PANAMA SMART

Semiconductor Microelectronics Advanced Roadmap Technology

National Strategy for Semiconductors and Microelectronics - Panama

Institutional authors:
Government of the Republic of Panama
Ministry of Commerce and Industry
National Secretary's Office for Science, Technology, and Innovation (Senacyt)

Republic of Panama

Panama's National Strategy for Joining the Global Semiconductor and Microelectronics Supply Chain

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Gerardo Valdespino Berrio

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National Commission for Innovation in Microelectronics and Semiconductors

Panama's National Strategy for Joining the Global Semiconductor and Microelectronics Supply Chain was developed by mandate and in collaboration with the National Commission for Innovation in Microelectronics and Semiconductors (CIMS), a body created by Executive Decree No. 7 dated April 30th, 2024, with the purpose of coordinating, promoting, and monitoring national policy in this area.

Members of the Commission:

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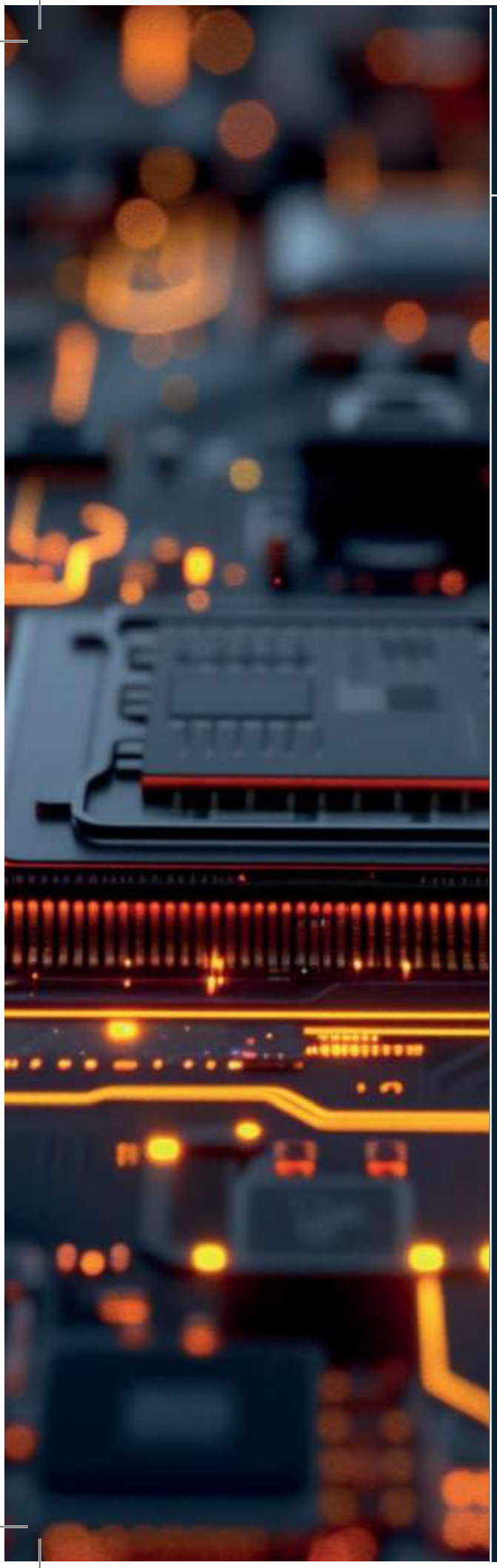

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Introduction

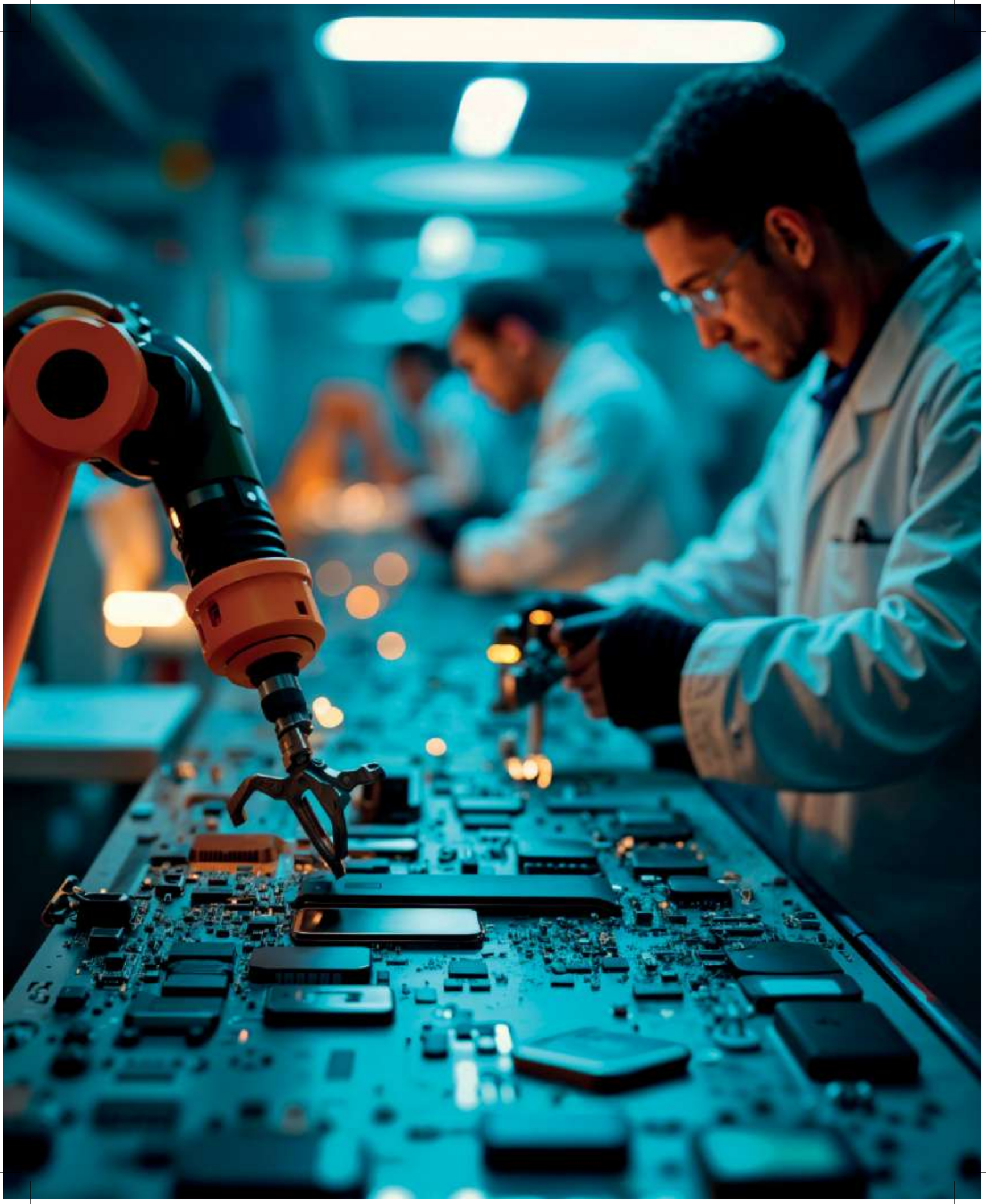
Panama's National Strategy for Joining the Global Semiconductor and Microelectronics Supply Chain arises in response to an international situation characterized by the reconfiguration of technology supply chains and the sustained increase in global demand for semiconductors. In this scenario, Panama is projected as a country with high strategic potential, supported by its privileged geographical position, its recognized logistics platform, and its regional leadership in trade and infrastructure.

The fundamental purpose of this strategy is to guide Panama's gradual entry into this high value-added industry. In the initial phase, the country will prioritize capacity building in areas such as assembly, testing, and packaging (ATP), semiconductor design, and printed circuit boards (PCBs), with the aim of advancing toward more complex stages of semiconductor manufacturing and the production of other critical components. This process will require sustained investment in technological infrastructure, innovation, and, especially, in the training and retention of highly qualified human talent.

Panama recognizes the need to adopt a long-term strategic vision that will attract investment in semiconductor manufacturing facilities and encourage the establishment of activities linked to the production of essential inputs for the global value chain. This initiative is part of the current geopolitical context, in which there is growing interest in strengthening and relocating supply chains in regions of the Western Hemisphere.

This document addresses the background of this strategy to position Panama as an emerging player in the global semiconductor ecosystem. It establishes strategic guidelines, outlines Panama's challenges and competitive advantages, the products that will be generated, and the beneficiaries. It also promotes a coordinated approach between the public sector, academia, the private sector, and international partners, aimed at the sustainable and competitive development of this industry in the country.

This is an opportunity for Panama to diversify its industry and move toward more complex economic activities that provide greater added value. Beyond diversification, this is a strategic step that could structurally reconfigure the country's economic model, traditionally based on logistics and financial services, toward an economy based on knowledge, innovation, and advanced technology. Panama's incorporation into the global semiconductor chain will not only boost the creation of highly skilled jobs and encourage new investment, but will also consolidate the country as a relevant player in an industry that is essential for global technological development.



1. Background

Semiconductors are one of the backbones of the global economy (Baisakova & Kleinhans, 2020), a trillion-dollar industry (Burkacky, Dragon, & Lehmann, 2022) that ranks fourth in the world and is expected to double in size by 2035 (PCAST, 2022).

Semiconductors represent an industry where manufacturing is not carried out uniformly worldwide. Approximately 75% of manufacturing capacity is concentrated in Asia. However, the supply chain extends globally due to the presence of multiple links required by the industry, either by semiconductor type or application. This complex chain ranges from the production of highly sophisticated semiconductors in some countries to assembly and testing facilities in others. While this geographical distribution benefits specialization, it also exposes the chain to a number of situations that make it vulnerable. Events ranging from environmental factors to geopolitical changes, such as the Covid-19 pandemic in 2020 and the war in Ukraine in 2021, have highlighted the vulnerability of global value chains.

As a result, in 2021, the United States ordered a review of critical value chains to maintain national security. This review specifically identified the semiconductor value chain as essential to maintaining its economic development, national security, and technological leadership. In this regard, although 20 companies that account for 80% of global production maintain a presence in the United States, the number of factories in that country continues to decline (De Obaldía & De Castillo, 2024). This has led to efforts to secure and expand semiconductor production in the Western Hemisphere, which has opened up an opportunity for Panama to seek to expand its participation in the semiconductor value chain beyond its limited involvement in the logistics phase by promoting post-manufacturing activities.

Determining factors such as the ecosystem, security, and access to skilled talent make the United States a favorable location for the semiconductor industry. A report on competitiveness and benefits for the semiconductor industry points to two key elements that have contributed to the decline of the sector: labor costs and lack of benefits. These factors have influenced the decline in the location of plants and production in the semiconductor sector in the region (Varas, Varadarajan, Goodrich, & Yinug, 2020). Consideration of these aspects could be fundamental to revitalizing the industry and encouraging interest in new players, actions that have been taken.

The United States government enacted the CHIPS Act, which aims to strengthen the semiconductor industry. Under this law, initiatives to support the sector's supply chain, such as nearshoring, have been opened up to competition. Since June 2021, the Embassy of Panama in the United States has been working to position Panama as a key strategic partner in the U.S. semiconductor value chain. This effort adds a critical dimension of technological security to our already strong relationship with the United States and allows Panama to play a role in the

future, a transformative task in global trade, similar to the historic impact of the Panama Canal. As a result of these efforts and close collaboration with U.S. partners, Panama was selected as one of the few countries worldwide that will be able to benefit from the U.S. CHIPS Act through the International Technology Security and Innovation Fund (ITSI).

