Innovation and Service

An Innovation Pioneer

As the founder and leader of the dedicated semiconductor foundry segment, TSMC actively promotes innovations in every part of our business. TSMC continues to invest in research and development to maintain our leadership position as an innovation pioneer. We consider product life cycle to help customers produce sustainable products with higher quality and lower energy consumption. At the same time, TSMC listens to our customers' needs and actively collaborate with them to take advantage of emerging opportunities.

5,000 / 8,000
More than 5,000 patent applications were filed worldwide and over 8,000 trade secrets were registered in 2017 to protect intellectual property.

10.1bn (NT$)
Continuous Improvement Team (CIT) completed 42,056 grassroots-level improvement proposals and 2,020 projects for total benefit of NT$10.1 billion.

93.3%
The annual customer satisfaction survey at TSMC reached over 90% satisfaction for four consecutive years, demonstrating our good relationship with customers.
Material Issue

Innovation Management

Strategies

- **Technology Leadership**
  
  Continue to develop leading-edge technologies to maintain TSMC’s technology leadership in the semiconductor industry

- **Intellectual Property Protection**
  
  - **Patent Protection**: TSMC continues to expand its patent portfolio with strategic patent filing goals, which are in close alignment with its R&D resources, so as to ensure full protection of R&D achievements.
  
  - **Trade Secret Protection**: Strengthening the company’s operations and intellectual property innovation through the registration and management of trade secrets, which involves recording and integrating applications for trade secrets that are competitive advantages for the company.

TSMC 2020/2025 Goals

- **Increase the number of worldwide patent filings by about 5% YoY**
  
  2020

- **Increase the number of trade secrets registered by 10% per year**
  
  2020

- **Exceed the total number of patents granted worldwide (45,000)**
  
  2025

- **Over 55,000 trade secrets registered**
  
  2025

Our Business

Focus One

- Ethical Management

Focus Two

- Innovation and Service

Focus Three

- Responsible Supply Chain

Focus Four

- Green Manufacturing

Focus Five

- Inclusive Workplace

Focus Six

- Common Good

Appendix
Production ramp-up of industry leading 7nm technology, the 4th generation of technology to make use of 3D FinFET transistors.

Target: 7nm process technology in risk production

>5,000
More than 5,000 patent applications were filed worldwide

Target: File more than 4,500 patent applications worldwide

>8,000
Over 8,000 trade secrets registered

2017 new item

File more than 5,100 patent applications worldwide

Over 8,800 trade secrets registered
“Being everyone’s foundry” is the core of TSMC’s strategy. Through the expansion of our technology and services, we built an open platform that welcomes all innovators in the semiconductor industry to realize their innovations and to quickly introduce their products to market in volume.

Morris Chang
Chairman

**Innovative Management Framework**

In an innovative business model, Dr. Morris Chang founded the world’s first dedicated IC foundry, which significantly reduces the barriers to entry into the semiconductor industry and contributes to the growth and prosperity of the global fabless IC design industry. Since its establishment, TSMC has actively built a culture of innovation and a work environment that is finely tuned to the ever-changing characteristics of the semiconductor industry.

In addition to continuing to develop leading-edge technologies to maintain TSMC’s technology leadership in the semiconductor industry in 2017, TSMC also developed an internal reward mechanism, encouraging employees to practice in their work a wide range of innovation to continuously strengthen the organization’s vitality. Meanwhile, TSMC also assists customers, industry and academics in cross-domain exploration, including product innovations in collaboration with customers, academics, and “green” suppliers.


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**Open Innovation Platform**

Cooperation with World-class R&D institute

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TSMC University Collaboration Programs

- TSMC University Research Centers Program
- TSMC University Shuttle Program

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**Innovative Values**

- Encouraging Innovation
- Innovation Initiative
- Innovation Collaboration

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**Technology Leadership**

- Green Product
- Intellectual Property Protection
- Intelligent Precision Manufacturing
- Green Innovation Cases
  - Develop Intelligent Chilled Water System
  - New Water Conservation Measures for Production Tools
  - Project Big Green
  - Refinement and Enrichment of Ammonium Sulfate Dewatering Technology
  - Application of Hydro-membrane

---

**Note**: TSMC is a core partner of IMEC (Interuniversity Microelectronics Center), Europe’s leading semiconductor technology research and development center, and continues to sponsor the world’s top universities in nanotechnology research to drive invention and the advancement of nanoelectronics.
In 2017, TSMC continued to invest in research and development, with total R&D expenditures amounting to US$2,651 million, up about 19% from the previous year, accounting for 8% of total revenue. R&D headcount increased to 6,145, up about 13%, a level that equals or exceeds the R&D investment of many other leading high-tech companies.

TSMC recognizes that the technology challenge of continuing to extend Moore’s Law is becoming increasingly complex and difficult. The efforts of the R&D organization are focused on enabling the Company to continuously offer customers first-to-market, leading-edge technologies and design solutions that contribute to their product success in today’s competitive market environment. In 2017, TSMC completed the transfer to manufacturing of the industry leading 7nm technology, the 4th generation of technology to make use of 3D FinFET transistors, and continued to fuel the pipeline of technological innovation needed to maintain industry leadership. TSMC’s 7nm technology is on track to ramp up volume production in 2018. TSMC 5nm technology is in full development stage, and the definition and intensive early development efforts have been progressing for nodes beyond 5nm.

In addition to CMOS logic, TSMC conducts R&D on a wide range of other semiconductor technologies that provide the functionality customers require for mobile SoC and other applications.

Technology Leadership

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In addition to CMOS logic, TSMC conducts R&D on a wide range of other semiconductor technologies that provide the functionality customers require for mobile SoC and other applications.

Note: Moore’s law is the observation that the number of transistors in a dense integrated circuit doubles approximately every two years.

