



HarmonyOS NEXT

Summary

HarmonyOS Next is an advanced version of Huawei's operating system designed to provide seamless connectivity and functionality across a diverse ecosystem of devices, including smartphones, tablets, and IoT products. Launched as part of Huawei's strategic response to geopolitical challenges and U.S. sanctions, HarmonyOS Next aims to foster a unified digital experience through its innovative features, such as multi-device collaboration, enhanced security protocols, and an upgraded user interface.^{[1][2]} The operating system represents a significant evolution in Huawei's software strategy, reflecting the company's commitment to establishing a competitive alternative to dominant platforms like Android and iOS.

Notable for its microkernel architecture, HarmonyOS Next facilitates secure and efficient inter-device communication, allowing users to transition tasks effortlessly between devices. With features like the "Super Device" functionality, users can drag and drop icons to connect and control multiple devices, thereby simplifying interactions and enhancing productivity.^{[3][4]} Furthermore, the OS incorporates advanced AI capabilities, such as the upgraded Celia virtual assistant, which aims to deliver a more intuitive user experience through contextual awareness and improved dialogue recognition.^{[5][6]}

The introduction of HarmonyOS Next has sparked both interest and scepticism within the tech community. Critics have raised concerns about Huawei's ability to build a robust developer ecosystem and differentiate its offerings sufficiently from existing platforms, while supporters highlight its potential to disrupt the global operating system landscape, particularly in the Chinese market.^{[7][8]} As Huawei prepares for the anticipated launch of HarmonyOS Next in October 2024, the company is focused on migrating critical applications and expanding its developer programs to solidify its position in the competitive smartphone market.^{[9][10]}

In summary, HarmonyOS Next is not just a software update but a pivotal part of Huawei's broader vision to create a cohesive digital environment, leveraging its capabilities to navigate complex market dynamics and consumer demands in an increasingly AI-driven world.



History

HarmonyOS, developed by Huawei, was officially launched on August 9, 2019, marking a significant entry into the operating system landscape aimed at creating a more interconnected ecosystem across various devices^[1]. The initial release, HarmonyOS 1.0, was designed to function on smartphones, IoT devices, and smart home equipment, emphasising Huawei's vision of a seamless user experience across multiple platforms^[1].

In the following years, Huawei continued to evolve HarmonyOS, integrating new features and expanding its capabilities. The second generation of HarmonyOS introduced a dual framework, allowing for convergence with both EMUI¹ and AOSP (Android Open Source Project), thereby enhancing its functionality across different device types^[1]. This adaptability was crucial as it allowed HarmonyOS to leverage existing Android applications while providing a unique operating environment. Huawei's strategy with HarmonyOS also included significant investment in research and development, as evidenced by a reported \$22 billion commitment to R&D in 2022 to strengthen its technological capabilities amid U.S. sanctions^[2]. This commitment underscores the importance of HarmonyOS not only as a product but also as a strategic response to the geopolitical landscape impacting Huawei's business operations.

By March 2022, the company launched HarmonyOS 2.0, introducing support for atomic service development, enabling developers to create cross-device projects more efficiently^[3]. The release of subsequent versions has included enhancements tailored for larger screens, paralleling trends seen in the broader mobile OS market. HarmonyOS is positioned within Huawei's broader ambition to establish a global digital ecosystem, contributing to its initiatives such as the Digital Silk Road, which seeks to enhance digital connectivity across Eurasia^[2]. As Huawei navigates the challenges posed by international scrutiny and competition, HarmonyOS remains a central element of its future technological roadmap.

¹ EMUI is an interface based on Android developed by Chinese technology company Huawei, used on the company's smartphones primarily globally.



Features

HarmonyOS NEXT introduces a variety of enhancements aimed at improving user experience and developer efficiency.

User Interface Improvements

The operating system has undergone significant visual updates, featuring humane design elements such as rounded maps for level adjustments and borderless folders. Buttons are now designed for better recognition, and the new font can be adjusted for thickness and size, enhancing readability and aesthetic appeal^[4]. Additionally, intelligent widgets on the home screen dynamically adjust content based on the user's daily cycle^[4].

Developer Enhancements

For developers, HarmonyOS NEXT offers an improved ArkUI² Development Framework, making app development more efficient, stable, and smooth. New features include intelligent editing capabilities such as code highlighting, error checking, and intelligent code completion to enhance coding efficiency^[5]. The introduction of the lightweight build tool, DevEco Hvigor, supports flexible build tasks and one-click application packaging^[5].

Multi-Device Collaboration

A standout feature is the seamless multi-device collaboration. HarmonyOS NEXT supports app continuation, allowing users to effortlessly transfer tasks between devices—be it smartphones, tablets, or smart cars—by simply bringing them close together^[6]. This integration enhances the overall user experience and increases productivity, particularly with applications like Amap and DingTalk, which support cross-device functionalities^[6].

