations include heterogeneous datasets and protocols, limited real-hardware validation, limited cross-dataset testing, weak scalability evidence, and limited assessment of energy-performance trade-offs, adversarial robustness, explainability, and zero-day detection.
	23c	Discuss any limitations of the review processes used.	Section 2.4, “Selection Process” (pp. 4–5); Section 2.6, “Quality Assessment” (pp. 5–6); Section 15, “Conclusions” (pp. 50–51). Limitations include single-reviewer screening, single-reviewer quality assessment, absence of inter-rater agreement assessment, restricted databases, English-language eligibility, no published protocol, and no review registration.
	23d	Discuss implications of the results for practice, policy, and future research.	Section 13, “Design Guidelines for Practitioners” (pp. 41–45); Section 14, “Research Gaps and Future Directions” (pp. 45–50); Section 15, “Conclusions” (pp. 50–51). The manuscript provides evidence-informed deployment guidance and identifies priorities for real-world validation, cross-domain transfer learning, energy-performance optimization, adversarial robustness, scalability, explainability, heterogeneous integration, and zero-day detection.
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Section 2.3, “Protocol and Registration” (p. 4): “This systematic review was neither registered in a review registry nor preceded by a published protocol.”
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Section 2.3, “Protocol and Registration” (p. 4): No review protocol was published or made publicly available. The review methodology is reported in the manuscript.

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	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Not applicable. The review was not registered and no protocol was published; therefore, there were no registered or protocol amendments to report.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Funding statement (p. 51): “This research received no external funding.”
Competing interests	26	Declare any competing interests of review authors.	Conflicts of Interest statement (p. 51): “The authors declare no conflicts of interest.”
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Data Availability Statement (p. 51): “No new data were created in this study. Data sharing is not applicable to this article.” The review is based on published studies cited in the reference list. No analytic code or publicly deposited extraction dataset is reported.

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