Specialty Technology / Integrated Interconnect & Packaging

- Advanced Fan-Out Packaging
  - The world’s leading volume production of Gen-2 Integrated Fan-Out Package on Package (InFO-PoP) for mobile application processor packaging
  - Successful qualification of Gen-3 InFO-PoP advanced packaging technology for mobile applications
  - Started risk production of Integrated Fan-Out on Substrate (InFO-oS) for die-partition and HPC applications

- Power IC/BCD Technology
  - Launched 0.18µm third generation BCD (Bipolar-CMOS-DMOS) technology resulting in the leading performance quick-charger and wireless charger

- Embedded Flash Technology
  - Successful production launch of eFlash 40nm node, NOR-based cell technologies and Split-Gate cell for consumer electronics applications such as IoT, smartcards and microcontroller units

- GaN Technology
  - Successful development and manufacturing qualification of 650V, 100V E-HEMT, and RF 30V D-MISFET GaN devices

- Panel Drivers
  - Completed 40nm high-voltage phase-2 technology readiness for both LCD (Liquid-Crystal Display) and OLED (Organic Light-Emitting Diode) drivers
Leading Technology and Innovations in IC Foundry Service

- Offered a first-to-market 28nm high-K/metal gate (HKMG) foundry technology portfolio.
- Completed the transfer to manufacturing of the industry-leading 7nm technology, the 4th generation of technology to make use of 3D FinFET transistors.
- Completed the transfer to manufacturing of industry-leading 10nm technology, the 3rd generation of technology platform to make use of 3D FinFET transistors.
- Offered TSMC’s customers with the first-to-market CyberShuttle® for both 45nm and 40nm technologies.
- Provided TSMC’s customers with the first-to-market CyberShuttle® for both 45nm and 40nm technologies.
- Successfully qualified InFO PoP (Integrated Fan-Out Package on Package) advanced packaging for mobile application processor packaging.
- The 3rd generation of 0.18μm BCD technology adopted TSMC proprietary device structure which boosts world leading performance higher.
- The third generation of 0.18μm BCD technology introduced for TSMC’s customers.
- Production ramp of the CoWoS® (Chip on Wafer on Substrate) 3D packaging technology.
- The first industry introduction of the BCD (Bipolar-CMOS-DMOS) power technology into a 12-inch fab environment.
- Manufacturing readiness of TSMC’s first wide bandgap Gallium Nitride (GaN) semiconductor technology for high frequency power applications.

Green Products

In each new technology generation for IC manufacturing, circuitry line widths shrink, making an IC chip smaller and reducing product power consumption.

More Advanced and More Energy-efficient Electronic Products

TSMC is consistently first among dedicated foundries to provide next-generation, leading-edge technologies. The Company also provides comprehensive specialty technologies and excellent frontend and backend integration capabilities. These help customers produce more advanced, energy-saving and environmentally friendly products to minimize the environmental impact of technology progress. Through TSMC's manufacturing technologies, customers' designs are realized and their products are used in a wide range of applications covering various segments of the computer, communications, consumer, industrial and other electronics markets. These chips make significant contributions to the progress of modern society.

<table>
<thead>
<tr>
<th>Chip Die Size Cross-Technology Comparison</th>
<th>Chip Total Power Consumption Cross-Technology Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>55nm</td>
<td>45nm</td>
</tr>
<tr>
<td>1</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Data source: TSMC

Unleash customers' mobile and wireless chip innovations that enhance mobility and convenience

Unleash customers' CIS and MEMS innovations that enhance human health and safety
Social Contribution Examples by TSMC Foundry Services

Unleash Customers’ Mobile and Wireless Chip Innovations that Enhance Mobility and Convenience

The rapid growth of smartphones and tablets in recent years reflects strong demand for mobile devices, which, in turn, offer remarkable convenience. TSMC contributes significant value to these devices, including: (1) new TSMC process technology helps chips achieve faster computing speeds in a smaller die area, leading to smaller form factors for these electronic devices. In addition, TSMC SoC technology integrates more functions into one chip, reducing the total number of chips in electronic devices, again resulting in a smaller system form factor; (2) new TSMC process technology also helps chips consume less energy. People can therefore use mobile devices for a longer period of time; and (3) TSMC helps spread the growth of more convenient wireless connectivity such as 3G/4G and WLAN/Bluetooth, meaning people can communicate more efficiently and “work anytime and anywhere,” significantly improving the mobility of modern society.

New process technologies reduce chip power consumption, enabling longer battery life for mobile devices

Integrate more functions into one chip, reducing the total number of chips in electronic devices, and resulting in a smaller system form factor

Achieve faster computing speeds in a smaller die area, leading to smaller form factors for electronic devices

Unleash Customers’ CIS (CMOS image sensor) and MEMS (micro electro mechanical systems) Innovations that Enhance Human Health and Safety

TSMC continues to enhance or develop innovative CIS and MEMS technologies, which are expanding from traditional sensing to machine sensing, such as NIR (near infrared), ultrasound, and micro-actuators. These new technologies can serve more product applications, from smartphones and consumer electronics to automotive and health services. By combining advantages of traditional sensing and machine sensing, new products using TSMC CIS and MEMS technologies can be made smaller and faster, while consuming less power, and greatly enhancing human convenience, health, and safety. For example, TSMC customers’ CIS and MEMS products are used in a number of advanced medical treatments as well as in preventative health care applications. Examples include early warning systems to minimize the injury from falls for the elderly, systems to detect physiological changes, car safety systems and other applications that greatly enhance human health and safety.

Our Business

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Appendix
30,000
Accumulated over 30,000 patent grants worldwide as of the end of 2017; ranked in the top 10 of U.S. patent assignees for the 2nd consecutive year

The highest allowance rate among the U.S. patent assignees in 2017

### Intellectual Property Protection

A strong portfolio of intellectual property rights effectively strengthens TSMC’s technology leadership. TSMC has established a strategic model to create value by leveraging intellectual property rights. This model not only protects TSMC’s freedom to operate worldwide, but also enhances TSMC’s competitiveness to increase business profits.

### Patent Protection

TSMC actively develops its patent holdings and strategically sets patent-filing goals in close alignment with the Company’s R&D resource allocations and investment plans to construct an ever-expanding global patent portfolio. Primary measures to achieve these goals include: patent filing within patent battlefields worldwide, in-depth invention mining for comprehensive protection, application monitoring throughout prosecution, patent quality enhancement, regular patent landscape monitoring, and patent strength and stockpile analyses. In terms of patent quantity, TSMC has accumulated over 30,000 patent grants worldwide as of the end of 2017. TSMC obtained an ever-increasing number of U.S. patents in 2017 and was ranked in the top 10 of U.S. patent assignees for the 2nd consecutive year. In addition, TSMC was ranked No. 1 in 2017 with respect to the number of patent filings in Taiwan. In terms of patent quality, the allowance rate of TSMC’s U.S. patent applications was the highest among the top 10 U.S. patent assignees in 2017. These achievements not only strengthen TSMC’s technological leadership, but have also established a solid reputation for its intellectual property while protecting the Company’s ability to conduct business worldwide.

