intel foundry

Platform Brief

Advancing microelectronics for aerospace, defense, and government

Our process nodes, technologies, and packaging solutions enable high-performance analog/digital designs.

Contents

Aerospace, defense, and government programs face rapid change, driven by geopolitical uncertainty, fast technology cycles, and the need to ensure interoperability across the land, sea, air, space, and cyber domains.

Agencies need security-enhanced, agile microelectronics to replace aging systems and ensure mission readiness and technological superiority.

Next-generation platforms will need extreme compute density, low-latency data access, and resilient architectures to support mission-critical applications in high performance computing (HPC), secure communications, and electronic operations. Intel Foundry delivers these capabilities through advanced process nodes and packaging technologies, backed by U.S.-based manufacturing for improved security and resilience.

Modernization begins by migrating proven designs to leading-edge nodes, integrating chiplets and updated IP.

Designs must meet stringent size, weight, power, and cost (SWaP-C) requirements while operating reliably in harsh environments. Intel Foundry's portfolio delivers advanced nodes for high performance compute and mature nodes for mixed-signal integration.

Intel 18A

Intel 18A introduces **RibbonFET** gate-all-around transistors and **PowerVia** backside power delivery, providing up to **2x performance gain** at ISO power, **5x power reduction** at ISO performance, and **10x chip density***[1] compared to Intel 16 (see Figure 1). These innovations enable extreme compute density within tight thermal and power envelopes—ideal for avionics, radar, and security-enhanced communications platforms operating in constrained environments.

When paired with **Foveros Direct 3D** packaging, Intel 18A supports logic-logic stacking to enable ultralow latency data access in compute-intensive defense workloads. Multi-Vt devices enable energy-efficient designs for battery-powered or off-grid systems.

For mixed-signal and radio-frequency-intensive applications, Intel 18A offers these advantages:

- Stable power delivery and signal integrity during high-transient loads, such as radar bursts or AI inference. **PowerVia** Backside Power Delivery Network (BSPDN) helps to ensure this by shortening the power path and minimizing voltage drop.
- Robust power integrity. **Omni MIM** capacitors for high-frequency decoupling achieve this by filtering noise and stabilizing voltage for fast-switching digital and analog circuits.
- Reduced interference and improved signal integrity for sensitive analog blocks. Electrostatic control achieves this by allowing isolated circuit domains without deep n-well structures, which traditionally isolate analog regions from digital regions.
- Radio frequency (RF) performance at very high frequencies. Thick backside metals enable high-Q inductors, which store energy efficiently for RF circuits, and low-resistivity signal routes, which are critical for maintaining performance.

Building on the foundation of Intel 18A, **Intel 18A-P** adds optimized transistor ribbon sizes and expanded threshold voltage options for finer control over leakage and performance. Intel 18A-P enables designs that balance high-speed logic with ultralow power operation, critical for SWaP-C targets in defense systems. Optimized skew corner modeling improves timing robustness in harsh environments. These refinements make Intel 18A-P well suited for avionics processors, low-leakage compute for off-grid platforms, and chiplet-based mission systems requiring advanced packaging.

Intel 18A delivers			Intel 18A-P delivers
2x performance per watt increase vs. Intel 16	10x chip density increase vs. Intel 16	5x power reduction (at same performance) vs. Intel 16	8% performance per watt increase vs. Intel 18A

Figure 1. Intel 18A delivers improvements in performance, power efficiency, and chip density compared to Intel 16.*[1] Intel 18A-P further enhances performance over Intel 18A.*[2]

Intel 18A-PT for 3D integration

Intel 18A-PT is the industry's first base die with backside power delivery plus design rule compatibility with Intel 18A-P, purpose-built for next-generation 3D integrated circuit (3DIC) architectures. Building on Intel 18A-P, it adds pass-through and die-to-die through-silicon vias (TSVs) along with hybrid bonding, enabling logic-on-logic stacking. This approach brings high-bandwidth memory physically closer to compute resources, reducing latency and increasing memory density. This is critical for HPC applications that need massive memory bandwidth for real-time analytics, and for mission-critical applications that require rapid data access and large model storage. Risk production of Intel 18A-PT is targeted for 2028.

