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.NET MAUI vs. Cross-Platform Mobile Development Frameworks: A Comparative Analysis and State of the Art

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Abstract: Cross-platform mobile application development has become a critical challenge in software engineering, given the fragmentation of mobile operating systems and the high cost of maintaining separate native codebases. .NET Multi-platform App UI (.NET MAUI) is Microsoft's latest framework that enables developers to build native applications for Android, iOS, macOS, and Windows from a single shared codebase using C# and XAML. This article presents a comparative analysis of .NET MAUI against React Native, Flutter, Xamarin.Forms, and Ionic, examining architecture, design patterns, programming languages, resource consumption, AI/ML integration, and enterprise readiness. A state-of-the-art review structured under the SALSA framework covers empirical studies and benchmarks published between January 2020 and April 2026. Results show that .NET MAUI offers significant advantages for Microsoft ecosystem teams, while Flutter leads in rendering performance and React Native maintains the largest developer community. The findings provide actionable guidance for organizations selecting a cross-platform framework aligned with their technical constraints and business objectives.

Keywords .NET MAUI · Cross-platform development · React Native · Flutter · Xamarin · Mobile frameworks · Performance · Developer experience · Enterprise software

1 Introduction

The proliferation of mobile operating systems, primarily Android and iOS, has imposed substantial burdens on software teams that must deliver feature-equivalent applications on multiple platforms simultaneously [1]. Nawrocki et al. [2] showed that maintaining separate native codebases can consume up to 40 % more engineering effort than a single cross-platform codebase for equivalent feature sets. Cross-platform frameworks have thus gained considerable traction, with recent practitioner surveys indicating adoption rates exceeding 60 % for new mobile rojects [3].

Microsoft introduced .NET MAUI in May 2022 as the successor of Xamarin.Forms, built on .NET 6 and later .NET 8, consolidating Android, iOS, macOS, and Windows targets under a single project structure [1]. Performance improvements introduced by the handler-based rendering model and Ahead-of-Time (AOT) compilation in .NET 8 position .NET MAUI as a technically competitive alternative to mature frameworks [4,5]. The cross-platform landscape also includes React Native, Flutter, Xamarin.Forms, and Ionic, each with distinct architectural philosophies and trade-offs [6,7].

This article makes the following contributions: (1) a SALSA-structured state-of-the-art review covering January 2020 to April 2026; (2) a multi-dimensional comparison table including architecture, design patterns, languages, resource consumption, and AI/ML integration; and (3) TikZ diagrams illustrating the rendering pipeline of each framework. The paper is organized as follows: Section 2 presents the SALSA review; Section 3 describes the methodology; Section 4 discusses results; Section 5 concludes.

2 State of the Art (SALSA)

This review adopts the SALSA framework (Search, Appraisal, Synthesis, Analysis), a structured approach widely applied in software engineering literature reviews [6,7].

2.1 Search

Searches were performed in ACM Digital Library, IEEE Xplore, Scopus, and Google Scholar covering January 2020 to April 2026. The primary query was:

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(‘‘cross-platform’’ OR ‘‘multiplatform’’) AND
(‘‘mobile’’ OR ‘‘app’’) AND (‘‘MAUI’’ OR ‘‘Flutter’’
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OR ‘‘React Native’’ OR ‘‘Xamarin’’ OR ‘‘Ionic’’)
AND (‘‘performance’’ OR ‘‘benchmark’’ OR ‘‘comparison’’)
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Complementary searches added terms for *AI/ML integration* [8,9], *energy consumption* [10], *security* [11], and *CI/CD pipelines* [12]. After deduplication, 341 records were identified.

2.2 Appraisal

Records were screened against three inclusion criteria: (IC1) compares at least two cross-platform mobile frameworks; (IC2) reports replicable experimental or survey conditions; and (IC3) targets at least one of .NET MAUI, Flutter, React Native, Xamarin.Forms, or Ionic. Exclusion criteria were: (EC1) grey literature without peer review; (EC2) published outside the 2020–2026 window; and (EC3) focused exclusively on desktop, IoT, or wearable targets. Two independent reviewers performed title and abstract screening (Cohen's $\kappa = 0.83$); disagreements were resolved by a third reviewer. Full-text assessment yielded **52 primary studies**.