² ArkUI is a declarative based user interface framework for building user interfaces on native HarmonyOS, OpenHarmony alongside Oniro OS applications developed by Huawei for the ArkTS and Cangjie programming language.



AI Integration

The OS also emphasises AI-driven intelligence through Celia, Huawei’s virtual assistant, which has been upgraded to manage third-party apps more effectively and offer natural interactions with users^[6]. This advancement not only facilitates better task management but also enhances dialogue recognition and contextual assistance.

Security Features

In terms of security, HarmonyOS NEXT has introduced the Star Shield Security architecture, which strengthens kernel security and system protection, ensuring a safer user environment^[6]. This commitment to security and privacy positions HarmonyOS NEXT as one of the most secure operating systems to date.

Technical Architecture

HarmonyOS is built upon a unique microkernel architecture designed to enhance security, efficiency, and inter-device communication. This design paradigm enables HarmonyOS to operate as a distributed operating system, integrating various devices into a cohesive environment.

Microkernel Design

At the core of HarmonyOS is its microkernel, which significantly differs from traditional monolithic kernels used in systems like Linux. The microkernel is streamlined, providing only essential services such as thread scheduling and inter-process communication (IPC)^{[7][8]}. Most system services are executed in user mode, thereby reducing the potential attack surface and improving overall system security^{[8][9]}. The microkernel employs formal verification methods, allowing for a rigorous validation of system correctness, which is vital in establishing trustworthiness in the system's operation^[8].

Device Integration and Communication

HarmonyOS features a communication base called DSoftBus, which allows physically separated devices to function as a virtual “Super Device”. This capability facilitates seamless data sharing and control among devices^[9]. The system supports various forms of applications,



including native apps from AppGallery and lightweight Meta Services, which are installation-free and can be accessed across multiple devices^[9].

Development Environment

For developers, HarmonyOS offers a robust toolkit through DevEco Studio, which integrates multiple essential components like the HarmonyOS SDK, Node.js, and an emulator platform^{[5][10]}. The DevEco Studio streamlines the development process with features like intelligent code editing, flexible build tools, and multi-terminal real-time previews^{[5][10]}. The use of ArkTS, a TypeScript-like language, enhances code efficiency and error detection during development^[11].

User Interface Development

The system incorporates ArkUI, a declarative UI framework that improves application interface development efficiency by 30% through concise syntax and rich elements^[11]. The UI can be visually constructed using a layout editor, reducing the complexity and cost of interface design for developers^[12].

Enhanced Features and Security

With its focus on security, HarmonyOS implements a Trusted Execution Environment (TEE) within its microkernel framework. This environment safeguards sensitive data during storage and processing, addressing potential security vulnerabilities across varied devices^{[8][9]}. Moreover, the system's architecture allows for scalable applications, capable of adapting to different form factors and screen sizes seamlessly^[10].

Devices

HarmonyOS Next integrates a variety of devices into a cohesive ecosystem, allowing seamless connectivity and interaction among them. A key feature is the 'Super Device' functionality, which enables users to effortlessly drag and drop icons representing various devices to connect them. For instance, users can switch audio from a smartphone to headphones by dragging the headphone icon onto the phone icon, or cast video content from their phone to a smart TV



simply by dragging the relevant icons together^[13]. This drag-and-drop interface aims to simplify the user experience, making it accessible even to those who are not tech-savvy^[4].

Multi-Screen Collaboration

HarmonyOS supports advanced multi-screen collaboration, where devices can work together to enhance productivity. Users can operate their smartphones on larger displays such as tablets or laptops, with options to extend or mirror screens for better visibility and interaction. In this mode, tasks like file sharing become effortless; users can simply drag and drop files between devices. This collaboration extends to gaming as well, allowing users to play smartphone games on a tablet while continuing to use the phone for messaging^[14]. Such features leverage the strengths of each device, combining computing power, display quality, and audio output to create a unified experience.

Future Prospects

The vision for HarmonyOS extends to smart home devices that utilise a smartphone's capabilities for functionality, minimising the need for individual sensors in appliances like air conditioners or smart speakers. This approach envisions a scenario where various devices, from TVs to smart home sensors, interact closely with a user's smartphone, thereby creating a more intuitive and efficient smart living environment^[4]. By breaking down the barriers between different types of hardware, HarmonyOS Next aspires to unify diverse devices into a single, expansive construct known as the Super Device^{[4][14]}.