### TSMC Worldwide Patent Rankings

<table>
<thead>
<tr>
<th>Year</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
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<td>2013</td>
<td>35</td>
</tr>
<tr>
<td>2014</td>
<td>23</td>
</tr>
<tr>
<td>2015</td>
<td>13</td>
</tr>
<tr>
<td>2016/2017</td>
<td>9</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
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</tr>
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<td>2014</td>
<td>13</td>
</tr>
<tr>
<td>2015</td>
<td>5</td>
</tr>
<tr>
<td>2016</td>
<td>3</td>
</tr>
<tr>
<td>2017</td>
<td>2</td>
</tr>
</tbody>
</table>

Note 1: 2017 Top 50 U.S. Patent Assignees (IFI CLAIMS)
Note 2: Top 100 patent assignees among domestic companies (TIPO)

### Achievements and Honors

#### 1st Annual National Industry Innovation Award
- 2011

#### 2nd Annual National Industry Innovation Award
- 2012

#### 3rd Annual National Industry Innovation Award
- 2013

#### 4th Annual National Industry Innovation Award
- 2014

#### Asia Top 5 Semiconductor Material Innovation Company
- 2015

#### 1st IEEE Spectrum Patent Pipeline Power for Semiconductor sector
- 2016

#### No. 1 Patent Filer in Taiwan Among Domestic Companies
- 2017

#### Top 10 Global Innovator
- 5th Annual National Industry Innovation Award
- Top 10 U.S. Patent Assignee (2nd Time)
- No. 1 Patent Filer in Taiwan Among Domestic Companies (2nd Year)
Trade Secret Protection

Trade secrets are TSMC’s most important intellectual property, and include the company’s process recipes, process flow, machine parameters, product yield, plant design, customer information, and financial information. Because trade secrets have an inseparable relationship with TSMC’s competitiveness, TSMC initiated its trade secret registration and management system in 2013 to comprehensively and effectively strengthen the company’s operations and intellectual property innovation. This system is intended to record and integrate applications for trade secrets that contribute to the company’s technology leadership, manufacturing excellence, and customer trust.

The trade secret registration and management system is located in an ‘ultra high security’ area, with control by a dedicated organization to ensure secrecy. To enhance the operational effectiveness of the company, TSMC has integrated this system with other Company systems to perform joint applications and has also estimated the economic value of the registered trade secrets.

The Golden Trade Secret Awards, given to inventors of trade secrets that contribute most to the Company’s competitiveness, are granted each year to increase the quality and quantity of trade secrets and to encourage contributions. As of 2017, 795 Golden Trade Secrets have been granted to more than 2,900 inventors. The number of trade secret registered has increased year by year. As for 2017, over 8,000 trade secrets were registered, which was the highest amount since the registration program began. The trade secrets included not only those related to process development and production improvement, but also use of artificial intelligence to optimize manufacturing performance and yield.
Intelligent Precision Manufacturing

TSMC is dedicated to manufacturing excellence, and has been developing its innovative and intelligent Precision Manufacturing system for many years. TSMC pioneered the foundry industry in equipment automation, transportation automation and dispatch automation. Experts' knowledge is integrated in the Precision Manufacturing system to reduce potential errors from human judgments and improve productivity. Machine Learning and Deep Learning are thoroughly studied and these algorithm-based artificial intelligence analysis techniques are applied in the system to achieve a manufacturing environment of self-diagnosis and self-feedback.

Machine Learning is the essence for intelligent manufacturing development. To speed up machine learning applications and sharpen our competitiveness, TSMC has a plan to train 300 machine learning experts starting from 2017 and build up its own machine learning development platform with high performance computing power, comprehensive wafer process big data and an open source machine learning software library to support fast function development. There have been numerous machine learning applications developed by TSMC, including smart scheduling and precise dispatching, people productivity improvement, equipment utilization optimization, process and tool control and quality defense, all to effectively improve production efficiency with the best product yield and performance guaranteed.
Open Innovation Platform®

TSMC’s Open Innovation Platform® (OIP) is a resource integrated platform that drives innovation. It encompasses the semiconductor design community, TSMC’s ecosystem partners, TSMC’s Intellectual Property (IP), design implementation, Design For Manufacturability (DFM) capabilities, process technology and backend packaging & testing services. OIP’s comprehensive design infrastructure promotes our customer’s speedy design implementation and improves first-time silicon success. Through 2017, TSMC developed more than 1,000 technology files and 200 methodology innovations for its latest advanced technologies of 7nm, 12nm and 3D IC design enablement platforms within two years. EDA tools, features, and IP solutions are readily available for customers to adopt to meet their product requirements at various design stages.

TSMC held Open Innovation Platform® (OIP) Ecosystem Forum in September 2017 in California, USA. Dr. Cliff Hou, TSMC Vice President of Design and Technology Platform, highlighted that to help our customer products’ time-to-market, TSMC has expanded design ecosystem solutions to address market demands with four application specific design platforms consisting of Mobile, High Performance Computing (HPC), Internet of Things (IoT) and Automotive. In addition, TSMC continues to enhance 3D IC solutions to integrate High Bandwidth Memory (HBM) on Integrated Fan-Out (InFO) design flows to meet customer’s system integration and high memory bandwidth requirements. Furthermore, machine learning is being leveraged to enhance customer design Power, Performance, Area (PPA) and productivity.

Throughout the integration of various R&D resources, TSMC’s OIP partners can be more focused on developing more innovations by leveraging the comprehensive ecosystem. Even smaller customers can leverage OIP to overcome obstacles they are facing, and accelerate their product roadmap.

For more details, please refer to our website: "TSMC Assists Customers to Improve First-time Silicon Success"
**TSMC University Collaboration Programs**

**University Research Center**
TSMC is committed to talent development in the semiconductor industry. Starting from 2013, four research centers have been established at National Chiao Tung University, National Taiwan University, National Cheng Kung University, and National Tsing Hua University, with 1,840 students participating. Through industry-academia cooperative projects, high-caliber talents are nurtured for semiconductor industry development, and professors are encouraged to initiate new research programs. As of 2017, over 100 patents have passed TSMC internal verification process, and filed for U.S. patent application. In 2017, TSMC invested over NT$100 million in industry-academia research, supporting the work of 1,181 students on semiconductor-related research projects across Electronic, Physics, Materials Engineering, Chemistry, Chemical Engineering, and Mechanical Engineering fields.

Furthermore, TSMC partners with world’s top universities including Stanford, Massachusetts Institute of Technology, and the University of California at Berkeley among others to conduct strategic research programs that aim to develop innovative transistors, wire technology, mask technology, simulation and special process technology research.

**University Shuttle Program**
TSMC University Shuttle Program is one of the most important design platforms in the world to provide professors and students at leading research universities worldwide with access to advanced silicon process technologies to implement innovative circuit designs. With the University Shuttle Program, TSMC links motivated professors and graduate students in 23 universities worldwide with enthusiastic managers at TSMC. The University Shuttle Program provides the chance for graduate students to implement exciting designs and achieve silicon proof points for innovations in various end-applications and nurturing new generations of engineering talent in the semiconductor field. In 2017, there were 39 publications about “Big Data,” “high speed file transfer technology,” “SRAM Technology,” “Wireless,” “Bio” and “Power saving” in International Journals (e.g. ISSCC, ASSCC, JSSC, ISCAS, IEEE VLSI) and International conferences (VLSI Circuits Dig Tech) to expand knowledge of design and innovation on circuit design.
Material Issue

Sustainable Products

Product Life Cycle Thinking
Based on comprehensive thinking on product life cycle, we evaluate environmental impacts in each stage to raise product environmental and social friendliness, and improve energy conservation effects for the use and application of semiconductor products.

