



# P&I

## Innovations

Special Feature:

# Today's Innovation is Tomorrow's Basic P&I Innovations

DNP strives to provide new value that will help solve society's challenges, primarily in four growth areas: Knowledge and Communication; Food and Healthcare; Lifestyle and Mobility; and Environment and Energy.

The "Sustainable Development Goals" adopted by the United Nations lists a number of the challenges for which corporations and other entities around the world are being asked to look for solutions. DNP will meet those challenges by refining and synergizing the strengths in printing and information technologies that we have been cultivating over the course of our 140-year history.

This Special Feature section contains a message from our management and examples of cutting-edge DNP projects, in order to introduce "P&I innovations" that generate innovative value by making use of all of DNP's abilities, including in areas like sales and project planning, manufacturing and production control, intellectual property and branding, in addition to our core technological strengths.

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# P&I Innovations

We create new value  
with P&I innovations.



**Toshiki  
Sugimoto**

Senior Corporate Officer  
Research and  
Development Center

**DNP has created many products that command top market share by using our core technologies: “Printing and Information technologies” that we have developed since the foundation of the company in cooperation with companies around the world. We will continue to develop a variety of products and services that will become “basics” of everyday life in the future.**

## **DNP’s capacity for technological development is what has enabled the expansion of our business areas**

While the industrial structure in Japan has changed dramatically since DNP was founded, we have succeeded in expanding into a wide variety of industrial fields. For example, by widening the range of materials on which we print, from printing paper to cardboard, plastic films, cloth, metal plate, glass and more, we have been able to develop and supply a wide variety of products.

Until supermarkets started appearing in the 1950s, many products were sold by weight at retail shops, but this system all but vanished with the start of pre-packaged product distribution. This trend in turn gave rise to demands for colorful packages, mostly for processed foods, cosmetics and household items, that would not only preserve their contents in a hygienic manner but also stimulate consumers’ desire to purchase upon being noticed at the store, and DNP’s packaging operations contributed to making such packages popular. During the period of rapid economic growth in Japan, DNP supplied interior materials printed with wood-like textures and patterns as the housing supply was expanded. Today, DNP’s “printing” can be found on a large number of items that are used in everyday life.

Photolithography, one of the techniques used for preparing printing plates, could also be used for making precise patterns required for manufacturing many electronics products. In 1958, we succeeded in producing shadow masks, components that were essential for manufacturing cathode ray tubes used in color televisions. DNP then contributed to the spread of Japanese-made color televisions by mass-producing shadow masks. Since then, we have provided a number of important components, such as color filters for liquid crystal displays (LCDs) and deposition masks used in the manufacture of organic light-emitting diode (OLED) displays. We also utilized photolithography in the manufacturing process in the

semiconductor field, and further developed it as a technology for manufacturing integrated circuits and also large-scale integrated circuits (LSIs). Today photolithography is the basic technology of “nanotechnology” that enables us to operate at the nanometer (1 billionth of a meter) level.

DNP was also one of the first printers to introduce digital technology in its printing production processes; in the early 1970s, we started working on computerized typesetting systems (CTSs) for prepress processes. After that, we constructed advanced systems capable of rapidly processing large amounts of text and image data that enabled us to promote digital media such as CD-ROMs, DVDs, and websites. Once digitized, all kinds of information can be processed in a variety of formats including printed paper materials and electronic books. DNP’s competency in handling both paper and electronic media is an advantage that we use in such businesses as multi-format publication planning and production, and development of our “honto” hybrid bookstore network that links online and in-store sales of paper and electronic books. Meanwhile, increasing digitization and networking have led to the need for a higher degree of information security. In addition to printing holograms and other anti-counterfeiting devices on smart cards and other products, DNP has been focusing on reinforcing security related to various types of software applications and networks.

In addition, we are working on more ways to use the advanced image processing technologies that we have developed through printing services in order to enrich people’s lives, for example, by applying them to the life science field. These are some of the ways in which DNP has expanded its business areas by valuing, refining and synergizing technologies in order to seize new business opportunities.

