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BAVARIAN CHIPS ALLIANCE

Bavarian Chips Alliance – Semiconductor Strategy

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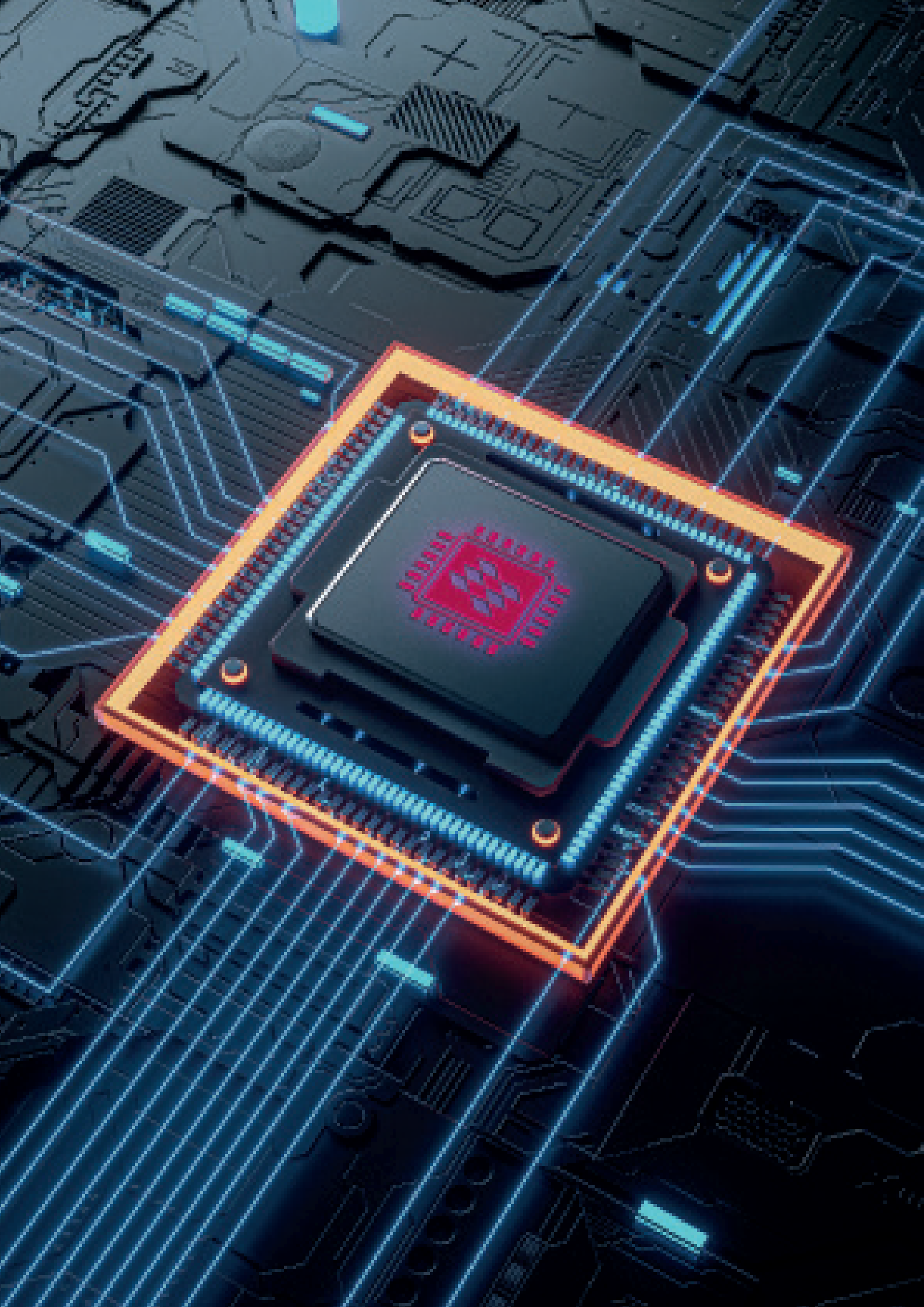