Product Hazardous Substance Management
Continue to promote hazardous substance replacement projects.

Strategies

TSMC 2020/2025 Goals

- Complete establishment of methodology for energy saving contribution assessment for semiconductor products application 2020
- 100% compliance for product hazardous substance free legal and customer requirements 2020
### 2017 Achievements

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete process used NMP (N-Methylpyrrolidone) phase-down project</td>
<td>✓ Surpassed</td>
</tr>
<tr>
<td>100% Compliance for product hazardous substance free legal and customer requirements</td>
<td>✓ Achieved</td>
</tr>
<tr>
<td>Verification of PFOA related substances replacement</td>
<td>✓ Achieved</td>
</tr>
</tbody>
</table>

### 2018 Targets

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Surpassed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete establishment and renew of product life cycle assessment of all fabs</td>
<td>✓ Surpassed</td>
</tr>
<tr>
<td>100% compliance for product hazardous substance free legal and customer requirements</td>
<td>✓ Surpassed</td>
</tr>
<tr>
<td>100% completion of verification of replacement for all chemicals containing perfluorooctanoic acid (PFOA) related substances</td>
<td>✔ Achieved</td>
</tr>
<tr>
<td>Complete process used NMP (N-Methylpyrrolidone) phase-down project</td>
<td>✔ Achieved</td>
</tr>
</tbody>
</table>

**Note:**
- The number of runs for process validation requested by special customers was more than the number required by standard practice.
TSMC has the broadest range of technologies and services in the dedicated IC foundry segment of the semiconductor manufacturing industry. We also take into consideration of reducing product environmental and social impacts and energy consumption, and carefully evaluate low hazardous raw materials selection to provide customers with sustainable products that combine innovation and environmental protection.

**Product Life Cycle Thinking**

TSMC considers, clarifies and compares environmental impacts of each stage based on product life cycle, including product design, raw material mining, production and transportation, product manufacturing and transportation, usage, and waste disposal. Therefore, we require good hazardous substance management, pollution prevention, energy saving, water saving, waste reduction and other clean production measures in our own factories. We also require and assist suppliers to do so, and even ask suppliers to have their suppliers do so and establish a semiconductor green supply chain together. These efforts can help customers produce sustainable products with low carbon footprint, low hazard, and use sustainable products with no conflict minerals and no human rights disputes.

In 2017, TSMC completed the revision of its Life Cycle Assessment (LCA) procedure, which stipulated that new fabs should complete the product life cycle, carbon footprint and water footprint inventory and verification within 18 months after the actual production capacity reached 80% of their design capacity. Existing fabs need to be updated at least once every five years in order to truly grasp the environmental impacts of each fab's product life cycle, and to promote relevant continuous improvement programs.

TSMC continues to encourage and assist suppliers to set up greenhouse gas (GHG) and water inventory procedures. We have collaborated with raw material suppliers and integrated circuit assembly vendors to complete 12-inch wafer and packaged integrated circuit product carbon footprints, which passed third party certification based on the ISO14067 product carbon footprint standard and the ISO14046 product water footprint standard. We not only can provide related information to customers but also continue to promote carbon reduction and water saving in the supply chain and TSMC from a life cycle point of view.

**TSMC Product Life Cycle Environmental / Social Impacts Consideration**

- **Environmental Impact Consideration**
  - Greenhouse gas reduction
  - Energy saving, water saving
  - Waste reduction
  - Pollution prevention

- **Social Impact Consideration**
  - Hazardous substance management
  - Responsible business alliance and its code of conduct
  - Product hazardous substance free
  - Product carbon footprint
  - Product life cycle assessment
  - Energy saving of products
  - Product application enables energy saving
  - Pollution control
  - Waste disposal properly
  - Mobile calculation and wireless communication bring convenience to life
  - Micro-electro mechanical system chip innovations improve human health and safety
  - Occupational safety and health
  - Responsible business alliance and its code of conduct
According to TSMC wafer product carbon footprint and water footprint inventory results, the wafer manufacturing stage and raw material mining, production and transportation account for about 70% and 30%, respectively. TSMC continues to improve carbon reduction, water saving and waste reduction. TSMC also asks aggressively for green actions from suppliers although their carbon and water footprint are relatively low.

For more TSMC sustainable supply chain measures, please refer to “Supplier Sustainability Management” in this report.

Product Hazardous Substance Management

TSMC’s principles to highly hazardous materials are (1) avoid use if possible (2) use less if possible. By practicing QC 080000 to establish its internal hazardous substance management system, TSMC prevents using hazardous substances contained raw materials in process and ensures that finished wafer and assembly products comply with international regulations and customer requirements. In the raw material procurement stage, TSMC’s Quality & Reliability Organization collaborates with procurement organization and corporate environment, safety and health organization to develop green procurement procedure, and strictly controls supplier engineering changes, includes green manufacturing as one of the important items of our supplier audit, and extends TSMC’s green products quality requirements to raw material suppliers so as to prevent using harmful substances in TSMC from sources. At the product production stage, hazardous substance management system quarterly management review:

- Goal achievement status
- Corrective and preventive actions for nonconformance
- Changes of legal and customer requirements and compliance status
- Opportunities of continuous improvement

Hazardous substance management system internal audit:

- Identification of legal and customer requirements
- Establishment of TSMC green procurement procedure, hazardous substance list
- Establishment of TSMC hazardous substance management objectives and projects
- Identification of process hazardous substance and establishment of control plans

Incoming material hazardous substance compliance certificate:

- Adoption of low hazard raw materials in R&D stage
- Green procurement requirement for new materials and new suppliers
- Employee training for hazardous substance management
- Implementation of hazardous substance replacement project

Third party test for product hazardous substance:

- Hazardous substance management system supplier audit

TSMC Product Hazardous Substance Management Process
besides carefully reviewing the engineering change to avoid misusing hazardous substances contained raw materials, TSMC’s Quality and Reliability organization has worked closely with operation organization and corporate environment, safety and health organization to implement process improvement to phase out raw materials that might be listed as banned or restricted hazardous substances in the future year by year to ensure TSMC’s green manufacturing capability.