Intel 18A-PT delivers		
~9x die-to-die bandwidth density vs. Intel 3-T	20–25% chip density increase vs. Intel 3-T	25–35% power reduction vs. Intel 3-T

Figure 2. Intel 18A-PT improves bandwidth density, chip density, and power efficiency compared to Intel 3-T (Intel Foundry's base die derivative of Intel 3), offering a more capable base die for multi-chip packages.*[3]

Intel and UMC 12nm process node

The Intel and UMC 12nm process node leverages Intel Foundry's at-scale U.S. manufacturing capacity alongside United Microelectronics Corporation's (UMC's) extensive experience on mature nodes to enable an expanded process portfolio for select applications.[4] The node offers a proven FinFET solution optimized for mixed-signal and RF integration in defense-grade designs.

Delivering strong performance, power, and area (PPA) improvements over 14nm (see Figure 3), the platform is well suited for analog-intensive workloads such as RF transceivers, satellite communication systems, and cost-sensitive defense electronics. A 6-track standard cell architecture improves area efficiency, while a three-mask layer reduction enhances cost competitiveness, supporting scalable deployment across a range of RF and mixed-signal designs.

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*Performance varies by use, configuration, and other factors. Results may vary.

Manufactured in Intel's Arizona fabs, the platform provides a trusted supply chain for government and defense customers. Designers can leverage Intel Foundry Advanced Packaging technologies to integrate 12nm RF and mixed-signal chiplets with advanced logic dies, enabling heterogeneous systems that meet stringent reliability and security requirements.

Intel and UMC 12nm process node delivers		
10% performance per watt increase (at the same power) vs. UMC 14nm	10% area reduction vs. UMC 14nm	20% power reduction (at the same performance) vs. UMC 14nm

Figure 3. Intel and UMC 12nm process node delivers improvements in performance, chip density, and power efficiency compared to UMC's 14nm technology (14FFC).[*5]

Advanced packaging

Intel Foundry Advanced System Assembly & Test (ASAT) provides advanced packaging solutions to support rigorous aerospace, defense, and government requirements. Working with our U.S. Military Aerospace and Government (USMAG) Alliance partners, we provide solutions that meet reliability standards.

Mission-critical applications require complex architectures to support workloads such as signal processing, AI, and security-enhanced communications. Intel Foundry's advanced packaging portfolio enables the integration of multiple heterogeneous chips (chiplets) within a single package, improving system functionality and power efficiency while reducing size and weight. Technologies such as Embedded Multi-die Interconnect Bridge 2.5D (EMIB 2.5D), Foveros 2.5D wafer-level stacking, and Foveros Direct 3D with copper-to-copper hybrid bonding interconnect (HBI) enable customized architectures that maximize data throughput and minimize latency.

Intel Foundry **Flip Chip Ball Grid Array (FCBGA)** packages enable high-density integration of advanced chips, supporting the processing power essential for mission-critical and real-time systems found in avionics, radar, and security-enhanced communications. The robust electrical and thermal performance of FCBGA enhances operational stability under extreme environmental conditions, which are common in aerospace and defense. These features make FCBGA a compelling choice for agencies seeking advanced and long life-cycle semiconductor solutions.

EMIB 2.5D provides high-density, high-bandwidth chip-to-chip interconnects without the need for traditional silicon interposers. With advanced system-in-package (SiP) designs, EMIB 2.5D enables rapid prototyping and chiplet upgrades, which are essential for long-lifecycle defense programs.

In April 2025, Intel unveiled the latest enhancement on the EMIB technology: **EMIB-T 2.5D**. EMIB-T provides relatively thick vertical copper connections called through-silicon vias (TSVs). The TSVs allow power from the circuit board below to directly connect to the chips above instead of routing around the EMIB, reducing power lost by a longer journey (see Figure 4). Additionally, EMIB-T contains multiple layers of copper power and ground meshes integrated with high-density capacitors. These reduce noise in the power delivered to processor cores and other circuits.

