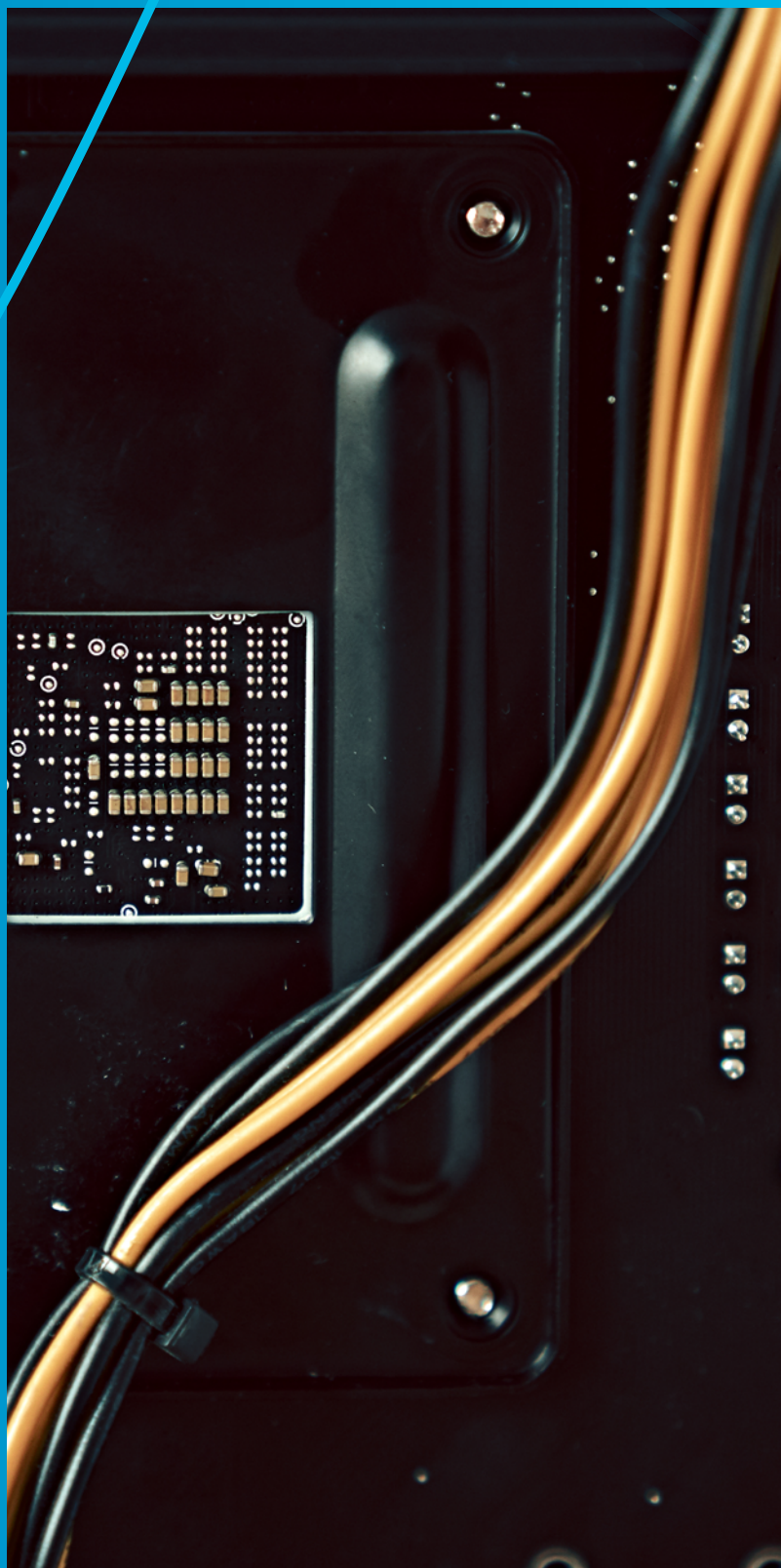
Softwarization *for* Semiconductors

The software revolution at the heart of the chip industry



Capgemini

Softwarization for Semiconductors

At the heart of our era's digital transformation – powering everything from satellites in the sky to consumer devices in our hands – it all comes down to tiny, intricate semiconductor chips. Today, the chip industry is undergoing a quiet evolution that will profoundly affect the digital world. Softwarization is coming to chip manufacturers.