This fund is part of a broader effort to secure and diversify the supply chain for semiconductors and other critical technologies. ITSI will disburse a total of $500 million over five years, distributed among seven selected countries, including Panama. The funds will go to U.S. institutions that will support the target countries. This investment seeks to improve technological capabilities and promote economic development.

The U.S. Embassy in Panama has met with key Panamanian government actors related to this sector to express its interest in collaborating with Panama on studies that identify segments and companies where Panama can play a key role.

It is understood that Panama has a number of competitive advantages, such as supply chain efficiency, skilled labor, tax benefits, and advanced infrastructure, in addition to the importance of Panama's multimodal transportation systems, which can be strengthened to meet the growing needs of this industry. In this regard, the great importance of air infrastructure should not be underestimated, as it is the main mode of transport used to move semiconductors, and Panama has a significant competitive advantage that allows the country to be seen as an important hub for this industry.

The development of the semiconductor industry requires a comprehensive strategy and legal framework covering aspects such as tax benefits, security in the handling of critical components, environmental protection, intellectual property, and the migration of specialized talent. Panama has identified these elements as strategic for building confidence among international investors and ensuring competitive participation in the global semiconductor chain, promoting a knowledge economy that is sustainable and secure.

Thus, given the global relevance that semiconductors have acquired and the importance that this sector could have for economic activity and technological development, given the possibility of leveraging the competitive advantages that the country possesses due to its geographical position, its expertise in logistics and related infrastructure, and given the possibility of joining global semiconductor chains, not only as a distribution center but also as a player in design and post-manufacturing activities, it is of utmost importance to design the conditions that will allow for the definition of a country strategy to insert Panama into the global semiconductor chain, identifying its capabilities, articulating them, and organizing them.

2. An opportunity for Panama

The semiconductor industry is estimated to be worth $630 billion globally in 2024, a figure that is on the rise, with estimates predicting that it will reach $1 trillion by 2030.

Figure 1. Global sales in the semiconductor sector.

Source: (Statista, 2024) and Semicon.

This sector has a strong presence in Asia, but for Western countries, mainly European countries and the United States, it is of great interest to be able to ensure production without becoming dependent on China's sphere of influence, due to several key factors:

I. During the pandemic, demand for semiconductors for use in computer equipment skyrocketed, while the use of semiconductors in the automotive sector faced delays in chip deliveries, which affected the industry and had an impact on the supply chain, highlighting the vulnerability of the sector.

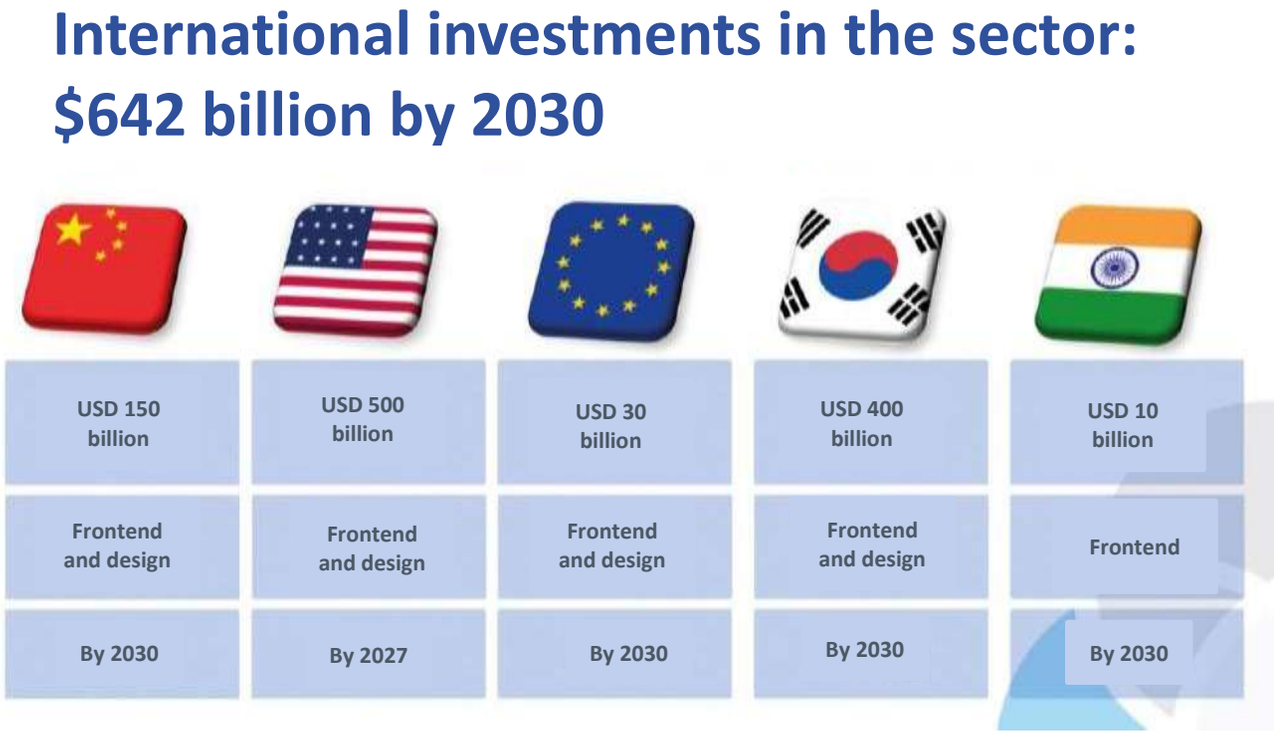
II. Due to economic, geopolitical, and national security issues, it is essential for Western countries to ensure semiconductor production in line with the efforts of Europe and the United States.

Seeking to bring semiconductor production closer to their sphere of influence and prevent geopolitical and security issues from jeopardizing the supply of semiconductors, the U.S. government has enacted the CHIPS and Science Act, with the aim of diversifying the supply chain by directing more than $50 billion to incentivize semiconductor production, reduce dependence on Asia, and thus strengthen U.S. national security.

Of this amount, $500 million is earmarked to support countries identified as strategic partners in strengthening the value chain. During her visit to Panama in July 2023, U.S. Secretary of Commerce Gina Raimondo announced that Panama would be part of a select group of U.S. strategic allies that would receive part of these funds to promote projects aimed at securing this critical industry. This designation is based primarily on the role that Panama can play in the assembly, packaging, and testing of semiconductors, an essential phase of production in which the United States will continue to rely heavily on Asian suppliers, mainly due to their low labor costs, even after expanding manufacturing capacity in North America.
In addition to the United States, the main countries in this market have announced significant investments to promote the sector's growth. The European Union will invest $30 billion, China $150 billion, South Korea $400 billion, and India $10 billion, all by 2030.

This set of economic packages announced by different countries amounts to more than $590 billion, allowing Panama to aspire to join global efforts and seize the moment to enter this sector.

Figure 2. International investments directed at the semiconductor sector.



Source: Prepared by the author with data from (Filipo, Guaipatín, Navarro, & Wyss, 2022.)

Given this situation, an opportunity has been identified for Panama to integrate into this global chain, which has been analyzed for this project. Four major areas of opportunity have been identified: design, assembly and testing, distribution and supply chain, and finally production of printed circuit boards (PCBs) for assembly and/or applications. Of these segments, the one with the lowest barriers to market entry has been identified as assembly and testing, which represents $33 billion globally and is a priority for the United States.

Although it is not the largest market segment in economic terms, it can be labor-intensive and requires less strong investments for entry.

The other segments: design and applications or PCB development are segments that warrant capacity building but may see more immediate growth in the semiconductor sector. The logistics sector is considered the most developed competitive advantage, and this sector could become the country's gateway to this global chain.

It should be noted that Panama's possible insertion into the semiconductor value chain is mainly due to the alignment of its economic interests with those of U.S. national security. It is due to its designation as a strategic partner of the United States and the historical role Panama has played as a transit site and key player in hemispheric security issues that Panama now participates in international forums and arouses the interest and curiosity of potential investors and strategic players in the industry.

Panama has a number of structural advantages that position it as an attractive destination for investment in semiconductors. Its advanced transportation infrastructure, established free trade zones, trade agreements with strategic partners, and strong tax incentive regime allow the country to play a crucial role in the efficient movement and management of technological products and components.

Thus, considering the country's strengths and the international strategic context, it is clear that Panama's strategy to expand its participation in the semiconductor industry should have as its main objective the establishment of the necessary conditions for the development of semiconductor post-production activities, particularly assembly, packaging, and testing (ATP).

In the start-up phase, Panama will focus on developing capabilities in printed circuit boards (PCBs), assembly, testing, and packaging (ATP), segments that offer more direct and rapid access to the semiconductor value chain. This will enable the country to position itself in activities that require technical labor and high-precision manufacturing processes, while laying the groundwork for expansion into higher value-added activities in later phases.

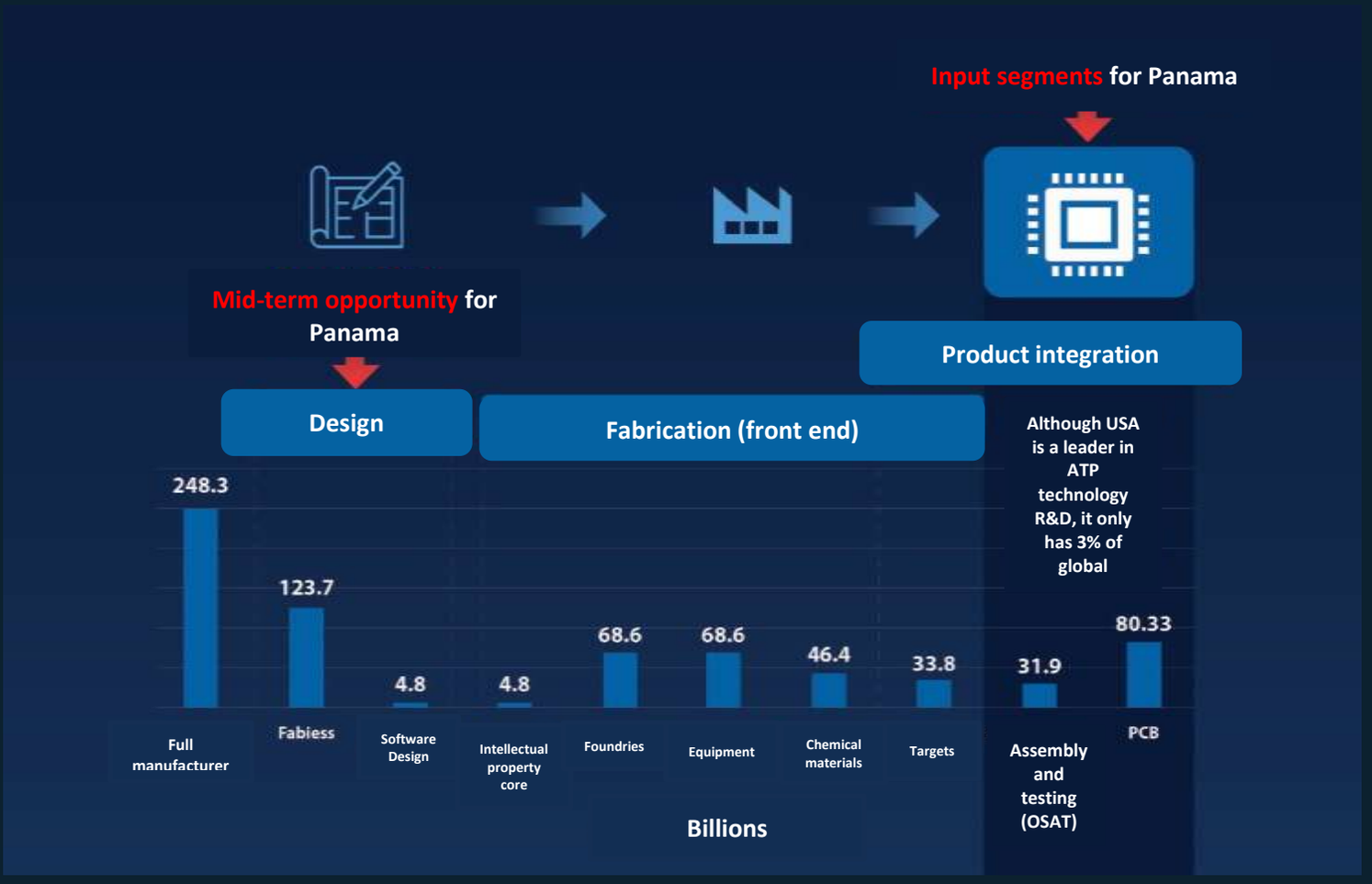
This objective provides strategic clarity, allows for the pursuit of intermediate goals, and enables the development of capabilities in the various links without neglecting the geopolitical context and strategic alliances that currently allow Panama to consider joining one of the most

strategic value chains on the planet. Without these alliances, any independent effort would face significant challenges, including positioning the country as a credible and viable solution to the global problem facing the industry.

