

Modern Product Development with the Unified Device Intelligence Platform (UDIP)

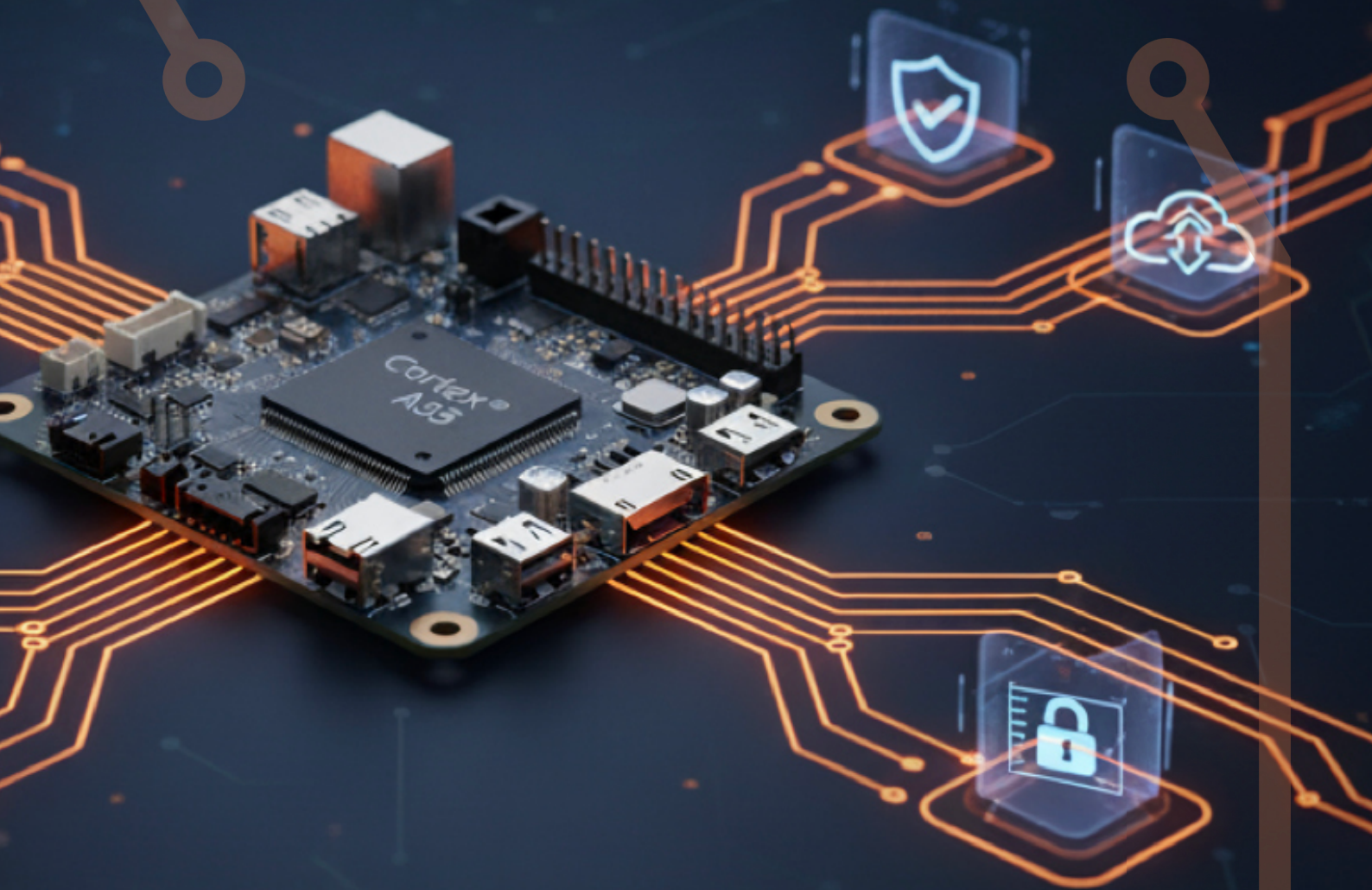


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MODERN PRODUCT DEVELOPMENT WITH THE UNIFIED DEVICE INTELLIGENCE PLATFORM (UDIP)

The Transformation of Intelligent Products: Accelerate Your Time-to-Market, Secure the Product Lifecycle, and Differentiate Through Agentic AI.