Foveros 2.5D and **Foveros Direct 3D** take integration further by enabling vertical stacking of logic, reducing overall footprint and power consumption. This is hugely beneficial for platforms such as satellites, avionics, and embedded systems that have size, weight, and power constraints.

EMIB and Foveros 2.5D can work with solutions that incorporate various nodes and dies from any foundry, embracing the evolving chiplet landscape.

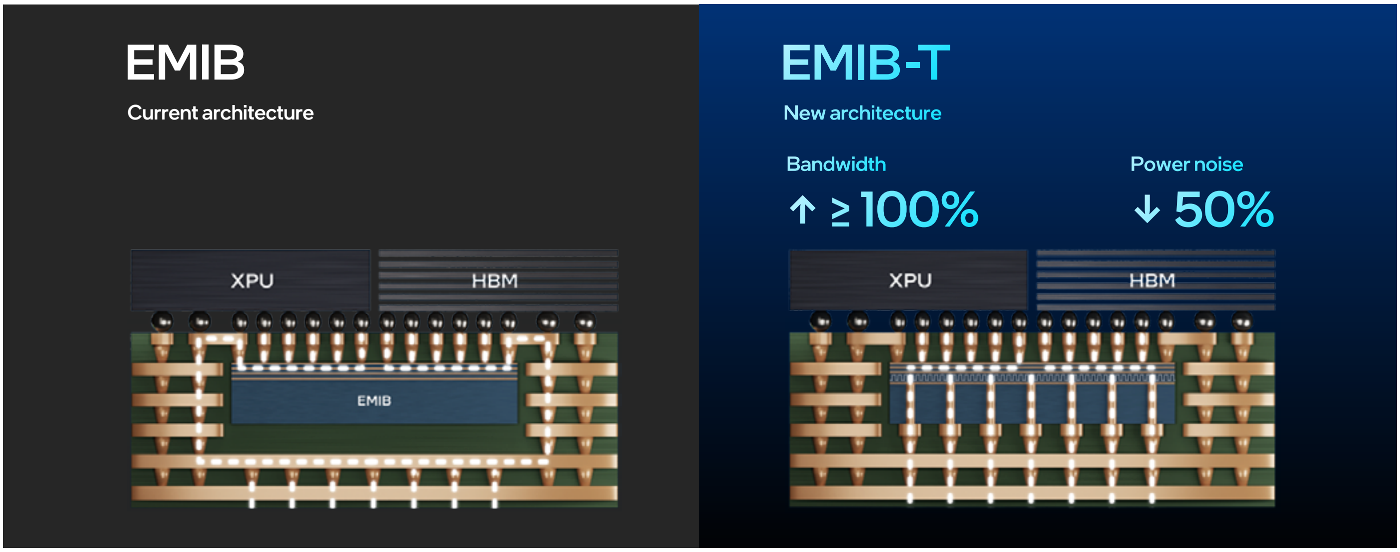

Figure 4. Embedded Multi-die Interconnect Bridge (EMIB) offers design flexibility by adding through-silicon vias (TSVs) to improve power and signal routing for high-bandwidth designs.

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*Based on UMC estimation and internal testing. All specifications are preliminary and subject to change. Intel does not control or audit third-party data. Consultation of other sources is recommended to evaluate accuracy.

Advanced chiplet test

As package sizes grow and complexity increases, comprehensive end-to-end testing is essential for quality and cost control.

Intel Foundry's singulated die sort test accelerates the identification of known good dies, which can improve yield over wafer-level testing. With our proprietary High-Density Modular Testers (HDMT) or third-party automated test equipment (ATE), we offer data-forward testing, from die to final system test, to ensure high yields and reliability.

Thermal management

Next-generation defense systems are exceeding the limits of traditional air-cooled packaging. To meet rising performance and reliability demands, Intel Foundry has developed high-performance integrated heat spreaders (IHS) optimized for liquid cooling. Preliminary assessments show these solutions deliver **> 3x the thermal efficacy** of state-of-the-art air-cooled designs (see Figure 6).*6 As cooling technologies advance, from cold plate integration to microchannel and die backside approaches, system thermal capacity is expected to scale by several times over traditional air-cooled baselines. Upper-end concepts suggest performance that reaches the multi-kilowatt class.