## Promoting P&I innovations —Providing new value by taking the initiative to solve social challenges

As shown in the diagram of basic printing processes on pages 20-21 of this report, “Project planning and design” processes relate to “Information processing” capabilities; “Microfabrication” techniques used for preparing printing plates lead to the development of “Precision coating” technologies, i.e. the application of thin layers of ink or other substances, and “Post-processing” technologies for making products in easy-to-use formats are related to commercialization of final products. DNP takes the various technologies involved in these printing processes, refines them and creates synergies by combining them with state-of-the-art technologies from fields such as material development, evaluation and analysis, “Kansei (sensibility) analysis,” brain science, the Internet of things (IoT), and artificial intelligence (AI).

As one of the very few comprehensive printing companies in the world, DNP possesses an abundance of top-class technologies and capabilities related to printing (P) and information (I). Our goal is to create innovative new value that solves social problems by flexibly combining these P&I-based strengths with other capabilities including sales and project

planning, manufacturing and production management, intellectual property and branding. In our “DNP Group Vision 2015,” we call these solutions “P&I innovations.”

Smart cards provide a good example of how this process can work. A smart card is a plastic card with an embedded IC chip. In the 1970s, DNP launched a “P” business of printing on plastic cards. From the 1980s, we started adding “I” value related to smart card development. For example, we developed all types of software needed for safe financial transactions. After receiving outsourcing contracts from financial institutions, we started handling card issuance processing including encrypting customer information, writing that information onto IC chips, and mailing a card to each customer. In other words, we developed this business into a diverse set of outsourced business processes. In addition, we began offering merchants who accept international brand cards like VISA, Mastercard and JCB, a platform for prepaid electronic settlement services as an alternative to payment by credit card. DNP has created a large number of innovations through these types of sophisticated combinations of “P” and “I” technologies.

## DNP technologies give rise to new value

### Realizing a more convenient society for consumers

As an example of how DNP creates new value, let us introduce a recent development related to distribution and sales promotion, whereby DNP serves to connect retail stores and consumers.

After starting with paper media such as newspaper inserts and product brochures, our sales promotion-related business branched out to include advertising and distribution of promotional campaign information and coupons, etc., through websites accessed via smartphones or other information devices, for e-commerce as well as more traditional sales. In recent years, as lifestyles have become more diverse, advertisers no longer seek to deliver the same information to everyone at once, but rather to transmit personally optimized information at the best time for each individual. In order to do so, it is necessary to understand the behavior of individual consumers. DNP has synergized big data with artificial intelligence (AI) technologies like deep learning in order to develop its “diip digital marketing platform,” a service that systematically analyzes and utilizes information related to consumer behavior.

The “diip” service quickly aggregates data related to consumers’ behavior at both physical and online stores and businesses. It then uses sophisticated functions to analyze those data, to determine the most appropriate types of information for each person—including the most suitable products—and to deliver the information via a combination of paper and digital media at optimal times according to each person’s lifestyle.

### For safe and reliable communication

At the same time that the importance of information in society is rapidly increasing and IoT and AI usage are becoming more widespread, risks related to cyber-attacks and various Internet crimes are also becoming more serious. In response to this growing risk, there is strong demand for secure and pleasant communication. As it works to provide solutions that meet this demand, DNP is employing technologies and expertise related to advanced information security, digitization and networking.

Based on our recognition that safety is essential for the IoT, our goal as we work to develop the systems and services necessary for a high level of information security is to achieve an “Internet of Secure Things” (IoST). For example, in addition to using authentication and encryption technologies that we have developed in our smart card business to protect various types of IoT devices from unauthorized use, DNP also provides “CrackProof” software that protects applications from a variety of risks including hacking and analysis aimed at reverse engineering. As part of our comprehensive information security business, in 2016 we established Cyber Knowledge Academy Co., Ltd. to train people to handle cyber-attacks against corporations. The academy provides a training environment that enables trainees to acquire, maintain and upgrade the skills they need to be able to respond to previously undiscovered new cyber-attacks.