EXECUTIVE SUMMARY

Smart, connected physical products are now developed under immense time and cost pressures. At the same time, the demands on security, updateability, and differentiation through artificial intelligence (AI) are increasing exponentially.

The Unified Device Intelligence Platform (UDIP) was designed to directly address these challenges. As a coordinated ecosystem, UDIP combines a pre-developed embedded computing platform, a fully maintained board support package (BSP) including security and over-the-air (OTA) maintenance, and state-of-the-art AI features and blueprints—right down to agentic, intent-based interaction patterns.

The results of this holistic approach are measurable: a drastically reduced time-to-market (30–50% reduction is possible), significantly lower technical debt, enhanced security, and a clearly defined path to AI-driven innovation and differentiation. UDIP allows you to focus on your core product development, while complex, recurring tasks like BSP maintenance are handled by our experts. We support companies end-to-end, from strategy and prototyping to mass production.

ABOUT U-EXPERTEN

U-Experten offers end-to-end services for smart products: IoT, HMI, and AI. Our mission is to guide companies in realizing smart products ("We make smart products").

We position ourselves as experts and partners in product innovation, addressing B2B/industrial or established product manufacturers who want to digitize or "smartify" their offerings. Our vibe is smart, strategic, and modern: Engineering Consultancy + Product Innovation Studio.

Our services are structured into clear phases, which underscores our reliability and precision:

- **Consulting** ("Think Big, Start Small")
- **Acceleration** ("Build on What's There")
- **Realization** ("Make It Real")

This interdisciplinary approach encompasses strategy development, prototyping/MVPs, series production, UX design, and hardware/software engineering.

Our goal is to create products that inspire people.

THE PRODUCT DEVELOPMENT SHIFT – WHY NOW?

The development of connected products is currently undergoing a profound transformation, driven by four key strategic vectors:

Time-to-Market Beats Greenfield Engineering

Developing each stack entirely in-house from scratch (greenfield engineering) is no longer viable given competitive pressure. The market rewards speed: Pre-configured platforms and modular systems are gaining ground because they drastically reduce time to market. UDIP offers a ready-to-use, pre-validated foundation.

Security & Compliance as a Non-Negotiable Hygiene Factor

The regulatory landscape is becoming increasingly stringent, driven by laws such as the RED (Radio Equipment Directive) and the CRA (Cyber Resilience Act). Devices without reliable update processes not only jeopardize the brand and revenue but also lead to potential liability risks. The obligation to keep devices up-to-date and secure throughout their entire lifecycle is now paramount.

AI as a Differentiation Driver

Artificial intelligence has evolved from an optional feature to a key competitive advantage. AI applications such as vision, voice, and especially agentic AI create measurable customer value and enable new, data-driven services. Integrating intelligence into connected products is key to product transformation.

From Touch UI to Intent Experience

The complexity of digital products demands a move away from rigid "screen-tap journeys." The next stage is the intent experience, where users delegate tasks to agents. The user formulates an intent, and the agent orchestrates the necessary workflows in the background.

Conclusion

Companies need a strategic framework that addresses all four vectors: speed, security, AI, and user experience.

THE THREE PILLARS OF THE UNIFIED DEVICE INTELLIGENCE PLATFORM

UDIP is the Unified Device Intelligence Platform. It is designed as a coordinated ecosystem that minimizes development risks and creates a foundation for scalable, innovative product families.