Beyond cooling performance, these IHS designs prioritize reliability, testability, and serviceability, essential for mission-critical environments and data centers. We rigorously test and qualify materials, interfaces, and geometries to withstand extreme profiles (wide temperature ranges, high-power transients, and repeated thermal cycling) while improving resistance to corrosion, leakage, and mechanical stress.

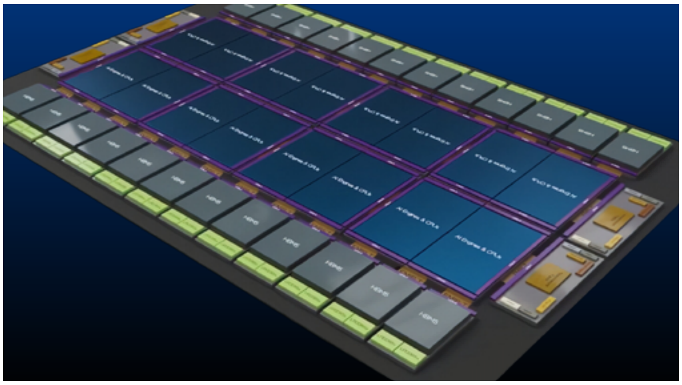
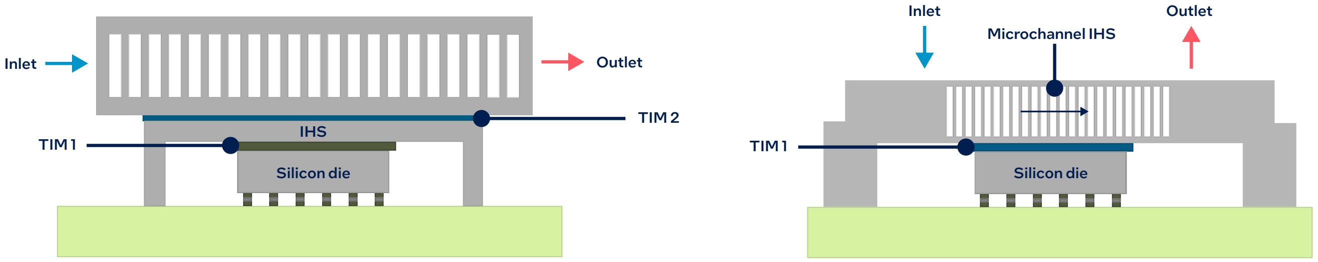


Figure 5. Rendition of a multi-chip architecture for complex defense applications.

Our approach to cooling also considers system-level integration, enabling seamless compatibility with substrates, interface materials, and cooling modules across diverse deployments. By pushing the boundaries of thermal design, Intel Foundry delivers solutions that combine performance, reliability, and adaptability for rugged ground systems, high-altitude flight, and command infrastructure.

Our advanced packaging roadmap is well aligned with the forward-looking needs of the aerospace and defense industry. By supporting heterogeneous integration of analog, digital, and RF components onto a single substrate, Intel enables the creation of highly integrated systems for radar, communications, and mission-critical electronic operations.



Cold plate on package

Microchannel IHS

Cooling potential comparison @ TJMax = 100C	Air cooling (baseline)	Cold plate on package	Microchannel IHS (integrated cold plate within IHS)
Max package power (W)	1kW	3kW	4kW
Improvement	1x	3x	4x

Figure 6. Simplified schematics, accompanied by a table of the comparative efficacy of cooling solutions.*6

*Performance varies by use, configuration, and other factors. Results may vary.

Spotlight: Direct RF sampling on Intel 18A

Redefining mixed-signal performance for mission systems

Modern aerospace and defense systems increasingly rely on direct RF sampling converters to digitize wideband signals without traditional intermediate frequency (IF) stages, enabling agile, multimode operations for radar and secure communications. These converters have demanding specifications with sampling rates up to 60 GSps, analog bandwidths of 30 GHz, and 70 dBc spurious-free dynamic range (SFDR). At the same time, the converters must meet stringent SWaP-C requirements with power targets close to 1W per channel. Achieving these goals requires a process technology that delivers highly performant logic alongside robust analog capabilities.