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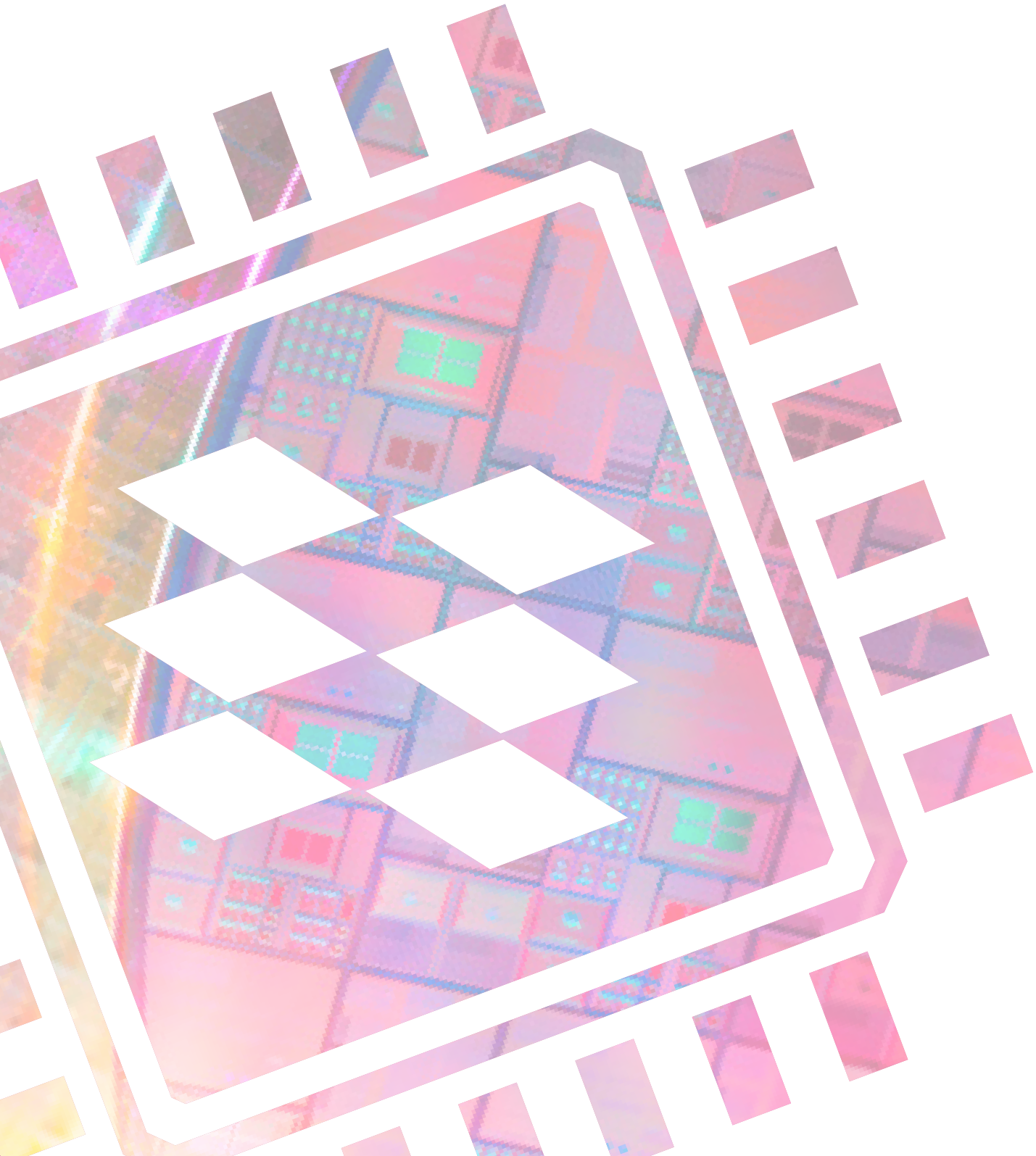

Foreword to the Semiconductor Strategy of the Bavarian Chips Alliance

Bavaria stands out as one of Europe's leading innovators thanks to its exceptional scientific and industrial landscape. Networking, digitalization and artificial intelligence emerge as top trends across all sectors. Mastering all aspects of microelectronics is key to achieving success in this industry.

By adopting the European Chips Act and providing federal and state funding for microelectronics investments and collaborative research, policymakers have significantly improved the framework conditions for industry and science. The Free State of Bavaria alone has contributed more than 350 million euros. Building upon this foundation, we can create an ecosystem that facilitates transformation and stimulates growth.

This is where the Bavarian Chips Alliance comes into play: The semiconductor strategy of the Bavarian Chips Alliance outlined in this paper highlights the key areas and approaches for success. Sustainability, global networking and training resources are major fields of action in this context.

Integrating Bavaria into the global market is the guiding principle of this strategy. The Bavarian Chips Alliance is open to collaboration with other regions, aiming to benefit all parties involved.

It must be noted that this strategy is a working document. Similar to microelectronics, the Bavarian Chips Alliance will constantly evolve and adapt. With this in mind, the authors warmly welcome suggestions on how to further enhance and refine the strategy.

Alfred Hoffmann
Spokesman of the Bavarian Chips Alliance

1 Introduction

The Bavarian Chips Alliance, launched in early 2022 as part of the Bavarian Semiconductor Initiative introduced in autumn 2021, is a network initiated by the Bavarian State Ministry of Economic Affairs, Regional Development, and Energy. Bayern Innovativ GmbH operates a branch office responsible for coordinating the activities of the Bavarian Chips Alliance.

The branch office receives strategic guidance and assistance in defining its action fields from a spokesperson, a steering committee, and an advisory board comprising representatives from industry, science, and associations.

The goal is to build an active and highly visible semiconductor ecosystem leveraging the strengths of the Bavarian semiconductor industry.

