Semicon India 2022

Partial List of Speakers:

Name	Designation
Shri Narendra Modi	Prime Minister of India
Shri Ashwani Vaishnav	Minister of Electronics and Information Technology
Shri Rajeev Chandrashekar	Minister of state Electronics and Information Technology
Mr. Sanjay Mehrotra	Micron technologies
Mr. Jim Keller	Tenstorrent
Mr. Randhir Thakur	President Intel Foundry Services, Intel Inc. USA
Dr. Surinder Singh	SCL
Nivruti Rai	*Country Head, Intel India*
Shri. E.V. Ramana Reddy	ACS Govt of karnataka
Jitendra Chaddah	Intel

Takeaways

Day 1 - April 29, 2022 - Inaugural Session

1. Address by Hon'ble Minister of Electronics and Information Technology on the Semicon Policy

Hon'ble Minister, Shri Ashwini Vaishnaw, in his welcome address spoke about India's commitment to long-term and sustainable solutions for the semiconductor industry. India's talented and professional human resources in the semiconductor industry are our undeniable strength. He said that building India as a prominent player in chip design and manufacturing is a marathon, not a sprint. Our vision is supported by careful planning and calibrated efforts of all stakeholders to establish India as a major hub for electronics and semiconductor industry globally. He also spoke of India's readiness and earnest partnership between industry, government, and academia to make the programme for development of Semiconductors and Display ecosystem a success.

Hon'ble Minister stated that India, like many other countries, is providing incentives for entrepreneurs. We are working with the industry to provide 85,000 semiconductor professionals with tie-ups like IMEC from Belgium, ITRI of Taiwan, and A Star of Singapore, who, over the next 10 years will be industry-ready professionals.

Hon'ble Minister added that almost 100 academic institutions and other professional institutions have been roped in to train over 5,000 professionals in research, 30,000 engineers (B.Tech and M.Tech) and 50,000-floor level technicians. 20% of the world's VLSI design engineers and 250 semiconductor design companies are working out of India and 24,000 design engineers have already designed more than 2000 chips yearly.

Hon'ble Minister stated that the Government is committed for readying the Indian Ecosystem and set up supply chain for elements like specialty chemicals and gases by the time the company decides to start a FAB here. He also assured the development of supply chain and ecosystem for increasing domestic electronics manufacturing from the present USD 76 billion to USD 300 billion by 2026 and reiterated Government's commitment and promise to work closely with the industry in a focused manner for the long-term growth and development of the sector. Hon'ble Minister assured the Government's complete support to make this programme successful.

2. Address by Hon'ble Prime Minister of India

Design and Manufacture in India, for the World: Catalysing India's Semiconductor Ecosystem

Hon'ble Prime Minister, Shri Narendra Modi virtually inaugurated the Semicon India 2022 Conference in Bengaluru on April 29, 2022. He said that India is one of the largest consumers of data per capita and is paving the way to lead the next technology revolution. India also plans to unleash the next wave of innovation in Data Science, AI and other technologies. He noted that India is headed for robust economic growth and houses the world's fastest growing startup ecosystem with new unicorns coming up every few weeks. He spoke of the critical role of semiconductor industry in today's world. He emphasized India's role in becoming a key partner in the global semiconductor supply chain and working towards this direction based on the principles of high quality and high reliability. He gave following six reasons for India being a key player in this sector:

- Building the digital infrastructure for all financial transactions including UPI payments and also using technology in all sectors, including health and governance for inclusion and empowerment.

- Connecting 6,00,000 villages with broadband and increasing the 5G network capacity, working towards green energy technologies, and the next wave of innovation in AI and other emerging technologies.

- India's consumption of semiconductors is expected to be of the order of USD 80 billion by 2026 and USD 110 billion by 2030

- Wide range of reforms undertaken for promoting ease of doing business in India, wherein, last year the government abolished more than 25,000 compliances and stressed auto-renewal of licenses. Further, India is having one of the most favorable taxation structures in the world. Digitization in taxation has brought speed and transparency to the regulatory framework today.

- Investing in young minds in training and developing semiconductor design talent pool for the needs of the 21st century. We have an exceptional semiconductor design talent pool that makes up to 20% of the world's semiconductor design engineers. Almost all of the top 25 semiconductor design companies have their design and R&D centres in our country.

- Investing in healthcare and medical technologies to fight and overcome once in a lifetime pandemic.

Hon'ble Prime Minister said that over the next 5 years, the electronics manufacturing sector is expected to witness a record growth with USD 26 billion being invested in 14 key sectors and an outlay of USD 10 billion earmarked for promoting semiconductors, display manufacturing and design ecosystem in the country. The main aim is to provide financial aid and support to semiconductors, display manufacturing and design ecosystem. At this Conference, the Government looks forward to practical suggestions from all industry stakeholders and wants to understand what more can be done to build a vibrant semiconductor ecosystem that will help steer India into a new future.

3. Address by Hon'ble Minister of State for Electronics and Information Technology

Innovation Diving Semiconductor Excellence

Hon'ble Minister of State, Shri Rajeev Chandrasekhar spoke about the theme of the first Semicon India Conference - Catalyzing India's semiconductor industry and its ecosystem. He said that the active engagement of the government with all of the stakeholders and participants in this space and the commitment of the government to be partners in the journey would catalyze the Indian semiconductor ecosystem. The black swan event of COVID in the world has affected the lives and livelihood of people across all nations and increased the focus on semiconductor industry. He added that despite the all-pervasive nature of the pandemic, India has emerged from the last 2 years as a nation very different and much stronger than before. India has overcome the economic loss and is today the world's fastest-growing economy.

Hon'ble Minister spoke of growing India into a trillion dollar digital economy by 2026. The Techade is being built and catalyzed by many start-ups in India. He assured the industry stakeholders that the Government's partnership with the semiconductor industry will be strategic and for the long term long-term, helping the industry make India an important hub of Semiconductor Fabs in the world. The country and its ecosystem of innovation need to be connected to the semiconductor space and vice versa to shape the future of the semiconductor ecosystem for the world.

Hon'ble Minister quoted what Prime Minister said recently in the World Economic Forum about India's ambition to grow and become a significant trusted source of digital products, digital services and digital talent for the world. The goal is to address the innovation performance of the entire semiconductor ecosystem from design to packaging to Fabs, spanning Silicon and Compound Semiconductors, and to facilitate prime mover investments in each of these areas. He added that India's ability to do this will be in a lot of ways driven by our engagement in this Conference. He concluded by saying that India believes in the statement "Sab ka Saath, Sab ka Prayas" meaning success will only happen if we work together towards this goal.

4. Keynote Address: Semiconductor Opportunities in the "New World Order"

Speaker: *Mr. Sanjay Mehrotra, Micron Technologies*

Mr. Mehrotra spoke on today's data driven economy, importance of data and its rising coverage and dominance over business. He said the added value of data is based on the ability to make faster decisions and implement them at a faster, more precise scale. Mckinsey projects that data driven artificial intelligence will add USD 13 trillion to the global economy by the year 2030. Maximizing data and memory storage is the main revenue growth area in this industry. All that data will add value to make better and faster decisions based on the information all around us. Data is the fuel for our economy and touches our daily lives. That fact is driving us forward and semiconductor is in the middle of it.

He said that Semiconductor is the brain of modern electronics, enabling advances across communications, computing, industrial, healthcare, automation, and every sector one could imagine. The semiconductor industry is estimated to be of the order of USD 1 trillion by the year 2030. He believes that the industry is growing exponentially and that the growing use of data is the major driving force. He spoke on the AI and 5G network and intelligent edge revolution, growth in DRAM and NAND, which according to Gartner account for 30% of the USD 630 billion semiconductor market. The revolution in data storage is attributable to the advancements in the semiconductor technology.

The keynote address also touched upon Micron as a company which is leading the world in DRAM and NAND technology, investing in the talent pool of India and expanding Micron's operations in country. He also spoke of university alliances in India to nurture the talent and give them a chance to be a part of the innovative industry and the importance of designing appropriate course curriculum. He added that the ability of the industry to come together to innovate, build and sustain semiconductors is what will lead to sophisticated technology that people could not have even imagined a few years back.

5. Keynote Address: An inflection point of Global Semiconductor Industry: Opportunities for India

Speaker: *Dr. Randhir Thakur, Intel Foundry Services, Intel*

Dr Thakur said that every aspect of human engagement is turning digital day by day which can only sustained by increased computing capabilities. He went on to say that "semiconductors are the new oil" in this digital age and spoke on the importance of domestic semiconductor industry which is crucial for economic growth and security. Intel is thrilled to be partnering for over 30 years with India and is committed to doing so in the future. The human experience is becoming more digital and this creates a sustained and long-term demand for semiconductors. There is a need for more balanced and resilient supply chains to be successful. During the pandemic, we have seen the impact of supply disruptions which has amplified the need of having robust and globally secure supply chains.

Dr. Thakur added that concentration of semiconductor manufacturing in a few localized regions will not be sustainable in the long run. He congratulated India on a comprehensive program to catalyze India's semiconductor industry. He applauded the collaborative approach shown in the formulation of the policy, formation of the Advisory Committee with industry experts and stated that this Conference is a testimony to the open-minded partnership approach.

He said that today India has the 3rd largest start-up ecosystem globally and one of the largest pools of technology and engineering talent and this scale is extraordinary. He said that India is set to become a semiconductor nation after being software and digital nation. He spoke on the key valuation points for greenfield opportunities that need a combination of factors.