Intel 18A rises to this challenge with the combination of RibbonFET gate-all-around transistors and PowerVia backside power delivery. They enable high transistor ft/fmax for analog blocks and compact, low-leakage logic for digital signal processing (DSP) functions. RibbonFET's advanced electrostatic control and native isolated domains reduce coupling noise, while stacked ribbons provide high-gain density for analog circuits operating at tens of gigasamples per second. PowerVia shortens the power path and minimizes IR drop, enabling stable voltage during the high-current transients typical of radar bursts and signal-processing workloads.

Beyond logic and power delivery, Intel 18A's thick backside metals support high-Q inductors and low-resistivity routes for RF integrity. Its rich passive device library, including high-density MIM capacitors and varactors, enables precision analog design. Together, these features allow direct RF sampling converters to integrate large DSP blocks for decimation, interpolation, and equalization at higher clock speeds, reducing latency and improving overall system responsiveness. When implemented as a chiplet with UCIe interfaces, these RF sampling converters can be reused across platforms, accelerating development.

Intel 18A delivers up to 5x power savings versus 16 nm-class designs (see Figure 7)*, with further improvements using digital-friendly analog design topologies expected to reduce per-channel power from 5W to 1W.* Across a 2,000-element radar, this can lower overall system power by up to 8 kW, translating to significant power savings in large radar arrays. Combined with advanced packaging options, Intel Foundry enables heterogeneous integration of mixed-signal chiplets with compute and memory, achieving the SWaP-C required for next-generation aerospace and defense systems.

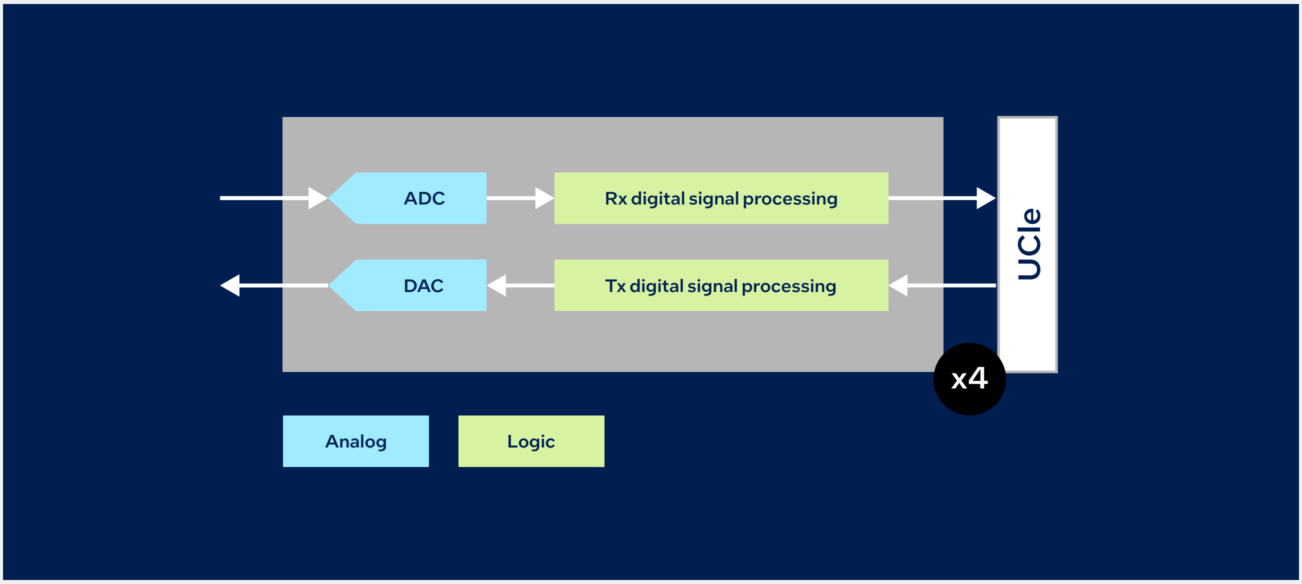


Figure 7. Diagram of a conceptual 4-channel direct RF converter chiplet integrating ADC/DAC, DSP, and UCIe interface.