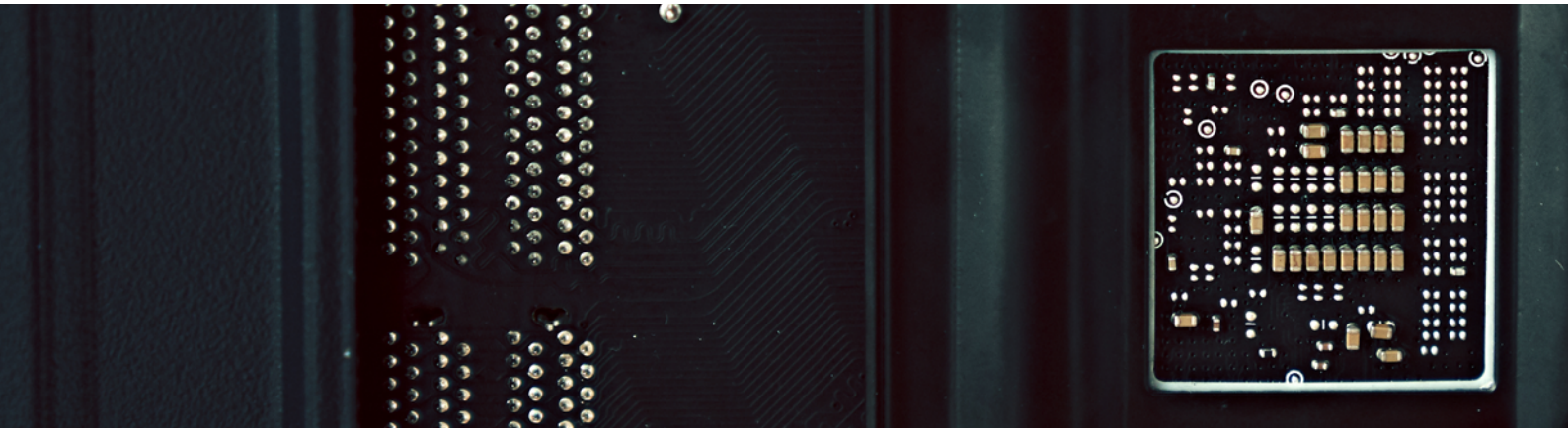
What can chip companies – and the rest of the industries – expect?

In this Point of View, we'll explore the opportunities facing chip companies at this turning point and some of the challenges along the way. We'll answer the questions:

- **What is driving this softwarization shift?**
- **What opportunities does this create for Semiconductor companies?**
- **Where can these companies expect to find value?**
- **What is holding companies back?**

Formidable obstacles stand in the way. Many semiconductor companies share the goal of becoming more 'software-centric' but lack a clear route forward to accelerate the transformation. Some have taken their first steps in the right direction but realized that softwarization is even more complex than expected.

Let's shed some light on the road ahead.



The march of software

In the early 2010s, a new idea was born in the automotive industry. An up-and-coming engineer needed software to complete his vision but couldn't find it on the market. He decided that his company would build it.

Tesla's longtime chief information officer, Jay Vijayan, shared what led them to develop their "Warp" system:

Elon's vision is to build a vertically integrated organization where information flow happens seamlessly across departments and where we have a closed feedback loop for our customers.

> "Tesla is as much a software company as it is a hardware company"
>
> **Elon Musk**

Tesla created a holistic software platform on a vehicle that was traditionally considered as a pure hardware product. This revolutionized the entire thinking for the automotive industry.

Since that moment, the march of software in the automotive industry has been unstoppable. (see – Putting Customers at the Heart of the Mobility Experience by Capgemini) What began on the periphery – small applications here and there – has moved to the core. In many ways, automotive OEMs today manufacture their vehicles' physical components to fit their software's needs.

For automotive leaders, the shift has not been easy. In a world where product iterations traditionally took years, the pace of software development required entirely new systems, business models, and mindsets. The idea of releasing an MVP software product completely contradicts traditional automotive manufacturing, where a single flaw can be disastrous. The role and pace of innovation is also different. Engineering progress tends to be slow and steady, whereas software capabilities are exploding at a rate that's hard even to keep track of, let alone leverage into innovative products.

The same process is underway in the telecommunications industry, the healthcare industry, and on and on. The steady march of software.

But what about Semiconductor companies? Which companies will be ready for it?

Opportunities on the horizon

The first question is: what horizon are we looking at? As semiconductor companies evolve from mass production of standard chips to produce more mission-specific chips, new opportunities arise. Here are some trends we can expect:

More custom chips:

More custom everything, in fact, and chips are no exception. Multiple trends are driving the need for more specialized chips, often called Application-Specific Integrated Circuits (ASICs)

Machine learning and AI:

Standard CPUs are not optimized for the matrix operations on which machine learning is based. Custom silicon like Google's Tensor Processing Units (TPUs) and Neural Processing Units (NPUs) by other vendors are specialized for these tasks.

Energy efficiency for mobile and IoT devices:

Custom chips can be optimized for energy efficiency, which is critical for battery-powered devices.