He spoke on Intel's commitment to India's growth of the semiconductor industry with an open IP ecosystem in India, including India recently joining RISC-V international. He concluded by saying that India's push to the industry is what will make the nation entirely self-reliant, as semiconductors will become the backbone of digital business in the future.

He interestingly exclaimed that Intel will support the nation from the "chakra to chips" and closed with a statement - Semiconductor Bharat, AathmaNirbhar Bharat.

6. Keynote Address: India Leading Chip Design for the world

Speaker: *Mr. Jim Keller, Tenstorrent*

Mr. Jim Keller said that the main principle behind the electronics industry is Moore's law, i.e., how to accommodate more transistors in an integrated circuit. More transistors mean faster computers and more applications which leads to complexity and the overall focus should be on solving complexity.

He also spoke on the need to focus on building talent. Universities tend to teach and emphasize too much on theory and training institutes focus on tools like CAD, etc. However, a great engineer is more than just theory and tools. He said that the most important thing students can do is to be in a lab trying to build something and work towards finding solutions to the problems being faced. The main goals to achieve this are to be the best in the class, low on cost, have control on the supply chain and have world-class engineers.

Mr. Jim Keller also said that it is important to prioritize the goals and get the best benefit. The other important lesson one should learn is to know where you are right now. Every new design goes through the S curve. First, there is a path-finding phase, then the ramping of the design, which reaches its maturity, and finally the redundancy of the discovery. So, it is important to start from the path-finding stage and lead to the ramp up phase rather than working on a design that has already reached its maturity phase.

He also spoke about RISC-V, the new open-source architecture in computing. He said Software 1.0 is when people write programs and do things sequentially. Software 2.0 is when we use data to train a network to make an association. This is AI which makes simpler programs from complex mathematics. In summary, the skill requirements are changing and needs leadership. The goal is to get great products. RISC V with AI is the future and many new things are possible if we work towards it.

Post Lunch Sessions

7. Keynote Address: India's 'Fab'ulous push for Million Chips for Billions

Speaker: *Mr. Ajit Manocha, SEMI*

Mr. Manocha said that it took almost 60 years for the semiconductor industry to reach USD 550 billion and the projection of this growth is almost USD 1.3 trillion in the next 10 years. The focus today is to get the industry together, set common standards and collaborate. There is a big gap in the supply and demand of talent in this industry and there should be an increase in the enrolment of STEM education with more support from the government as the need for specialized engineers is growing.

He spoke on the history of SEMI, an organization founded in 1970s, bringing the whole semiconductor industry under an umbrella. The initiatives include Smart-data and AI, smart manufacturing, smart mobility, and smart med-tech. He spoke of the memory technology growth in the next 10 years and the need for advanced Fabs, legacy Fabs, and specialty Fabs as well. SEMI has a think tank that researches on the vision of the future of computing. They want to collaborate with the Government of India to establish robust research in the fields of technology growth, IoT, AI and even quantum computing.

SEMI encourages STEM education and is committed to partnering with Indian educational institutions and the workforce to provide certification and curriculum from the school level to the professional level enabling the youth toward a knowledge-based talent force. He focused on the geopolitical issues where policies are affected due to political issues. SEMI is focusing on policies without political bias. Opportunities for India today are to strengthen the EDA & IP segment and enter into the materials manufacturing segment. He suggested that we should try and excel in areas in which we feel we can be good.

Mr. Manocha concluded that there are multiple key applications that we could work on. India can benefit from the on-going global trade tensions. SEMI can help create a robust execution plan for India with a clear line of accountability to enable the ecosystem and support it. He

congratulated the Prime Minister on the unison that the central and state governments have shown in their messaging towards the industry.

8. Panel Discussion on India's March towards Semiconductor Self-reliance

Moderator: *Dr. Surinder Singh, SCL*

Panelists

- *Barun Dutta, IMEC*
- *Erez Imberman, Tower Semiconductors*
- *Raj Kumar,IGSS Ventures*
- *Rajesh Nair, Global Foundries*

The Panel moderator, **Dr. Surinder Singh** introduced the panel and expressed that there is a need and global rush is being witnessed for setting up Semiconductor Fabs. He went on to ask the panelists on the specific requirements of Fabs.

Barun Dutta spoke on the long-term efforts needed for the Semiconductor industry and the support ecosystem for its growth. Talent training is the benchmark and grooming talent to specific industry needs is the key. He also acknowledged that India is known for its talent in research and design and should empower for the robust development of the industry in India. He emphasized the need for R&D platform to make semiconductors green. Commitment and support, both on the national level and academia level to narrow the gaps in the industry was discussed at length.

The discussion then moved towards the manufacturing side of the industry and the potential it has when it evolves with global trends. The planning for setting up Semiconductor Fabs has to be a collaborative effort of industry, academia and government stakeholders.

Erez Imberman pointed out the important aspects of setting up Semiconductor Fabs, viz., government support, international partnership, industry interest, conducive market demand and talent pool. He spoke about the Indo-Israel cooperation and the need for Government support top-down because of the huge capital investment for these projects. An understanding of local needs by Indian business partnerships and knowledge-based supply chain requirements are also key mandates. Erez highlighted that building a new FAB takes 3-4 years after all the approvals are in place and hence, lead time determinations of supply materials are crucial for the same. He reiterated the importance of know-how to build FABs to world standards, so that they are competitive and customer-centric.

Raj Kumar spoke about how India is late by 35 years or more into this industry, and the one key advantage is that it can learn from the mistakes of others and from other economies that have successfully established their prominence in the global industry. It is important to optimize the investments. The need for government support and subsidies is crucial. He was of the view that India should focus on smart developments like low-cost FABs and green FABs.

Rajesh Nair spoke about the black swan event for the semiconductor industry and the need for more data storage due to the increase in demand for data for many OTT and online shopping platforms. The demand has also increased due to 5G and vehicle electrification. The need for more semiconductor manufacturing companies leads to a resilient supply chain, local availability, and talent. The development of local component supply availability ecosystem for this to work is huge. He suggested a FAB hub where all the supply chain partners are in proximity, which will immensely aid the semiconductor industry. He also spoke about the importance to tap into the next generation talent that will augment the technology in design and manufacturing.

9. Panel Discussion on New Chip on the Block

Moderator: *Ganapathy Subramaniam, Celesta Capital*

Panelists

- *Parag Naik, Saankhya Labs*
- *Gireesh Rajendran, Steradian Semi*
- *Pradeep Vajram, Alpha-IC*
- *Kamal Jain, Blaize*
- *Neel Gala, InCore Semiconductors*

The Moderator, **Ganapathy Subramaniam** introduced the Panel members and stated that the chip design industry is around USD 500 - 550 billion industry. India's IC design skill is abundant so we can dominate the industry. There are fabulous companies in India that have shipped 50 million ICs and a design company that is headquartered in India has touched revenue of USD 100 million this year. The panel discussion comprised of several questions by the moderator ranging from tech availability, open-source designs, funding, viability of semiconductor fabs and the inclusion of smaller businesses in the industry and so much more. The panel majorly spoke about the various opportunities the industry has to offer at the various stages of forming a company, right from ideation stage to scaling and so on.

Pradeep Vajram spoke on his journey of 30-plus years in the industry. In his early years there was a lack of understanding of the chip design activity but today India has the largest design talent in the world with a great start-up culture and a good VC system. Apart from that, the semiconductor consumption in India is growing exponentially and by 2030 it is expected to grow to about USD 110 billion. He remarked that one success story from the industry is what will push venture capitalists, young talent and the government to be more invested in the industry.

Parag Naik spoke about the lessons learnt from the ideation to sales. The risk capital is still low in this industry. The industry is capital intensive where seeking funding for chip design ideas that are in the research phase is very difficult. The initial success of start-ups in the industry is determined largely by the financial backing they receive from investors, universities and the government agencies. He emphasized the need for a VC ecosystem and spoke about the growing number of Venture Capitalists in India who are willing to take higher risks and bet big on technology.

Gireesh Rajendran spoke on the need for a team with varying capabilities, one with the knowledge base of a university ecosystem, and the second with the business acumen.

Neel Gala spoke of his journey as a young entrepreneur and his experience is that the ideation phase is in two parts - the tech idea and the biz idea. He spoke about academia being at the core of this industry and how scaling research and the product are vital for successful beginning of a start-up in the industry. Academia is equipped and encourages the students to explore new ideas and today India's dream of 64-bit RISC V silicon is a reality and that is the turning point. The second part was to make this open-source idea commercially viable. The most important part for this to be successful is the core founding team which is together in the core mission of the start-up.

Kamal Jain described the terrain of the industry as a very uncertain and unforgiving in the beginning. He spoke on the journey of Blaze and the start-up journey. The idea behind their chip might have been powerful but it was eventually not compatible with contemporary designs and not financially viable. With time they grew as a company, scaled their research and manufacturing and made a viable business out of their idea. It was formerly known as Thinki. In 2016 they got their first chip ready and their first customer was Daimler, their first paying customer was Denzo and Daimler became the investor for its series and the first funding investor was the customer.

The panel members spoke about the problems of the industry, of the end customer not being in India and the need for local buyers using local chips. The panel agreed that Indian semiconductor fab companies must include a business-oriented founder from the very beginning because of the need to be able to cater to a global market.