To achieve this, the Bavarian Chips Alliance engages in dialogue with partners from academia, research, semiconductor companies, and industry users. Networking efforts are facilitated through the involvement of network partners in Germany and abroad, including the clusters of the Cluster Offensive Bavaria, various networks, initiatives, and associations.

The Bavarian Chips Alliance provides stakeholders throughout the semiconductor value chain with access to information, networking opportunities, and a platform to contribute to shaping the semiconductor ecosystem. Companies can become partners of the Bavarian Chips Alliance, register their profiles, and showcase their competencies on the competencies map to participate in the strategic activities within the defined fields of action. The network continues to expand, regularly assessing the requirements at each stage of the value chain.

Figure 1 shows an overview of these relationships:

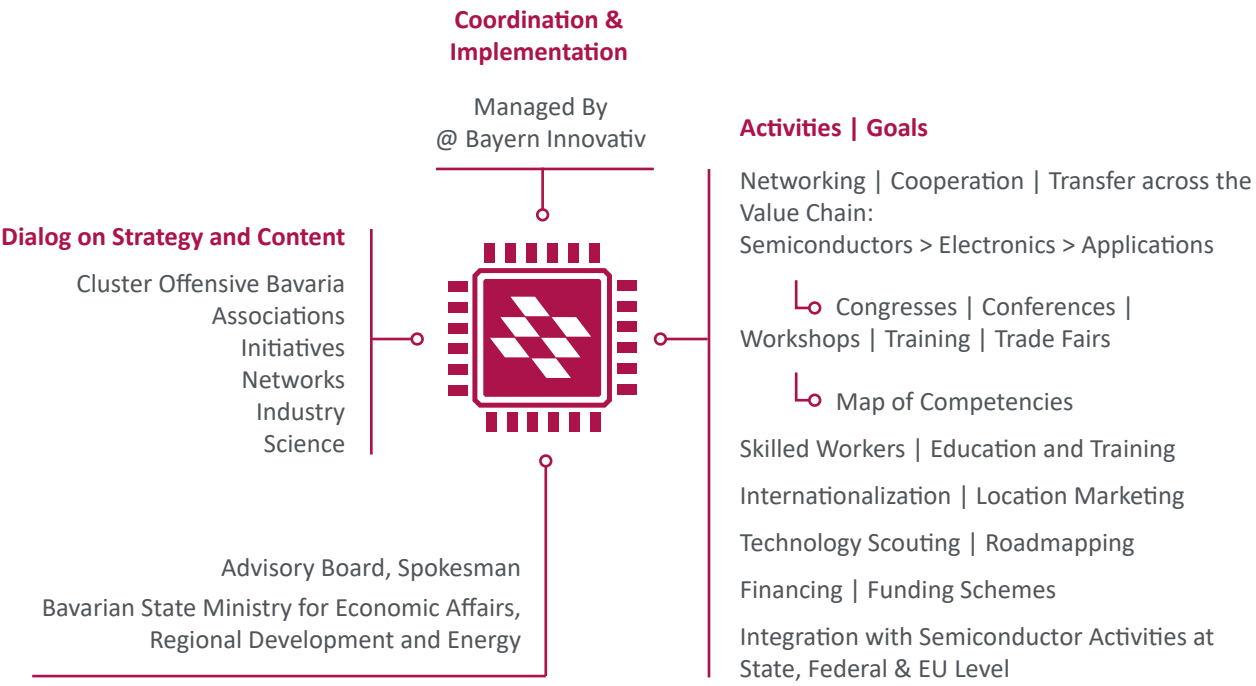

Figure 1: Overview of the structure and networking of the Bavarian Chips Alliance

2 Significance for Bavaria as a business location

This chapter highlights the overall significance of the semiconductor industry and specifically its importance for Bavaria. We will begin by introducing the global semiconductor value chain and exploring the role of semiconductors in major trends. The paper will conclude by discussing the present challenges, potential future crises, and the semiconductor industry in Bavaria.

2.1 The global semiconductor value chain

The complex manufacturing process required to produce semiconductor components has lead to a global value chain for the semiconductor market. A limited number of companies, known as Integrated Device Manufacturers (IDMs), handle all crucial steps including design, front-end manufacturing and back-end manufacturing. This intricate web involves diverse agents collaborating at various stages. Figure 2 gives an overview of the semiconductor value chain illustrating its different stages.

Scientific institutions conduct research while manufacturers require products and services from suppliers and service providers throughout the value chain.

The chip design phase plays a decisive role in defining the properties of integrated circuits which is carried out by the design departments of chip manufacturers or design service providers. Often, specific functions of integrated circuits are predetermined and predefined by so-called core IPs. Similarly, the design process for these circuit systems relies on Electronic Design Automation (EDA) software. Companies specializing in IPs and EDA software frequently provide these essential services.