Security:

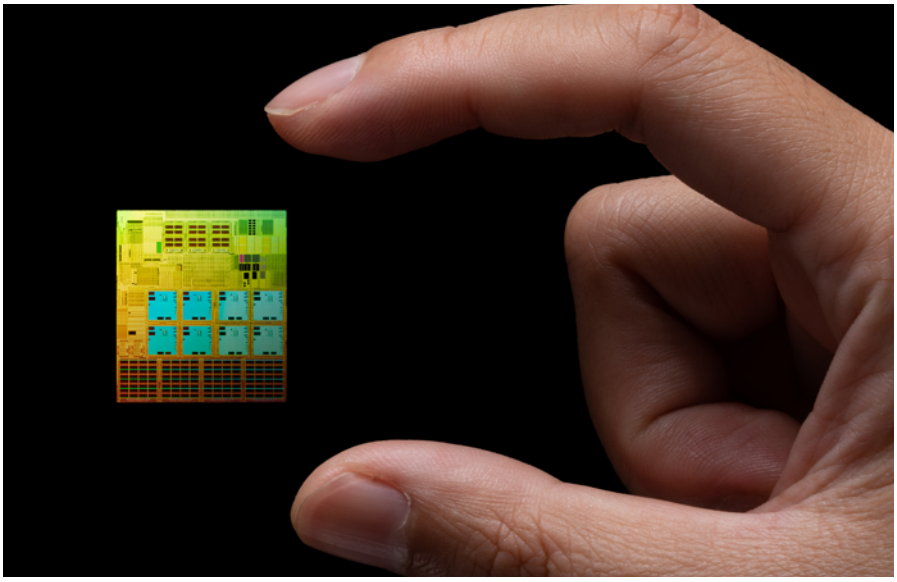
Chips can be designed with security in mind from the ground up. (Apple's T2 chip, for example, is used for secure boot and encrypted storage.)

Edge computing:

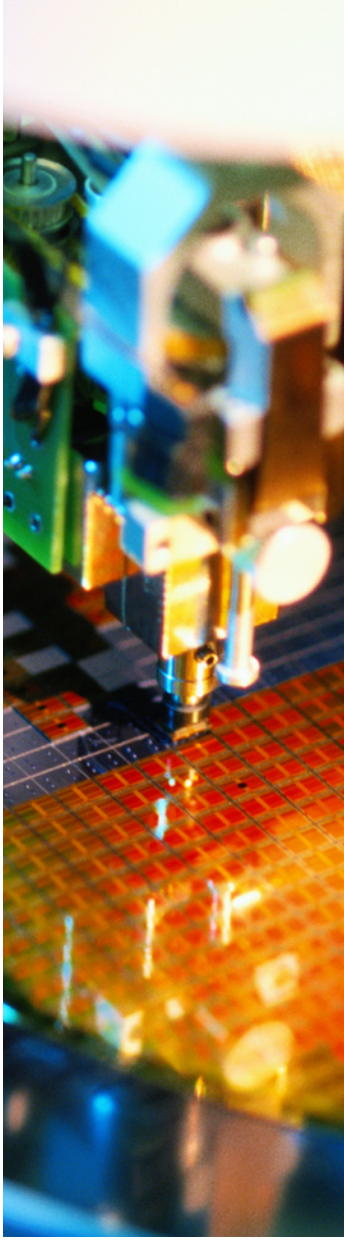
As computing moves closer to the data source, lower-power custom chips optimized for edge computing tasks like AI inference are needed.

Quantum computing:

As this technology matures, specialized chips designed to work with quantum processors will likely become more common.



The hardware-centric approach



When developing "custom chip" for an industry, the current state of semiconductor companies is heavily focused on custom silicon design to manufacturing chips with required features and capabilities that cater to the needs of target industry such as automotive, healthcare, or telecommunications.

This is what we call a "Hardware-centric" approach.

Today, these opportunities are met primarily with a hardware-centric approach. The focus is on creating a product that meets the industry's unique hardware needs first, and the primary value lies in the physical chip capabilities. Software plays a 'supporting role,' developed to complement and support the hardware after its specifications have been established.

Of course, even in a hardware-centric approach, the software is essential to exploit a chip's full potential. The software makes the hardware accessible and valuable to the end-user by providing the necessary interfaces, controls, and customizations.

This HW-centric approach has several challenges, namely:

Additional challenges driven by a hardware-centric approach are Inventory and logistics complexities and a more limited customer experience.

a. **Long lead times.** Time-consuming design and manufacturing processes due to the complexity of custom HW – often leading to missed time-to-market targets.

b. **Rigid solutions and fixed functionality.** HW with fixed functions designed for specific tasks within an industry, with limited flexibility for updates or changes once the HW is deployed.

c. **Software costs** constitute a significant portion (up to 40%) of the overall budget, yet there's no effective corresponding revenue model. Software is a cost of doing business rather than a product to be sold.