## Manufacturing to evolve people's lifestyles

Next we'd like to introduce examples of technical innovations related to manufacturing.

In order to display an image by using liquid crystals, we must use "orientation technology" to form the liquid crystal materials so they will be aligned precisely in an arbitrary direction. In order to exhibit high-level optical performance on thin and flexible film substrates, we have developed novel precision coating technology and new materials that enable liquid crystals to be aligned accurately.

We are using these technologies to develop products like retardation films that correct the coloration of OLED displays, and dimming windows that control the amount of transmitted light without the use of mechanical blinds.

## Supporting lifelong health maintenance

DNP started to expand its business area into the life science field about 10 years ago, by sending some researchers to a university hospital that was conducting advanced research in regenerative medicine and other state-of-the-art areas. At the time, not a few people seemed to think it was rather strange for a printing company to begin doing medical research. However, in regenerative medicine, there is a need for cell-culturing dishes that enable various kinds of cells to be cultured uniformly, or to be cultured in specific patterns, or to be peeled off in sheet form from the dish. DNP has been able to meet these demands by processing the surface of cell-culturing dishes using microfabrication and surface processing technologies that we developed through

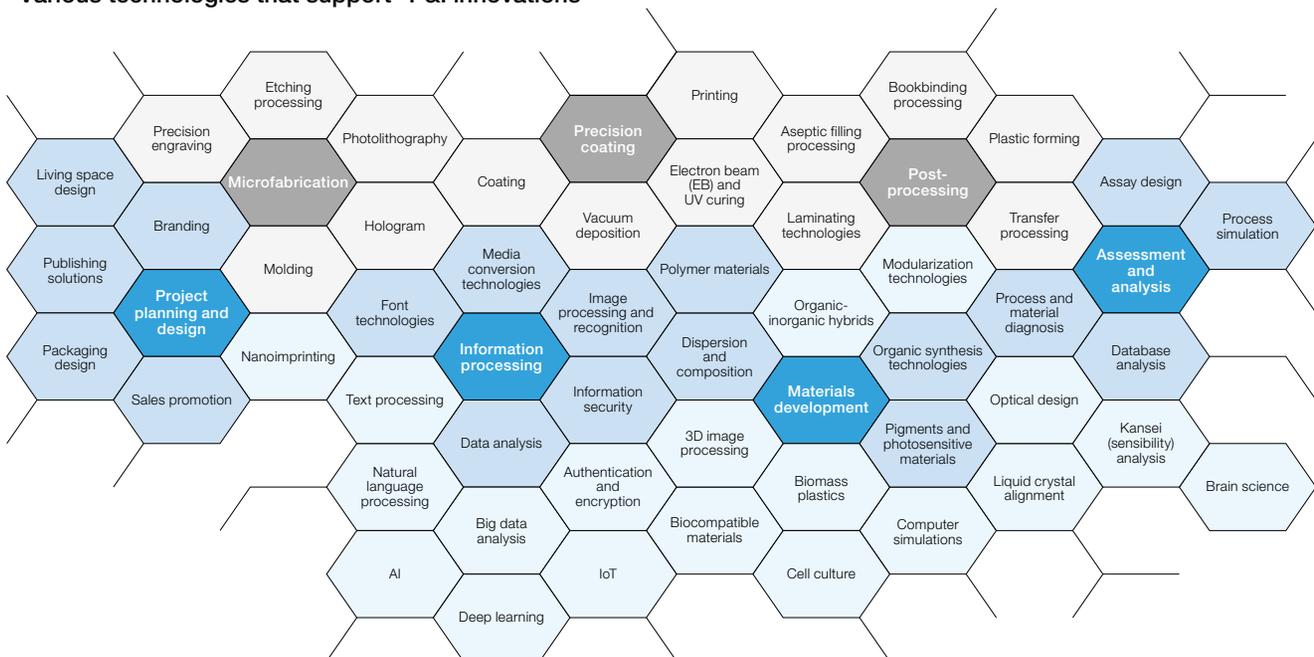
our printing business. In addition, we were able to establish a pathway for the development of culturing vessels of the quality required to make regenerative medicine practical.