Developer Ecosystem

Overview of HarmonyOS Next Development

The HarmonyOS Next platform is positioned as a competitive alternative to existing mobile operating systems, primarily dominated by Android. A key challenge lies in establishing a robust ecosystem of applications tailored specifically for HarmonyOS Next. Currently, convincing developers to create HarmonyOS-specific applications is critical for widespread user adoption^[15]. To address this, Huawei has initiated several developer programs, such as the Huawei Developer Program, which aims to provide developers with essential tools,



resources, and financial incentives to foster innovation and application development for the platform^[15].

Tools and Services for Developers

Huawei's DevEco Studio Next Beta 1 serves as a comprehensive development environment that incorporates various features aimed at enhancing the application development process. This includes application security testing, vulnerability assessments, and privacy testing—facilitated through fully automated testing processes and detailed reporting to identify potential security issues^[16]. Additionally, the studio supports application automation testing that covers compatibility, stability, and performance throughout the application's life cycle^[16].

To further streamline development, DevEco Studio Next offers project templates and cross-device preview capabilities, allowing developers to create applications adaptable across different device types^[16]. The environment supports multiple programming languages, including Java, JavaScript, and C/C++, thus catering to a broad developer audience^[17].

Collaborative Open-Source Initiatives

Huawei has also engaged in collaborative open-source efforts to expand the reach and capability of HarmonyOS Next. The partnership between the Eclipse Foundation and OpenAtom Foundation aims to develop OpenHarmony, an open-source project that allows for vendor-neutral collaboration among global developers. This initiative seeks to bridge the gap between eastern and western developers while promoting the adoption of open-source software across different markets^{[17][1]}. By encouraging local specialisation while maintaining a global community, Huawei hopes to leverage regional innovations to create a universally applicable operating system^[17].

Future Development Plans

Looking ahead, Huawei has outlined a roadmap for the HarmonyOS Next platform, including several developer previews and beta releases set to expand the developer ecosystem further. Key features slated for inclusion in future updates involve enhancements to artificial intelligence capabilities and improved user interface elements, contributing to a more cohesive



development experience^{[1][5]}. As the ecosystem grows, ongoing support for developers will remain a focal point to ensure the successful adoption of HarmonyOS Next across devices.

Reception

HarmonyOS has received a mixed reception since its introduction. While it has been praised for its innovative features and integration across various devices, there have also been concerns about its differentiation from existing Huawei devices.

Consumer Feedback

Early users of HarmonyOS have reported a generally positive experience, noting that the operating system provides a smooth user interface and good performance across multiple devices, including smartphones and wearables like the Watch GT series.^[18] However, there are critiques regarding the lack of substantial differentiation from Huawei's previous operating systems. Analysts have observed that many of the core apps and camera features remain like those found on Huawei devices, leading some to question the uniqueness of HarmonyOS as a standalone product.^[2]

Market Impact

The impact of HarmonyOS on the market has been significant, especially in the context of Huawei's challenges due to sanctions and restrictions. The introduction of HarmonyOS was seen as a strategic move to mitigate these challenges and retain consumer loyalty. However, the transition to HarmonyOS has faced obstacles, such as a fragmented software ecosystem, which may hinder its broader adoption compared to established operating systems like Android and iOS.^[19]

Future Prospects

As HarmonyOS continues to evolve, its prospects appear promising, particularly within the Chinese smartphone market. Analysts from Counterpoint Research anticipate that Huawei's strategic positioning in the 5G segment will facilitate a significant challenge to Apple's iPhone dominance, leading to a potential reshuffling in the smartphone operating system hierarchy^[20].



Techinsights projects that HarmonyOS could surpass iOS to become the second-largest smartphone operating system in China starting in 2024^[20].

The anticipated launch of HarmonyOS Next, scheduled for October 2024, aligns with Huawei's plan to strengthen its presence in the smartphone market. This version is expected to provide a pure native experience and will focus on migrating the 5,000 most critical apps to the new platform^[21]. Achieving this ambitious goal could position HarmonyOS as the third-largest smartphone operating system, enhancing Huawei's competitive edge in an increasingly AI-driven industry^[21].

Moreover, with the global smartphone market projected to experience a 3% year-over-year increase in 2024, Huawei is expected to make a notable recovery in sales, which could further redefine the operating system landscape and diminish the market shares of existing players like Apple and Android^{[20][22]}. The growing demand for AI-capable smartphones also supports this outlook, as the penetration of such devices in Mainland China is expected to exceed the global average significantly^[23].

In preparation for the transition, the developer beta for HarmonyOS Next was unveiled in June 2024 during the Huawei Developer Conference, highlighting the company's commitment to engaging developers and facilitating the migration process from Android^[21]. As Huawei continues to ramp up its AI capabilities and expand its ecosystem, the prospects for HarmonyOS appear increasingly favourable, positioning it as a major contender in the competitive smartphone market landscape.