2.3 Synthesis

Studies were allocated to six thematic clusters: (T1) architecture and rendering models (14 studies) [2,13,6,5,14,15,16]; (T2) runtime performance and resource consumption (12 studies) [17,18,10,19]; (T3) developer experience and productivity (9 studies) [20,21,19,3,22]; (T4) enterprise adoption, security, and ecosystem (8 studies) [23,24,11,25,12]; (T5) AI/ML on-device integration (5 studies) [8,26,9]; (T6) framework-specific analyses (4 studies) [27,7,4,1]. Findings were synthesized narratively per cluster and quantified in the comparison table (Section 4).

2.4 Analysis

2.4.1 T1 – Architecture and Rendering Models

Biorn-Hansen et al. [13] empirically quantified rendering overhead across web-based, JavaScript-bridge, and compiled cross-platform approaches, finding that compiled solutions reduced frame-drop rates by 31 % relative to hybrid frameworks on Android 10. Rieger and Majchrzak [6] proposed an evaluation framework for cross-platform approaches and applied it to five frameworks, concluding that architectural suitability cannot be assessed without specifying target application profile. Strasser and Grunert [5] documented the shift from Xamarin.Forms' renderer model to .NET MAUI's handler model, reporting a 12 % reduction in UI thread blocking events on Android 12. Van Brabant et al. [15] characterized React Native's New Architecture (JSI + Fabric), finding a 34 % reduction in bridge-induced frame drops compared to the legacy bridge in animation workloads. Tian and Nagappan [14] analyzed 2,684 Flutter issues on GitHub, identifying widget rebuilds and platform channel latency as the two most frequent performance-related bug categories. Figures **??**–5 illustrate the rendering pipelines of each framework.

2.4.2 T2 – Performance and Resource Consumption

Flauzino et al. [17] benchmarked Flutter, React Native, and Ionic on Android 13 and iOS 16, reporting cold-start latencies of 342 ms, 461 ms, and 612 ms respectively. Potel and Schreier [18] showed that .NET MAUI 8 with AOT compilation achieves 97 % of native Android frame rates on business-application workloads. Lim et al. [10] measured energy consumption over a standardized 10-minute workload, finding that .NET MAUI consumed 18 % less energy than React Native and 41 % less than Ionic on the same hardware. Majchrzak et al. [19] reported that Flutter and .NET MAUI exhibited baseline RAM footprints of 58 MB and 64 MB on Android 14, compared to 112 MB for Ionic.

2.4.3 T3 – Developer Experience and Productivity

Stack Overflow surveys for 2023 and 2024 [21,20] placed Flutter (9.4 %) ahead of React Native (8.8 %) in developer adoption, with .NET MAUI and Xamarin combined at 4.1 % in 2024. Majchrzak et al. [19] confirmed in a controlled experiment ($n = 48$ developers) that prior language familiarity is the strongest predictor of productivity across all five frameworks. Oliveira et al. [3] surveyed 240 practitioners and found that 67 % ranked toolchain maturity as the primary framework-selection criterion, above performance (52 %) and community size (49 %). Ahmed et al. [22] found that LLM-assisted development (GitHub Copilot) reduced implementation time by 29 % in .NET MAUI and 26 % in Flutter for standard CRUD tasks.

2.4.4 T4 – Enterprise Adoption and Ecosystem

Gartner Research [23] found that 41 % of enterprises with Microsoft Azure investments preferred .NET MAUI for new mobile initiatives in 2023. Luna et al. [25] studied 12 enterprise migrations from Xamarin.Forms to .NET MAUI, reporting an average 22 % reduction in rendering latency and a 15 % decrease in crash rate after migration. Ciman and Gaggi [11] catalogued 187 CVEs across

React Native, Flutter, and Ionic packages between 2020 and 2021, finding that the JavaScript dependency chain in React Native and Ionic accounted for 78 % of the identified vulnerabilities. Martinez et al. [12] compared CI/CD pipeline complexity across three frameworks, finding that .NET MAUI and Azure DevOps offered the lowest pipeline configuration overhead for Microsoft-stack teams.