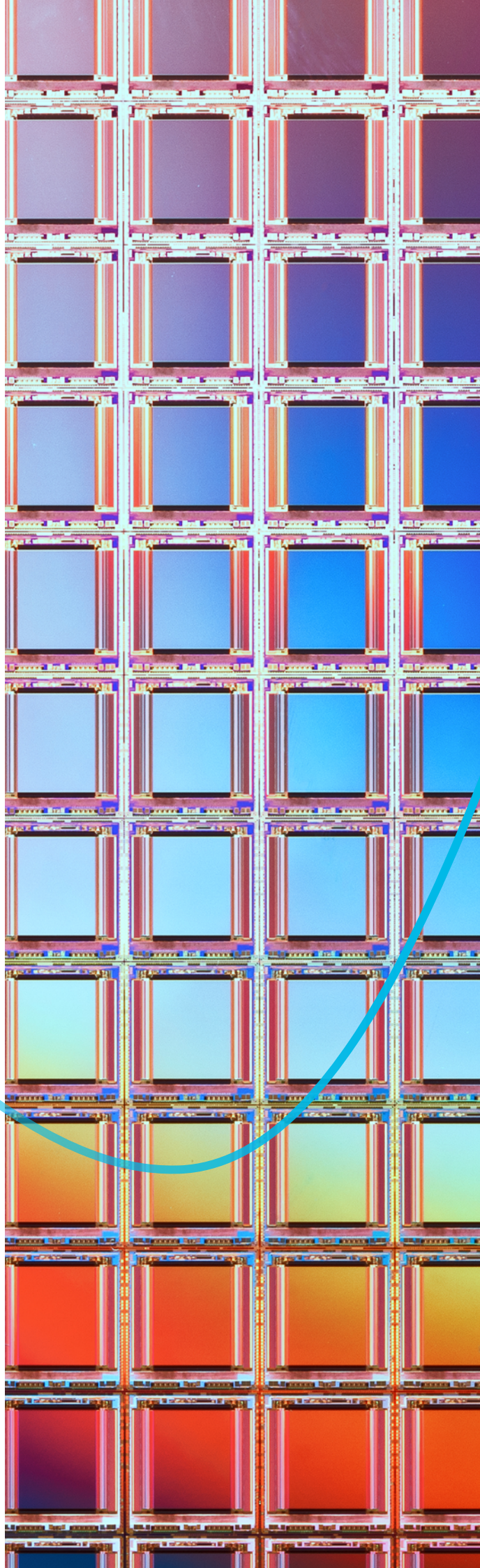
d. **The hardware limits SW customization possibilities** – hence, there are few opportunities for additional SW-based revenue.