Following the IC design phase, the microchips are manufactured on silicon wafers during front-end fabrication. Other substrate materials like silicon carbide (SiC) or gallium nitride (GaN) are also used. Wafer processing takes place in clean rooms, either by IDMs or foundries that produce semiconductor components on behalf of fabless companies and IDMs. During this stage of the value chain, suppliers provide the required products, including wafers, chemicals, gases, implantation materials, photomasks, and semiconductor manufacturing equipment for the more than 1,000 process steps involved in chip production within the clean room environment.

After the wafer dicing process, specialized OSAT companies (Outsourced Semiconductor Assembly and Test) conduct testing and packaging to integrate the chips into the respective environments for end-users. This segment of the value chain is referred to as back-end manufacturing. Subsequently, electronics companies can incorporate these microchips into their devices for a wide range of applications. Users then purchase the required microchips either directly from the manufacturer or through a distributor.

Today's semiconductor market is characterized by a multitude of interdependencies. For instance, Dutch supplier ASML is the only company worldwide capable of manufacturing cutting-edge EUV (Extreme Ultra Violet) lithography equipment. Germany-based Zeiss and Trumpf produce components needed to build these highly complex machines. Other companies such as BASF, Merck KGaA, and Linde supply chemicals and gases to the semiconductor industry.

In the domain of fabless semiconductor manufacturers, the United States leads the industry with companies such as Qualcomm, Broadcom, Nvidia, and AMD. Taiwan dominates the production of chips with its foundries TSMC and UMC. Other major international contract manufacturers include Samsung from South Korea, GlobalFoundries in the US, and SMIC from China. In addtion to operating as a contract chipmaker, Samsung also designs and manufactures chips for its own products.

Taiwan, China, and the USA dominate the OSAT market, with noteworthy companies such as ASE, JCET, and Amkor Technologies operating in these regions.

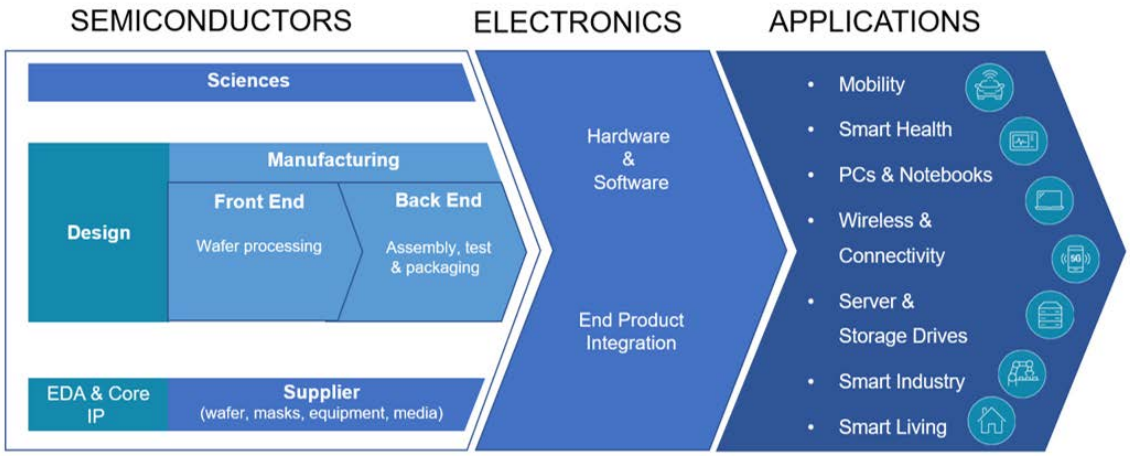

Figure 2: Overview of the semiconductor value chain from the semiconductor industry to electronics and applications.

These complex interactions have important implications for Bavaria: It is vital for the region to have expertise and production capacities across the entire value chain to position itself as a significant contributor to the global semiconductor ecosystem and ensure highly resilient supply chains. After all, key user industries in Bavaria, including automotive, mechanical engineering, medical technology, and defense technology, rely on a reliable and sufficient supply of semiconductors at the end of the value chain.

2.2 The impact of the semiconductor industry on mega trends

The semiconductor industry plays a pivotal role in many of today's mega trends.
This section underscores the industry's significance, highlighting two mega trends:

- digitalization of industry, society and administration
- climate change

Digitalization of industry, society and administration

The continuous advancement of semiconductor technologies drives the development of more powerful mobile communications (6G, NFC, ZigBee, etc.), high-performance sensor networks with real-time processing, and the decarbonization of the energy industry. This progress has a profound impact on industry, society and administration. Notable examples include the transformation of retail IT platforms, media restructuring, and the electrification of private transportation. Furthermore, digitalization in agriculture and administration, the concept of work 4.0, and the development of smart cities are all relevant in this context.

To maintain a competitive edge in the global industrial landscape, industrial societies must establish their own semiconductor capacities to effectively tackle the aforementioned challenges. Securing access to semiconductor components and systems is crucial for industrial societies to be successful. This holds true for Bavaria which boasts significant system industries in electrical engineering, automotive engineering, aviation, and medical technology that operate within a highly competitive global market.