UDIP unites three core components that traditionally had to be developed in isolation:

Embedded Computing Platform (Hardware Layer)

This is the pre-validated physical foundation for the smart product.

- High-performance multi-core SoCs (System-on-Chips), ideally with NPU/GPU options for edge AI.
- Pre-validated drivers, interfaces, and peripherals.
- Focus on production readiness: Consideration of thermal management, EMC, ESD, and provision of complete manufacturing documentation.
- Implementation of security features such as TPM/SE and key storage/fuses (project-specific).

Board Support Package (BSP) with Lifecycle Maintenance

The critical software stack that brings the hardware to life and maintains it throughout its entire lifecycle.

- Security-first approach: Ensured through Secure Boot, signed images, and continuous SBOM (Software Bill of Materials) maintenance.
- Long-term maintenance of kernel, bootloader, drivers, and middleware (such as GStreamer or OpenCV).
- Implementation of a robust OTA (Over-the-Air) update path throughout the device's lifecycle.

AI Building Block: Embedded AI & Agentic Experience

The layer that enables intelligence and new intent-based interaction.

- Provision of AI playgrounds and blueprints for common use cases (e.g., vision and voice use cases).
- Agent blueprints with defined access to device data (sensors) and actuators.
- Enabling the intent-based user interface paradigm: Users define intents, agents orchestrate workflows.
- Support for hybrid UIs (touch/voice/vision).

Benefit in brief: UDIP offers a ready-to-use, pre-validated foundation of hardware, OS stack, and AI building blocks. Teams can focus on differentiation instead of reinventing and maintaining the core stack.

UDIP ARCHITECTURE OVERVIEW

The UDIP architecture is built in clear, interdependent layers to ensure scalability and maintainability, reflecting the structured approach of U experts.

Hardware Layer (Embedded Computing Platform)

This layer provides the physical performance and connectivity:

- **Processing:**
High-performance ARM-based multicore SoCs.
- **Industrial-grade interfaces:**
Essential for B2B/industrial applications, including Ethernet, USB, UART/I²C/SPI, CAN, WiFi 6E, and audio.
- **Security anchors:**
Project-specific security mechanisms such as TPM/SE (Trusted Platform Module/Secure Element) for storing critical keys and protection against cloning/tampering.

System software (BSP):

The Board Support Package is the foundation of the software infrastructure. It includes:

- **Core components:**
Bootloader, kernel, device tree, and hardware drivers.
- **Packaged middleware:**
Pre-configured and tested libraries such as Qt/QML, Flutter, AWS/Azure/Google IoT Stack, IoT Management Client, and SpeechStacks (speech).
- **Security Artifacts & Policies:**
This includes Secure Boot, signed image strategies, and rollback mechanisms in case of failed updates.
- **OTA/Device Lifecycle Management:**
Robust OTA management with staged update rollouts and product feature licensing is integrated.

AI & Intent Layer:

This layer integrates intelligence from the edge to the cloud:

AI Runtimes and Edge Pipelines: Utilizing frameworks such as ONNX Runtime and NPU/GPU/DRP accelerators. This includes preprocessing, feature extraction, and fast inference directly on the device.

Agents and Tools/Skills: The agents are equipped with the necessary capabilities (vision, speech, control commands) and use standardized, MCP-compatible adapters for communication with device sensors and actuators.

Orchestration and Security: Task orchestration includes security and health checks before actuators. Optionally, a cloud backbone can be used for model registry, OTA control, and analytics.

SECURITY & COMPLIANCE AS A DESIGN PRINCIPLE (BSP MAINTENANCE)

The quality and expertise of UDIP's experts are particularly evident in the consistent integration of security and compliance. In UDIP, security is not an "add-on" but an integral part of the maintained BSP and lifecycle services.

The Relevance of BSP Maintenance

Outdated computer systems pose a high risk of security breaches, which are actively exploited by attackers. The UX Group's Board Support Package (BSP) Maintenance Offering provides a comprehensive plan to keep the components of your embedded systems up-to-date, stable, and compliant.