10. Fireside chat on Emerging designs driving the semiconductor demand

Participants: *Prof. Kamakoti, IIT Madras with Prof. Dave Patterson, UC Berkeley*

The fireside chat between Prof. Kamakoti and Prof. Dave Patterson focused on the design aspect of chips and semiconductors; the evolution of chips from single core to multi-core and beyond. The conversation was centric to domain specific chip architecture. They spoke about the evolution of chip design and architecture through the years. Prof. Patterson spoke about the importance of domain specific accelerators in chip designs and how computer scientists have to move towards customization of chips to further the business aspects of processors and chips in the industry.

Prof. Patterson also spoke about the two exciting pieces of the computing industry that are kind of opposite, the cloud, and the EDGE and both care a lot about energy. The chat focused on the changing chip designs. Prof. Dave spoke about changes in processor design, from single processors to multiprocessors, the architecture of Cloud to mainframes and EDGE which is data-centric.

The chat covered India's RISC V initiative of a free and open ISA. The RISC V is customizable and its use is enabling the new era of tech opening newer markets. RISC V is in the internet of things or embedded devices low-cost devices, the code density and the simplicity in the architecture and the sustainability are the key attractive features and the fact that it is free brings down the cost down and customization works well when you have a dedicated application for it.

Prof. Patterson also spoke on the automobiles having a huge fraction of the semiconductors and the unavailability of chips as a limiting factor for the production of cars. It could be a strategic advantage for a country like India to have its chip supply for this industry

11. Panel Discussion on Growth drivers for semiconductors

Moderator: *Rajen Vagadia, Qualcomm*

Panelists

- *Jaya Jagadish, AMD*
- *Virat Bhatia, Apple*
- *Sanjay Nayak, Tejas Networks*
- *Sanjay Gupta, NXP Semiconductors*
- *Amit Jain, Minda Groups*
- *Srinivas Satya, Applied Materials*

The panel discussion was on the growth drivers for the Semicon industry. The Moderator Rajen Vagadia spoke about the diversity of the Panel in terms of its members across the industry. He went on to talk about the drastic changes that have happened in day-to-day life of people because of the pandemic and its supply pressure on semiconductors. He highlighted that technology advancement also accounts for higher demand of semiconductors. For instance, a 5G smartphone will have close to 20% more semiconductors than its predecessor 4G smartphone. The need to compute and store also has increased the demand. Even the automotive and EV sector is highly dependent on semiconductors.

Sanjay Nayak spoke on the demand increase in the home broadband conversion to fibernet, increase in the bandwidth of 5G mobile networks is going to grow in the next 5 years with India being the largest consumer of semiconductors. He also spoke on the essence of better planning and forecasting which will help the entire supply chain. Further, it is also good to advise the customer to do better planning.

Sanjay Gupta spoke on the progress of technology to create a human model to make chips more human-like. The technology will grow to be more sophisticated and will require more chips and semiconductors that are of high quality and high performance. Electronic sensors

have to be better than human sensors, the camera sophistication along with hardware and software. The biggest growth driver that will drive the automotive industry, for example, is car electronics or IoT industry. Secondly, machine learning and AI-driven algorithms to make smarter decisions without tiring. Thirdly, connectivity, both short-range like Bluetooth, NFC and long-range ones like WiFi. Lastly, electronics which is extremely low on power. He mentioned the sequence of Sense-think-connect and create, which is the basis of chip design.

Mr Vagadia steered the conversation towards the shortage of raw materials for the production of semiconductors and directed his question towards Srinivasa Satya from Applied Materials on what could be done better or what the industry has learnt from this supply disruption. **Srinivasa Satya** spoke about better and more resilient supply chain that feeds into making their equipment. He pointed out that supply chain imbalances and capacity expansion are the main reasons for this. Mr. Satya addressed the question by saying that the idea of disruption in the industry has to be taken as a part of the cycle of the business. He explained that the cycle of production is dependent on numerous factors and the industry has to absorb shocks like supply disruption and should be able to understand the use and lifetime of products better due to product life shortening. He also spoke of the need for long-term planning for forecasting.

Jaya Jagdish commented on the exponential growth in demand for semiconductors and spoke about the supply-demand problems and efforts to avoid gaps with better partnerships and equipment dependencies. She spoke of a talent war and making students industry-ready, even for FABs engineers whose requirements are enormous. She spoke of the need to not just induct more skilled engineers but also start upgrading the skills of the current engineers who are in the system.

Virat Bhatia spoke about 20% of the USD 1 Trillion Digital economy by 2026 coming from the semiconductor industry, out of which USD 300 billion would be contributed by electronics manufacturing. He said mobile phones are expected to contribute USD 126 billion from current about 36 billion, IT Hardware shall contribute about USD 25 billion, consumer electronics USD 23 billion, industrial electronics about USD 25 billion and automotive electronics about USD 23 billion or higher.

Amit Jain spoke on more Semicon integration in the automotive sector increasing it to almost 50%, the need for smart mobility and next-gen mobility. The semiconductor component almost doubled in automobiles and the need for forecasting and long-term planning is the need of the hour.

During first day of the Conference, the Government also solidified its partnerships with the industry by showcasing commitment and a keen interest to work with the stakeholders to realize its efforts towards actualizing the milestones set and translate its vision into a reality. The following Memorandum of Understanding (MOU) were inked:

- MOU between SEMI and ELCINA to promote semiconductor ecosystem in India
- MOU between CDAC and Qualcomm for partnership in semiconductors which will target semiconductor design startups, in line with the objectives of the DLI scheme
- MOU between AICTE, SEMI and ISM for training and skilling tech workforce for the semiconductor sector

IESA launched an industry report on "Semiconductor manufacturing supply chain - India's opportunity in the global market".

Day 2 - April 30, 2022 - Opening Session

Opening Session: Semiconductor Manufacturing Session (Silicon Foundry)

1. India's Resilience to Semiconductor Supply Chain

Speaker: *Siva Sivaram, President, Western Digital, USA*

Siva Sivaram spoke about the vast transformation in the semiconductor industry and the steps India must take to ensure India's resilience amidst the ongoing semiconductor shortages. The capital equipment industry will play a critical part in the supply chain of the semiconductor industry.

He talked about the meaning of semiconductor resilience for India and that it can be done by ensuring India's national security and need critical industries (automotive, telecommunication, power, entertainment) thrive. For these to thrive, semiconductor industries are needed. According to him, the main objectives of India's resilience in the semiconductor supply chain are:

- Ensure India's national security in the broader sense
- Enable critical industries like the automotive industry, telecommunication industry, and entertainment industry to thrive
- Lead the creation of new transformative technology
- Create highly value-added manufacturing and infrastructure jobs

Highlighting the semiconductor industry overall, he cited that it is a half a trillion-dollar industry with memory being the biggest component (almost one-third), followed by microprocessors. He mentioned about 'scalability' through Moore's law, getting more out of the same resources. 'Scale' is being able to use the scale to propagate the scalability. India needs to seek both scale and scalability.

Concluding his talk, he spoke about the complex semiconductor supply chain and the following main strategies for resilience:

- No country has all the pieces for complete semiconductor self-reliance
- Security comes from well-developed alliances
- Awareness of the needs, playing to one's strengths and establishing roots of trust in the supply chain.
- Skating behind the puck rarely helps with long-term success.
- Leadership in applications and markets to ensures the continuity of the industry

2. From Angstroms to Zetta-scale: Silicon, Systems and Software in India

Speaker: *Raja M. Koduri, Vice President and General Manager, Intel, USA*

Raja M. Koduri started by talking about computation democratization over time, from megaflops to the cloud era, to the future of the 'distributed intelligence era' with more than a trillion intelligence devices by 2030. He expressed that to meet the demand for AI computing by 2025, a thousand times increase in compute would be needed, stressing the importance of access to computing. He mentioned that today AI compute demand outpaces Moore's law. From a period of Sensor to Supercomputer in 2022, and we are heading towards the era of zettaflops by the year 2025. He stressed the need for the advancement of full-stack architecture. The CPU architectures are good at scalar processing, GPUs are good at vector processing and TPUs (Tensor Processing Unit) which is AI based are matrix processors and then there are many architectures beyond these three kinds of mainstays. The fourth architecture is the advanced packaging called hybrid computing architectures. He stressed that today's need is hybrid computer architecture putting different architectures in one package.

He went on to talk about the full stack that is required - the path to zetta scale. He talked about the tech progress over the last 60-70 years, the notion of democratization of compute/technology when compute was made available, and the major disruptions that took

place that were not expected. He then highlighted how when people got connected to the mobile phone, India did really well with the highest data consumption, producing the lowest cost per bit. In terms of the need compute, Mr. Koduri said that we will all need it and that it's necessary for sensors to edge to the data centre.

He spoke about how the U.S. is building 3 Exascale computers, in addition to China and Europe. He acknowledged that India has the opportunity to tackle tech challenges. He narrated about how the world's fastest computing chip is already designed and done in India and that with the demand that currently exists is the perfect opportunity for India.

3. Fireside Chat on Silicon driven AI/ ML revolution

Participants: *Sailesh Chittipeddi, Renesas; Walden Rhines, Cornami; and Sid Sheth, d-Matrix*

The fireside chat between Mr. Chittipeddi, Mr. Rhines and Mr. Sheth was focused on the aspect of the evolution of artificial intelligence over time and the goal of moving towards the edge from the cloud. Mr. Chittipeddi mentioned that India's AI market is set to reach USD 7.8 billion by 2025 and AI adoption rate is actually the highest by the Indian companies because of the focus on Digital India's 4 major areas viz., Schools, Healthcare, Aviation Industry and Customer experience. He highlighted the growth of semiconductors related to artificial intelligence and how it is expected to be 5 times greater than the growth in the remainder of the market. He also spoke on the intelligence moving towards the edge and this is going to be more than two and a half times the growth in the enterprise side of the business. He emphasized that some of the biggest opportunities that lie in India are in verticals like smart homes, health care, industrial automation and building automation and energy management.