Simultaneously with the consolidation of ATP's operations, the strategy also promotes a gradual expansion into semiconductor design and technological development. This growth phase envisages fostering collaboration with international research centers, as well as developing a local innovation ecosystem that allows national and international companies to develop high-value chips and technological solutions.

The ultimate goal of the strategy is to incorporate Panama into the advanced manufacturing phases of semiconductors and other key components. This phase will involve greater investment in infrastructure and cutting-edge technologies, as well as an intensive focus on training specialized talent. Panama will seek to attract investment in semiconductor factories (fabs) and activities related to the creation of critical materials and components in the long term.

Figure 3. Global semiconductor value chain with sales in each segment.



Panama has competitive advantages that set it apart from other alternatives for the development of semiconductor post-production activities in the Western Hemisphere. These include its political stability, the availability of human capital, its financial system, its status as a carbon-negative country, its dollarized economy, its maritime logistics hub and air transport, among others. However, it is the logistics platform, particularly the region's unrivaled global air connectivity, that allows Panama to position itself as a global post-production and distribution hub for the industry. Achieving this position could have positive impacts on the economy and society, such as the creation of specialized jobs, attracting foreign investment

and productive diversification.

Based on the information collected and the structured work carried out by various institutions in Panama, it has been identified that, in accordance with the country's competitive advantages, the opportunities presented by the market, and the capabilities that Panama has developed as a country, the segments of the semiconductor chain that can be entered are:

Immediate Target Segment:

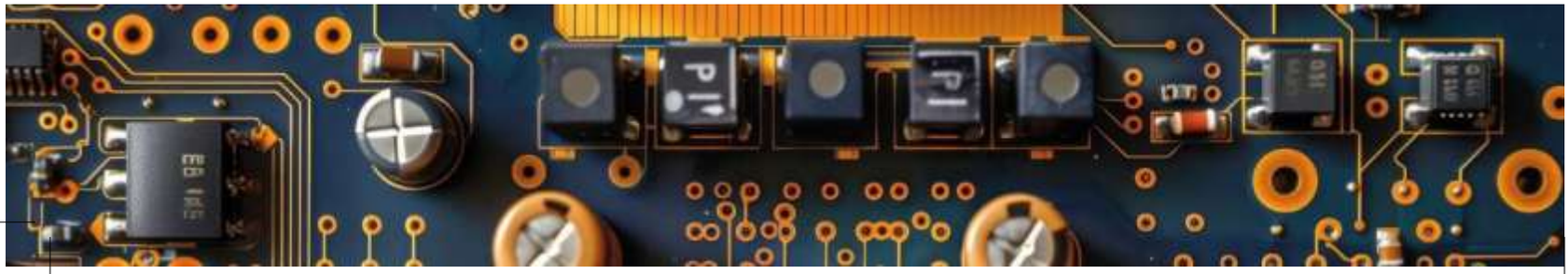
1. **Printed circuit boards (PCBs)**: This is a segment that complements the assembly link, which would allow Panama to achieve vertical integration and thereby increase operational efficiency. Although it requires an initial investment in technical infrastructure and training, PCB manufacturing is a feasible field for Panama due to its lower complexity compared to chip manufacturing, and global demand for PCBs continues to grow, especially with the rise of consumer electronics, automotive, and IoT devices, among others. This sector is associated with microchip applications and may include software development and other technical skills that are in high demand in the sector.

2. **Assembly and testing**: This segment requires a balance between skilled labor and advanced technology. Panama can leverage its educated human capital and train it specifically for these tasks. In addition, compared to semiconductor manufacturing, assembly and testing have lower technological and infrastructure requirements, making it easier for Panama to enter the market. Furthermore, this segment tends to generate a significant number of jobs, which will also promote the development of technical skills among the population and could lead to faster and more effective integration into the global semiconductor supply chain, contributing to the development of local capabilities and expertise. The North American value chain has a significant deficit in these capabilities, and Panama is well positioned to take advantage of the geostrategic situation that has opened up the possibility of the country's insertion into this value chain.

3. **Supply chain**: The existing infrastructure in ports, airports, and distribution centers is strong, facilitating the implementation of efficient and rapid logistics operations. Panama can also position itself as a regional logistics hub for the transit of technological products, improving efficiency and reducing transportation costs for semiconductor companies. Panama's geographic location, together with its advanced logistics infrastructure and favorable tax regime, offers a unique opportunity to develop a strong ecosystem of suppliers. The integration of local and regional suppliers will not only reduce costs and delivery times but also improve the competitiveness of companies established in Panama and the region. The existence of the Tocumen air hub with flights to more than 89 destinations in the United States, Europe, Asia, Latin America, and the Caribbean, as well as the Panama Canal, connecting more than 160 destinations globally, give Panama a unique position to add value to the global semiconductor chain.

4. **Design**: Semiconductor design is a stage of high value addition in the supply chain, which can increase Panama's technological competitiveness and attract foreign investment. Fostering a culture of innovation and technological development, supporting startups and local companies to participate in semiconductor design, can position Panama as a center of creativity and advanced technology. This segment is of interest because the cost of entry is lower.

Therefore, the efforts that must be made as a country should focus on creating new capacities and strengthening existing ones, with a view to entering the global semiconductor supply chain at these links. Focusing efforts on these segments will allow Panama to leverage its competitive advantages, such as its strategic location and logistics infrastructure, while developing new technological and human capacities.



3. Emerging Technologies Associated with the Semiconductor Industry

To consider developing a semiconductor capabilities strategy, it is necessary to identify emerging technologies associated with this industry. Developing capabilities in these technologies could expand Panama's capabilities in existing sectors such as banking, logistics, construction, tourism, and others, while also enabling the development of capabilities for new industries, such as semiconductors.

1. **Advanced Computing:** This involves the use of high-performance processing technologies to handle large volumes of data and perform complex calculations, which are essential for semiconductor design and simulation. Banking and logistics can benefit from advanced processing capabilities to improve efficiency in data and transaction management, optimizing decision-making and information security.

2. **Advanced Engineering Materials:** This includes the development and use of new materials with improved properties, such as greater strength, durability, and efficiency, which are crucial in the manufacture of more efficient and durable semiconductors. In construction, the use of advanced materials can improve the durability and efficiency of projects. In turn, the development of sensors based on new materials for the IOT can increase energy efficiency, improve cargo traceability, and enhance the strength of equipment and vehicles. The development of advanced packaging for semiconductors is also part of this category.

3. **Advanced Manufacturing:** This refers to the implementation of innovative technologies and automated processes in the production of goods and components, which are vital for the precise, large-scale manufacturing of semiconductors and other industries. Advanced manufacturing can improve efficiency and product quality in all of the sectors mentioned above. In tourism, it could be applied to the creation of innovative and sustainable infrastructure.

4. **Artificial Intelligence:** The ability of machines to perform tasks that normally require human intelligence, such as learning, decision-making, and problem-solving, is used in the design and optimization of semiconductor manufacturing processes. Artificial intelligence can revolutionize banking through process automation, fraud detection, and service personalization. In logistics, it can optimize routes and manage inventories more efficiently.

5. **Data Privacy, Data Security, and Cybersecurity Technologies:** A set of techniques and tools to protect digital information from unauthorized access and cyberattacks, where advanced semiconductors play a key role in creating secure hardware. Banking and tourism, which handle large volumes of personal and financial data, can benefit significantly from improvements in data privacy and cybersecurity, protecting customer information and strengthening trust.

6. **Integrated Communication and Networking Technologies:** These facilitate the transmission of information and connectivity between devices and systems across networks, with advanced semiconductors improving the speed and efficiency of these communications. Logistics and banking depend on strong and secure communication networks for their daily operations. Improvements in these technologies can increase the efficiency and reliability of transactions and the tracking of goods.

7. **Quantum Information and Enabling Technologies:** Explore the use of quantum mechanics properties to improve information processing and transmission, using advanced semiconductors to develop quantum computers. Banking could use quantum computing to improve cryptography and security in financial transactions. Logistics can benefit from advanced optimizations in the handling and transportation of goods.

The focus on these emerging technologies will not only strengthen existing sectors, but also open the door to the development of a semiconductor industry in Panama. This will diversify

the country's economy, creating high-tech jobs and positioning Panama as a leader in technological innovation in the region.

4. Challenges that become opportunities

The semiconductor industry is fundamental to the global economy, driving innovation in many sectors, from consumer electronics to automotive and healthcare, making this sector an attractive economic activity as it can generate synergies with other areas of the global economy. In the case of Panama, an important window of opportunity is opening up due to the United States' interest in moving the supply chain from China's sphere of influence to the Western Hemisphere.

Panama, with its renowned logistical capabilities, geostrategic position, and leadership in sectors such as trade and infrastructure, is uniquely positioned to take advantage of opportunities in the dynamic semiconductor sector. Growing global demand and efforts to diversify supply chains offer Panama a strategic role in this high value-added industry.

However, despite Panama's competitive advantages in logistics, there are also a number of significant challenges that must be addressed in order to seize the opportunity and attract foreign investment.

This set of challenges that have been identified gives a sense of specific action to the strategy presented in this document. The set of challenges that have been identified based on the joint work between the institutions involved in Panama, as well as studies conducted by the Inter-American Development Bank and the consulting firm BreakWater Strategy, provide clear guidance on the needs that must be addressed. The challenges identified are:

1. **Regulatory and policy framework:** It has been identified that Panama will have to adapt its regulatory framework, making it consistent with the international norms and standards expected by the industry, in order to promote innovation, foreign investment, and intellectual property protection. This could require the signing of international treaties, the proper formulation and dissemination of the national strategy for the sector, the review of mechanisms for controlling exports of sensitive technologies and the protection of scientific research products, and continued political support at the highest level for national efforts related to this industry.