UDIP's structured approach utilizes mainline libraries and components from the active open-source community. This, combined with cascading synergies across the Accelerator platforms, it reduces the complexity and recurring costs of maintaining a current BSP.

Security Mechanisms in UDIP

UDIP implements critical mechanisms based on a secure-by-design approach:

- **Secure Boot & Chain of Trust:**
Ensures that only signed and verified software can boot on the device.
- **Hardware-Based Cryptography:**
Secure key storage in the TPM/SE protects against cloning and manipulation.
- **Robust OTA Update Lifecycle:**
Robust OTA strategies with staged rollouts and fallback/rollback mechanisms are essential to ensure update capability throughout the entire product lifecycle.
- **SBOM & Vulnerability Management:**
Transparency through the Software Bill of Materials and the rapid remediation of relevant CVEs (Common Vulnerabilities and Exposures) are guaranteed.

Compliance and Regulatory Requirements

Mastering new regulations is a key success factor. UDIP supports your CRA and RED readiness strategy, thereby reducing complexity.

Compliance with the Cyber Resilience Act (CRA)

The CRA aims to improve the cybersecurity of digital products. This requires that devices be kept up to date throughout their entire lifecycle.

- The UDIP BSP Maintenance Service ensures this through its focus on mainline components, regular updates, Long-Term Support (LTS), and automated regression testing. For example, key milestones such as the end of LTS for kernels 5.10 and 6.6 in 2027 are taken into account.
- The structured handling of vulnerabilities and ensuring the security of BSP components directly support the goals of the CRA.

Compliance with the Radio Equipment Directive (RED)

The RED aims to ensure the security of radio equipment in the EU and prevent interference.

The BSP maintenance plan in UDIP supports RED compliance by focusing on centralized SBOM-based CVE management and aligned security policies.

An up-to-date BSP and software stack eliminates CVEs, thus ensuring product compliance with RED requirements.

Process Integration

Beyond the technical aspects, UDIP ensures reliability by integrating security into the development process:

- **Standards & Orientation:**

Work is carried out according to IEC 62443-compliant practices (Secure Development Lifecycle), and the EN 303 645 baseline for consumer IoT is considered depending on the product segment.

- **Vulnerability Management:**

Security reviews, threat modeling, penetration tests, and incident playbooks are included.

Become faster and more secure.

Contact me to learn how our BSP Maintenance Subscription and Test Automation Suite keep your products compliant and competitive. Focus on your core business while we handle the complex, recurring testing and maintenance tasks.

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AI AND THE INTENT EXPERIENCE REVOLUTION

UDIP's third pillar is the driving force behind future differentiation and the transformation of user interaction.

From HMI to Intent Experience

Traditional HMI development focuses on optimizing screen flows and touch UI journeys. Intent Experience is the logical next step, taking human-centered user interaction to a new level.

- Instead of navigating complex menus, users formulate their intentions. For example: "...clean the machine outside of peak hours."
- The agent running on the UDIP platform handles the planning, checks states, and executes the intention multimodally (voice, vision, touch) and proactively.
- UDIP provides not only the UI, voice, and vision building blocks, but also the agent blueprints.

Result: Shorter interactions, a drastic reduction in operator errors, increased satisfaction, and new potential for data-driven services.

AI Innovation through UDIP: Use Case Patterns

UDIP enables developers to quickly implement AI functionalities by providing an AI playground and pre-validated blueprints.

A. Vision-Based Perception (Sensing):

- **Active Object Recognition:**
Devices can recognize, segment, and classify objects. This is crucial for automation in industry or retail.

B. Audio & Speech (Interaction):

- **Speech Recognition:**
Enables hands-free operation in complex environments (e.g., laboratories, production facilities).
- **Acoustic Events:**
Detection of leaks, malfunctions, or anomalies.
- **Dialogue Agents:**
Provide on-site service and support without human intervention.