Furthermore, as printing processes, including information processing, have become increasingly digitized and networked, we have been investigating the potential of various information processing technologies that DNP has developed to be used in medical imaging and medical information systems. Together with PSP Corp., with which we established a capital and business alliance in December 2014, we are developing a medical image management system called Picture Archiving and Communication System (PACS), and working to develop systems that automatically analyze X-rays, CTs, MRIs and other images to support diagnosis of breast cancer and other diseases. In addition, DNP is promoting a remote medical imaging diagnostic support business that uses IT to transmit images recorded at regional hospitals or clinics to radiologists in remote locations and to return diagnostic reports from the radiologists to the requesting facility.

Although we have already produced some impressive achievements through our P&I innovations, DNP's P&I technologies still have more tremendous potential. By considering social problems that consumers face in their daily lives and working hard to solve them through one innovation after another, we believe that we can create a safe and secure society where people can live pleasant and comfortable lives. We intend to continue creating new value by enhancing and synergizing our P&I strengths.

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## Various technologies that support "P&I innovations"



# Expanding DNP's Business Areas by Applying and Developing Technologies

DNP is one of the largest comprehensive printing companies in the world. We provide a variety of products and services in a wide range of business areas to consumers and some 30,000 corporate clients in Japan and around the globe. DNP's main strengths are the printing and information technologies that it has cultivated since its founding in 1876. The Company has used these technologies to branch out from book, magazine, and commercial printing into diverse fields including packaging, decorative materials, display components, and electronic devices, and has developed many products in which it holds the world's largest market share.



\* C for cyan, M for magenta, Y for yellow, K for "key plate" (black)

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Effectiveness assessment

Product delivery

# Printing Processes

Publication printing

## Binding and post-processing

Collate and bind printed pages together to form books.



## Printing

Wrap plate around roll, supply ink, and perform high-speed, high-precision printing.



Biomatech® biobased packaging materials



Aseptic filling system for PET plastic bottles



Pouch for lithium-ion rechargeable battery



Printing inspection equipment for printed materials

## Post-processing

Form into easy-to-use shapes

Stabilize development quality of aseptic filling systems and other packaging products; improve productivity

- Bookbinding processing
- Aseptic filling processing
- Plastic forming
- Laminating technologies
- Transfer processing etc.



Transparent barrier films

## Precision Coating

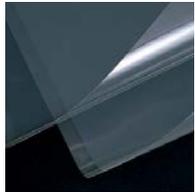
Apply a thin, uniform layer of ink

Combine material design with technologies like film thickness control, multi-layering, and surface processing in order to provide functionality

- |                  |                        |
|------------------|------------------------|
| Printing         | Coating                |
| EB and UV curing | Vacuum deposition etc. |



Dye-sublimation thermal transfer printing media



Anti-reflection films



Residential interior materials (floor coverings)

# IoST<sup>®</sup> Technologies

## Information security initiatives aimed at helping society use the IoT safely and reliably

The “Internet of Things” (IoT) is a world in which many things have built-in sensors and connect directly to the Internet so that they can collect and exchange information. As use of the IoT becomes more widespread, it is becoming increasingly likely that lifestyles and business styles are about to radically change. Along with hopes for a more comfortable future comes increasing risk of global-scale cyber attacks. With cyber attacks becoming more organized and more sophisticated, corporations and public entities have been hit by shutdowns of their information systems, information theft, and other problems arising from security breaches.

That is why DNP has set to work to solve social problems related to information security; we aim to make the “Things” of the IoT “secure,” i.e. to make it an “Internet of Secure Things” (IoST<sup>®</sup>).

### Improving device security by using technologies that we cultivated in our smart card business

Cryptographic protocols like SSL (Secure Sockets Layer) and TLS (Transport Layer Security) have been used for years to encrypt data transmitted by Internet as a security measure for e-commerce and other online services. However, we do not yet have adequate security measures for handling data exchanged with IoT devices.