In recent years, as Perfluorooctanesulfonic Acid (PFOS) and perfluorooctanoic acid (PFOA) and its related substances may harm human body and the environment, the international legislation has gradually led to regulation. TSMC led the global semiconductor industry and has completely stopped using raw materials containing PFOS and PFOA in year 2010 and 2015 respectively, and all products do not contain these substances. Although PFOA related substances include its precursors and derivatives have not yet been restricted to be used in semiconductor manufacturing processes in the world, TSMC has initiated chemical replacement projects in 2016. As of 2017, we have completed 82% of the verification process for alternative substances. It is expected to be 100% completed in 2018.

In addition, in order to respond to the requirements of Article 14-1 of the Water Pollution Control Act of Taiwan, factories must reduce the hazardous substances discharged into the wastewater to reduce the environmental and health risks. TSMC has conducted N-Methylpyrrolidinone (NMP) - hazardous substance used in process reduction program since 2016 to prevent it from being discharged into the wastewater. This project was conducted on schedule in 2017 and is expected to be completed in 2018.

Product Hazardous Substance Management is Compliant with or Surpasses International Regulations

<table>
<thead>
<tr>
<th>International Regulations / Customer Requirements</th>
<th>Description of Legal Compliance</th>
</tr>
</thead>
</table>
| European Union Restriction of Hazardous Substance (EU RoHS) | • TSMC provides lead free bumps to customers. A few customers still need trace lead contained bump which is exempted by EU RoHS  
• Other EU RoHS restricted substances are not used in TSMC process |
| Product Halogen Free Requirements | • All TSMC products are compliant |
| Perfluorooctanesulfonic Acid (PFOS), Perfluorooctanoic Acid (PFOA) Restriction in Process | • TSMC has totally phased out using PFOS and PFOA, and all products also do not contain these two substances |
| EU Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) (REACH) Annex XVII | • All TSMC products are compliant |
| EU REACH Substances of Very High Concern (SVHC) | • All TSMC products are compliant |
| EU Waste Electrical and Electronic Equipment (WEEE) Directive | • TSMC’s products are not final products and this law is not directly applicable |

Gating Hazardous Substance from the Sources – TSMC Green Procurement for Hazardous Substances

<table>
<thead>
<tr>
<th>Prohibited or Restricted Substances</th>
<th>Controlled Substances</th>
<th>Reportable Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 categories of prohibited or restricted substances including legal, customer requirements and TSMC voluntary.</td>
<td>Carcinogenic, mutagenic or toxic for reproduction (CMR) substances.</td>
<td>Required to report by regulations</td>
</tr>
<tr>
<td>• Prohibit or restrict containing in process raw materials or products</td>
<td>• “Not use” as the principle, but to be used following environmental, safety and health requirements and approval of R&amp;D, Operation Vice Presidents and Corporate ESH unit if no available alternatives.</td>
<td>• Use after confirming related information</td>
</tr>
</tbody>
</table>
Case Study

Assist Customers in Producing Sustainable Products that Consume Less Energy and Enable Global Energy Conservation

With the continuously vigorous development of global information and communications technology (ICT) industry, and in various ICT products including computers and communication equipment, integrated circuit (IC) plays a key role. TSMC is not only the world’s largest dedicated semiconductor foundry and also an important component of ICT industry. To understand better efficiency of energy consumption and the enablement of potential energy saving to other industries and livelihood by using advanced ICT products, TSMC collaborated with IEK and the U.S. Massachusetts Institute of Technology (MIT) to conduct a research on the contribution of the application of ICT products to Taiwan overall energy conservation. From the result, it can be inferred that when R&D in the ICT industry increased by 1.0%, energy consumption decreased by approximately 0.27~0.31%, whereas TSMC’s R&D expenditure was 21.8% of the entire ICT industry in Taiwan. In addition, smart applications of ICT products in various fields have an effect of saving 2%-7% energy.

For more details, please refer to TSMC CSR website: "TSMC Assists Customers Manufacturing Lower Energy Consumption Products and Enabling Global Energy Saving Sustainable Solutions."

Tasks of 2018

Complete establishment or renew of product life cycle assessments, carbon footprints and water footprints in all fabs, and continue to promote product life cycle environmental impacts reduction projects.

Complete all PFDA related substances alternative chemical verification and replacement gradually.

Continue to collaborate with ITRI Industrial Economics and Knowledge Center and MIT to further study the energy conservation contribution of global information and communications technology and semiconductor products to other industries and smart households.
**Product Quality**

**Quality Culture Enhancement**
- Enhance internal quality culture by promoting continual improvement programs
- Enhance local supply chain’s quality culture and competitiveness by promoting their participation in National Quality Control Circle competition

**Quality Capability Enhancement**
- Increase visual inspector’s productivity for 12-inch wafers to 5,670 pieces in 2020
- Establish 100% (813) materials’ analysis capability for carcinogenic, mutagenic, or toxic for reproduction (CMR) substances in 2020
- Increase employees’ productivity by establishing 12-inch wafer outgoing visual inspection defect automatic classification system with machine learning methodology
- Ensure employees’ health and safety by establishing chemical lab’s capability for hazardous substance analysis

**Quality Application Realization**
Complete reliability qualification for leading technologies and specialty technologies at design and development stage according to the technology roadmap

Create NT$10 billion benefit from continual improvement programs annually in 2020

90% local suppliers participate in the National Quality Control Circle competition (original goal 80% is planned to be achieved in 2018) in 2020

Complete reliability qualification for 5nm technology and characterize the process window in 2020
2017 Achievements

42,056 Suggestions were issued from basic level
Target: Issue 38,000 suggestions

2,020 Continual improvement cases were completed
Target: Complete 1,850 continual improvement cases

10.1 billion Benefit created from suggestions and continual improvement cases
Target: Create NT$10 billion benefit

4,747 Increased visual inspector’s monthly productivity for 12-inch wafers to 4,747 pieces
Target: 4,500 pieces 12-inch wafer

23% (183 materials’ analysis capability)
Established 23% (183) materials’ analysis capability for carcinogenic, mutagenic, or toxic for reproduction (CMR) substances
Target: Established 18% (146) materials’ analysis capability

10.1  Completed the second generation Integrated Fan-Out (InFO) assembly technology and reliability qualification for application processor with integrated passive device.

Completed the Chip on Wafer on Substrate (CoWoS) assembly technology and reliability qualification for advanced silicon technology chip with High Bandwidth Memory.

Completed the Diffractive Optical Element (DOE) process development and reliability qualification to support mobile phone with 3D sensing and facial recognition application.

Completed reliability qualification for leading technology and specialty technologies according to R&D’s goal.