Climate change

Tackling climate change and meeting the objectives outlined in the Paris Convention and the EU Commission's Green Deal necessitate the use of low-loss power electronics. Wide bandgap substrates like silicon carbide, gallium nitride, and other compound semiconductors, besides the traditional silicon substrate, enable more efficient power generation, distribution, and utilization. Advancements in power electronics will be a vital component of the energy transition, complementing developments in photovoltaics, wind power, and the hydrogen economy.

Accommodating the increased capacity of renewable energy generation in the energy mix will require the implementation of intelligent and robust storage technologies and networks, such as smart grids. Bavaria is deeply committed to reducing carbon emissions and actively promotes the expansion of renewable energy sources. Consequently, the region stands to benefit from advancements in semiconductor technology in this field, but will also be dependent on energy supply.

2.3 Current challenges and crises

The automotive sector along with industrial electronics experienced a chip shortage during the COVID-19 pandemic. This shortage was caused by various factors, including increased demand for electronic devices in the consumer sector which put additional pressure on the availability of microchips. The automotive industry was particularly impacted by the decline in demand during the pandemic, leading to the cancellation of previously placed chip orders. As demand for automobiles rebounded, there was an insufficient supply of new microchips. Semiconductor manufacturers, operating at full capacity, struggled to meet the sudden surge in chip volumes, resulting in a shortage. This situation is further compounded by the current challenging macroeconomic conditions which have been impacted by supply chain disruptions caused by the COVID-19 pandemic, the Russia-Ukraine conflict, and the trade tensions between the US and China.

An escalation in the conflict between China and Taiwan would pose a significant threat to semiconductor chip supplies. According to Trendforce, Taiwan, particularly companies like TSMC and UMC, account for nearly two-thirds of semiconductor contract manufacturing. In the event of a war between the two countries, the global chip supply would be at risk.

[1]TrendForce Corp., Joanne Chiao and Eden Chung, (2023, März 23). Total Revenue of Top 10 Foundries Fell by 4.7% QoQ for 4Q22 and Will Slide Further for 1Q23, Says TrendForce. https://www.trendforce.com/presscenter/news/20230313-11612.html, abgerufen am 10.05.2023

This underscores the existential economic and social importance of semiconductor supply. These crises and conflicts, particularly the East-West conflict, highlight the importance of establishing more resilient supply chains and regionalizing the global economy.

Since microchips are a critical component in many products, value chains must be designed in a more diversified and resilient manner. Consequently, we need location policies that create an attractive environment for companies of all sizes throughout the semiconductor value chain, encouraging them to locate their business in the region. The user industry, in particular, would greatly benefit from such a development.

2.4 The semiconductor industry in Bavaria

The Bavarian semiconductor industry is primarily centered in Munich and its surrounding area, as shown in Figure 3. For example, Munich is home to Infineon Technologies AG, Germany's largest semiconductor manufacturer that ranks among the top companies worldwide. Besides Infineon, many international companies have set up their research and development centers in Munich, including industry giants like Nvidia, AMD, Apple, Samsung, ARM, and Intel. Other well-known semiconductor manufacturers with a focus