DNP is working to address this problem and improve the security of IoT devices by embedding in them an IC chip that incorporates the same high level of security used for smart



cards. Using this IC chip to safely store important data, such as electronic certificates, individual IDs used for personal authentication, and data encryption keys, will guard against malicious outsiders seeking to tamper with or illicitly acquire data, or to impersonate a legitimate user.

DNP became one of the first in its industry to enter the smart card business in 1981, and it was through developing smart cards that DNP cultivated the abilities necessary for solving this problem. In addition to the counterfeiting prevention technologies that we had already developed in order to safely print and process stock certificates, cash vouchers, and other valuable certificates, we had to develop technologies for securely managing networked data as we have continued to lead the domestic smart card market from its inception: for example, we developed smart card operating systems and applications, we developed and operate card issuance processing systems, and we manage the online transmission of card-related data. According to our own research, DNP currently controls about 55% of the Japanese

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market for credit cards (in terms of the number of cards produced) and about 80% of the market for cash cards (in terms of the number of orders received). DNP produces about 150 million smart cards per year in Japan. We have applied the strengths we acquired through our smart card business to the construction of advanced personal authentication technologies for use in a wide variety of information platforms including SIM cards used in smartphones. Now we intend to extend our reach further, to the IoT.

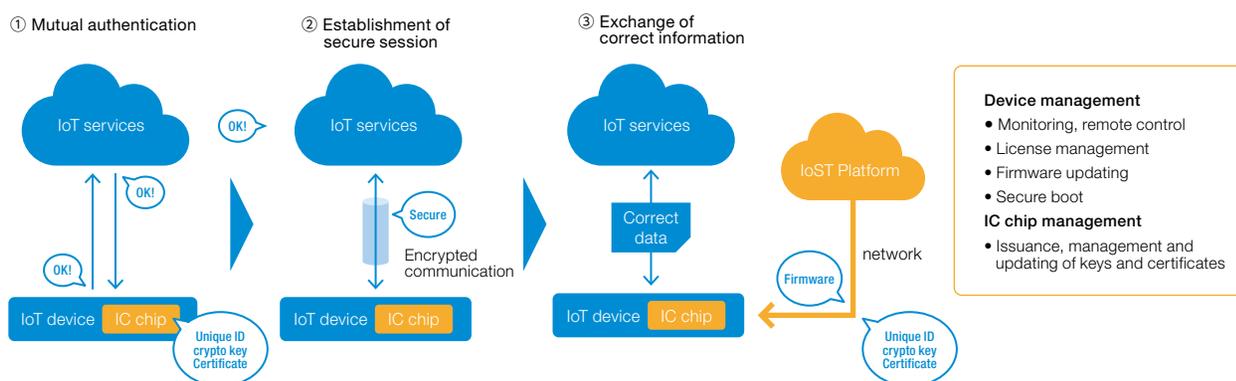
### | DNP's "IoST Platform"

In the future, the number of IoT devices is expected to increase sharply, climbing as high as 50 billion units worldwide by 2020 according to a forecast by Cisco Internet Business Solutions Group. With the advent of the "IoT society," in which many of the devices that surround us in daily life will

become contact points for information exchange, information security is becoming more important than ever.

In answer to this growing need for information security, DNP proposes to create an "Internet of Secure Things" (IoST). Based on our awareness that information security is vital to the IoT, DNP will focus on developing products and services for the secure version that we call the IoST.

By utilizing the information processing and security technologies that we cultivated through the development of smart cards, DNP's "IoST Platform" will appropriately expand the scope of IoT applications while solidly protecting information pertaining to companies and private citizens. By creating a secure information infrastructure that safely and securely connects cloud environments and IoT devices, we intend to support a society that can truly enjoy the convenience of the IoT.



# Electron Beam (EB) Technologies

## Approaching technology with the consumer in mind —Taking our environmentally conscious floor coverings to world markets

Electron Beam (EB) coating technology is one of DNP's core technologies. It allows us to instantly improve the durability of resins and coating films by exposing them to electron beams. We use this technology in the development of highly scratch-resistant, abrasion-resistant, and soil-resistant decorative sheet used as building material. Amid increasing awareness of the need to protect our global environment, DNP set about to develop decorative floor coverings made with environmentally conscious resin films.