2. **Technological infrastructure:** Panama has great potential to develop a technological infrastructure that will drive innovation and local development. Currently, although the country depends on imports of finished technological products, this situation opens up a unique opportunity to invest and strengthen internal capacities. By establishing research and development (R&D) facilities and production centers equipped with advanced technology, Panama could position itself as a key player in the global semiconductor value chain. With strategic investments in physical and digital infrastructure, the country has the potential to become a hub for technological innovation in the region.

3. **Specialized human capital:** The semiconductor industry requires highly trained personnel in areas such as electronic engineering, materials science, and information technology. In Panama, a significant gap has been identified in the availability of specialized training and resources for research and development in the field of semiconductor technology. Panama not only faces the challenge of training specialized talent, but also of attracting and retaining professionals with the skills necessary to work in this highly technical and specialized industry.

4. **Investment in education and training:** Panama has a great opportunity to boost its development in the semiconductor industry by investing in educational and training programs specializing in STEM (Science, Technology, Engineering, and Mathematics). Fostering a STEM culture from basic education to university training, in collaboration with academic

institutions and companies in the sector, is key to preparing a highly skilled workforce. In addition, it is essential to strengthen soft skills such as communication and teamwork, as well as English language proficiency, which will enable Panamanian professionals to successfully integrate into a competitive global environment.

5. **Establishing strategic alliances:** To position itself as a relevant player in this highly competitive industry, Panama needs to forge partnerships with leading companies and countries in the semiconductor sector. These alliances are essential for acquiring advanced technical knowledge, accessing cutting-edge technologies, and attracting significant investments that drive development and innovation in the country. Panama's ability to establish and maintain these strategic relationships will be crucial to its success in fully integrating into the global semiconductor value chain.

6. **International competition:** Establishing a semiconductor assembly and test (ATP) industry in Panama presents several significant challenges. This industry is highly competitive, especially in countries such as Taiwan, South Korea, China, Singapore, Malaysia, the United States, and the Philippines, requiring Panama to develop competitive advantages.

   In the design sector, Panama would be competing with leading countries such as India, Israel, Japan, and South Korea. However, the global nature of the semiconductor industry allows companies to establish satellite design centers in various locations, as no extensive physical infrastructure is required.

   In the logistics sector, Panama has many competitive advantages in the region, but it must consolidate its position as a key hub for the supply of raw materials and equipment, and as a cargo distribution center. Taking advantage of its strategic geographical location, the Panama Canal, its advanced port infrastructure, and its air infrastructure, Panama can facilitate the efficient flow of materials and products. However, to establish itself as a true logistics hub, it is crucial for Panama to continuously improve its storage, transportation, and distribution capabilities and to promote favorable policies to attract foreign investment and foster the development of an integrated and strong supply chain.

   In terms of printed circuit board (PCB) production, Panama can quickly develop strategic capabilities in this area, providing essential support to design and manufacturing companies in the semiconductor supply chain. This sector requires the training of specialized technical talent, for which Panama already has a significant base of engineers and technicians in the areas of electronics.

   This will enable Panama to consolidate its position as a distribution and supply center for the semiconductor industry and other high-tech industries in the region. China and Taiwan account for around 65% of the PCB industry. Many sensitive technology companies in the United States and Europe are tasked with stopping the consumption of inputs from China for security reasons and eventually from Taiwan for geopolitical reasons. Panama should aim to bring a small percentage of this industry to Panama.

7. **Access to financing:** The investment in infrastructure, education, and technological development required to enter the semiconductor value chain can be costly. Therefore, it will be necessary to access both internal and external sources of financing to support these development efforts, which requires the design of a smart and well-structured strategy with resources from both the state and private investment.

8. **Conducive business environment:** To attract and position the semiconductor industry in the region, it is essential that Panama focus on strategic areas where it can integrate its capabilities with hemispheric markets. Rather than attempting to develop all capabilities domestically, priority should be given to creating a strong national offering in key niches, such as chip packaging and specialization in circuit design and verification.

   It is also crucial to strengthen the supply chain by attracting companies that offer specialized materials and equipment, and to promote partnerships with research and development centers to facilitate technological innovation. This strategy of integration and collaboration

with hemispheric markets will enable Panama to develop a competitive and sustainable environment in the semiconductor industry, avoiding the over-extension of resources and capacities.

9. **Highlighting the advantage of sustainability and carbon negativity:** Panama stands out as one of the few carbon-negative countries in the world, which represents a competitive advantage in the semiconductor industry. As global companies seek to reduce their carbon footprint and align themselves with sustainability policies, this characteristic of Panama could attract investors and partners interested in establishing operations in a cleaner and more environmentally responsible environment. In addition, carbon-negative status facilitates the development of policies and benefits to support sustainable industries, reinforcing the country's commitment to sustainability and offering added value to companies that prioritize sustainability in their supply chains.

10. **Strengthening infrastructure linked to the sector:** ensuring adequate infrastructure is a critical factor in attracting semiconductor companies, as this industry depends on stable energy and water supplies, efficient logistics, and high-level digital connectivity. In the energy sector, Panama must strengthen its energy generation, distribution, and storage capacity, ensuring a reliable supply, competitive prices, and 24/7 availability to support high-demand industrial processes. In terms of water management, semiconductor manufacturing and testing require large volumes of ultrapure water, making it necessary to optimize its use through treatment and recycling infrastructure, ensuring that industrial demand can be met without affecting other sectors. From a logistical standpoint, although Panama has advanced ports, airports, and special economic zones, it is essential to improve the integration of these systems with specialized logistics corridors that facilitate the safe and efficient transport of sensitive materials. Finally, strengthening digital connectivity will be key to attracting high-tech companies. The expansion of fiber optic networks, the implementation of 5G, and the adoption of artificial intelligence will improve operational efficiency and consolidate Panama as a competitive destination for the semiconductor industry.

11. **Security:** The semiconductor sector faces security challenges that must be addressed. Issues such as data protection, designs, and industrial processes are a priority for attracting investment in semiconductors. Panama must strengthen its cybersecurity infrastructure and establish advanced protocols for protection against cyberattacks. Similarly, companies in the sector require guarantees that their technology will be adequately protected, which is why intellectual property regulations must be strengthened and international agreements established to facilitate the secure transfer of technology.

12. **Control of sensitive materials:** Given the strategic importance of certain components in semiconductor manufacturing, Panama must develop an efficient control system for the import, storage, and use of sensitive materials, ensuring alignment with international security standards.

Thus, the challenge facing the country in creating the optimal conditions to enter the global semiconductor chain is not an easy one, as it involves several aspects such as development, training, attracting and retaining human talent, investment in specialized infrastructure, regulatory framework, changes in educational models, and access to financing.

While Panama recognizes the challenges it faces in terms of the density of technological activities and the training of specialized talent, these represent key areas where transformations are underway. The country is actively investing in strengthening its educational programs, with a particular focus on science, technology, engineering, and mathematics (STEM), while creating international partnerships that ensure the effective transfer of knowledge and technological capabilities.

While entering the global semiconductor value chain could offer significant opportunities for Panama's economic growth and technological development, the main problem identified is that several major challenges will be faced that require a strategic and coordinated approach by the government, the private sector, and other key stakeholders.

With this strategy, Panama is positioning itself as a regional center for semiconductor innovation and production. Through continued investment in technological infrastructure and human capital, coupled with favorable public policies, the country has the potential to become a key hub for the assembly, testing, and packaging of semiconductor components, with a view to expanding its capabilities toward advanced design and manufacturing in the future.

Global companies such as Samsung, LG, and Dell have already recognized Panama's strategic value as an operational base in the region, demonstrating the country's ability to attract and retain investment in high-tech sectors. These successful experiences serve as a foundation for the expansion of more specialized activities within the semiconductor ecosystem.

Panama is poised to become a key player in the global semiconductor supply chain. With a clear vision, strong government commitment, and an environment conducive to innovation, the country invites technology industry leaders to be part of this story of growth, resilience, and success in one of the most critical industries of the 21st century.

5. Panama's competitive advantages

Panama is not starting from scratch to consolidate its position as a relevant player in the global semiconductor supply chain. While the country faces challenges related to the availability of specialized talent and the need to strengthen its innovation ecosystem, it has a number of competitive advantages that position it favorably with international investors. These advantages, backed by solid infrastructure, an attractive regulatory framework, and strategic alliances with leading economies, provide a firm foundation for driving growth in Panama's semiconductor sector.

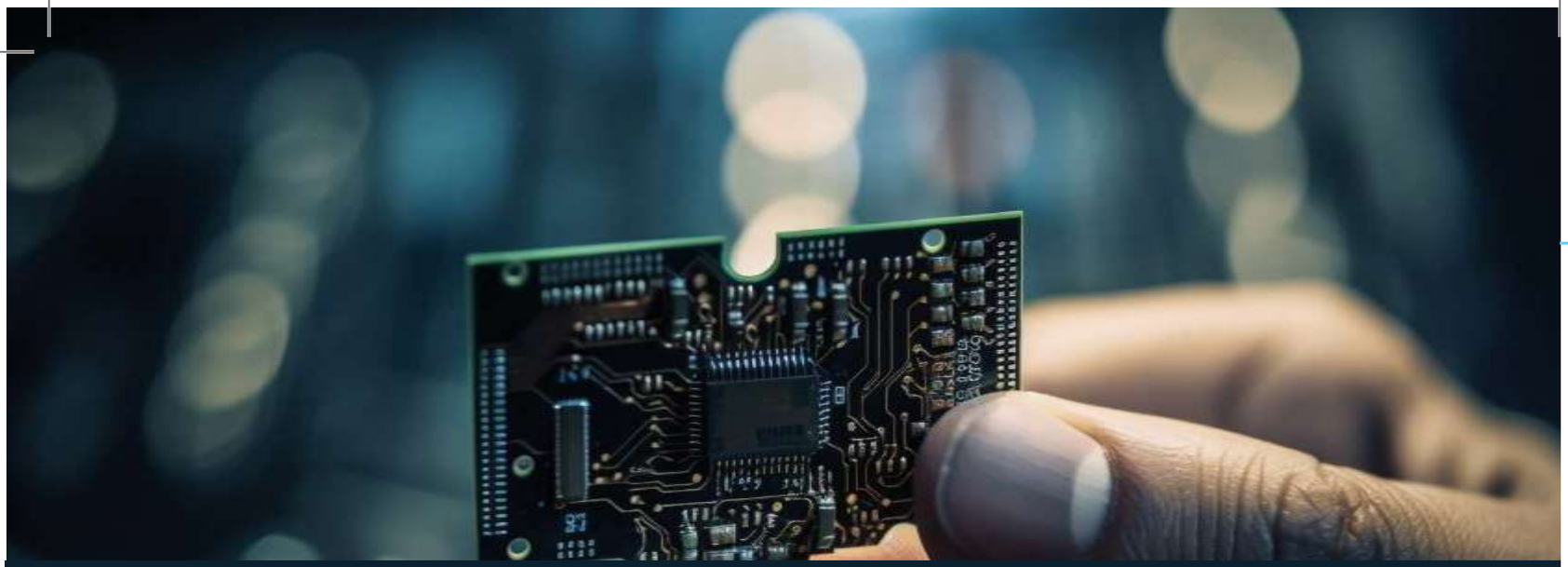
Panama's strategic geographic location, together with the Panama Canal, undoubtedly gives it an unparalleled advantage as a global distribution center. This privileged position efficiently connects the markets of the Americas, Europe, and Asia, allowing for the smooth transit of high-tech goods, including semiconductors, optimizing shipping times and reducing logistics costs. In addition, the country already has an **advanced logistics infrastructure** that includes world-class airports and high-performance seaports, as well as a trans-isthmus railway, facilitating its integration as a key node in the global semiconductor supply chain.