2018 Targets

Target: Issue 41,228 suggestions from basic level

Complete 1,957 continual improvement cases

Create NT$10 billion benefit from suggestions and continual improvement cases

80% of local suppliers participate in the National Quality Control Circle competition

Increase visual inspector’s monthly productivity for 12-inch wafers to 4,860 pieces

Establish 49% (396) materials’ analysis capability for carcinogenic, mutagenic, or toxic for reproduction (CMR) substances

Target: Create NT$10 billion benefit

74% Of local suppliers participated in the National Quality Control Circle competition
Target: 60% of local suppliers

Completed reliability qualification for 7nm technology and characterized the process window.

Target: Complete reliability qualification for 7nm technology and specialty technologies
Quality is the critical factor for TSMC’s sustainable development. To continuously provide excellent product quality while providing a green, healthy, safe and enjoyable working environment, and also establish a customer-oriented approach to quality – these are what the Quality and Reliability Organization have always insisted upon.

The sciences and technologies change with each passing day. In addition to traditional 3C (Computer, Communication, Consumer) products, with the increasing popularity of new electronic products – Mobile Device, Internet of Things (IoT), Smart Car, Virtual Reality (VR) and Artificial Intelligence (AI) – our safety and convenience are closely linked with the quality and reliability of electronic products. Semiconductors are the soul of electronic products, and TSMC is the world’s largest integrated circuit technology and services provider. We lead in technology development, achieving our commitment to our customers to provide them with the quality and reliability they count on, along with low power and high performance.

To ensure sustainable development with excellent product quality, the Quality and Reliability organization promotes continual improvement activities for TSMC’s quality culture enhancement and deploys them to supply chains for management consideration, introduces new methods for quality capabilities enhancement, and collaborates with other organizations to have strict reliability qualifications for ensuring each product application.

**Quality Culture Enhancement**

In TSMC, quality is the basis for all work and services. All employees are dedicated to increasing quality in all aspects of our business. The benefits are not only product quality improvement but customer satisfaction enhancement.

To enhance corporate quality culture with continual improvements on product quality, production efficiency, cost reduction and customer satisfaction, TSMC fully promoted the “Suggestion” in basic levels and the activities of “Continual Improvement Team (CIT)”. TSMC also held a corporate-level “Total Quality Excellence and Innovation Conference.” With the public rewards and praises, we expect to provide a cross-department communication and study platform with continual improvement cases sharing. It aims to enhance employees’ problem solving and innovation capabilities for achieving the win-win goal of TSMC’s competitiveness and customer satisfaction. In 2017, there were 42,056 suggestions issued by the basic levels and a total of 2020 continual improvement team activities were registered and implemented. The benefits from these improvement cases were NT$10.1 billion. Among them, 45% (915 cases) of continual improvement team activities were related to product quality enhancement.

**Continual Improvement Team (CIT) Program**

<table>
<thead>
<tr>
<th>Unit: case</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIT Cases (Actual)</td>
<td>1,702</td>
<td>1,906</td>
<td>1,846</td>
<td>1,996</td>
<td>2,020</td>
</tr>
<tr>
<td>CIT Cases (Goal)</td>
<td>1,252</td>
<td>1,596</td>
<td>1,617</td>
<td>1,844</td>
<td>1,850</td>
</tr>
</tbody>
</table>

**Suggestion Program**

<table>
<thead>
<tr>
<th>Unit: thousand cases</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suggestion Cases (Actual)</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>Suggestion Cases (Goal)</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>38</td>
</tr>
</tbody>
</table>

**Benefit from Suggestion Program and CIT**

<table>
<thead>
<tr>
<th>Unit: NT$ billion</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>16</td>
<td>15</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Goal</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Note 1: Suggestion – Employee identifies ways to improve routine jobs and initiates action with the manager. The scope of suggestion includes Quality, Cost, Transportation, Production Process, Service, Safety, Facility and Equipment.

Note 2: Continual Improvement Team (CIT) – A cross-functional task force formed with three to 10 members solves the same work-related problems. The improvement targets are related to Quality, Cost, Delivery, Service, Productivity, Process Technology, and Safety.
In addition to internal cross-department communication and study, TSMC also participates in the ‘National Quality Control Circle’ competition to share and learn continual improvement methods in cross-industry communication and study setting. Other local industries can adopt improvements learned from TSMC’s sharing, and TSMC employees can also enhance capabilities of problem solving and innovation with the learning from others’ sharing. In 2017, TSMC secured six gold and two silver medals in the National Quality Control Circle competition and Fab 6 was the team with the most gold medals since the inception of these awards. With their perfect mechanisms for continual improvement, TSMC also won first prize for ‘Excellent Promotion for Continual Improvement Activities in Taiwan’ over the past 30 years.

### Examples in 2017 Total Quality Excellence and Innovation Conference

<table>
<thead>
<tr>
<th>Group</th>
<th>Cases</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Enhancement</td>
<td>To improve the methods in Lithography processes</td>
<td>99.7% Enhanced product yield to 99.7%</td>
</tr>
<tr>
<td></td>
<td>To improve the methods in Integrated Fan-Out (InFO) clean process</td>
<td>88% Improved test reject rate 88%</td>
</tr>
<tr>
<td></td>
<td>To improve the methods in Furnace process</td>
<td>75% Reduced specific product defect rate 75%</td>
</tr>
<tr>
<td></td>
<td>To improve the methods in 3D image sensor Etching process</td>
<td>50% Enhanced image resolution 50%</td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>To develop 40nm Ultra Low Power technology</td>
<td>80% Improved customer product standby power performance 80%</td>
</tr>
<tr>
<td></td>
<td>To establish innovative design service platform for stacked CMOS image sensors</td>
<td>70% Shortened customer product development schedule for image analysis and test 70%</td>
</tr>
<tr>
<td>Environment, Safety, Health</td>
<td>To reduce 8-inch Fab carbon emissions and save energy</td>
<td>63,500 metric tons 60,290,000 kWh Reduced CO2 emission 63,500 metric tons and saved the use of electricity 60,290,000 kWh annually</td>
</tr>
</tbody>
</table>

Note 1: In Taiwan, the National Quality Control Circle competition is held by Corporate Synergy Development (CSD) Center which is commissioned by the Industrial Development Bureau of the Ministry of Economics. The purpose of the National Quality Control Circle competition is to promote the continual improvement team activity to public and private organizations for their enhancement. With the competition, organizations among different industries have a communication and study platform to learn improvement methods from others and enhance their international competitiveness.

To strive for a win-win between TSMC and local suppliers, the Quality and Reliability organization not only enhances TSMC's corporate quality culture, but also coaches local suppliers to participate in the National Quality Control Circle competition for suppliers' quality culture and capability enhancement by applying the practices of continual improvement. In 2017, local suppliers' participation rate in National Quality Control Circle competition was 74% and suppliers secured two Silver Medals and seven Bronze Medals.