### Using EB technology to develop environmentally conscious decorative sheet

A wood grain pattern emerges gradually as layers of color are overlaid in stages on resin film. In the mid-1990s, polyvinyl chloride (PVC) film printed with wood-grain patterns was widely used as decorative sheet in the Japanese building industry. However, as plasticizers used in the manufacture of this sheet, as well as hydrogen chloride gas, dioxin, and other substances generated during burning of the sheet, were found to have damaging effects on the global environment and on people's health, the development of PVC-free products became a hot topic.



Polyolefin is a kind of plastic that turns into mainly water and carbon dioxide when burned completely, with no hydrogen chloride or dioxin released. However, polyolefin film was problematic in that it is less durable than PVC film. By employing EB technology, it became possible to use polyolefin as PVC-free decorative flooring that resists scratches, abrasion, and dirt. According to our research, DNP currently controls about 60% of the Japanese market for composite flooring sheet made with PVC-free surface material. Composite flooring—consisting of decorative sheet laminated onto the surface of a base material (generally plywood or laminated timber)—is less susceptible to the sunburn or cracking that may appear in natural wood floors as they age. Choosing composite flooring also makes it possible to obtain a desired quantity of flooring with a consistent color and pattern.

Demand for this type of environmentally conscious flooring material is now growing in parts of the world where there is a strong awareness of the need to preserve the global

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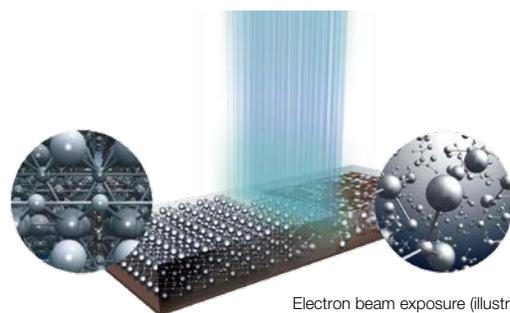
environment. However, flooring developed to Japanese specifications will not necessarily pass muster in other parts of the world. Especially in places like Europe or North America, where people wear shoes inside the house, a higher degree of resistance to scratching and wear is required compared to what suffices in Japan, where people generally do not wear shoes inside their homes. With that in mind, DNP first studied living environments and lifestyles in Germany and other European countries, investigated flooring material requirements, and employed EB technology to meet the flooring quality standards established by the European Union. As a result, in 2015 a number of European companies began to use DNP's PVC-free decorative sheet for flooring, and today it is sold in every European country. Sales of DNP's EB products are also growing within Asia, and the distribution area is expanding. For example, EB products were introduced for sale in South Korea in 2016.

**With full attention to both functionality and aesthetics, we ventured into Europe, the land of cutting-edge interiors**

In order for our highly durable, environmentally conscious decorative sheet to be accepted all over the world, we need continuous technological innovation along with novel ideas for making wood grain and other aesthetic designs. People tend to choose flooring materials based first of all on appearance. DNP's surface design experts work the surface of the natural wood that we use as our "original manuscript" until it is smooth and polished, coat it, scan it, and use that data as the basis for designing natural wood grain patterns that evoke a

pleasant sense of rhythm and balance in the eye of the viewer. Even among wood grain patterns, there are fashion cycles and fads. A few years ago, flashy designs with large knots were popular, whereas more recently lacy, elegant patterns are in favor. One of DNP's specialties is the fabrication of natural wood-like textures ranging from delicate, smooth surfaces to uneven surfaces with relief features.

DNP attaches a good deal of importance to the European market as a leader in global design trends. Adoption of our products in Europe gives us a good foothold from which to enter other international markets. Going forward, we plan to expand our lineup of more specialized designs with niche market appeal that European manufacturers are not equipped to handle, such as stone-like or metallic-looking textures for use in high-end products. In order to expand our PVC-free decorative sheet and other Living Spaces businesses, DNP will continue to build the brand value of its products and take on the challenge of entering world markets.