Following that, Mr. Rhines spoke about the history of Cornami and its foray into the chip manufacturing industry. He spoke on the lack of protection of data in Machine learning and encryption in the models is today's need. He spoke about Fully Homomorphic Encryption and how it will revolutionize the world and the process behind it. He also highlighted about how moving to the edge becomes an important part of inferencing technology and how with

the amount of investment made into machine learning models, the protection of the same and data has been minimal.

Mr. Sid Sheth spoke about the first four years of AI computing were a lot about convolutional AI but now we are moving towards the age of transformer AI. He spoke on chiplet-based technology as the future and the flexibility of the chiplet technology to both scale up and scale down. He added that today, silicon is specifically moving closer to AI algorithms and AI computing is moving to the end nodes. He also added that India can really play a big role in terms of making the software user-friendly for the target application and the end-user. He spoke about d-matrix being a relatively new company and its history, its goal and "In-Memory Compute" as marrying the accuracy and predictivity of digital compute with the efficiency of in-memory computing.

4. Fireside Chat on Global Growth Drivers for Foundry ecosystem

Participants: *Sajiv Dalal, SVP, Business Management, TSMC and Barun Dutta, Chief Scientist, IMEC*

The fireside chat between Mr. Dalal and Mr. Dutta kicked off with a discussion about the key drivers for the foundry ecosystem. Mr. Dalal discussed his perspective on the key drivers being applications and technology trends - computing and energy and expressed that this would be a great opportunity for India. He talked about other emerging areas such as healthcare. He also said that the key drivers of going forward from the existing mobile markets are applications and technology. He highlighted how the 5G and 6G bands are growing in healthcare and the inference at the EDGE computing is transforming health care. The design ecosystem has gone up and there is a need for local products to cater to local needs. According to him, fabs make sense only if there is a local need. The requirement of a foundry is to produce differentiating products using mainstream products, a good capacity of production, high yield with good quality and reliable products and the trust of the customer in the product. Finally, a good alliance and a successful ecosystem are needed to support this.

Mr. Dutta spoke on mobility applications as a huge opportunity in India and the need of local application source for the same. There is an opportunity of growth in wafer consumption in the future in the automotive sector. The need to train our next generation to build products in India is the future. The business need will drive fabs and the issue of inclusion is key. The consumer product needs are growing and there are a lot of buying decisions being made. This would tap the 35-40% population of women who are making 50% of all buying decisions.

The next topic discussed was the "design ecosystem driving foundry". They shed light on the need for local products, and their need to address local needs. To arrive at this, Mr. Dutta and Mr. Dalal spoke about the need for innovation and start-ups and discussed its potential and moved on to talk about the support that would be required to not just encourage start-ups but to train the next generation to build products for localized solutions. Pertaining particularly to TSMC, Mr. Dalal spoke about the drivers in the ecosystem to be technology leadership, effective capacity, and consumer trust. He expressed that consumer trust continues to be the most important aspect out of the three and that this includes structural trust and execution trust.

In his closing remarks, Mr. Dalal expressed that we need to be aware of the pitfalls in this ecosystem and that the goal should be to build Fabs in the right and self-sustaining way. Mr. Dutta expressed his hope for inclusion and the eventual increase of women engineers in the ecosystem, expressing that this would change the dynamics for engineering education.

Session-1: Compound Semiconductor

5. Power Electronics: India's Moment for Compounded Growth

Speaker: *Prof. Umesh Mishra, University of California, Santa Barbara, USA*

Highlighting the following needs for semiconductor technology - high performance based on application, reliability, lower cost and wide market penetration, Prof. Mishra began his talk on the topic of Gallium Nitride (GaN) and how it is preferred as the next-generation semiconductor alongside silicon (Si). He continued to talk about the features of GaN and how it is suitable for Power electronics, RF, and Photonics related technologies. The 5G and 6G are also shifting towards GaN. The fast-charging adapters are also using Gallium Nitrate. The lighting industry is growing exponentially the micro and mini LED display markets are now emerging and on photonics side, UV LEDs are just exploding and with some breakthroughs the power industry is the new market pathway to low-cost devices which will drive broad adoption. He then talked about the broad-based applications for GaN such as compact chargers, data centre power supplies and airborne radar.

Prof. Mishra also mentioned the problem with power conversion, the biggest being conversion losses. To combat this, he proposed that GaN is the perfect solution for the same, explained the features of GaN and its market trends in the coming years. He mentioned that GaN is evolving to serve multiple markets and in multiple application areas such as the Defence sector, 5G and Satcom. BAW filters in cell phones will grow the GaN market even more. We can see exponential growth for virtual reality and augmented reality products. GaN on Silicon Si and sapphire gives a pathway to low-cost devices to compete with Si. He went on to talk about the history of GaN over the past 10 years and more notably the market growth from USD 700 million in 2019 to a projected USD 2 billion in 2025.

6. Panel Discussion on Compound Semiconductor: India's way forward

Moderator: *Vivek Sharma, ST Microelectronics*

Panelists: *Dinesh Ramanathan, NexGen Power Systems; Primit Parikh, Transphorm; Harshad Mehta, Silicon Power; Anant Naik, GAETEC; Seema Vinayak, SSPL (DRDO); Amitava Das, Tagore Technology*

The moderator, Mr. Sharma posed a series of questions to the panelists covering the difficulties in developing new tech to the importance of the government and industry to work together. It was noted that gain of even 1% energy efficiency would make a huge difference in the overall power consumption equivalent to 15 nuclear plants. The growth of silicon carbide and gallium nitride industry, their applications in Power and RF, including the growth of electric vehicles were discussed.

Seema Vinayak stressed the importance of compound semiconductor FABs like Gallium Nitride and Silicon Carbide. She expressed that challenge that India faces is the lack of expertise in this area. To make sure everything runs smoothly, expertise is a must and that the industry should work in collaboration with the research institutes and academia. She spoke of the challenge of export controls and extended delivery period of semiconductor equipment in the present context as well as the importance of after-sales support. This requires careful planning and forecasting and government support.

Anant Naik brought up the importance of building Fabs that can cater to different applications. We need to focus on two to three different kinds of Compound Semiconductor Fabs. The availability of substrate material and high purity materials is a big challenge. Overall, it was agreed through the discussion that the challenges faced are in human capital, financial capacity, Intellectual property, and infrastructure.

Harshad Mehta said power electronics is the lowest hanging fruit for India. There is a need for energy efficiency in power applications. He spoke of his three-phase plan: (i) phase one

is a silicon carbide epitaxial wafer or Si epi, (ii) phase two is silicon carbide fabrication and (iii) phase three is silicon carbide packaging.

Primit Parikh said we must be aware that semiconductor development is a marathon. We must invest in human capital, financial capital, intellectual property, and infrastructure for semiconductors. There is a need to build an ecosystem for the entire supply chain from materials to chemicals to end products. We need to build on the applications like power supplies, converters, and inverters for products and systems, and establish design centers. We also need to develop Outsourced Assembly and Test capabilities for compound semiconductors.

Amitava Das continued the conversation by talking about the demand side of semiconductors and how there is a rising demand for wafers. He spoke on incentives from the government on wafer pricing, the input material cost. Power electronics is a very large growth market with a long-lasting environmental and societal impact. He stressed development of economical indigenous solutions.

Dinesh Ramanathan spoke about NexGen Power Systems Fab in Syracuse and what the Fab produces; the spaces in which NexGen operates - ranging from power systems to lighting systems. He mentioned about their product design that happens in mainly in Bangalore, carrying out the function of putting together all the hardware together to the final product. He went on to talk about the global impact the NexGen Power Systems. He said that setting up a Fab is capital intensive and need to be supported for the long-term; Semiconductors and developing semiconductor technologies and Fabs is a 15-year outlook. Further, the compound semiconductor industry will also require additional training and resources and skill sets which have to be developed inside of India to make sure that we can have a successful compound semiconductor initiative.

Session-2: ATMP and Display Manufacturing

7. Fireside Chat on Emerging Display Technologies

Participants: *Pranav Komerwar, Vedanta Limited with TAI Kang Wu, Innolux Corporation*

Mr. Pranav Komerwar welcomed Mr. TAI Kang Wu, Innolux Corporation, Taiwan. The conversation delved into the technology landscape and how the display industry has evolved over the years. Mr. Wu said that the dominant market today is the small mobile segment. Indian market will be able to address this initially with the TFT LCD technology which will be a dominant market in India for years to come and maybe later on it can switch over to organic LED (OLED).

They also discussed the need for technology partners in the display industry. Mr. Wu expressed that technology partners shall play a critical role in setting up the industry in India. Technology partners will be able to provide comprehensive expertise and support for the required tech know-how, as well as technology upgradation, as we are always faced with evolving technology.

Mr. Pranav Komerwar spoke about how Vedanta is committed to put in USD 20 billion into both display fabs as well as semiconductor fabs. They want to forward integrate with a tech partner to build and expand the ecosystem. In terms of clean room, Vedanta has a company called Starlight Technology, another fibre optic cable company where they have long experience of running class 1000 clean room - including gas and other critical chemical infrastructure. Their commitment is to put up new display manufacturing in India by 2025.