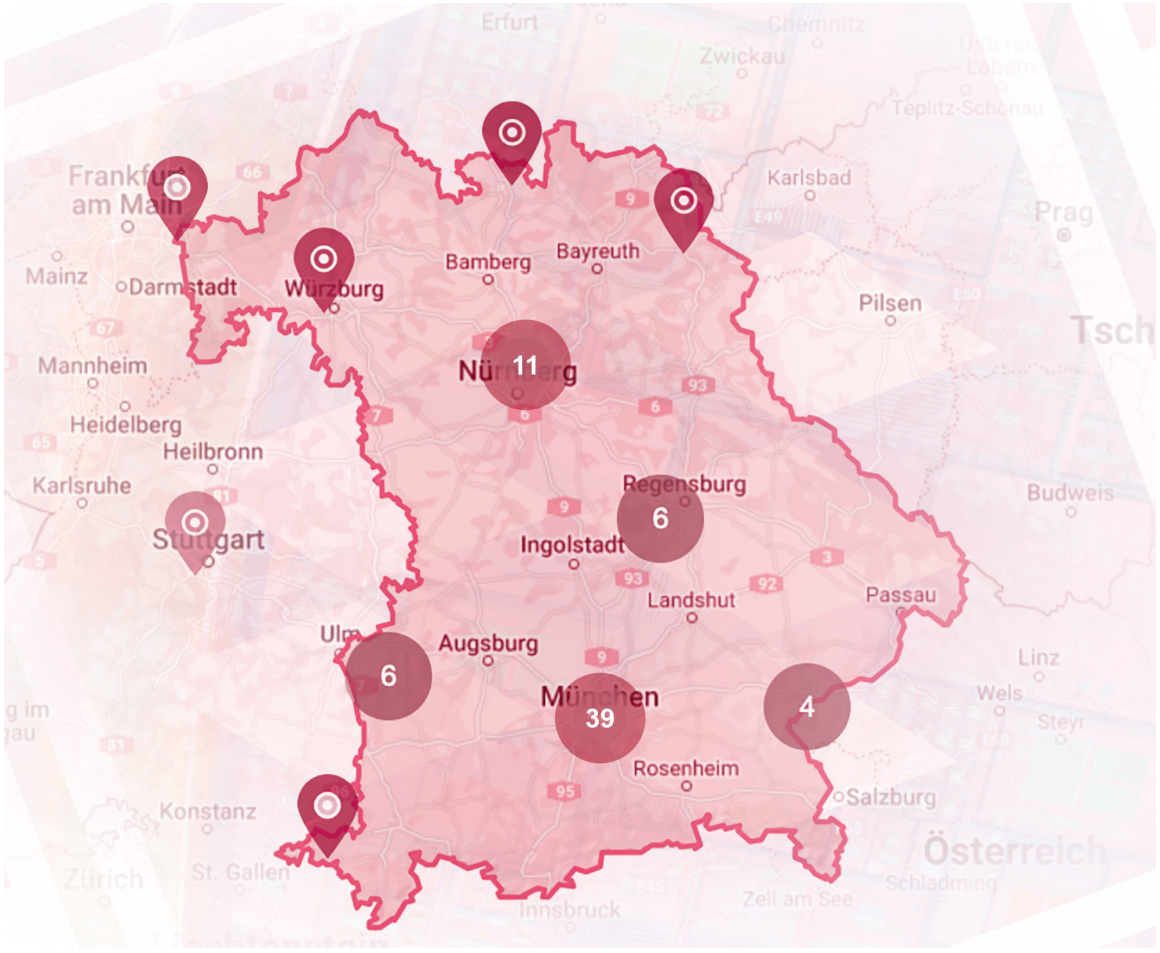

Figure 3: The continually growing competence map (here: May 2023) represents the Bavarian ecosystem based on the number of Bavarian Chips Alliance partners at the various locations inside and outside Bavaria. The interactive map listing all partners is available at Bayern Innovativ - Innovation leben (bayern-innovativ.de).

on research and development have also established bases in Munich, such as NXP, STMicroelectronics, Micron, Qualcomm, Bosch Sensortec, Analog Devices, and Renesas to name a few. Texas Instruments operates a semiconductor production facility near Munich and semiconductor products are also fabricated by ams OSRAM and Infineon in Regensburg. Semikron Danfoss, based in Nuremberg, is a global technology leader in power electronics. Bavaria is home to numerous other companies across the semiconductor sector, including wafer manufacturers like SiCrystal in Nuremberg and Siltronic in Munich as well as semiconductor equipment supplier SÜSS MicroTec in Garching near Munich.

This list highlights that Bavaria can draw on existing partnerships with industry members and leverage them to expand the semiconductor ecosystem.

Furthermore, Bavaria benefits from its robust user industries: Securing a reliable supply of semiconductor products is crucial for automotive manufacturers such as BMW and Audi or Siemens Healthineers, a provider of life-saving medical systems, among many other examples. This proximity to the industries that utilize semiconductor products makes Bavaria an attractive location for the semiconductor industry.

Bavaria's excellent research landscape, particularly in chip design, is another important asset for the regional semiconductor industry. Notable research institutions in this domain include the four Fraunhofer institutes: IIS, IISB, AISEC, and EMFT. The semiconductor research landscape thrives on vibrant exchanges and close collaborations with universities across Bavaria, including TUM, FAU, OTH Regensburg, TH Nuremberg, the University of the Federal Armed Forces in Munich, and others.

3 Embedded in the European context

3.1 Relevant networks and organizations in the EU

In order to achieve success, the Bavarian Chips Alliance should strive to establish connections with other organizations in Bavaria and beyond. The semiconductor industry operates on an international scale, with complex supply chains spanning multiple countries. In Germany, there are several relevant organizations worth noting, such as:

- Silicon Germany
- ZVEI
- Silicon Saxony

Within the EU, the following organizations are relevant:

- Semi Europe
- European Semiconductor Industry Association (ESIA)
- Alliance for Processors and Semiconductor Technology

- Alliance of European Semiconductor Regions (currently being established)
- various national and regional semiconductor initiatives

Outside the EU, there are other important associations:

- Global Semiconductor Alliance – GSA
- Semiconductor Industry Association – SIA
- Electronic System Design Alliance
- RISK-V International

3.2 The European Chips Act

The EU Chips Act comprises three pillars which are fundamental to Bavaria's semiconductor ecosystem:

Pillar 1 titled "Chips for Europe" aims to promote the EU's capacity for innovation.

Pillar 2 focuses on improving incentives for leading microelectronics investments.

Pillar 3 is designed to identify market bottlenecks and support the supply of chips to critical sectors as needed.