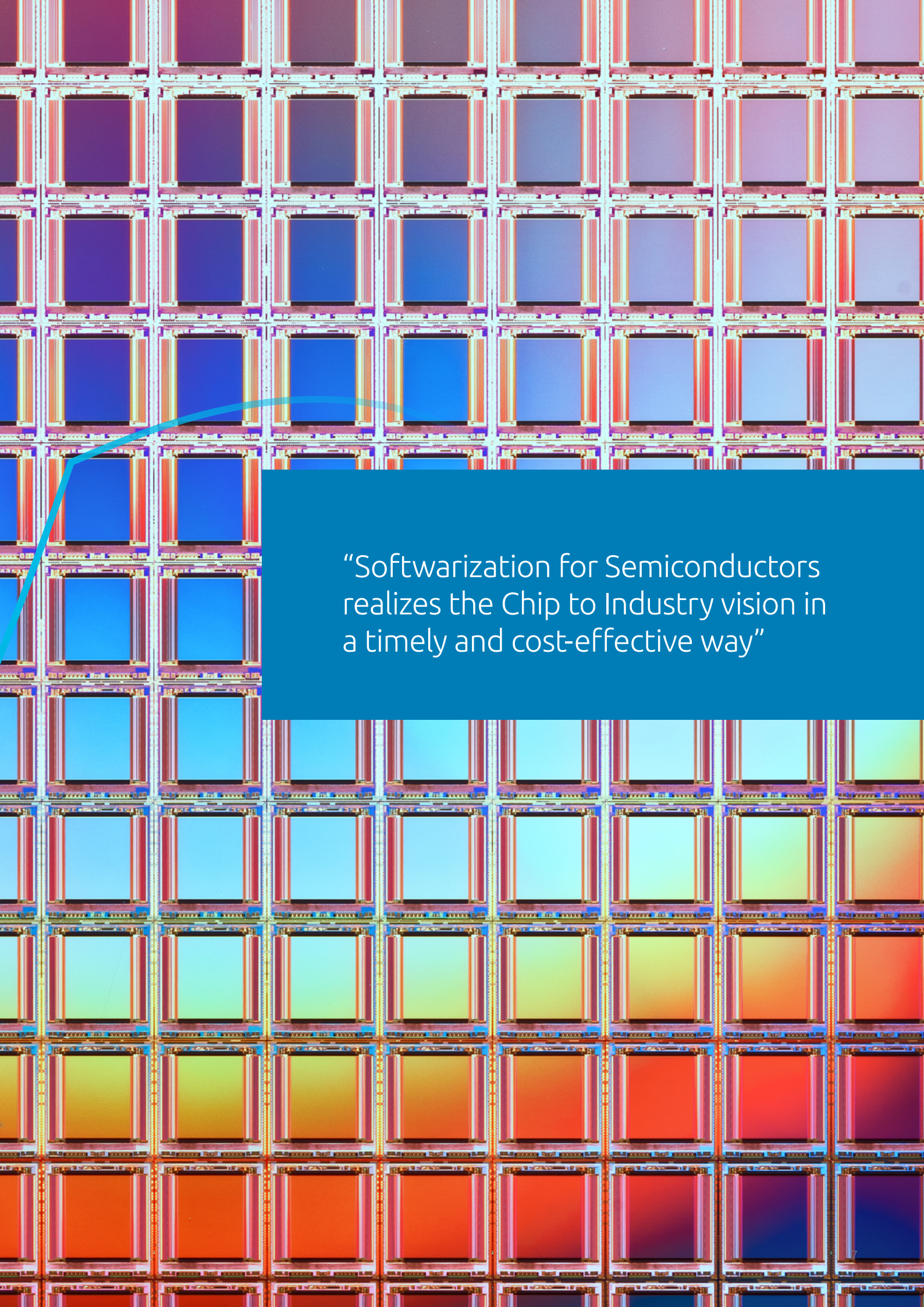
Nvidia and Dominance in Generative AI

Nvidia makes the chips driving the Generative AI revolution – and make no mistake, it is a revolution. However, despite making chips like the H100 and now the H200, Nvidia is not a Semiconductor company. It is a platform company, and platform means software. Nvidia focuses on bringing developers onto their software platform, which creates switching costs to other chip manufacturers' emerging AI chips.

The Case for Softwarization

With Softwarization for Semiconductors, the vision of Chip to Industry can be realized in a timely, cost-effective way. The objective is to develop a more standardized, limited set of base chips that can be customized for various industries and solutions through software. The idea is to reduce the number of unique hardware designs and instead leverage software to provide the industry-specific functionalities – moving the “logic” from silicon to software. The basis of competition becomes the software stack, no longer the hardware stack.