**Quality Capability Enhancement**

The failure analysis capability plays an important role to support advanced and specialty technology development, reliability qualification and mass production timing. To help customers meet their time-to-market requirements, the Quality and Reliability organization collaborates with academicians, suppliers and customers to develop failure analysis techniques, enrich advanced material and chemical analysis capabilities and enhance fault isolation methods.

TSMC continually enhances its manufacturing capabilities. To reduce product defects, enhance process controls, detect abnormalities early and prevent quality events affecting customers, the Quality and Reliability organization and Operation organization collaborate to establish real-time defense systems by applying advanced statistical methods and quality tools. In 2017, the deep machine learning methodology had successfully been applied for advanced spectral analysis to detect differences among processes and equipment, and triggered improvement actions. With machine learning methodology, an automatic defect classification system for 12-inch wafers outgoing visual inspection was also established to enhance the consistency of visual inspection and enrich a visual inspector's monthly productivity to 4,747 pieces.

### Suppliers' National QCC Participation Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>74%</td>
<td></td>
</tr>
</tbody>
</table>

### 12-inch Wafer Outgoing Visual Inspector Productivity

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>3,500</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>4,076</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>4,247</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>4,441</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>4,500</td>
<td></td>
</tr>
</tbody>
</table>

#### Highlights in 2017

- Enhanced 35% resolution of fault isolation equipment
- Completed fault isolation capability buildup for 7nm, extendable to support 5nm
- Established scanning and transmission electron microscopy laboratory in Nanjing site and executed failure analysis since Nov. 2017
- Enhanced trace metal impurity analysis capabilities to Part Per Trillion (PPT) level for 10 chemicals
- Established organic impurity analysis capabilities for 10 chemicals
- Coached suppliers to enhance their analysis capabilities for trace metal impurity in chemicals to Part Per Trillion (PPT) level
- Coached suppliers to establish organic impurity analysis capabilities for chemicals
On the other hand, to prevent carcinogenic, mutagenic and reprotoxic (CMR) substances in materials affecting employees’ health and safety, Quality and Reliability organization enhanced the chemical laboratory’s ability to detect and analyze hazardous substances. With risk assessment, the Quality and Reliability organization collaborated with the Environmental Safety and Health organization to establish a sampling plan for analyzing suspicious materials used in TSMC. For new material control, suppliers were also required to declare their compliance and a sampling inspection was executed by TSMC to validate suppliers’ declarations. In 2017, the Quality and Reliability organization established 23% (183) suspicious materials’ analysis capability for CMR substances.

In addition to meeting customers’ requirements, striving for customers’ satisfaction and creating customers’ value, product quality must be balanced with environmental sustainability to ensure environmental and ecological stability, and sustainable development. To comply with the European Union’s regulations and the customer’s green product requirements, TSMC integrated the IECQ QC 080000 hazardous substance process management system developed by the International Electrotechnical Commission Quality Assessment System with automotive quality management system IATF 16949. The hazardous substance management requirements were built-in the operations of process design and development, material procurement, supply chain management and process controls. In 2017, suppliers were required to provide materials with non-PFOS (Perfluorooctanoic acid) derivatives for replacement of existing materials with PFOS derivatives. Additionally, a third-party audit verified the effectiveness of TSMC’s hazardous substance process management system and quality management systems in compliance with IECQ QC 080000 and IATF 16949. Equally important, the products made by TSMC complied with European Union regulations and customer requirements with the sampling validation by a third-party external laboratory.

Quality Application Realization
To provide excellent and reliable product quality for customers’ requiring timely delivery, ensuring users’ safety and product applications, and preventing post-production recalls, the Quality and Reliability organization assists customers in the technology developmental stages and product design stages to design-in superior product reliability. An automotive quality improvement program is in place to meet automotive customers’ low Defect Parts Per Million (DPPM) requirements.

In 2017, the Quality and Reliability organization collaborated with R&D to complete reliability qualifications for leading-edge 7nm technology (the third FinFET generation), the second generation Integrated Fan-Out (InFO) assembly technology for application processors with integrated passive devices, the Chip on Wafer on Substrate (CoWoS®) assembly technology for advanced silicon technology solutions with High Bandwidth Memory, and the Diffactive Optical Element (DOE) supporting mobile phone with a 3D sensing and facial recognition application. In addition, the design rules for automotive products were also enhanced and the Automotive Quality System migrated to version 2.0 which enhanced Fab in-line and Wafer Acceptance Test process capability and strengthened maverick wafers handling. TSMC also provided dedicated resources for customer return analysis and timely physical failure analysis (PFA) for process improvement. With these efforts, TSMC did not have any product recalls in 2017.

For more details, please refer to TSMC’s 2017 Annual Report “5.3.5 Quality and Reliability”.

<table>
<thead>
<tr>
<th>Materials’ analysis capability for CMR substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: %</td>
</tr>
<tr>
<td>2013</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

Actual Goal

Tasks of 2018

Add “New Quality Tool Application” competition group in Total Quality Excellence (TQE) & Innovation Conference

Enhance outgoing visual inspection defect automatic classification system and chemical laboratory’s capability for material analysis

Complete 7nm+ technology and specialty technologies reliability qualification
Material Issue

Customer Service

Strategies

- **Customer’s Virtual Fab**
  - Provide complete and timely information to facilitate production success; enhance process and security mechanism to ensure customer information protection.

- **Listen and Respond to Customer Needs**
  - Closely collaborate with customer and conduct meeting/questionnaire to understand and answer customer’s questions, so that we can provide the best customer service.

**TSMC 2020/2025 Goals**

- Align with TSMC technology development roadmap, available technologies through TSMC-Online to reach 370 in 2025.
- Pass customer product information audit without major defect in 2025.
- "Customer Service" score in Quarterly Business Reviews to reach 75% with satisfactory feedback in 2025.
**2017 Achievements**

0. **Pass customer product information audit without major defect**
   - Target: Pass customer product information audit without major defect

8.8. **"Customer Service" score in Quarterly Business Reviews reaches 8.8 points**
   - Target: Reach 8.8 points

**2018 Targets**

- **Pass customer product information audit without major defect**
- **Align with TSMC technology development roadmap, available technologies through TSMC-Online to reach 330**
- **Customer Service" score in Quarterly Business Reviews to reach 72% with satisfactory feedback**
To provide the best service to customers, TSMC has a dedicated customer service team as the main contact window for coordination and facilitation. TSMC strives to provide world-class design support, mask making, wafer manufacturing, and backend services. TSMC also protects customers' confidential information with the highest standard. These are aimed at achieving an optimum experience for customers and enable customer success, so TSMC can be a reliable partner customers can trust.

**Customer’s Virtual Fab**

Customer trust has always been a very important core value in TSMC, and it is also the reason why customers entrust their manufacturing service to TSMC. Real-time interactive information exchange and secure customer information protection are the key factors to win customer trust.