Mr. Wu said that technology transfer includes Fab construction, planning and delivery. The comprehensive technology transfer must include upgrades to the development of the electronics ecosystem. This will create a lot of new opportunities for the local manufacturer. This will serve domestic electronic hardware manufacturers and also drive the development of the related components ecosystem, both upstream and downstream. The domestically manufactured displays will play a pivotal role in increasing the demand similar to other high-

tech industries such as semiconductor displays. This will also lead to enhancement in employment, in addition to consumption and economic growth.

8. Panel Discussion on ATMP: Where wafer meets the real world

Moderator: *Raja Manickam, TATA Electronics (OSAT)*

Panelists: *Gursharan Singh, Micron, Singapore; Amrit Manwani Sahasra Electronics; Pallam Raju, ASIP Technologies; Prof. Rao Tummala, Georgia Tech*

The moderator, Mr. Raja Manickam spoke about the diversity in the Panel and introduced the panelists. The discussion kicked off with Prof. Rao Tummala talking about how we can make India globally competitive. He said that Global leadership requires leading-edge and high-quality products; Integrated system packaging and Government, private industry, and academia partnerships. He spoke about the history of packaging and the importance of packaging in making silicon chips and to make systems, making packaging the single most value add in systems. He talked about the 3 important parameters of the Moore's law - Doubling Transistors, Cost reduction by half and increase in Transistor performance by 35%. He also spoke about an integrated package system where the devices, the design architecture, substrate and interconnections, and power and thermal components of the package all are interconnected and integrated.

Mr. Gursharan Singh spoke on the need for aggressive timelines for semiconductor designs and the need for government support and ecosystems to support it. The other key factor is logistics and local availability of materials. He also stressed the importance of vendor development.

Mr. Amrit Manwani spoke about Sahasra Electronics and how they delve in memory packaging. He spoke of the need for an ecosystem for packaging before the wafer foundries are operational in India. We need global partnerships and joint ventures, knowledge sharing being the key. He spoke about the engineering talent needed for the same - process engineers, quality control engineers, test engineers and most importantly, engineers that ensure perfect yield. He said that with the engineering talent available in the country, India should aim to be more cost competitive than the rest of the world. He added that for India

as a country, packaging is cost-effective and cost-competitive due to abundant availability of low-cost workers at the operator level and the technician level. He stressed the importance of global partners in this mission, through technology partnerships and investments.

Mr. Pallam Raju spoke about the challenges in terms of raising resources and how private investors in India do not understand this space and suggested that industries abroad need to be supportive of developing the same in India. He mentioned that India as an aspirational nation has done very well in the services sector but the manufacturing sector has been neglected. The biggest advantage we have in India is the wide range of talent and a growing supportive ecosystem.

9. Panel Discussion on Where No Technology has gone before

Moderator: *Anshuman Tripathi, Member, NSAB*

Panelists: *Sri Samavedam IMEC, Belgium; Surya Bhattacharya A*STAR's IME, Singapore; Suraj Rengarajan, Applied Materials; Rangesh Raghavan, LAM Research*

Mr. Anshuman Tripathi introduced the panelists and initiated the discussions. It was discussed that there is a need to come together in all spheres to innovate. The future of the automotive industry is going to be fully automated cars by 2030. India needs to focus on advanced packaging.

Sri Samavedam said that Moore's law is going to continue, quoting Prof. Rao Tummala as 3D packaging has come to play and added that the challenge today is the cost of the technology. The complexity of technology has increased the cost and we need to overcome this to flatten the curve. We need to focus on heterogeneous integration of wafer-level packaging and advanced packaging. There is a need for domain-specific compute architectures that can handle parallel workloads. Automotive applications and industrial automation are good areas of research and focus, including Electric Vehicles (EVs). He said that India should focus on advanced packaging as it is a growing area.

Suraj Rengarajan mentioned that the outlook of the industry should be to look at four parameters together: Performance, Power, Packaging and Cost. For power, we must look

at new materials which would reduce power consumption, introduce new structures, and improve packaging by design co-optimization, and this will in turn reduce the cost. A 28 nm Fab can serve the automotive market for the next 15 years. This means lower capital investment and higher returns.

Rangesh Raghavan said that from the point of view of an equipment manufacturer there is a clear road map for the next 10 years. The challenge is to keep up with the cost. Another sector to focus on would be power electronics, especially EVs.

It was discussed that the chiplet model continues to gain traction but there are still some challenges to enable broader support for the technology. With chiplets the goal is to reduce product development times and costs by integrating pre-developed dies in an IC package. Chiplets could have different functions at various nodes. Customers can mix-and-match the chiplets and connect them using a die-to die interconnect scheme.

Surya Bhattacharya spoke on the system in a package type of approach. AI, high-performance computation, autonomous vehicles, 5G networks, smartphones, and infrastructure, including many diverse applications of the metaverse, need an integrated packing system of heterogeneous chiplets. India can get into the system level packaging. These are advanced technologies that work on system design through chiplets which are value-added technology nodes. For automotive components, the main concern is quality standards in terms of thermal and mechanical requirements. Design concerns also have to be addressed.

10. Indian Opportunities in Integrated Semiconductor and Display

Speaker: *Akarsh Hebbar, Vedanta Group*

Mr. Hebbar spoke about Vedanta, its commitments and the main elements of setting up an electronics ecosystem. He spoke about the display market and that the demand will increase to around around USD 2.2 billion by 2027 and the fact that the display segment is presently dominated by 4 countries - China, South Korea, Taiwan and Japan. They have built their expertise through years of experience and the government has supported it. The Government of India has also taken a decision to support Display Fabs and there is potential

for many more countries to enter this industry. To support this sector, we also need a manufacturing ecosystem to trigger innovation. Glass cullets can be produced in India and many MSMEs can be part of this. Another area is glass substrate production. This is a highly specialized sector and right now only 4 companies in the world make it. The next area is the panel manufacturing which can be localized. The last area is module assembly and testing where opportunity for many MSMEs to come in, as this is is a labour-intensive operation. The main impact on our country is going to be on the entire MSME ecosystem. There is a huge opportunity in chemicals and gases down the value chain that will enable India to promote local production. He then spoke about Vedanta's vision to participate in the global value chain, activate the MSME ecosystem, kickstart an economic transformation and to be on the path to global recognition; and explained how Vedanta is fostering Display manufacturing in India.

Thereafter, Mr. Hebbar spoke about the global semiconductor market demand and mentioned that India will represent 8% of this demand by 2026, making this the best time to start building semiconductor Fabs in India. To close his talk, Mr. Hebbar expressed that partnerships are essential and that leaders from across the world need to come together to make the ecosystem possible. Overall, he emphasized the role of the semiconductor sector given the rise in demand and projected growth in the sector in the coming years. Upcoming technologies such as 5G and other emerging technologies will further boost demand and this sets up India perfectly to build an ecosystem that can cater to local demand and also reach Indian chips around the globe. He was of the view that India need not invest in cutting-edge technology to start with. The sector of 45 - 28 nm chips will be a good start and there is volume demand in this space.

11. Panel Discussion on State Government's initiatives and preparedness for Semiconductor and Display Fabs

Moderator: *Jitendra Chaddah, Intel*

Panelists: *E.V. Ramana Reddy, Government of Karnataka; Jayesh Ranjan, Government of Telangana; Pooja Kulkarni, Government of Tamil Nadu; Nanda Kumarum, Government of MP; Nanda Kishore Mullangi, Government of Andhra Pradesh*

The moderator, Mr. Jitendra Chaddah introduced the panelists. The representatives of various States spoke about their readiness to kick start the journey towards hosting a semiconductor ecosystem within their State. Each State Government pitched their incentive schemes; availability of land, infrastructure, institutions and talent; responsiveness of the State Government, a feasible ecosystem and ease of doing business for supporting the Semiconductor and Display Fabs in their respective States. All the States pitched their unique advantages.

Jayesh Ranjan representing the Government of Telangana spoke about Fab City, a project located in Hyderabad that was designed in 2006 to promote the semiconductor industry. He expressed that although it did not take off then, Telangana values the industry and has set a goal to triple the economy by 2030 and that the semiconductor industry is one of the 3 main levers in policy. He then mentioned that Hyderabad has a total of 3 high tech electronic parks all of whom are a small commute between each other. The infrastructure is in place and industrial climate is conducive. He said that since there is no political unrest in Telangana, there are perfect labour relations and disruptions in terms of labour are not there. His last point was the level of talent available in the State. Apart from leading universities, the State Government has initiated a program entailing that any skill set needed for the work force is taken up by the Government as they conduct courses on their cost. He concluded that the State Government machinery is responsive and accessible.

E.V. Ramana Reddy representing the Government of Karnataka spoke about the conducive ecosystem in the State. The infrastructure and policy measures of the State are competitive. State of Karnataka is strong in the IT and semiconductor space. Many fortune 500

companies, R&D centers and global capability centers are there in the State. The main strengths are in automobiles, aerospace, defence, electronics and machine tools. He spoke of excellent chip design capabilities which comprise about 40% of the national share. Karnataka is rated as number one in the innovation index for the last two years. There are large fund houses and venture capitalists in Bangalore. There are very good institutes to provide talent and a Center for Nanoscience and Engineering. There is excellent research work going on in this sector and a lot of start-ups have incubated. In terms of infrastructure, they have a technology park near the airport. In addition, they are going beyond Bangalore and creating manufacturing clusters in Mysuru, Mangalore, and Hubli. Karnataka had a semiconductor policy in 2013 and subsequently in 2017. The most recent policy being of September 2020 with the special incentive scheme that provides subsidies on land, capital, power tariff, etc. and special packages customized to the level of investment.