Pillar 2 in particular addresses the challenge of attracting semiconductor investments to the EU which has been an area of concern. The EU's grant policy will enable the promotion of major "first-of-a-kind" investments in the EU.

This presents significant opportunities for Bavaria to step up its innovation capacity and drive advancements in the semiconductor industry as defined in pillar 1 but also for promoting investments, e.g. to encourage more companies along the semiconductor value chain to establish offices in Bavaria.

The pillar encompasses six operational goals:

- developing pilot plants for testing innovative process technologies and design concepts
- creating a design platform to facilitate access to design resources
- supporting advancements in quantum chips
- establishing centers of excellence and strengthening skills to improve access and talent across the European Union and
- creating a chip fund to support start-ups and SME expansion

The above objectives are to be achieved by means of mixed financing from the EU Commission and member states. The Bavarian Chips Alliance has a clear mission to advocate for stakeholders operating in Bavaria and effectively communicate their interests to policymakers and administrations.

The EU policy addresses companies of all sizes. In February 2023, the Commission published a paper titled "A Green Deal Industrial Plan for the Net-Zero Age", emphasizing the prioritization of SMEs in Important Projects of Common European Interest: "The Commission is also preparing to speed up the implementation of smaller, IPCEI related, innovative projects, in particular by small and medium-sized enterprises, through higher notification thresholds and greater aid intensities under the General Block Exemption Regulation."

The Chips Act and the Green Deal Industrial Plan collectively provide a policy framework that grants more flexibility for both the federal government and the Free State of Bavaria. Industrial policymakers are called upon to align their strategies with technology policies and adapt Europe's economy in response to geopolitical changes.

The Bavarian Chips Alliance is committed to closely monitoring these political processes and providing expert advice to the network. However, it does not have the mandate to represent the interests of individual companies or institutions.

4 Goal and mission

In view of the regional and global contexts outlined above, the Bavarian Chips Alliance's overarching goal is to collaboratively shape a robust semiconductor ecosystem in Bavaria. To achieve this, it has defined the following mission:

- **promoting Bavaria as a business location** in the semiconductor industry
- becoming the voice and brand for the Bavarian **semiconductor ecosystem**
- increasing **collaboration** between stakeholders throughout the semiconductor and electronics **value chains**
- making **supply chains** more resilient
- promoting **innovation and knowledge transfer** (also across industries)
- **networking** with other networks, clusters and associations inside and outside Bavaria

5 Fields of action

These goals translate into various fields of action for the Bavarian Chips Alliance. In order to strengthen Bavaria as a business location, it is crucial to promote and further develop its existing assets. Chip design stands out as a major asset, leveraging the well-established research landscape in Bavaria, including institutes such as IIS, AISEC, and EMFT of the Fraunhofer Gesellschaft. Moreover, Bavaria is home to both global players (e.g., Apple, Infineon, Texas Instruments, Qualcomm) and SMEs (e.g., MINRES Technologies), giving rise to **chip design** as the first field of action.

The goal is to encourage companies across the semiconductor value chain to **locate their business** in the region, working closely with Invest in Bavaria, the business development agency of the Free State of Bavaria. Besides chip design, the back-end (testing, assembly, and packaging) is also identified as a critical area offering significant potential.

To further strengthen the business landscape, it is essential to disseminate information about available support opportunities and funding programs. This is the responsibility of the **information on funding programs** field of action. In this context, the expertise of Bayern Innovativ can be leveraged, using the Bavarian support and start-up guide among other tools. Moreover, it is imperative to raise public awareness about the pivotal role of microelectronics in driving positive societal transformations, particularly among the younger generation with the aim of addressing the shortage of skilled workers.

To further enhance collaboration among stakeholders within the semiconductor value chain and bolster the resilience of supply chains, it is crucial to establish a dedicated field of action under the banner of the Bavarian Chips Alliance. This initiative aims to facilitate **networking** among all stakeholders **along the value chain**.

Innovations often emerge at intersections of different industries, underscoring the significance of **interdisciplinary networking**. This, in conjunction with general networking efforts, contributes to the objective of fostering innovation and promoting knowledge transfer.

This objective is also addressed in the **trend and technology scouting** field of action where valuable information is gathered and shared with all stakeholders. This insight, particularly beneficial for small and medium-sized enterprises, makes them better prepared for the future. Additionally, it enables creating a holistic overview of the entire value chain.

Start-ups play a vital role in generating groundbreaking innovations. Therefore, they represent an important aspect in achieving the goal of promoting innovation and knowledge transfer.

Establishing strong public relations is key to becoming the voice and brand of the Bavarian semiconductor ecosystem. This is where the **marketing** field of action comes into play.

To effectively network with other networks, clusters, and associations both within and outside Bavaria, it is crucial to integrate Bavarian semiconductor activities at the federal and EU level. Additionally, expanding international reach emerges as another key area, commonly referred to as **internationalization**.