Regarding the real-time interactive information exchange, TSMC has provided the web-based TSMC-Online system which offers customer integrated service for design, engineering and logistics. With this service, customers can have 24/7 access to the most critical information and customize their reports based on their unique requirements and management key index. Through TSMC-Online, TSMC has offered a transparent and complete semiconductor manufacturing information system which serves as a customer’s virtual fab. This enables customers to have real-time access and control over the entire production cycle with access to critical information to help them achieve product success. In 2017, TSMC offered a new “Customer Service Package” which allows customers to have fast and convenient access to the corresponding service function based on the product life cycle.

**TSMC-Online Framework**

**2017 Highlights**

- 300 Available technologies offering through TSMC-Online
- 9,000 Available technology files through TSMC-Online
- 100,000 Customer downloads of technology files through TSMC-Online
- 400,000 TSMC-Online access times

**Customer Service Strategy Pyramid**

- Customer Trust
- Virtual Fab
- Complete & timely information via TSMC-Online
- Customer information protection
- Close collaboration

**TSMC-Online Framework**

- Business Engagement
  - Design Collaboration
    - Design Portal
    - Reference Flow
    - Technical Document
  - Engineering Collaboration
    - iTape-out
    - CyberShuttle®
    - Engineering Data
- Design In
- Tape-out and Mask
- Pilot and Production
- Post Service
- Logistics Collaboration
  - Real-time WIP
  - Order Management
  - Integrated Report

**Customers**

- TSMC-Online

**Product Life Cycle**
Regarding customer information security, TSMC is committed to protect all customers' proprietary information. With the Virtual Fab architecture, TSMC has implemented special security controls throughout the customer's product lifecycle that are examined and refined every year. In 2017, TSMC enhanced customer information access with even more comprehensive control on TSMC-Online. Customers can only access TSMC-Online through pre-defined and verified security paths and are required to update passwords regularly, all aimed for eliminating any security risk. In 2017, TSMC passed all customer audits on product and information protection and specific security products, TSMC has supported customers to pass the ISO 15408 product security audit successfully. Besides, no customer complaints relating to information leakage. In 2018, TSMC plans to certify the security and information protection related audit for specific Fab locations, to ensure the safe production of wafer manufacturing. We aim to pass all customer product and information protection audits each year, and continuously strengthen customer trust and partnership with TSMC.

**Listen and Respond to Customer Needs**

To assess customer satisfaction and ensure that our customers' needs are appropriately understood, Quarterly Business Reviews (QBRs), which include technology, quality, yield, design support, customer relationship and customer service, are conducted by the customer service team so customers can give feedback to TSMC on a regular basis. Customer feedback is routinely reviewed and considered by executives and then developed into appropriate improvement plans, all-in-all becoming an integral part of the management process with a complete closed loop.

In 2017, "Customer Service" score in Quarterly Business Reviews with satisfactory feedback is 71%, with 1% loss as compared to 2016. The major reason for this minor decrease is due to the length of time it took for technology collaboration discussion and decision. In the future, TSMC will improve the communication process and enhance the collaboration information sharing in order to facilitate rapid decision making on projects, and move toward the 2025 goal of reaching 75% in customer service satisfaction.
TSMC also conducts the Annual Customer Satisfaction Survey (ACSS) with most active customers, either by web survey or interviews through an independent consultancy. The ACSS is divided into 3 categories: Behavioral, Image and Execution. TSMC uses customer survey data as a base to identify future focus areas for customer relationship development. Through surveys, feedback reviews and intensive interaction with customers, TSMC is able to maintain close contact for better service and collaboration. In the future, TSMC will continue to focus on technology leadership, manufacturing excellence and customer service to enable win-win partnerships with our customers.

TSMC believes that continuous innovation, high quality products, and superior customer service are critical to enhancing customer satisfaction, thereby retaining existing customers, attracting new customers, strengthening customer relationships, all leading to higher levels of retention and expansion. In 2017, TSMC manufactured 9,920 different products for 465 customers, deliver 10.5 million 12-inch equivalent wafers with an 8.8% year-over-year increase. In the global integrated semiconductor industry, TSMC will keep playing its role of the trusted technology and capacity provider and an important partner to customer success.

Proprietary Information Protection

Proprietary Information Protection is a promise from TSMC to customers, shareholders and employees. TSMC responds to the increasing importance of proprietary information protection in regard to maintaining current and future competitive advantage, and devises "Proprietary Information Protection — PIP" policy to define the proprietary information protection and management guidelines. TSMC trade secrets and related undisclosed confidential information are protected under these guidelines in the best interest of company, shareholders, employees, customers, and vendors. TSMC PIP strategy is based on Plan-Do-Check-Act, PDCA management, which continuously upgrades the information protection mechanisms, raises PIP awareness in employees, and mitigates the risk of information disclosure.

TSMC promotes PIP programs continuously, including annual PIP training classes and several promotion channels, not only to employees but also to...
vendors. In 2017, TSMC further enhanced vendor information access and badge control, in addition to promoting PIP in annual vendor meetings. TSMC ensures proprietary information protection by forming an alliance with vendors.

2017 Proprietary Information Protection Enforcement Status

8 Promotion Micro Films
6 PIP micro films to deliver PIP major concepts

12 Regulations
Newly created or revised 12 Proprietary Information Protection regulations

5 Customer Security Audits
Passed 5 customer security audits and certifications, ensured product information protection during manufacturing

100% Employee PIP violation rate: 1.2%
Main cause: individual negligence or fail to comply with PIP procedures
Corrective actions:
- Reinforce PIP promotions and training by multiple channels
- Information access control for resigned employees
- Document printing and information access control enhancement.

94 Points
94 points average score for employees PIP engagement
- Conducted PIP engagement survey, collected over 42,000 surveys and over 91% response rate. Survey results show significant PIP engagement with 94 points

100% Over 45,000 employees completed Proprietary Information Protection annual refresh e-learning course
Course content:
- PIP policy and core concepts
- PIP milestones and new regulations in 2017
- PIP violation case studies and reminders
- PIP information channels

100% Over 3,000 newcomers completed Proprietary Information Protection training course

24 Promotion Posters
24 PIP promotion posters to raise PIP awareness

3M Checks
3 million PIP checks conducted per month, including:
- PIP prohibited item inspection
- Physical access compliance check
- Proprietary information handling
- E-mail handing
- Vendor PIP compliance check

Enhance TSMC-Online usage rates in functions of self-customizing production report and “Customer Lot-Handling”
Upgrade system hardware for TSMC-Online information security
TSMC Delivers Unrivalled Manufacturing Service

2017 total wafer shipments increased 8.8 percent from 2016 to reach 10.5 million 12-inch equivalent.