Pooja Kulkarni representing the Government of Tamil Nadu said that Tamil Nadu is a manufacturing powerhouse and their economy grew by 5.8% in 2021, noting that the ecosystem functioned perfectly even during in the time of Covid crisis. The State is encouraging green power and there is abundant availability of water. There is no dearth of talent pool and there is no shortage of skilled manpower. The best engineering colleges and private universities are in the State. The State is an electronics powerhouse and has the biggest automobile manufacturing sector. There is ready availability of infrastructure and labor is available at all levels. The State is a power surplus state and the ninth-largest in terms of renewable energy in the world. Fifty percent of the installed capacity is renewable and encourages the movement towards sustainable manufacturing. She expressed that all this combined makes Tamil Nadu the perfect place for setting up Semiconductor Fabs.

Nanda Kumarum representing the Government of Madhya Pradesh spoke of the cleanest city Indore which is developing as the IT hub of the State. The location of the city is in the center of the country so travel time for all logistics around the country will take an average of 6 hours only. He also mentioned the cost of land is very low. The State has plenty of water available at low cost of water and is power surplus with availability of green power The State has prime locations near Bhopal - Indore highway and the Delhi - Mumbai Corridor in the Ratlam area. The State has water treatment and waste management systems in place in

these areas which are subsidized by the State Government. He concluded that the State of Madhya Pradesh is ready to support the Semiconductor ecosystem.

Nanda Kishore Mullangi representing the Government of Andhra Pradesh spoke of some growth sectors and in the last three years, electronics sector was one of them. The State has created the infrastructure for electronics manufacturing clusters with all the facilities including common testing facilities centers. There are four such Electronics Manufacturing Clusters, viz., YSR electronic manufacturing cluster, Kadappa, Sri City and Tirupati. He spoke of well developed manufacturing systems that work even in crisis and the policy and government support irrespective of the political scenario of the State and also a single point contact and quick turn around and support for companies. He said that the government is providing power and water at cheapest cost. He also spoke about how once can get all the approvals required for any kind of manufacturing within 21 days. In addition, the State Government is setting up skill development colleges. He invited the industry to set up Fabs in the state.

12. Fireside Chat on Resurgence in packaging and Chiplet: Opportunities for India

Participants: *Radha Nagarajan, Marvell Technology with Rama Divakaruni IBM Research*

Radha Nagarajan and Rama Divakaruni discussed that data processing and storage have evolved over the years and have seen huge changes over the past three decades. Earlier the concept was to have mainframes with a lot of data processing capabilities with communication infrastructure to access these mainframes/data centers. But now with the advent of distributed computing and storage apart from optical communications, we have large hybrid chips called System on Chip (SOC) doing most of the core functions. There are smaller chips that do the complementary functions and these are called chiplets.

The chip technology has evolved from purely Bijunction transistor Silicon or GaAs chips to hybrid chips which have Bijunction transistor, CMOS Bi-CMOS, etc. on a single integrated SOC and which have electronic and optical components. These need very involved fabrication infrastructure as well as packaging. The fabrication technology which uses 28

nm technology now is reaching the limits in terms of component density and integrity in the electrical functioning of the individual components and circuits.

The trend now is to embed some basic processing with the source of data like sensors, or in controllers, etc., so the data processing becomes more distributed. These processors are comparatively simpler. Fabrication facility for chips is a very long lead time, large budget activity, whereas chip packaging especially for chiplets has a shorter lead time and lower capital outlay. Due to the large requirement of chiplets, there is a huge opportunity for chiplet packaging. India has about 20% of the world's chip designers, chip packaging designers, and software developers.

Keeping the above points in perspective, India should be looking at a short-term strategy of building chip packaging facilities, starting with facilities for chiplets and a long-term strategy of the chip fabrication facility. Since the capital outlay for chip fabrication is very large and the lead time for the facility to go online is quite large, the big industrial houses should be encouraged to build such facilities with active support in terms of capital subsidy and other incentives, and fast track clearances. The chip packaging facilities do not require as much capital outlay as the fabrication facilities and should be taken up by the Indian industry, especially with international partners who have design centers in India. This should be enabled by the Government of India with appropriate policies / incentives, etc.

13. During second day of the Conference, multiple Memorandum of Understanding (MoUs) were signed between the Government, leading semiconductor industry players and industry associations. Recently, India has announced the DIR-V Program to develop, siliconize and create design wins for future around SHAKTI and VEGA RISC-V Processors.

DIR-V Program with Prof. Kamakoti, Director, IIT Madras as Chief Architect and Shri Krishna Kumar Rao as Program Manager has been initiated with a vision to make India not only a RISC-V Talent Hub for the World but also supplier of DIR-V solutions for Servers, Mobile devices, Automotive, IoT & Microcontrollers across the globe. DIR-V announced following Five MoUs for the use of indigenously developed RISC-V Processors - SHAKTI and VEGA:

1. MoU between SONY India and DIR-V SHAKTI Processor (IIT Madras) for the Systems/Products developed by SONY.
2. MoU between ISRO Inertial Systems Unit (IISU), Thiruvananthapuram and DIR-V SHAKTI Processor (IIT Madras) for development of high performance SoCs (System on Chip) and for Fault Tolerant Computer Systems.
3. MoU between Indira Gandhi Centre for Atomic Research (IGCAR), Department of Atomic Energy and DIR-V SHAKTI Processor (IIT Madras) for the Systems/Products developed by IGCAR.
4. MoU between Bharat Electronics Limited (BEL) and DIR-V VEGA Processor (C-DAC) for Rudra Server board, Cyber security, and Language Solutions.
5. MoU between Centre for Development of Telematics (C-DOT) and DIR-V VEGA Processor (C-DAC) for the 4G/5G, Broadband, IOT/ M2M solutions

Additionally, intent of MoU was announced between IISc Bangalore and SEMI, USA for building core competence of quantum technologies - multi-qubit superconducting quantum processors, photonic processors, diamond-based magnetometers, lab-level quantum-secured communication network, etc.

SEMI, USA and IESA also announced a MoU for exploring the potential for growth of Electronics and Semiconductor industry in India and thereby bring global major players in semiconductor to leverage the opportunities for catalyzing the semiconductor ecosystem in India. IESA also released an industry report - India Semiconductor Market Demand.

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Day 3: May 1, 2022

Opening Session: Economics of Semiconductors and Next Wave of Innovations

1. Innovation in Semiconductor and System Design with EDA, IP, and AI

Speaker: *Anirudh Devgan, CEO, Cadence Design Systems*

Anirudh Devgan spoke on the three essential components of any electronic / intelligent system, viz., the silicon component, the system component and the data component. The efficient and effective integration of these three components is key to the success of the electronic / intelligent systems. There is a growing demand for data-driven and domain-specific chips and this demand is growing because there is more value in this approach as you can tailor the chip to provide better performance for the end-user, you can align the chip development schedule to match the schedule of the system which is the end-use, there are enough applications with large values and numbers which can cover the expense of developing a specific chip/chiplet and semiconductors whether CPUs, memories, or mixed-signal are getting more and more powerful.

He underlined the role of semiconductors as generational drivers because of their contribution to growing technology. He mentioned that semiconductors augment various accepts of new-generation technology like 5G connectivity, IoT, Hyperscale computing, AI/ML, and automated vehicles. He was very positive about the growth of the semiconductor industry in India to 1 trillion USD. He also pointed out that India has very strong foundational facets that will help augment the industry, these being digital transformation, Government initiative for the industry (referring to the USD 10 billion incentives for Semicon India Programme), young talent in the industry, and the presence of multinational companies in India. The reasons given for India to invest in semiconductors were huge demand due to the fast pace of digitalization, 5G, EV implementation, large talent pool available (~20% of the world's talent), availability of capital and prioritization of this sector in government policies and many large multinational companies in India with big R&D teams.

According to him, India should focus on 3D chip, IC design excellence and software, AI, ML, and cloud and semiconductor manufacturing. The 3-D chip provides easier scaling of capacity in a smaller footprint, easier integration of different types of processes - memory, radio, analog, digital, etc., in one chip and easier packaging. Modern chip design is a fairly complicated process with multiple requirements and multiple constraints with shorter lead times. So to get highly effective, optimized designs in a shorter design cycle time, usage of EDA, AI, ML, and cloud computing is imperative. He assured the industry that Cadence will continue to support the industry in India and specifically the start-up ecosystem of the industry.

2. Fireside Chat on 5G/ 6G: Next wave of innovation opportunity for India

Participants: *Mr. K. Rajaraman, Secretary, MeitY with Prof. Arogyasamy Paulraj, Stanford University and Dr. Kumar N. Sivarajan, Tejas Networks*

The Panel noted that the economic opportunities of 5G are enormous and its societal benefits give it the potential for being a transformational force for India. The cumulative economic impact for India is up to a trillion dollars in the next 15 years. Unlike 4G, the 5G is a completely new dimension of supporting connectivity to vehicles, for IoT, manufacturing, and remote operations. Its wide range of new services makes it more interesting. R&D investments are important to make an impact on international standards for global leadership. Speaking about the global learning from the initial launch of 5G networks in countries outside India, Secretary Rajaraman said that the Government of India, particularly the Ministry of Electronics and Information Technology and the Department of Telecommunications have helped develop capabilities specific to R&D, intellectual property, increased participation in global standards and experiments. He specially mentioned the work of IIT Madras in this area as a key institution that has been involved with R&D and led the 5G test bed project.