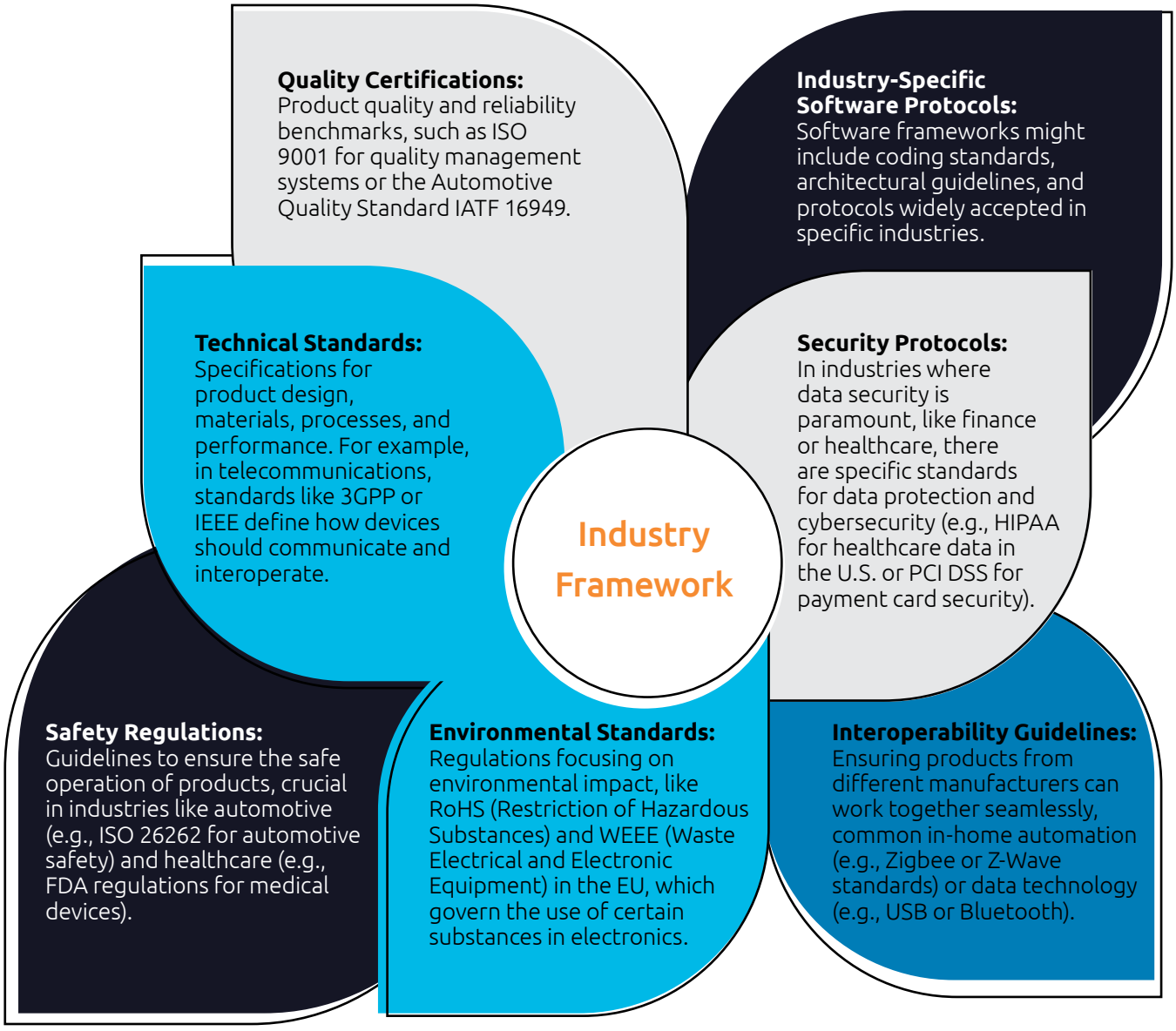


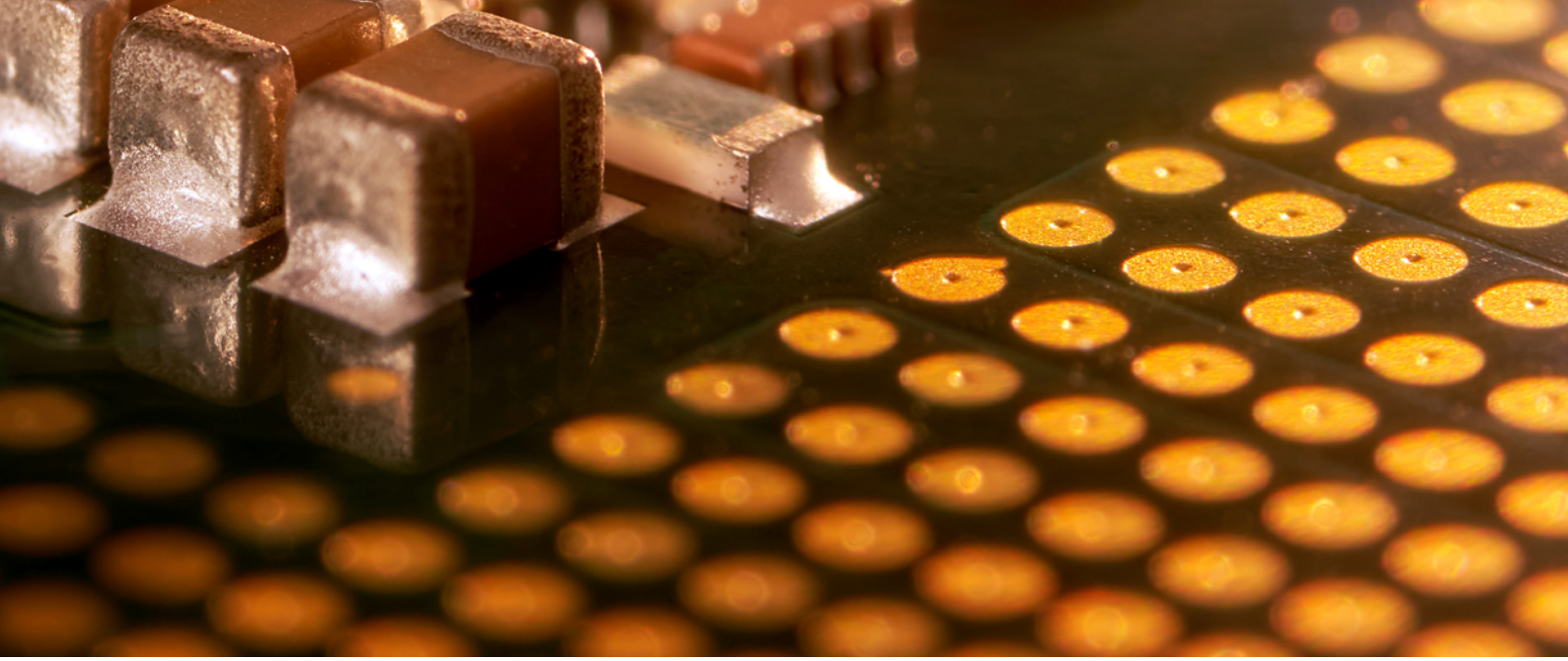
"Softwarization for Semiconductors realizes the Chip to Industry vision in a timely and cost-effective way"

The Industry Framework

Software-designed custom silicon is **validated against industry frameworks** for performance and functionality, as the integrated solution (hardware plus software) must meet the stringent performance and functionality standards of specific industries.