Citations

HarmonyOS has garnered attention for its rapid development and deployment across various devices. The operating system's architecture aims to facilitate a seamless user experience, allowing for interoperability between different types of devices, including smartphones, IoT devices, and other smart appliances. Its ambition aligns with Huawei's broader strategy to enhance its ecosystem amidst growing challenges in the tech landscape, particularly following legal disputes and trade restrictions in key markets like the United States.



The operating system's design has drawn parallels to existing platforms, emphasising a robust framework that can adapt to diverse hardware specifications. This flexibility is seen as a significant advantage in the ever-evolving tech environment. Additionally, HarmonyOS's potential to support 5G applications is particularly relevant as the demand for high-speed connectivity continues to rise globally.

Recent developments indicate that Huawei is committed to continuously improving HarmonyOS, as evidenced by its investments in research and development. This commitment has led to an increase in patent filings related to the operating system, signifying Huawei's intent to safeguard its innovations in a competitive market.

Further Reading

Key Features of HarmonyOS NEXT

HarmonyOS NEXT introduces several significant advancements designed to enhance user experience. One standout feature is "Celia sees the world", which caters to visually impaired users by reading aloud objects in their vicinity, including details like freshness and location of items in a refrigerator^[24].

Celia Intelligent Agent

Huawei has upgraded its Celia Smart Assistant to the Celia Intelligent Agent, leveraging the Pangu Large Model 5.0. This allows users to command the assistant for various tasks, ensuring efficient completion of operations based on specific requests^[24].

Celia Keyboard Enhancements

The Celia keyboard has also seen improvements with an auto-error correction tool that automatically addresses common spelling mistakes and grammar errors, enhancing the efficiency of text input. It also offers suggestions for better word choices, aligning it with contemporary AI-powered writing assistants^[25].



Multimedia Improvements

The HarmonyOS NEXT beta 3 update brings notable enhancements in camera and video playback capabilities, providing users with more vibrant images and an overall improved multimedia experience^[25].

Application and Device Management

Further, the OS integrates a device-cloud cooperation mechanism for more accurate control of applications, along with an upgraded “Huawei Reading” service, offering a high-quality reading experience with access to numerous books and AI-driven features^[11].

Official Website

The official website for HarmonyOS NEXT serves as a central hub for developers and users interested in exploring the features and capabilities of the operating system. It provides a curated list of resources, libraries, tools, and other relevant materials for developers working with OpenHarmony and HarmonyOS, facilitating easier access to learning resources and updates about the platform^[26].

Additionally, developers can manage their project repositories and associate them with the harmonyos-next topic, enhancing visibility and engagement within the developer community^[26]. The website is expected to be continuously updated with the latest news, including the release of new versions and developer previews^{[9][27]}. As HarmonyOS NEXT evolves, the official website will play a crucial role in disseminating information and fostering a collaborative environment for users and developers alike^[9].

Developer Resources

DevEco Studio

DevEco Studio serves as a comprehensive development environment tailored for creating applications on HarmonyOS. It integrates a range of tools and features, such as the HarmonyOS SDK, Node.js, and an emulator platform, thereby streamlining the installation and configuration processes for developers^[5]. The studio also supports historical project migration, enabling developers to efficiently convert existing projects into the HarmonyOS framework.



Language Support and Refactoring

For developers utilising the ArkTS language, DevEco Studio offers enhanced code editing capabilities, including Refactor-Convert functionalities. This feature supports high-frequency operations, such as converting literal types to mapped types, assisting in efficient code refactoring^[5]. Additionally, the platform provides support for multiple programming languages, including Java, JavaScript, and C/C++, allowing developers to choose the language that best fits their needs^[16].

Distributed Application Development

In developing distributed applications, DevEco Studio emphasises the need to accommodate various device specifications, including screen resolution, shape, and size. The cross-device preview function allows developers to view UI layouts and interaction effects across different devices at any stage of the development process^[16].

Project Templates and Code Management

DevEco Studio 2.0 introduces new Ability templates tailored for various device types and development languages, along with five additional mobile phone project templates. This facilitates the creation of projects that automatically generate corresponding code and resource templates based on developer selections^[16]. Furthermore, component management enhancements grant users improved control over application elements, providing detailed settings for each component of the app^[28].

Performance Analysis and Debugging

The Build Analyser tool within DevEco Studio allows for visual analysis of the compilation and build processes, aiding in troubleshooting performance issues^[5]. The debugging experience has also been improved, with features like the visualisation of debugging variables for JavaScript and C/C++ applications^[16].

Advanced Features

Recent updates to HarmonyOS NEXT include effective gestures and improved motion control, enhancing user interaction capabilities within apps. The updated ArkUI Development



Framework allows developers to create more efficient, stable, and visually appealing applications, including advanced 2D graphics and innovative visual effects^[28]. This array of features and resources positions DevEco Studio as a pivotal tool for developers in the HarmonyOS ecosystem.



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