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Government program support

Intel Foundry plays a pivotal role in government semiconductor initiatives. Through efforts such as Rapid Assured Microelectronics Prototypes – Commercial (**RAMP-C**), Intel Foundry enables government agencies to access leading-edge process technologies, such as Intel 18A, in parallel with commercial customers, accelerating the development of mission-critical systems. Similarly, State-of-the-Art Heterogeneous Integrated Packaging (**SHIP**) leverages Intel Foundry's advanced packaging technologies to integrate multiple chiplets into high-performance systems. These programs ensure trusted access to cutting-edge nodes while maintaining compliance with export control regulations, such as ITAR, that govern the handling of sensitive technologies to prevent unauthorized access. Compliance measures include strict controls on technical data in design and manufacturing environments.

Complementing these efforts, Intel Foundry collaborates closely with the U.S. federal government to strengthen trusted manufacturing and advanced packaging capabilities across key U.S.-based technology hubs. This partnership emphasizes semiconductor production for government systems through initiatives such as the **Secure Enclave program.**

These U.S. programs create a model of cooperation that allied governments and international partners could adopt to help ensure resilient, trusted supply chains.

Services

Prototyping services enable rapid design validation on advanced process nodes, helping teams move from concept to silicon efficiently. Through **multi-project wafer (MPW) shuttles,** customers gain cost-effective access to leading-edge technologies for early-stage designs, reducing time to market while optimizing resources. In addition, specialized enablement teams provide hands-on support across the entire lifecycle, from commercial applications to highly classified programs, ensuring compliance, security, and performance requirements are met for highly demanding environments.

Ecosystem

Intel Foundry fosters a trusted ecosystem through strategic collaborations such as the **U.S. Military Aerospace and Government (USMAG) Alliance** and the **Chiplet Alliance.** The USMAG Alliance brings together more than 30 electronic design automation (EDA), intellectual property (IP), and design partners to streamline development on advanced nodes, ensuring robust toolchains and verified IP for sensitive applications.

Complementing this, the Chiplet Alliance drives interoperability standards and packaging innovation, enabling heterogeneous integration through technologies such as EMIB and Foveros.

These alliances are critical for providing validated components, trusted workflows, and supply chain resilience.

Figure 8. Intel Foundry's USMAG Alliance brings together key partners in service of US government objectives.

Transform mission concepts into silicon

Modernizing defense and government platforms requires more than advanced technology; it demands speed, trust, and integration. Intel Foundry provides a full-stack design and manufacturing solution that accelerates time to deployment. Our approach enables the transition from traditional system-on-chip architectures to modular system-of-chips designs, combining trusted process technologies, from mature nodes to leading-edge Intel 18A, with advanced packaging and system-level integration.

Ready to deliver your next mission-ready system? Visit intel.com/foundry.

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[1] Based on Intel internal analysis comparing Intel 18A to Intel 16 as of February 2025. Results may vary.

[2] Based on Intel internal analysis comparing Intel 18A-P to Intel 18A as of February 2024. Results may vary.

[3] Based on Intel internal analysis comparing Intel 18A-PT to Intel 3-T as of April 2025. Results may vary.

[4] Intel and UMC 12nm process node is not eligible for U.S. defense-based applications.

[5] Based on UMC estimation and internal testing. All specifications are preliminary and subject to change.

[6] Based on preliminary internal assessments under defined test conditions. Actual results may vary with system design, operating environment, and integration choices.

Intel does not control or audit third-party data. Consultation of other sources is recommended to evaluate accuracy.

All product and service plans, roadmaps, and performance estimates are subject to change without notice. Projections about future node performance and other metrics are inherently uncertain. Performance results are based on testing as of dates shown. Your costs and results may vary.

This document contains forward-looking statements about Intel's future plans or expectations, including its process and packaging technology roadmaps. These statements are based on current expectations and involve many risks and uncertainties that could cause actual results to differ materially from those expressed or implied in such statements. For more information on the factors that could cause actual results to differ materially, see our most recent earnings release and SEC filings at intc.com.

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