AGENTIC WORKFLOWS (EDGE + CLOUD)

UDIP's true strength lies in enabling complex, agentic workflows. These agents can be orchestrated at the edge or in the cloud and are capable of acting autonomously after a human intent has been formulated.

Typical Agentic Use Cases:

Use Case	Description
Autonomous Planning Agents	The agent schedules maintenance windows, checks the current sensor status, and initiates cleaning or self-healing.
Self-healing	The agent detects a fault or deviation, checks defined safety rules, and executes a predefined recovery sequence.
Predictive Maintenance	The agent combines signals from the edge (real-time data) with historical data in the cloud and prioritizes necessary interventions.

Example scenarios enabled by UDIP:

- **Smart Retail – Agentic Cleaning:**

A cleaning agent monitors frequency and soiling. It automatically schedules non-disruptive cleaning windows, controls autonomous cleaning equipment, and documents the execution. Result: Lower operating costs and consistent quality.

- **Lab Automation – Intent UI:**

Technicians specify intents ("Start protocol X after calibration"). The agent performs the preparation, sensor checks, and protocol-compliant execution. Result: Fewer operator errors, higher productivity.

SECURITY AND GOVERNANCE FOR AGENTIC SYSTEMS

The implementation of autonomous agents requires a high degree of governance and reliability. UDIP directly addresses the potential risks of agentic systems with a policy-first approach and clearly defined design guidelines.

Design Guidelines in UDIP

The connection of agents to device data and actuators is critical. UDIP ensures that agents can only operate within a defined framework:

- **Clear Policy Corridor:**
This defines which actions an agent is permitted to perform and which require mandatory approval from the user or a system.
- **Context Adapter / Tooling:**
Standardized agent interfaces are provided to ensure reusability and scalability. MCP-compatible adapters are available as blueprints and are extended and integrated on a project-specific basis.
- **Safeguards (Security Gates):**
Status and safety checks are performed before each actuator (control of a physical device). This minimizes the risk of uncontrolled or dangerous actions.
- **Sandboxing & Least Privilege:**
Agents receive only the minimum necessary privileges required for their specific task.
- **Telemetry & Human-in-the-Loop:**
Measurement points, audit logs, and the possibility of human intervention (human-in-the-loop) are provided. This increases explainability through traceable logging.

Reducing Technical Debt:

A major problem in long-term product development is increasing technical debt.

UDIP significantly reduces this by:

- Providing a well-maintained BSP with clear update paths.
- Promoting component reusability.
- Utilizing standardized integrations.

By offloading the complexity and effort of maintaining the base system through our expertise, internal teams can focus their resources on developing features that deliver real value to the customer.

BUSINESS BENEFITS: FACTS AND FIGURES

The strategic partnership with the UX Group and the implementation of UDIP result in direct, quantifiable benefits.

Business Benefits in Numbers (Example Values)

The following table summarizes the typical effects that can be achieved by implementing the pre-validated platform and lifecycle services:

Metric	UDIP Effect	Leverage
Time-to-Market (TTM)	-30 – 50 %	Through pre-validated platform and blueprints.
Engineering Effort	-20 – 40 %	Through BSP maintenance and stack reuse.
Field Support Tickets	-15 – 25 %	Through timely OTA patches and telemetry.
Revenue Potential	+10 – 30 %	Through enabling data-driven services and upgrades.
Internal Costs (Personnel/ Infrastructure)	Significant Reduction	Through outsourcing complex, repetitive testing and test setup maintenance.

(Actual effects depend on domain, volume, and level of integration.)