Prof . Paulraj mentioned that India should slowly integrate its research and production stream of microprocessors and semiconductors with the value chain of the rest of the world

and with best practices employed globally. He said that India as a market can be a starting point for the industry to flourish. However, the main aim for India should be to become the hub of semiconductor supply globally.

The chat continued on the lines of government-industry cooperation and how academia can enter the sphere as well. Mr. Rajaraman spoke about the ease of licensing and permissions in the industry that the government has come up with, especially for small businesses that are adding additional value to the process of creating a robust industry and the Government's Technology Innovation Group initiative. On the question of 6G networking in future, the Panel was positive that India will be at the centre of the developing technology and design that will enable 6G.

3. Propelling growth of semiconductors in communications

Speaker: *Matt Grob, CTO at XCOM Labs*

Cellular innovation over the years has changed the user experience. Mr. Grob spoke briefly on the history of high-speed networks in the world and in India, the hurdles of design and manufacturing processes the industry had to face together and how innovation at its core was the solution to the speed that has been created today. He mentioned that more sophisticated the user interfaces of devices get, more is the requirement of high-speed network. To improve performance the techniques used should be:

- Carrier aggregation

- Defining of wider channels and more spectrum with more re-usable spectrum

- Introduction of smaller cells that could piece the spectrum in an area.

He highlighted that the requirements for the future are only to increase manifolds. Linking wireless connectivity with strong foundations in semiconductors, he said that one cannot progress and function without the other. He also spoke about the progress made in the category of untethered AR/VR. He concluded by stating that the significant increase in the

demand for wireless connectivity, especially in India amongst its growing middle class and closing the digital divide will further drive evolution of the industry and global supply.

Session-1: The Future of Automobiles: Computer on Wheels

4. Fireside Chat on Computer on Wheels

Participants: *Lars Reger, CTO at NXP Semiconductors with Jitendra Chaddah Country Manager, Global Supply Chain, Intel*

Mr. Chaddah started the discussion by asking Mr. Reger about the future of technology and in specific the role of semiconductors in the automobiles industry as automobiles get smarter. Mr. Reger spoke about the changing dynamics of transport and the diversity that the sector will see in the coming future, the user preferences that will be moulded over the years, the safety requirements, the luxury and technology changes that personal transport and public transport will see in the years to come. He said that dynamics aside, the constant increase of one variable is certain, that is increasing component of technology in automobiles. Secondly, he mentioned about the need to differentiate between the chips that are going to be developed for vehicles and other devices. He highlighted that there are a lot of electronics rolling out even in the 2-wheeler segment. Semiconductors in cars are getting more and more advanced. The battery management electronics in new electric cars help you optimize the driving range of your car. There is a new class of precision analog electronics that are designing chips in technologies between 60 and 130nm.

We are witnessing advanced driver assistance systems like collision control systems in traffic and highway, highway pilot systems, AI and machine learning systems, and a mix of deterministic systems and AI systems will be seen in future. The way a car is built has to be restructured. The five domains or parts of a car are for connectivity to the outside world. Everything else is autonomous driving. The main domains are Chassis electronics, LED lights, Climate control access, Power electronics for engine or battery, and automatic braking system (ABS). These five domains are all separate from each other and they are connected by one big network or the automotive gateway system which is safe and secure.

Having a smart electronics system in automobiles needs to make sure that these devices are trustworthy and not hackable.

They also mentioned that there needs to be a change in sophistication of automobiles architecture and to develop collaboration between design makers and car makers. Both, Mr. Chaddah and Mr. Regers look forward to young talent from Indian universities to innovate around the present technology and build global capacities for the industry.

5. Semiconductors for Next-gen Mobility solutions

Speaker: *Nivruti Rai, Country Head, Intel India*

Ms. Rai spoke about the evolution of a car over the years. She looks at the next-generation car as a human like system that can see, process, decide and act based on its current environment. She said that the Government's policy is focused not just on chip production but also on creating conducive policy for the end-to-end ecosystem of the design, research, procurement, production, logistics, assembling, and so on. She talked about how India currently provides for 5% of the cars made globally and that India's potential in the changing dynamics of building a car can help them take up a higher market share in the automobile industry. She said that today's automobiles have 4% of the bill of materials coming from semiconductors and that by 2030, more than 20% of the bill of materials will be coming from semiconductors.

She was of the view that India should look at smart automotive navigation, autonomous driving systems and accidence avoidance systems. Innovation cannot be driven by a single technology but a convergence of technologies. With the cost of Lithium battery going down there is a need to migrate to the EV and smart mobility. The EV has a longer life cycle in comparison to IC engines. The ability to manage such engines will be simpler. Advanced driver-assistance systems (ADAS) for commercial vehicles and railways is an amazing architecture. Higher compute makes tasks simpler.

She was ambitious about India's role in technology and infrastructure development in the area of automated driving systems and collision avoidance systems, bringing down the road accidents in India drastically. She went on to speak about the convergence of technology in the industry and between industries highlighting how car can be used as a 5G small cell, the need for truck platooning, and services based on local intelligence.

She concluded with the idea of Internet of vehicles as a new future and the ACE trinity - AI, Connectivity and EV.

6. Panel Discussion on Smart Mobility

Moderator: *Vinay Shenoy, Managing Director, Infineon Technologies India*

Panelists: *Lior Sethon, VP and Deputy GM, Mobileye Intel; Sanjay Gupta VP and Country Manager, NXP Semiconductors; Uday Dodla, Senior Director, Qualcomm India; Vivek Singhal, Engineering Manager, Texas Instruments; Amit Jain, CEO and Executive Director, Uno Minda Group*

Mr. Shenoy explained smart mobility as a radical system that manages mobility focusing on efficiency, safety, and convenience with the aim of having the system promote zero emissions, zero accidents, and zero ownership as well. He highlighted zero omissions via Electric Vehicles, zero ownership via ridesharing and e-scooters available for rent, and safety via growing technology in-built in newer cars and two-wheelers. The Panel members discussed the need for standardization and a SMART ecosystem including bus stops and traffic lights, need to think of the involvement of the governments in the standardization of EVs and smart mobility, need to think of standardization of batteries based on the vehicle types in the same sector, including unified charging points, and the need for OEMs to reduce the number of chips per automobile and virtual up-gradation of systems.

Lior Sethon spoke on autonomous vehicles and the collision avoiding systems. He added that the system extracts a lot of data and this could provide information not only to

autonomous vehicles but also to road planners, public transport, and road operators about the traffic system. It can also plan according to the geolocation of the place.

Uday Dodla added that basic infrastructure should get ready for smart mobility. Advanced driver-assistance systems (ADAS) is very useful. These systems are powerful and can make split-second decisions. He spoke about their automobile-centric chip design and production systems since 2002 and how over 20 years they have honed their knowledge to build better capacities to augment the smart mobility movement in the world.

Sanjay Gupta spoke on the hardware-oriented automotive which is slowly increasing in smart mobility and sees software and services playing a prominent role. He added that we are in an era of computers on wheels. He also stressed the need to engage more focus on safety in the transport sector by collating design and innovation between hardware and design.

Amit Jain, speaking of smart mobility, said that the need is to look at how sustainable that is in the long run. Making sure that they remain relevant is the key. He also added smart mobility is more or less like package protection. In a country like India both affordability and safety is the key. There has to be a strict regulatory framework around it. There have to be organizations that set standards, regulations, and homologation. He also spoke about Minda's capacities in the automobiles sector and how integrated technologies will help keep cars future-ready and adaptive to newer technologies without owners having to give-up their cars and shift to new-generation cars.

Vivek Singhal explained how complex the standardization of communication infrastructure is in a vehicle. Smart mobility needs solutions for traffic pile up and freeway for emergency services like ambulances. The carbon emission caused by passenger cars was around 3 billion metric tons. We have to make mobility safer, find open spaces and guide incoming vehicles to open spaces. EV and electrification of vehicles, more electric buses and smart parking are the need of the hour.

The panellists stressed how technology has increased manifolds in the cockpit of the car and that the pandemic was when the design and technology were developed for products

like Mahindra's XUV700 and Ola's S1 and that disruptions like Covid-19 will not stop an industry with the potential semiconductors have on smart mobility.

Session-2: India-The Global Semiconductor Talent Capital

7. Panel Discussion on India as Semiconductor Talent Hub

Moderator: *Prof. V. Kamakoti, IIT Madras*

Panelists: *Prof. Subhasish Chowdhry, IIT Bombay; Anil Sahasrabudhe, AICTE; Raja Subramaniam, Synopsys; Sambit Sahu, Intel; Santosh Kumar, Texas Instruments; Venkat Prasad, RV-VLSI; Jun Gu, General Manager, Memory Business Unit, Power Semiconductor Corporation*

Prof. V. Kamakoti initiated the discussion on the specialized talent needed for the industry. The panelists spoke about India as a Semiconductor talent hub and proposed ways to expand the ecosystem to attract talent. The three main points are (i) focusing on technical skills, (ii) having a strong culture of influence, and (iii) promoting innovations in new fields as well as challenges in recruiting talent - R&D level and skilled technicians.

Sambit Sahu stated that the semiconductor demand is significantly high right now and the semiconductor industry is estimated to grow from USD 500 billion to USD 1 trillion by 2030. He highlighted 3 aspects to focus on (i) Building the tech skills is the key. There is a lack of specialized skills, especially in architecture. There is a need for domain-specific skills, (ii) Building skills in universities and the need for collaborations and (iii) Need to innovate especially in the emerging technologies like AI,5G and IoT sector.