Another key aspect is Panama's **political and economic stability**, which reinforces its appeal to international investors. Its dollarized economy provides a predictable and reliable environment, complemented by a strong financial system and a regulatory framework designed to facilitate foreign investment. This favorable environment is strengthened by low inflation and the implementation of competitive tax regimes, such as those for Multinational Company Headquarters (SEM) and the EMMA regime, which provide technology companies with an environment conducive to their expansion and development.

In addition to these benefits, there are **special economic zones** such as the Colon Free Zone, Panama Pacifico, City of Knowledge, and the Barú Free Zone, among others, which play an essential role in global trade. These zones provide tax benefits and customs facilities that can be directly integrated into semiconductor supply chain operations, increasing efficiency and reducing operating costs for companies in the sector.

Additionally, as will be seen below, consideration is being given to integrating and promoting specific legislation for the microelectronics and semiconductor sector, which would allow for the integration of various benefits and the creation of an optimal business environment.

In terms of human capital, Panama has launched **specific educational programs** to meet the demands of the semiconductor industry. The country, in collaboration with international institutions such as Arizona State University (ASU) and Purdue University, is developing specialized talent in key areas such as electronic engineering and microelectronics, with an emphasis on microelectronics and semiconductors. This commitment to specialized training in science, technology, engineering, and mathematics (STEM) positions the country as an emerging hub of skilled talent, capable of supporting the sustained growth of the technology industry.



The training of talent goes hand in hand with a commitment to innovation and research and development (R&D), which have been an important driver for attracting investment in advanced sectors. The National Secretary's Office for Science, Technology, and Innovation (SENACYT) leads efforts to promote scientific and technological development, a strategic priority for the country. In this regard, efforts are being guided by the creation of the Center for Advanced Semiconductor Technologies (C-TASC) under the auspices of the Technological University of Panama (UTP).

Panama is also aligned with global sustainability trends, with more than 70% of its energy matrix coming from renewable sources, making it an attractive destination for companies seeking to reduce their carbon footprint while optimizing energy costs.

In this regard, Panama positions itself as a country committed to sustainability and environmental protection, being one of the few nations in the world that maintains a **negative carbon** balance. This status reflects its ability to capture more carbon than it emits, giving it a key advantage in a global environment increasingly focused on sustainability. This condition, together with its advanced environmental policies, makes Panama an attractive place for investments in green technology and industries such as semiconductors, where sustainability is increasingly valued.

Furthermore, Panama's **international strategic alliances**, especially its close relationship with the United States, offer a unique opportunity in the context of the global reconfiguration of semiconductor production. Initiatives such as the U.S. CHIPS Act, aimed at relocating semiconductor production outside Asia, open the door for Panama to position itself as a strategic partner in the region. This collaboration could catalyze the installation of assembly, testing (ATP), and other operations linked to the semiconductor industry.

Finally, Panama's commitment to sustainability and its ability to offer competitive energy costs, backed by high use of renewable energy, reinforce its attractiveness as an investment destination. In a context where sustainability is increasingly a decisive factor in investment decisions, Panama is positioning itself as an optimal destination for technology companies seeking to minimize their environmental impact while maximizing operational efficiency.

6. Proposed actions to be implemented

To take advantage of these competitive advantages, address the challenges identified, and build a comprehensive strategy that encompasses the various dimensions, working meetings have been held between the government, industry, and academia, including the Technological University of Panama, the Superior Technical Specialized Institute (ITSE), the Ministry of Commerce and Industry, the Ministry of Foreign Affairs, SENACYT, private sector organizations such as Panama Pacífico and the City of Knowledge, public interest associations such as CENAMEP and INDICATIC, and entities such as Georgia Tech Panama, among others.

In addition, work has been done with the Inter-American Development Bank to conduct a study to identify the country's capabilities for joining the global semiconductor and microelectronics sector. The IDB has made the following set of recommendations:

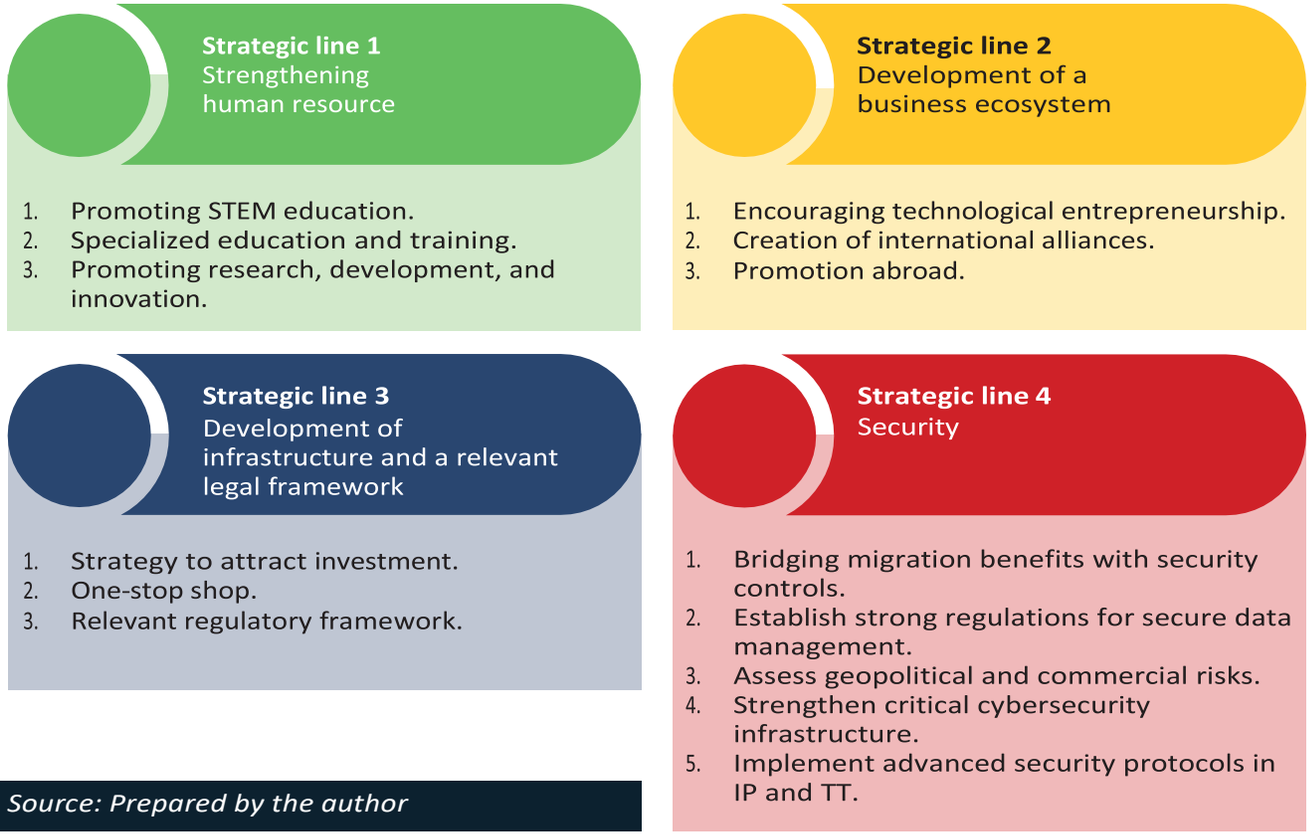
- To separate the national semiconductor strategy from the political cycle, as demonstrated by the continuity of SENACYT's CTI support instruments.
- To update or expand regimes in line with the national agenda on CTI.
- To adapt tax benefits to be competitive with other interested countries.
- To develop a strategy that does not end with semiconductors, but also extends to other emerging technologies (generally requiring semiconductors) that enable the creation of an ecosystem. Also include segments where the U.S. is weak and Asia dominates (Chemicals, PCBs).
- To provide funding for CTI specifically for semiconductor research projects.
- To run scholarship programs focused on skills relevant to the sector.
- To create partnerships with the private sector to design specific study programs; modify existing programs to expand content.
- To create partnerships with foreign universities as sponsors of Panama compared to companies in the sector.
- Logistics and clean energy are highly valued by the CGV, and Panama must be able to highlight its strengths in these areas.
- To consider a partnership with the logistics sector as a promoter of the country.

Work has also been done with the international consulting firm Breakwater, which, as a result of an initial exploratory study, has put forward a set of observations:

- Benefits should be created to generate specialized jobs and attract international talent.
- To integrate educational programs to develop specialized human talent.
- To promote the establishment of industrial clusters, free trade zones, and industrial parks.
- To work on the design of an intellectual property regime appropriate to the conditions of the semiconductor market.
- To invest in ensuring the quality of specific infrastructure such as water, electricity, logistics, and cybersecurity.
- To create programs to support R&D&I and technology transfer.
- To design a mix of benefits and subsidies to attract companies and investors.
- To create mechanisms for clear communication between companies and the executive branch.
- To promote the creation of public-private partnerships.

As a result of these discussions, as well as recommendations received from the IDB and Breakwater, a strategy has begun to take shape that includes thirteen clearly defined tactical lines of action organized into four strategic lines that seek to address the country's challenges in an organized manner.

Figure 4. Lines of the national strategy for microelectronics and semiconductors.



Source: Prepared by the author

This proposal seeks to address these critical concerns by promoting a comprehensive strategy that addresses the thirteen dimensions identified, focusing on the country's incorporation into the semiconductor value chain. This comprehensive strategy seeks not only to attract investment but also to consolidate a sustainable and secure ecosystem around the semiconductor industry in Panama.

The first strategic line focuses on strengthening human talent, promoting training in STEM disciplines and specialized training. It also seeks to encourage research, development, and innovation, creating a talent base prepared to face the challenges of the semiconductor industry.

The second strategic line is aimed at developing a solid business ecosystem. This includes benefits for technological entrepreneurship, the creation of international alliances, and the promotion of Panama as a competitive destination for this industry abroad.

The third strategic line focuses on improving infrastructure and establishing an adequate legal framework to attract investment. This involves creating a favorable regulatory environment and benefits that make Panama an attractive location for high-tech companies.

Finally, the fourth strategic line addresses the issue of security. Here, priority is given to balancing immigration benefits and security controls, as well as establishing strong regulations for secure data management, assessing geopolitical and commercial risks, and strengthening cybersecurity infrastructure and advanced protocols for intellectual property protection and technology transfer.

7. Objective and scope of the strategy

General Objective: To position Panama as a key player in the global semiconductor value chain, integrating capabilities by creating a competitive and sustainable ecosystem that leverages the country's logistical, fiscal, and talent advantages, promoting international investment, technological innovation, and the creation of highly skilled jobs.

To achieve this objective, an investment is estimated to develop technical and human capacities that will allow Panama to join the global microelectronics and semiconductor chain, taking advantage of its competitive logistical advantage. To achieve this, it is proposed to work on four strategic lines containing 13 tactical actions:

Strategic line 1: Human talent development

The first strategic line focuses on developing the human capabilities required by a sector as specialized as microelectronics and semiconductors. Although Panama already has qualified professionals in this field, analyses indicate that a larger, highly trained workforce is needed to compete effectively in the global value chain. Currently, the country has doctors and teachers in its educational institutions, but it is essential to strengthen and expand this talent base to meet the needs of the industry.