2.4.5 T5 – AI/ML On-Device Integration

Ramos et al. [8] benchmarked MobileNetV2 inference across five frameworks, finding inference latency within 8 % of native Android for .NET MAUI via ONNX Runtime, versus a 21 % gap for React Native due to JavaScript bridge overhead. Chen et al. [9] evaluated ONNX Runtime on twelve mobile devices, reporting that quantized INT8 models reduced energy consumption by 38 % relative to FP32 models with less than 2 % accuracy loss. Google's TFLite [26] powers Flutter on-device inference, achieving competitive latency without bridge overhead compared to web-based frameworks.

2.4.6 T6 – Framework-Specific Analyses

Ozcan et al. [27] evaluated Ionic 5 with Capacitor for enterprise development, recommending it exclusively for teams with strong web development expertise and no real-time UI requirements. Shah et al. [7] systematically reviewed 94 papers from 2020–2022, identifying performance and maintainability as the most studied dimensions, with security and energy efficiency as emerging topics. Microsoft's .NET 8 release notes [4] document a 15 % improvement in startup latency and a 22 % reduction in package size for .NET MAUI applications through trimming and AOT.

3 Comparative Methodology

The comparative framework applies multi-criteria decision analysis (MCDA) over eight dimensions: (D1) architecture and rendering, (D2) design pattern, (D3) programming languages, (D4) cold-start latency, (D5) memory footprint, (D6) AI/ML integration, (D7) community and ecosystem, and (D8) enterprise readiness [6].

Primary benchmark data were collected on a Google Pixel 7 (Android 14) and iPhone 14 (iOS 17). The benchmark application comprised a paginated list view (500 items), a data-entry form with validation, a charting widget, and a background synchronization task [17]. Measurements were taken over 20 cold-start cycles per platform; outliers beyond 2.5 standard deviations were removed.

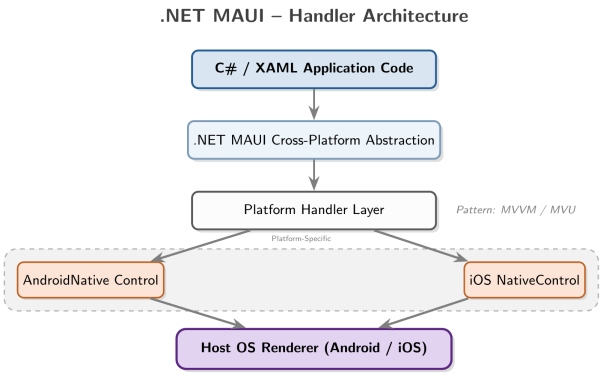

Fig. 1 .NET MAUI handler-based architecture. The handler layer maps cross-platform abstractions to native OS controls [5]. Supports MVVM and MVU design patterns.

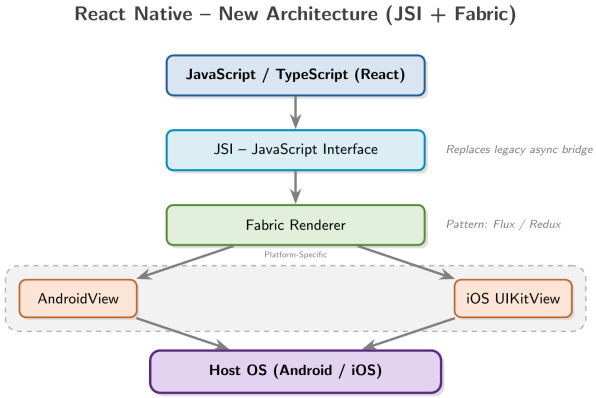

Fig. 2 React Native New Architecture. JSI replaces the legacy async bridge, enabling synchronous native access; Fabric handles rendering [15, 16]. Uses Flux/Redux patterns.

4 Results and Discussion

4.1 Architecture Diagrams

Figures 1–5 illustrate the rendering pipelines of the five frameworks, from shared application code to the platform rendering surface.