An **"industry framework"** is a set of standards, regulations, guidelines, or specifications established by industry groups, regulatory bodies, or standard-setting organizations. These frameworks ensure that products and services meet specific quality, performance, safety, compatibility, and interoperability levels within a specific industry. Concretely, it can include:





The Value in Softwarization for Semiconductors

There are several substantial benefits to transitioning from a hardware-centric approach to a software-centric approach. We believe the answers are clear not simple to achieve by any means, but the North Star of business value includes:

1. **Efficient and Cost-Effective Design and Production:**

   Adopting a software-centric approach streamlines a Semi's business model by developing a limited array of versatile base chips customized for various industries through software, significantly reducing the cost and time involved in hardware development.

2. **Quicker iterations and a more efficient production process, addressing the risk of missing market deadlines.**

3. **Software as a Revenue Generator:**

   Software development transitions from a cost center to a revenue stream. Firms can monetize software development efforts by offering customizable software solutions, feature upgrades, ongoing service subscriptions, and developing a robust ecosystem for third-party applications.

4. **The Platform Effect:**

   As we say in Silicon Valley, the platform always wins. The ecosystem approach of Softwarization for Semiconductors not only allows for direct revenue generation but also enhances the value proposition of my products, creating a 'platform effect' that attracts more users and developers, expanding reach and creating new revenue opportunities.

5. **Flexibility and Adaptability:**

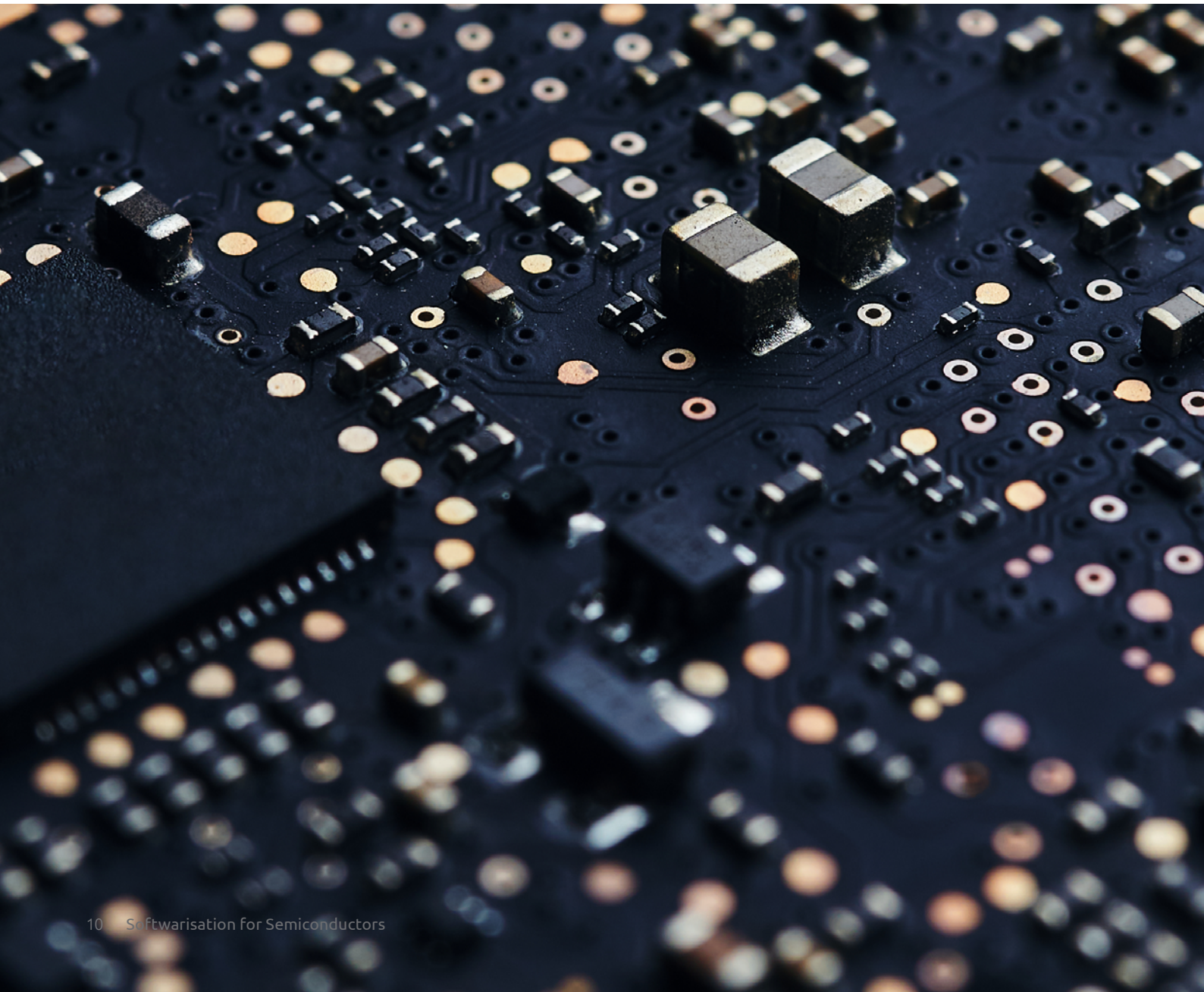
   The ability to update and customize software for different industry requirements means I can swiftly adapt to market changes without needing time-consuming and expensive hardware redevelopment. This adaptability allows me to respond rapidly to evolving industry needs.