The objective of this strategic line is to have specialized human talent with the technical skills and specific knowledge required by the semiconductor industry. To achieve this, the following tactical lines are proposed, which aim to strengthen the supply of specialized talent in the country:

- STEM Training

As mentioned in the preliminary analysis, the semiconductor industry requires a highly skilled workforce in technical and scientific areas. Therefore, if Panama wishes to integrate into the global chain, it must develop long-term capabilities to ensure that its entry into the industry is sustainable over time. STEM training ensures that Panamanian professionals are prepared to design, manufacture, and manage advanced technologies, from semiconductor assembly and testing to highly complex design activities.

With this, Panama's educational strategy will not only address the immediate needs of the industry, such as semiconductor assembly and testing, but will also open up opportunities to move toward advanced design and manufacturing in the future. This approach will position the country in a high value-added segment within the semiconductor chain in the future.

The STEM Training initiative aims to develop educational programs and extracurricular activities that spark interest and participation in science, technology, engineering, and mathematics (STEM) among children and young people from an early age. This line of action seeks to strengthen STEM education from basic to higher levels, creating a solid foundation of skills that promotes interest and excellence in key disciplines for technological innovation. Furthermore, this strategy is essential to ensure the long-term sustainability of the semiconductor industry in Panama.

Collaboration with the Ministry of Education (MEDUCA) is essential, including curriculum adaptation to improve the teaching of subjects such as physics, mathematics, and chemistry, and to promote competency-based learning, projects, and problem solving. Developing these skills will enable future generations to be prepared for the technological and scientific challenges of the sector.

- Specialized education and training

Implementation of specialized training and technical training programs in semiconductors to develop and strengthen the human talent needed for both professional and technical industries. Specifically, through master's and doctoral programs, trainer training programs, in-person and online certifications for micro-credentials, specialized English programs in semiconductors, teacher training in the area of semiconductors, and educational programs in collaboration with educational institutions in Panama such as UTP, UP, ITSE, USMA, and foreign universities such as Arizona State University, and Purdue University, and taking advantage of the opportunities generated by the Center for Advanced Semiconductor Technologies, and in technical training with the support of ITSE, INADEH, and the Professional Technical Institutes.

- Research, Development, and Innovation

Promotion of scientific and technological research in the field of semiconductors, as well as the development of new technologies and innovative products by promoting research and development in Panama with the integration of **the Center for Advanced Semiconductor Technologies**. In addition, specific research projects in the microelectronics and semiconductors sector will be promoted through SENACYT calls for proposals and by encouraging collaboration between the country's educational institutions and the private sector, so that efforts converge at the **Center for Advanced Semiconductor Technologies**[1].

The specific objectives of this line of action are to generate an environment conducive to research and technological development, encouraging the creation of innovative solutions that position Panama at the forefront of the sector and promoting collaboration between academic institutions, research centers, and industry to generate significant advances in the field of semiconductors.

- Public-Private Partnership

This tactical line focuses on establishing solid collaboration with national productive sectors to develop skills in emerging technologies associated with the semiconductor industry and strengthen the sector's capabilities in Panama. This collaboration includes the joint design of training and education programs with leading companies in the sector, seeking to ensure the implementation of professional practices and internships in technology companies, as well as the development of joint research and development (R&D) projects. In addition, the active participation of industry in the definition of educational curricula and in the offer of scholarships and financing for studies in emerging technologies related to semiconductors will be promoted.

The objective of this collaboration is to ensure that human talent training is aligned with market demands and that technological advances in the semiconductor sector translate into concrete benefits for the national economy.

[1] The Center for Advanced Semiconductor Technology at the UTP (C-TASC) will be a non-profit academic training center designed to meet the needs of the semiconductor industry in Panama. This center represents a strategic partnership between industry, academia, and government, with the aim of strengthening local capacity and increasing Panama's attractiveness as a hub for the semiconductor industry.

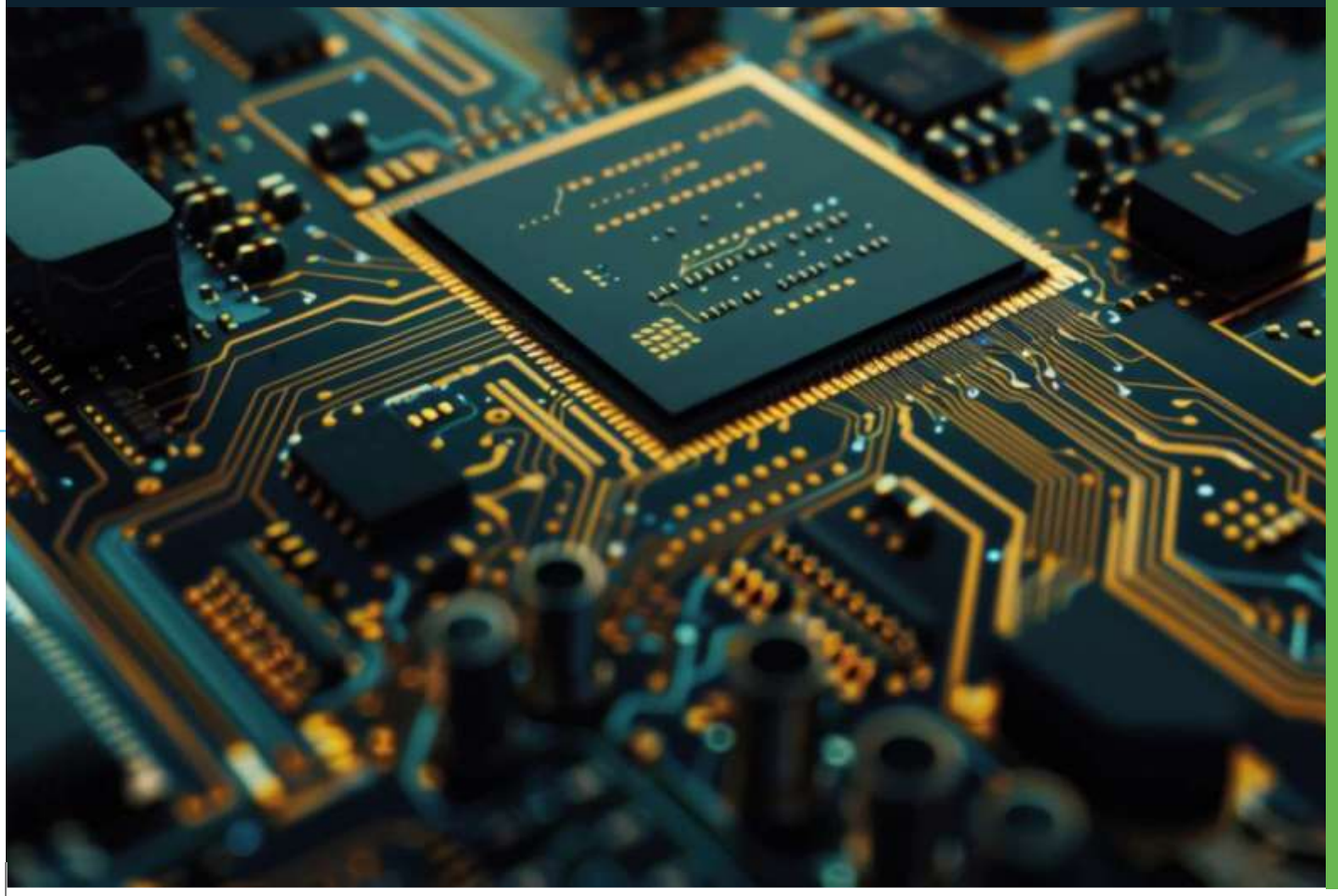
The C-TASC will provide the necessary infrastructure for the development of advanced capabilities, including specialized training programs and a virtual platform that will facilitate collaboration in research and innovation. Its main objectives include Collaborative Innovation, Technology Transfer, attracting Private Investment, creating International Strategic Partners, and promoting Research, Development, and Innovation in the country.

Strategic line 1

The C-TASC will have a series of laboratories, including: Advanced Materials Laboratory, Supply Chain Laboratory, Design Laboratory, Cybersecurity Laboratory, Assembly and Testing Laboratory, Applications Laboratory, and Packaging Pilot Plant.

These laboratories will not only facilitate the technical training of Panamanian students and professionals, but will also complement the dual programs that will be carried out in collaboration with Arizona State University (ASU). These dual programs will allow participants to receive a comprehensive education that combines theory and practice, using the C-TASC facilities to develop advanced skills. In this way, C-TASC will be a fundamental pillar in the training of highly skilled talent and the promotion of innovation in Panama, consolidating the country as a key player in the global semiconductor value chain.

Another key focus is the phased development of human talent in Panama, aligned with the country's progressive integration into the semiconductor value chain. In an initial phase, training will focus on technical processes related to assembly and testing (ATP). In later stages, training will be expanded to include the preparation of engineers a n d technicians in areas of design and advanced manufacturing. These actions will be supported by strategic alliances with international universities and prestigious research centers, ensuring that local talent is prepared for the challenges of each phase of the industry's growth.



Strategic line 2: Development of an optimal business ecosystem

The following strategic line seeks to position Panama as a key destination in the global semiconductor value chain, promoting a competitive, dynamic, and innovative business environment. Through actions focused on stimulating technological entrepreneurship, international promotion, and the creation of strategic alliances, local capacities will be strengthened and key industry players will be attracted.

With initiatives that include the creation of platforms for technological startups, the organization of international events, and the implementation of promotion strategies abroad, Panama is projected as an attractive center for investment, capable of effectively integrating into the global semiconductor industry. These actions are designed to foster collaboration, promote the transfer of advanced knowledge, and ensure sustainable growth in the sector. To this end, the proposed tactical actions are:

- Benefits for technological entrepreneurship

This tactical line aims to promote a favorable environment for the development of startups and innovative projects in the emerging technologies sector linked to semiconductors. Through the creation of science and technology-based business incubators, the promotion of technology transfer offices, specific benefits for entrepreneurship, and training programs, the goal is to strengthen Panama's capacity to drive innovation and business development.

These actions are designed to stimulate business creativity, promote the transfer of knowledge and resources, and enhance the integration of new companies into the semiconductor value chain. The aim is to consolidate a dynamic and competitive ecosystem that contributes to the sustainable growth of the technology industry in Panama.

- Creation of international alliances

This tactical line seeks to position Panama as a strategic partner in the global semiconductor ecosystem, promoting collaborations with international actors, academic institutions, and leading companies in the sector. Through the organization of international events, strategic missions, and active promotion in key markets, the exchange of knowledge, technologies, and best practices will be promoted.

Strengthening these alliances will enhance the country's competitiveness and innovation, consolidating it as an attractive destination for investment and a relevant player in the global semiconductor value chain.