6 Actions

These identified areas of focus can be translated into actionable steps. Moving forward, it is envisioned to organize workshops, seminars and specialized conferences on **chip design** in close collaboration with the Bavarian Chip Design Center which is currently being established. These initiatives aim to stimulate professional exchange, enhance networking among key players in chip design and identify specific needs and requirements.

The Bavarian Chips Alliance working closely with foreign companies and Invest in Bavaria will actively pursue the field of action aiming to **promote Bavaria as a business location**. These efforts will involve showcasing the offerings of the semiconductor network while facilitating rapid networking within the Bavarian semiconductor ecosystem. Hence, the Bavarian Chips Alliance itself is another strong argument in favour of locating semiconductor businesses in Bavaria. The subsequent internationalization initiatives additionally promote the field of action centered on attracting and facilitating establishments.

To effectively communicate **information about funding programs**, additional informational events can be organized using both the funding and start-up guide of Bayern Innovativ and external speakers (e.g. VDI-VDE-IT). The regular newsletter is another option that is used to offer up-to-date details on current funding opportunities.

Networking along the value chain is being actively pursued through various measures. An exemplary initiative is the organization of an annual semiconductor congress where stakeholders from all sectors can get together to engage in networking activities. A B2B matchmaking service can provide further support by facilitating targeted business interactions. Additional activities within this field of action include interactive networking platforms such as Digital Innovation Coffees or the establishment of a B2B marketplace similar to Smart Regions.

Strengthening interdisciplinary stakeholder **networking** can be accomplished by adopting a two-step approach: The initial step involves identifying potential collaboration topics that are already being explored. Subsequently, joint events can be organized with adjacent areas to promote collaboration. Promising opportunities are provided by 6G Thinknet, Cluster Automotive, Automation and Quantum Technology, and others.

The **trend and technology scouting** field of action presents a multitude of potential actions. Keeping track of emerging trends can be achieved through a trend radar and roadmap. Additionally, conducting market analyses, scientific studies, and surveys can provide valuable insights, which can be disseminated through publications such as white papers. Bayern Innovativ's Digital Innovation Platform (DIP) can serve as a useful tool for these endeavors. Furthermore, involving journalists as influencers, particularly highlighting the social benefits of microelectronics, presents an opportunity to expand the reach.

The **start-ups** field of action can be addressed through various actions. Firstly, identifying the specific requirements of start-ups within the Bavarian semiconductor industry is essential. Subsequently, networking these start-ups with other companies in the Bavarian semiconductor value chain can be facilitated through events organized by the Bavarian Chips Alliance. The goal is to encourage close collaboration with existing support programs and networks for start-ups, including UnternehmerTUM, Gründerland, BayStartUp and more. Additionally, we seek to promote connections between Bavarian companies and foreign start-ups.

Expanding existing marketing efforts will be a focus of the **marketing** field of action. This includes regular posts on social media platforms such as LinkedIn, Facebook, and Instagram with particular attention given to LinkedIn. Moreover, information materials about the Bavarian Chips Alliance will be distributed at events and these events will be further promoted through the regular newsletter. Location marketing initiatives will be carried out in collaboration with Invest in Bavaria. Technical articles by partners of the Bavarian Chips Alliance will be published in collaboration with media partners.

The **internationalization** field of action leads to three specific types of actions. Firstly, there are visits to international trade fairs conducted in partnership with Bayern International. These trade fairs serve a dual purpose: promoting Bavaria as a business destination and establishing connections with international companies and institutes. Partners of the Bavarian Chips Alliance have the opportunity to participate in international trade fairs at a reduced rate through the Bavarian Trade Fair Participation Program with joint stands available for showcasing their offerings. Cooperation with the Enterprise Europe Network (EEN) and its associated technology database offers another avenue to promote internationalization. Additionally, joint efforts with Invest in Bavaria involve organizing delegations to Bavaria as well as trips with delegates from Bavarian companies geared towards enhancing internationalization. The Bavarian Chips Alliance can also benefit from the support provided by Bavaria's extensive network of over 30 foreign representative offices.

BAVARIAN CHIPS ALLIANCE

Contact

Jürgen Frickinger
Head of Bavarian Chips Alliance | Project Manager
Technology | Electronics | Medical Technologies, Bayern Innovativ GmbH, Nürnberg
Tel.: +49 911 20671-160
Mail: frickinger@bayern-innovativ.de

Dr. Malte Kohring
Projektmanager Technologie I Digitalisierung, Bayern Innovativ GmbH, Nürnberg
Tel.: +49 911 20671-259
Mail: malte.kohring@bayern-innovativ.de

Lukas Zillich
Projektorganisation I ZD.B Themenplattformen, Bayern Innovativ GmbH, München
Tel.: +49 911 20671-724
Mail: lukas.zillich@bayern-innovativ.de

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Bayern Innovativ GmbH
Am Tullnaupark 8
90402 Nürnberg
T +49 911 20671-0
info@bayern-innovativ.de
www.bayern-innovativ.de

MANAGING DIRECTOR
Dr. Rainer Seßner

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