6. **Sustainable and Environmentally Friendly:**

   This future approach aligns with global sustainability trends by significantly reducing the frequency of new hardware development. The focus on software updates and longer-lasting hardware reduces material use and waste, promoting an eco-friendlier production model.

What's holding the industry back?

A transformation of this scale affects every part of a Semiconductor company, so the change is hard, but the reward (or necessity) is massive. Typically, a Semi company will start with one strategic, software-intensive business unit and pilot all the needed components there. It is a holistic business transformation, not just an engineering transformation, and it all starts with the right mindset for leaders.



Design

Semi companies must start by decoupling hardware and software architectures and creating an independent lifecycle for each layer. This presents many challenges in a 'hardware first' mindset, but optimizing what software can do is essential. Software is no longer the servant but the boss.

Industry Focus

Create industry-focused platforms and ecosystems by transferring industry-specific logic to the software layer. (See Industry Frameworks above)

Platform Enablement

Deploy easy-to-use software tools (SDKs) to configure and optimize the platform to meet industry / use-case requirements. Make these tools accessible to the ecosystem of internal and external developers, ISVs, and hardware partners.

Business Models

Define new business models to support customer journeys (pre-to-post sales) and open new revenue streams. Assure management systems reward software sales and ecosystem development as much or more than chip sales. This can turn a compensation system on its head and deserves a measured but determined rollout.

Customer Experience

Improve the customer / ecosystem experience, enable new features via software upgrades, and create performance management and SLAs, all in an IP-secure fashion.

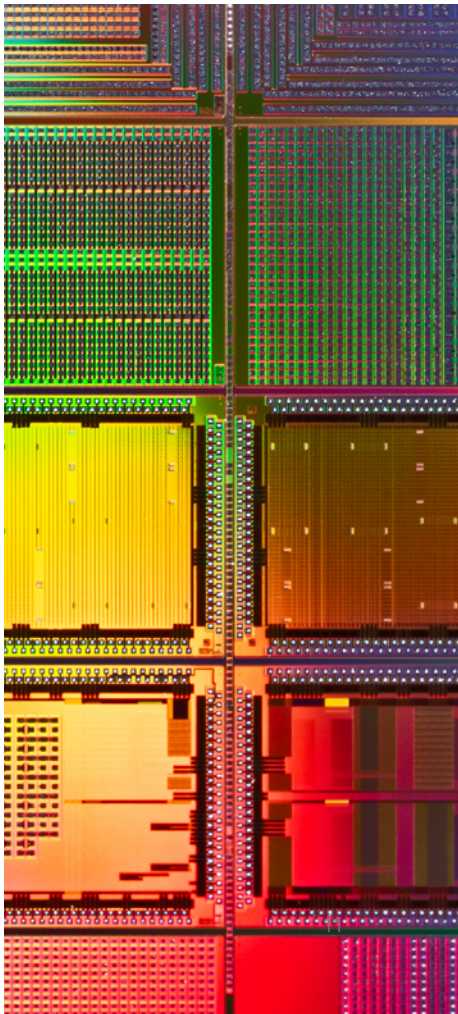
Scale via the Ecosystem

Build and fertilize an ecosystem of application developers, tools providers, and enablement software providers as your primary focus to promote the sale and adoption of chips. Stay ahead of the curve, catching the next disruptive trend in YOUR ecosystem.

Conclusion

- **How?** If implemented well and soon, it could revolutionize the 'spot' semiconductors that have been playing for a long time
- **Why?** Possibility for market dominance
- **When?** Tighter opportunities with geo-local strategies (& funding), all the way to the customer end.
- So what are you waiting for?

To capture their share of the $1T semiconductor chip industry, companies need to challenge their current hardware-centric approach. Softwarization for Semiconductors is the software-centric transformation of business models, ecosystem, design approach, and most importantly the mindsets of chip manufacturers required to gain a disproportionate share of the growth to $1T. Building Different is essential at this pivotal time in semiconductor history – firms must transform, or risk being left behind.



About Capgemini

Capgemini is a global business and technology transformation partner, helping organizations to accelerate their dual transition to a digital and sustainable world, while creating tangible impact for enterprises and society. It is a responsible and diverse group of 340,000 team members in more than 50 countries. With its strong over 55-year heritage, Capgemini is trusted by its clients to unlock the value of technology to address the entire breadth of their business needs. It delivers end-to-end services and solutions leveraging strengths from strategy and design to engineering, all fueled by its market leading capabilities in AI, cloud and data, combined with its deep industry expertise and partner ecosystem. The Group reported 2023 global revenues of €22.5 billion.

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