Partnership Benefits

Choosing UDIP is a strategic decision that offers clear advantages over in-house development:

- **Increased Security:** Minimized risk of security incidents thanks to a constantly updated software stack.
- **Reduced Complexity:** Full support for CRA and RED readiness.
- **Faster Cycles:** More reliable release cycles that shorten time to market and enable a rapid response to customer needs.
- **Scalability:** Comprehensive and scalable test coverage without the need to build or expand your own automation environment. Our Test Automation Suite, for example, can automate up to 1,300 test cases daily on dedicated hardware, resulting in enormous manual savings (approximately 300 hours daily in a real-world example).
- **Enhanced Reputation:** Improved product quality and a reduced risk of field failures lower support costs and strengthen brand reputation.

BUILD VS. BUY: A STRATEGIC DECISION FRAMEWORK

Given the increasing pressure to bring innovations to market quickly, securely, and with AI capabilities, CTOs and development leaders must make the strategic decision between in-house development ("Build") and platform adoption ("Buy/Adopt").

The UDIP Differentiation

Criterion	In-house development ("Build")	UDIP ("Buy/Adopt")
Startup speed	Slow (building the entire stack).	Very fast (immediately usable, pre-validated foundation).
Security & Updates	High effort, requires a specialized, dedicated internal team.	Integrated (complete BSP maintenance, OTA updates, CVE management).
AI Integration	Complex tool/model selection and building the MLOps infrastructure.	Playground & Blueprints (accelerates prototyping and use).
Scaling	High risk of technical debt and fragmented solutions.	Platform family (designed for reuse and lifecycle management).
TCO/Capex	High fixed costs and initial investments.	Predictable, value-oriented, and reduced ongoing costs.

The Strategic Recommendation

Our recommendation is: Think Big, Start Small.

UDIP enables the rapid validation of your vision and forms the basis for sustainable scaling. It is a strategic decision that supports product transformation by outsourcing technical complexity.

IMPLEMENTATION: THE UDIP ROADMAP

The introduction of UDIP is based on a clear, structured, and multi-phase approach. The duration and depth depend on the project (domain, complexity, certifications).

The typical UDIP implementation process:

- **Vision & Use Cases (Consulting Phase)**

- Goal: Defining the target vision, identifying the greatest value drivers (e.g., revenue potential, cost reduction), and conducting a compliance check.
- Focus: Prioritizing "first wins"—quick, impactful successes.

- **AI Playground & Prototyping (Acceleration Phase)**

- Goal: Rapid prototyping and clarifying technical feasibility.
- Activities: Utilizing the AI hardware playground (U-Agent Kit) for validating vision, audio, and agency performance on the UDIP platform.

- **Pilot MVP (Acceleration/Realization Phase)**

- Goal: Initial field test and operational readiness of the critical system.
- Activities: Development of the hardware pilot, implementation of the first HMI/intent flows, and establishment of a functional OTA path.

- **Series Production Preparation (Realization Phase)**

- Goal: Preparation for mass production.
- Activities: Industrialization, comprehensive testing and verification (including automated regression testing), obtaining necessary approvals/certifications, and ensuring the supply chain.

- **Rollout & Lifecycle (Ongoing Service)**

- Goal: Continuous improvement and operational reliability throughout the entire lifecycle.
- Activities: Ongoing provision of telemetry, security patches, feature releases, and continuous maintenance of the BSP.

Our accelerators: AI hardware playground, pre-validated driver stacks, reference skills, MCP adapters and OTA blueprints.

CONCLUSION

The Unified Device Intelligence Platform (UDIP) is the strategic answer to the increased demands of modern product development – it is the synthesis of reliable engineering, lifecycle management, and AI innovation.

By adopting UDIP, you ensure that your products not only reach market quickly today, but also remain secure, compliant (RED/CRA-ready), and competitive throughout their entire lifecycle. You lay the foundation for a platform family and maximize the reusability of your development resources.

Kickstart your AI innovation

Start with an AI Vision workshop and utilize the AI Hardware Playground. We'll then define targeted MVPs based on UDIP. Make your products faster, safer, and smarter.

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