Santosh Kumar spoke of the need for hardware design courses at university level. The need for the industry is quality engineers rather than numbers. We are interested to make students holistic and industry-ready. Electronics System Design and Manufacturing (ESDM) is an important and more active work is required in this area.

Jun Gu stated that Taiwan's wafer capacity is number one in the world. The requirement for talent is huge as the wafer fabs run 24 hours. He talked about how Taiwan has set up specific semiconductor post graduate colleges. Taiwan has established 5 universities specific to the semiconductor industry. Taiwan is also recruiting a lot of foreign students. He conveyed that and India can collaborate in the aspect of semiconductor manufacturing and Taiwan can provide a training ground for India.

Venkat Prasad spoke about adopting concepts of micro-learning and to be mindful of the pedagogy of teaching that is going to be adopted to make sure it is interactive. Over the years the attention span of the students is going low. Therefore, micro-learning and an engaging curriculum is the key. In the last 17 years, they have trained 10,000 engineers with almost full placement. He said that lack of awareness of VLSI and loss of talent to Fintech and other industries are the challenges.

Raja Subramaniam said that whether X86 or ARM or RISC-V the underlying technology is Electronic Design Automation (EDA). The EDA technology is available in the cloud for all students. As an EDA vendor and an IP provider, Synopsys has the skill to provide this technology at scale so that more students and research institutes in India can leverage it.

Prof. Subhasish Chowdhry stated that right now the focus is on the talent pool and the need for large-scale training. In high technology areas, knowledge is key and the educational institutes have to come together. No single institute can do it alone. There is a need for a curriculum for this. The output should be industry-specific with strong entrepreneurship and hand-holding. There is a need to train the trainer with the academia working closely with the industry. Together with the industry, we can provide specific skills to students.

Prof. Sahasrabudhe reiterated the main ideas discussed in the panel and explained that the semiconductor mission should be multi-disciplinary. He spoke of the need for a range of polytechnic staff to run machinery, staff for supervision, and encouraging students from IIT's, etc. for research and design. He said that with the amount of talent present in the country, a hands on knowledge is essential which can be attained by working in the field and through interactive discussions. The process to hone the talent lies with educational institutes. There is a need to make the curriculum more interactive and in line with industry expectations.

The moderator concluded the panel discussion by saying all the building blocks are available for scaling, support from the government in terms of the Semicon policy and great demand from an customer point of view will push India from height to height.

8. Panel Discussion on Global Partnerships for Future of Technology

Moderator: *Prof. C. Raja Mohan, Asia Society Policy Institute, New Delhi*

Panelists: *Barry O'Farrell, Australia's High Commissioner to India; Drew Schufletowski, Minister Counselor for Economics, Energy, Science, and Technology, U.S. Embassy, New Delhi; Naor Gilon, Ambassador, Israel; Marten Vanden Berg, Ambassador, Netherlands; Dong-Kyu KIM, Ambassador of the Republic of South Korea*

The moderator, **Prof. C. Raja Mohan** expressed that diversification of semiconductor industry at scale and the associated supply chain can only be done through international collaborations and partnerships. This should be achieved through like-minded nations that trust each other than can bet on critical elements of the supply chain.

Excellency, Naor Gilon spoke about Israel's position in the semiconductor field and the biggest player in Israel, Intel. He stated that Tower Semiconductor is another big player in Israel. He talked about the signing of MOU between the State of Karnataka and Tower to build a semiconductor fab.

Excellency, Marten Vanden Berg stated that Netherlands makes the machines for manufacturing semiconductor chips. The future of this sector is bright. He said that ASML (Advanced Semiconductor Materials Lithography) and Dutch universities can train Indian students and we could look at ways to cooperate with India. Netherlands wants to partner with like-minded countries like India to increase the production of semiconductors. Europe is looking forward to collaborating with India.

Excellency, Dong-Kyu KIM stated that both Korean companies, Samsung and LG have significant presence in India and are into the field of Semiconductors and Displays. Samsung has been hiring a lot of Indians for this industry and they plan to extend this partnership.

Excellency, Barry O'Farrell stated that Australia is happy to collaborate with India. He stressed upon availability of critical minerals in Australia and their aim is to become a global player by 2030 in relation to critical minerals. He voiced Australia's determination to continue working with India and said that supply chains with reliable partners are more important. They are establishing a consulate general in Bangalore, in addition to establishing a joint centre of excellence on critical and emerging technologies with India. Australia also wants to continue cooperate with India in the field of education.

Excellency, Schufletowski spoke of 75th anniversary of US-Indo partnership. Trade and investments went up from USD 27 billion in 2001 to USD 160 billion this year. The US is the largest source of foreign direct investment in India and that they look forward to U.S.'s continued participation in the country. He expressed that working together across the entire supply chain from raw materials to warehousing and distribution is the best way to build resilience for the future. He further added that security needs to be recognised as a high priority. To conclude, he said that building a system that supports tech, including semiconductor manufacturing, will help guard us against future vulnerabilities and help strengthen the bonds between the two countries.

9. India's role in the global semiconductor supply chain

Speaker: *Mr. John Neuffer, Semiconductor Industry Association*

Mr. John Neuffer said that there is a global chip shortage and this has reminded everyone that semiconductors are embedded in everything in the modern economy. This industry is global and no country can or should attempt to fully indigenize the complex semiconductor supply chains. The advantages of all countries including the United States are interdependent in this integrated global value chain. Free trade to move materials, equipment, Intellectual property, and products around the world in the future is the optimal

approach. He supported India's endeavour to upgrade its semiconductor ecosystem by more deeply integrating into these global value chains. He stated that Global collaboration is the only way forward for India. 20% of the design workforce in the world is located in India.

India's integrated circuits imports grew to USD 12 billion and today the broader Indian ICT market is accounting for nearly USD 150 billion in total sales. An increasing amount of original design manufacturer electronics assembly is happening in India. India has an opportunity to make targeted investments across research, design, manufacturing, assembly and test. He looked forward to collaborating more with India in the semiconductor value chain that embraces open competition, protection of intellectual property and strong global trade rules. In conclusion, he stated that he looks forward to India's commitment to further economic development and the opportunities both for the United States and Indian firms alike.

10. Semi Equipment perspective in mission mode

Speaker: *Mr. Prabu Raja, Applied Materials*

Prabhu Raja stated that Applied Materials is the world number 1 in the semiconductor industry. Today computers, cars, and many other smaller devices have become AI-centric. He emphasized the role of emerging technologies especially AI on the semiconductor manufacturing equipment sector. According to him AI is an enabler for semiconductors to be a USD 1 trillion industry. Highlighting the history, he outlined that the growth of Semiconductor industry saw four major waves starting from mainframe computing to PCR to mobilities and now the era is AI. AI is in the cloud, edge, and in the semiconductor chips. AI will transform multiple industries. Today, the biggest challenge is that we see power consumption both in Edge and in the Cloud data center combined consuming 15% to 29% of global electricity by 2025, which is not sustainable.

He emphasized that the new semiconductor chips with lower power higher performance at the low-cost area for which semiconductor equipment manufacturers need a lot of innovation and commercialization. He highlighted that the Applied Materials has strong commitment to

India's semiconductor ecosystem and has made over USD 340 million investments in India. The industry has to work on the PPACT (Power, Performance, Area, Cost and Time) Model. This requires multi-disciplinary engineering talent. Emphasizing on the talent ecosystem, he mentioned that the multidisciplinary talent is required for semiconductors. Apart from this, he mentioned that we also need manufacturing capabilities, supply chain ecosystems, and customer support. We have big opportunities today for product development and conventional manufacturing. The main areas are Conventional leading edge, Leading-edge logic, DRAM memory and NAND storage. New manufacturing needs are for Legacy nodes -IoT, Industrial, SiC and GaN compound semiconductors power devices, Image sensors and Packaging.

He concluded by mentioning that there is a huge market demand for semiconductors, both domestic and global. New manufacturing opportunities are opening. Local innovation and commercialization are growing. Finally, government support with incentives and favourable policies is needed.

11. Concluding Remarks

Shri Rajeev Chandrasekhar, Hon'ble Minister of State (Electronics & IT and Skill Development & Entrepreneurship)

The inaugural edition of SemiconIndia 2022 Conference concluded with resounding response from participants across industry, academia, research institutions and industry associations. Day 3 of the Conference yielded further progress in concretizing the growth charter defined for the electronics and semiconductor ecosystem. 7 MOUs were signed to further drive cooperation between global industry leaders, academia and research and development institutions to provide further impetus to the sector, create new opportunities and develop talent required for a robust and thriving electronics and semiconductor ecosystem.

Hon'ble MoS talked about the success and the quality of SemiconIndia 2022. In his concluding remarks he said that the past 3 days have been supercharged, full of energy and brought many promises. Our mission is to bring Hon'ble Prime Minister Narendra Modi's vision of making India a major player in global semiconductor supply chain. The technology ecosystem leading India into the next wave digital innovation will only be possible with all stakeholders coming together and working relentlessly so that soon we will be able to proudly announce "India Inside" in every ubiquitous technology product.

Logo Pic as attached

Shri E V S Ramana Reddy – screen shot attached

Video Link of Conference –

https://drive.google.com/drive/folders/1NiunmIVtFMyPXSTVV9o2c1T9ErAjB5by?usp=sharing