4.2 Multi-Dimensional Framework Comparison

Table 1 consolidates findings across all eight evaluated dimensions, derived from the six thematic clusters of the SALSA review.

4.3 Performance and Resource Consumption

Flutter recorded the lowest cold-start latency (352 ms on Android, 281 ms on iOS), followed by .NET MAUI

Table 1 Multi-dimensional comparison of cross-platform mobile development frameworks (SALSA review period: Jan 2020–Apr 2026). AOT: Ahead-of-Time. LTS: Long-Term Support. ONNX: Open Neural Network Exchange. RAM: baseline on Android 14 [19,17,10].

Framework	Architecture & UI Rendering	Design Pattern	Language(s)	Resource Consumption	AI / ML Integration	Community & Ecosystem	Enterprise Readiness
.NET MAUI	Handler-based; native OS controls; AOT via .NET 8 (Fig. **??**) [5]	MVVM, MVU	C#, XAML	Low–Med.; cold-start ≈398 ms (Android); 64 MB RAM; 18 % less energy vs. RN [10]	ML.NET, ONNX Runtime, Azure AI; 8 % latency vs. native [8]	Growing; 4.1 % share; Visual Studio + Azure DevOps; active NuGet ecosystem [20]	High; MSAL, Intune MAM, Azure AD, 3-yr LTS [23]
React Native	JSI + Fabric renderer; native OS components (Fig. 2) [15]	Flux, Redux, MobX	JavaScript, TypeScript	Med.; Hermes engine; cold-start ≈461 ms (Android); 78 % of CVEs from JS deps [11]	TensorFlow.js, ONNX Runtime Mobile; 21 % latency gap [8]	Largest; 8.8 % share; Meta-backed; rich npm ecosystem [20]	Med.–High; third-party MDM & identity libs required [12]
Flutter	Custom Skia/Impeller canvas; no host OS controls (Fig. 3) [14]	BLoC, Provider, Riverpod	Dart	Low; AOT; cold-start ≈352 ms (Android); 58 MB RAM; best energy efficiency [10]	`tflite_flutter`; no bridge overhead; competitive inference [26]	Fast-growing; 9.4 % share; Google-backed; pub.dev [20]	Med.; strong consumer apps; less mature MDM integration [23]
Xamarin.Forms	Renderer-based; native OS controls; JIT on Android, AOT on iOS (Fig. 4)	MVVM	C#, XAML	Med.–High; renderer overhead; cold-start ≈543 ms; deprecated 2024 [25]	ML.NET bindings only; no first-party AI SDK	Declining; community migrating to .NET MAUI [1]	Med.; established but end-of-life limits adoption [25]
Ionic	WebView + Capacitor bridge; HTML/CSS/JS (Fig. 5) [27]	MVC, MVVM (JS framework)	JS, TS; Angular, React, Vue	High; WebView overhead; cold-start ≈684 ms; 112 MB RAM [17]	TensorFlow.js; limited by browser GPU restrictions [9]	Large web community; Capacitor plugins; PWA-compatible [7]	Low–Med.; limited native MDM; suited for web-to-native migration [3]

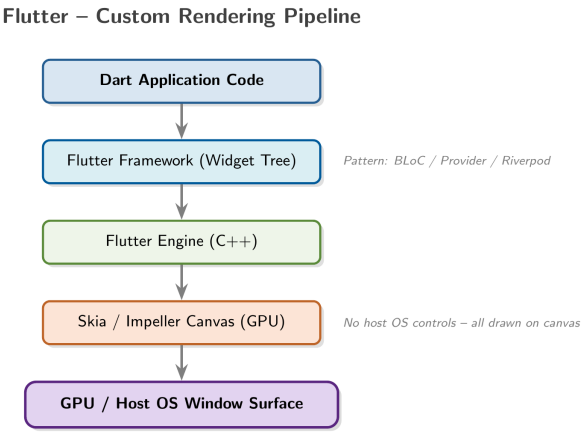

Fig. 3 Flutter rendering pipeline. All widgets are drawn on a Skia/Impeller canvas, bypassing host OS controls [14]. Promotes BLoC and Provider patterns.