- Promotion abroad

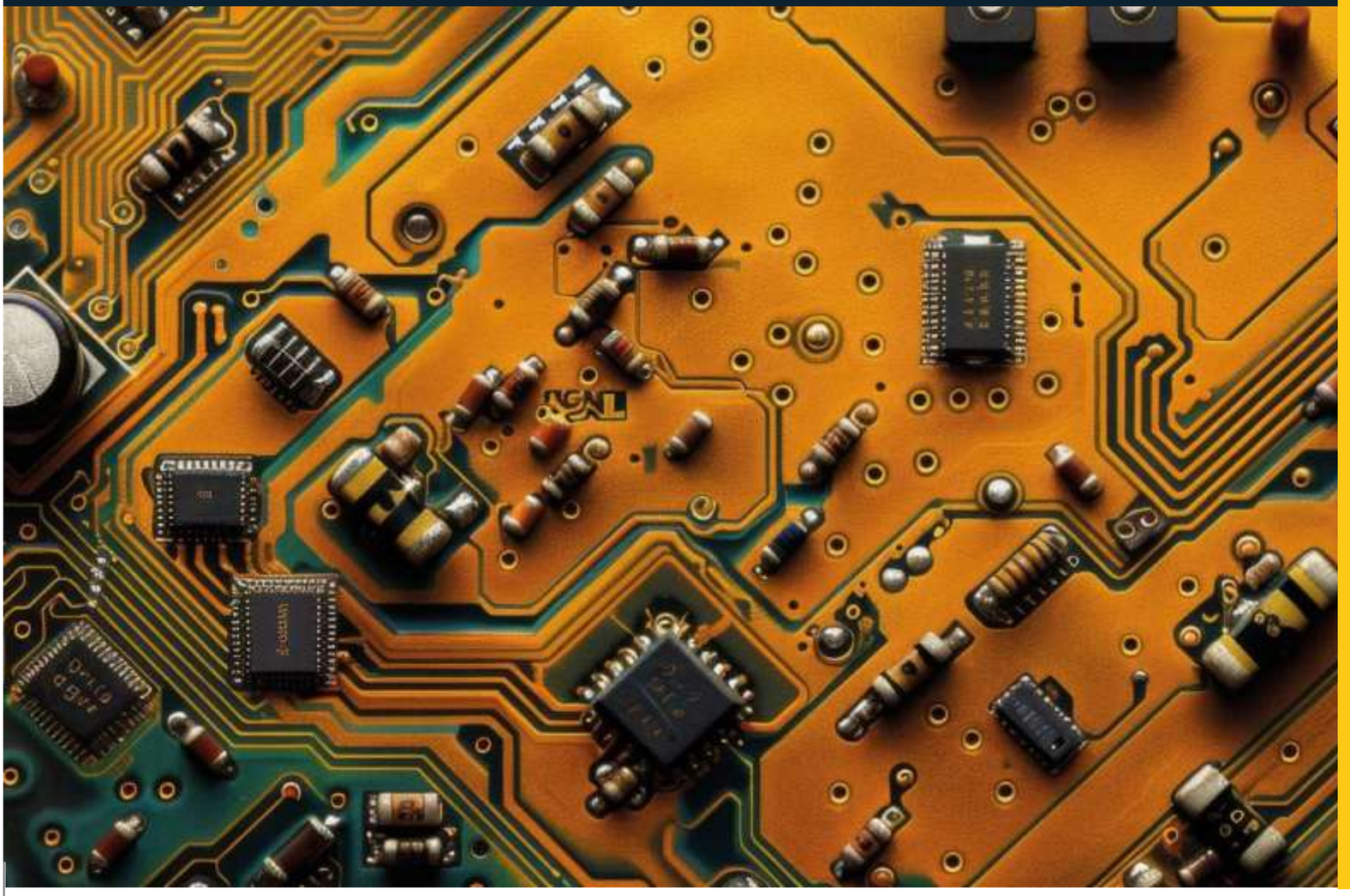
This tactical line aims to position Panama as an attractive and competitive destination for the global semiconductor industry, highlighting its strategic advantages and building confidence in the international market. To achieve this, a comprehensive promotion campaign will be implemented to highlight the country's strengths, complemented by specific actions to attract key investments.

Initiatives include the creation of the position of semiconductor commissioner, the promotion of joint ventures with strategic governments, and the hiring of consulting experts to design and execute investment attraction strategies. These actions seek to strengthen Panama's international visibility and consolidate its position as a relevant player in the global semiconductor value chain.

Strategic line 2

These actions will be supported by mechanisms for consultation and continuous feedback with the semiconductor industry. To ensure the success of this strategic line, coordinated work will be implemented between key institutions such as the Ministry of Foreign Affairs, the Ministry of Commerce and Industry, and the National Secretary's Office for Science, Technology, and Innovation (SENACYT). This joint effort will allow for constant feedback from key players in the sector and international partners on the requirements and improvements needed in the regulatory framework, with the aim of resolving queries quickly and ensuring that changes respond to real and validated needs.

In this context, and as part of this approach, the Commission for Innovation in Microelectronics and Semiconductors (CIMS) was created, a mechanism whose purpose is to ensure fluid and effective communication between the government and the semiconductor industry. The CIMS will facilitate decision-making on strategic issues, promoting growth and innovation in the sector. In addition, this mechanism will ensure that improvement efforts focus on specific changes driven by market demands, thus optimizing the impact of government initiatives for the benefit of the sustainable and competitive development of the semiconductor sector in Panama.



Strategic line 3: Development of infrastructure and a relevant legal framework

This strategic line addresses the essential pillars for integrating Panama into the global semiconductor chain, ensuring a competitive and attractive environment for investment. It focuses on three key aspects: attracting capital and investment instruments, strengthening national infrastructure, and designing a modern and efficient regulatory framework that promotes the development of the sector.

The strategy includes the implementation of tax benefits, the creation of investment networks and regional co-investment funds, together with the development of technological, logistical, energy, and water infrastructure, which is essential for the specific needs of the semiconductor industry. In addition, priority is given to a regulatory framework that addresses intellectual property, investment and immigration benefits, and advanced technical standards, ensuring the confidence and sustainability of the industrial ecosystem.

Through these actions, Panama will consolidate the foundations to position itself as a relevant player in the global semiconductor industry, promoting innovation, economic development, and technology transfer. To this end, the following tactical actions are proposed:

- Strategy to attract capital and investment instruments

This tactical line seeks to establish a financial ecosystem that promotes the development of the semiconductor industry in Panama, not only by attracting foreign capital, but also by mobilizing local and international sources of financing that support the sector's sustainable growth.

The strategy includes the implementation of a specialized tax regime that favors productive chains, the promotion of local venture capital funds, and the creation of a national network of angel investors. In addition, a specialized office will be established to identify and manage international grants, along with a proposal for a regional technology co-investment fund that will enable collaboration with neighboring countries.

In collaboration with international actors, the Panamanian government will promote investment in critical semiconductor infrastructure, ensuring access to clean energy, modernization of logistics systems, and advanced digital connectivity. These actions are designed to position the country as a competitive and reliable destination in the global semiconductor chain, encouraging both the arrival of international companies and the strengthening of the Panamanian private sector.

- Strengthening national infrastructure

This tactical line prioritizes the development of critical infrastructure to meet the specific needs of the semiconductor industry. It includes actions aimed at strengthening energy supply with a focus on renewable sources, managing the water access necessary for industrial processes, and improving the country's logistics capabilities by modernizing transport corridors and specialized storage centers.

It also envisages improving digital connectivity, ensuring strong and secure networks that enable the efficient operation of advanced technologies. These actions seek to consolidate Panama as a competitive destination, capable of offering optimal conditions for the development of high value-added industrial and technological activities.

- Regulatory framework and public policies

This tactical line focuses on the analysis, design, and implementation of a modern, flexible, and efficient regulatory framework that promotes investment, innovation, and sustainable development of the semiconductor industry in Panama. This effort seeks to ensure legal certainty, adequate benefits, and favorable conditions for attracting technology companies, with an emphasis on the specific needs of the sector.

Strategic line 3

The development of this framework will include key regulations in areas such as intellectual property, metrology, security, tax and immigration benefits, as well as the creation of a Single Window to simplify and speed up administrative processes for investors and companies. These actions will be carried out in coordination with various government entities, such as the Ministry of Commerce and Industry, the Ministry of Economy and Finance, the Ministry of Labor, and the Ministry of Foreign Affairs, in collaboration with international and private sector actors.

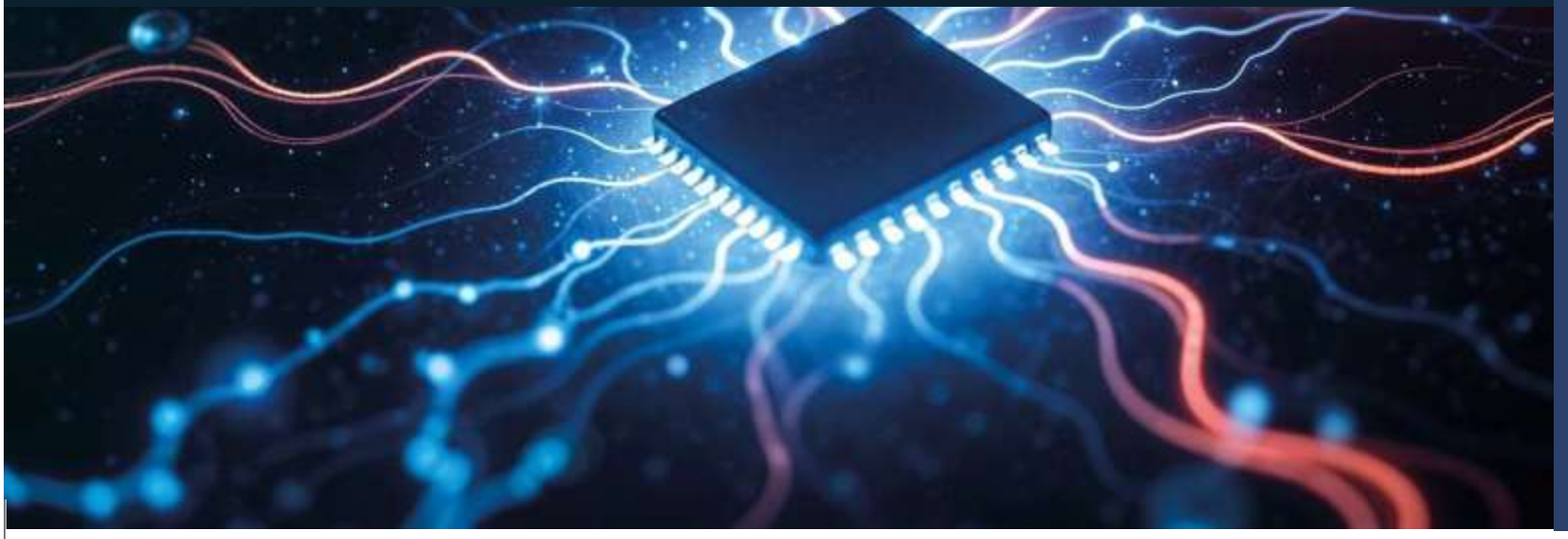
In the area of migration, flexible policies will be established to attract highly specialized talent. This will include priority visas for engineers, researchers, and specialists in advanced technologies, as well as residency benefits for foreign professionals. In turn, these initiatives will be complemented by strategic alliances with international universities to strengthen the training of local talent.

A strong tax benefit framework will also be a priority. Technology companies will be able to benefit from tax exemptions on profits, capital goods, and assets, especially in special economic zones. In addition, customs processes for the import and export of critical components will be facilitated, creating attractive conditions for companies wishing to establish operations in the country.

Finally, to ensure responsible development, strict regulations will be implemented for the management of critical components and waste. This will include the control of sensitive materials from a national security perspective, as well as environmental measures that promote the adoption of clean and sustainable technologies. With clear protocols for the safe handling of materials, Panama will ensure that its industrial ecosystem is aligned with international standards and best practices in sustainability.