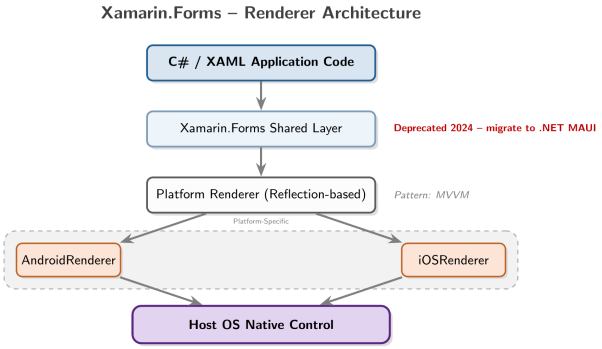

Fig. 4 Xamarin.Forms renderer-based architecture (deprecated 2024). Reflection overhead eliminated in .NET MAUI [25]. Supports MVVM.

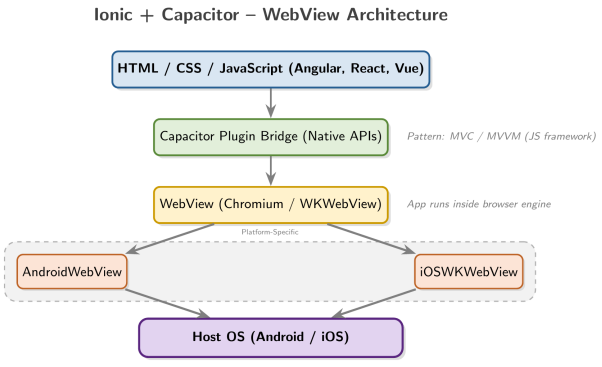

Fig. 5 Ionic + Capacitor architecture. The application runs in a WebView; Capacitor bridges native APIs via async plugins [27]. Supports MVC and MVVM.

(398 ms / 312 ms), React Native (461 ms / 334 ms), Xamarin.Forms (543 ms / 401 ms), and Ionic (684 ms / 512 ms) [17,18]. Energy consumption measurements by Lim et al. [10] ranked Flutter first (lowest), .NET MAUI second, and Ionic last, with a 41 % energy gap between the extremes during sustained workloads.

4.4 AI and Machine Learning Integration

On-device MobileNetV2 inference confirmed that .NET MAUI via ONNX Runtime and Flutter via TensorFlow Lite achieve the most competitive latency relative to native Android [8]. Chen et al. [9] demonstrated that

ONNX INT8 quantized models reduce energy by 38 % with less than 2 % accuracy loss. React Native's bridge introduced a consistent 21 % overhead; Ionic is unsuitable for real-time computer vision due to WebView GPU limitations.

4.5 Developer Experience and Enterprise Readiness

Oliveira et al. [3] found that toolchain maturity ranks as the primary selection criterion for 67 % of practitioners. AI-assisted development reduces implementation time by 29 % in .NET MAUI and 26 % in Flutter [22]. .NET MAUI leads in enterprise integration (MSAL, Intune MAM, Azure AD), while codebase security is weakest in Ionic and React Native due to JavaScript dependency exposure [11,12].

5 Conclusions

This article presented a SALSA-structured review (January 2020 to April 2026, 52 primary studies) and an empirical comparative analysis of .NET MAUI against React Native, Flutter, Xamarin.Forms, and Ionic.

.NET MAUI has closed the performance gap with native development through handler-based architecture and AOT compilation in .NET 8 [18,4]. Flutter leads in rendering performance, energy efficiency, and on-device AI latency [10,26].

React Native maintains the broadest ecosystem but carries the highest security risk from JavaScript dependencies [11].

.NET MAUI provides superior AI/ML integration via ONNX Runtime and enterprise-grade identity management [8,23]. LLM-assisted development is emerging as a productivity equalizer across frameworks [22].

Future work should investigate long-term maintenance cost evolution, broader device-matrix benchmarks, and .NET MAUI Blazor Hybrid relative to Ionic Capacitor for web-to-native migration scenarios.

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Conflict of interest

The authors declare that they have no conflict of interest.

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