Panama's technological infrastructure and legal framework will evolve strategically to support each stage of the semiconductor industry's development. In the first phase, priority will be given to assembly, testing, and packaging facilities, ensuring efficient access to key components, equipment, and services. As the industry grows, specialized infrastructure for research, development, and advanced manufacturing will be implemented, positioning the country as a competitive hub in the region.

The legal framework, designed to offer stability and flexibility, will provide long-term benefits tailored to the changing needs of companies. This approach will ensure that both initial operations and future expansions find a favorable environment in Panama in which to thrive.



Strategic line 4: Security

Given the globalized and highly competitive nature of the semiconductor industry, the risks associated with cybersecurity, intellectual property protection, and technology transfer are becoming increasingly relevant. This strategic line seeks to ensure a secure environment for the development of semiconductor-related activities, protecting the integrity of operations and strengthening the confidence of investors and strategic actors.

- Balancing migration incentives with security controls

A key aspect for the development of the sector is balancing migration benefits with security controls. To attract and retain highly specialized talent, Panama will implement migration facilities for engineers, researchers, and experts in advanced technology. However, this process must be accompanied by strict verification mechanisms to minimize risks related to technology transfer and access to strategic information, ensuring a balance between the sector's growth and the protection of national interests.

- Establishing strong regulations for secure data management

Secure data management and operational continuity are also essential in an industry that depends on the processing and storage of large volumes of critical information. Strong regulations will be developed to ensure the integrity, availability, and confidentiality of data throughout the value chain. In addition, measures will be implemented to strengthen the sector's operational resilience, ensuring protection against potential cyberattacks, technical failures, or unexpected interruptions.

- Assessing geopolitical and commercial risks

In a dynamic global context, assessing and mitigating geopolitical and commercial risks will be a priority to ensure the stability of the sector. Monitoring mechanisms will be established to anticipate impacts arising from trade disputes, technological restrictions, or changes in international regulations. Likewise, periodic audits will be conducted in key institutions to strengthen the capacity to respond to risk scenarios, ensuring that Panama maintains its competitiveness in the industry.

- Strengthening critical cybersecurity infrastructure

Strengthening critical cybersecurity infrastructure is another fundamental pillar. The technological systems that support semiconductor production, design, and testing must be protected against cyberattacks and potential disruptions that could compromise not only the local economy but also the global supply chain. To this end, Panama will implement secure networks, constant threat monitoring, and strategic collaborations with international entities to ensure compliance with the highest cybersecurity standards.

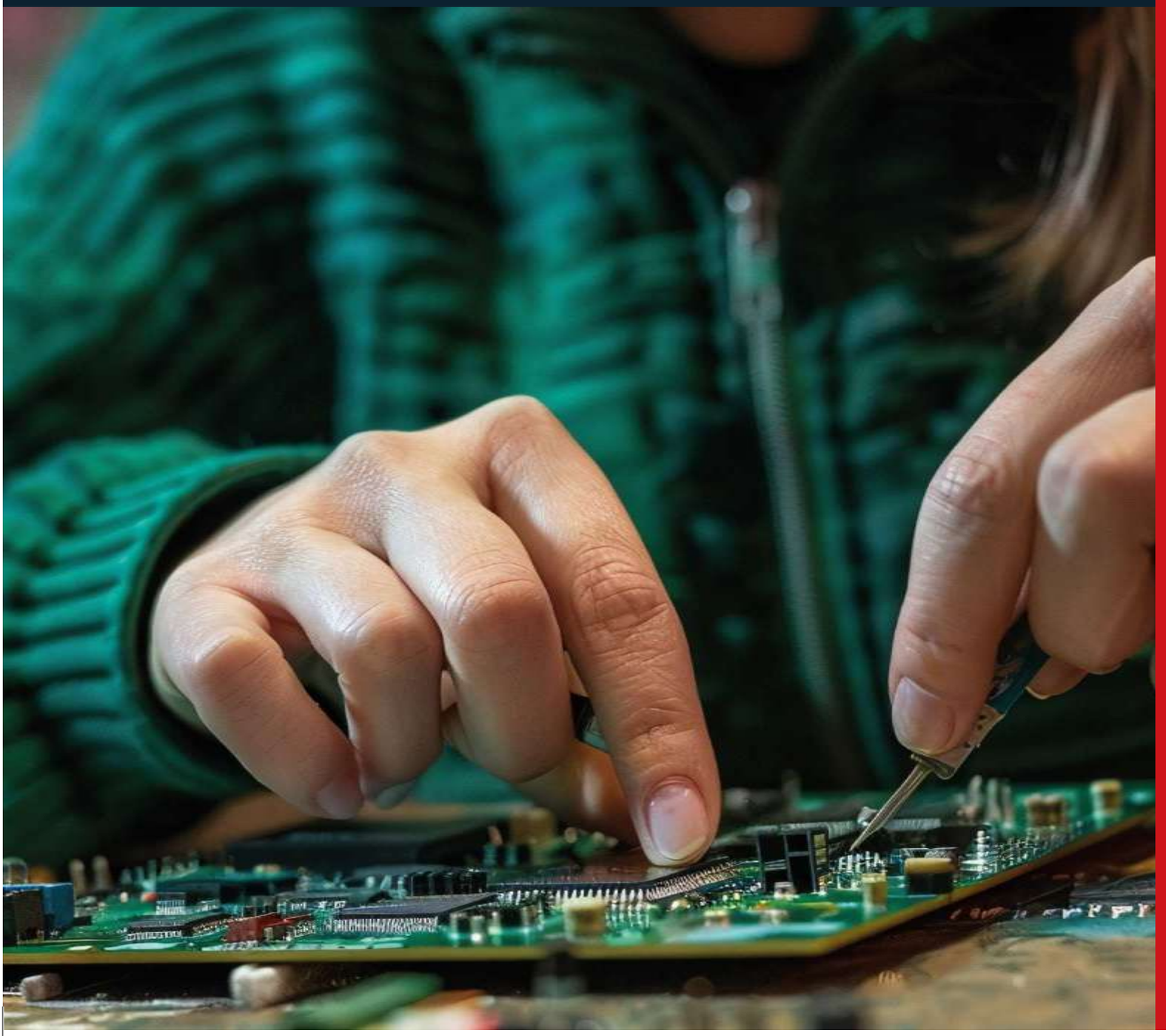
- Implementing advanced IP and TT security protocols

Finally, the implementation of advanced security protocols in intellectual property and technology transfer will be promoted. The protection of innovations and technical knowledge will be key to attracting companies and strengthening the local ecosystem. Regulations will be established to reinforce the confidentiality of industrial processes, and strategic agreements with international institutions will be promoted to ensure a solid legal framework in these areas.

To complement these actions, strict regulations will be designed for the management of critical components and waste. Controls will be established for sensitive materials from a

national security perspective, together with environmental measures that promote clean and sustainable production. The implementation of clean technologies and safe material handling protocols will help consolidate Panama as a reliable and sustainable destination for the semiconductor industry.

With these strategies, Panama will not only offer a competitive and attractive environment for investment, but also a secure, resilient ecosystem aligned with international safety and sustainability standards.



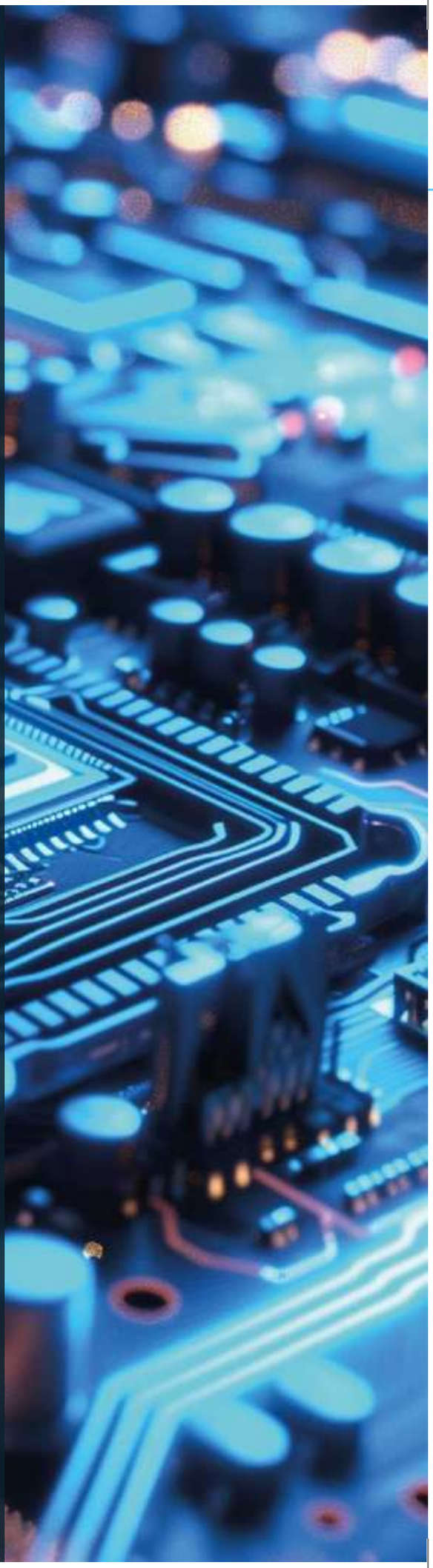
The National Semiconductor and Microelectronics Strategy represents the Panamanian government's commitment to building a new model of productive development based on knowledge, innovation, and strategic integration into high value-added technology sectors. This document constitutes a structured roadmap that defines the fundamental pillars on which a strong national ecosystem will be built, capable of integrating into the global semiconductor value chain. In particular, the strategy promotes the country's positioning in segments such as assembly, packaging, and testing (ATP), integrated circuit design, and printed circuit board (PCB) manufacturing, recognizing them as a realistic and strategic opportunity to leverage the country's logistical, regulatory, and human capabilities.

The relevance of this strategy lies not only in its long-term vision, but also in its ability to guide public policies, investment decisions, international alliances, and educational programs toward a common goal: to make Panama a key hub for technological innovation and advanced manufacturing in the Western Hemisphere. To this end, efforts have been made to build a strategic framework that combines ambition and viability, aligned with international trends in the relocation of productive capacities, sustainability, technological security, and digitization.

However, it is essential to note that this document defines only the general strategic framework. The effective implementation of its objectives requires detailed, precise, and coordinated operational planning that will translate the vision into concrete actions. In this regard, a complementary Action Plan has been developed, which systematically outlines the specific activities to be carried out, the implementation timelines, the necessary financial and human resources, as well as the products and indicators associated with each line of intervention.

This operational plan not only ensures orderly implementation consistent with the defined strategic priorities, but also allows for the establishment of monitoring and evaluation mechanisms that guarantee the traceability of progress. Its application seeks to generate real and measurable impacts in key areas such as the creation of specialized employment, the strengthening of human capital, the development of national productive capacities, the attraction of foreign investment, and the promotion of technological innovation.

Together, the strategy and its action plan form a comprehensive architecture that enables the country to take firm and sustainable steps toward its transformation into a relevant player in the global semiconductor ecosystem. This synergy between vision and action will allow Panama not only to participate in this strategic industry, but to do so from a position that reflects its potential, its commitment to development, and its vocation for regional leadership in technology and innovation.



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NOTES

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This document has been prepared as part of the Panamanian government's commitment to developing national capabilities in microelectronics and semiconductors, in accordance with Executive Decree No. 7 of 2024, which establishes guidelines for promoting this strategic industry.

The strategy was formulated on an inter-institutional basis through the National Commission for Innovation in Microelectronics and Semiconductors, in coordination with key actors from the public, private, and academic sectors.