Electron beam exposure (illustration)

# Film Technologies for OLED Displays

## DNP technologies support organic light-emitting diode (OLED) displays —the next-generation electronic display

OLED displays offer excellent color reproduction compared to liquid crystal displays. Also, because they are based on self-luminescent organic substances that can deliver high-performance from a simple structure, many people consider them to be innovative components that will enable production of lighter, thinner, more energy-efficient devices. Another reason OLED displays are attracting attention as the next-generation display is the expectation that in the future they will enable the production of bendable and curveable products.

Metal masks supplied by DNP are essential to the production of an OLED display's core. DNP also produces and sells specialized films with optical functions that make OLED displays even more appealing to the eye. To make these optical films with their specialized functions, DNP employs the liquid crystal coating technologies that it developed by synergizing materials technologies with precision coating technologies that it has cultivated over the course of many years.

### Expansion of the OLED display market and the new value that DNP provides

OLED displays are being heralded as the next-generation display to follow liquid crystal displays.

Because these innovative displays can emit their own red, green, and blue light by means of special elements composed of an organic substance, they can deliver much better color reproduction and contrast compared to displays made with the currently prevalent liquid crystal technology.



Because of these advantages, usage of OLED displays is increasing in a wide variety of settings, from digital signage seen on street corners to large-scale televisions, smartphones and even small wearable devices.

With OLED displays already in use in advanced smartphones worldwide, the global market for OLED panels made for smartphones is expected to reach 18.6 billion U.S. dollars in 2018, representing a 75% increase over 2015 and exceeding the 17.6 billion U.S. dollars forecast for the 2018 LCD smartphone panel market according to research by IHS Inc.

OLED displays also have disadvantages: their contrast can decline markedly as a result of reflected sunlight or other external light, and the colors they display appear differently when viewed from a diagonal position. To eliminate these drawbacks, DNP has developed a special optical film. DNP

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first made this film—called “retardation film” for OLED displays—by using a special liquid crystal material developed in-house together with DNP’s proprietary precision coating technologies. Today, DNP’s retardation film is used in a large number of international brand smartphones and televisions.

**Making the most of our strengths in various printing technologies to support the future evolution of OLED displays**

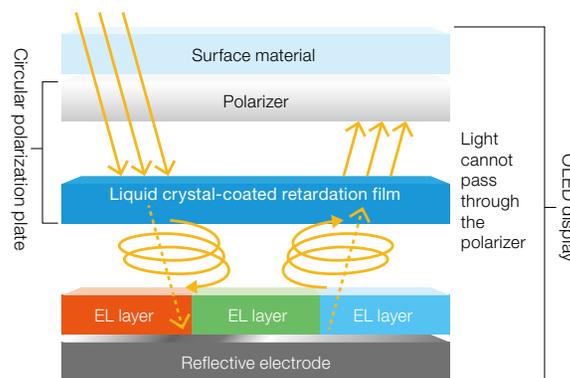
Based on the various technologies we have cultivated through our printing business, DNP has developed products aimed at helping make OLED displays more popular.

Manufacturing OLED displays involves lining up light-emitting elements made of organic material to form ultrafine patterns. Essential to this process are ultrahigh-precision products called “metal masks,” which are made using DNP’s proprietary microfabrication technologies. After we undertook to develop these metal masks in 2001, it took many years of trial and error before we were able to introduce metal masks that can support the high performance of today’s OLED displays.

From the beginning of the 2000s, we continued to refine the specialized coating technologies required in order to uniformly align liquid crystal on film. We were first able to show the value of this type of specialized film in the manufacturing of 3D liquid crystal televisions. Later, with the emergence of OLED displays, we developed our liquid crystal coating technology even further, leading to the successful production of our retardation film.

In addition to OLED displays’ high performance in terms of color reproduction capabilities, there are also expectations that in the future it will be possible to develop applications requiring flexible displays that can be bent or curved. Toward that end, the displays will need a high degree of flexibility and durability while remaining thin and lightweight. In order to make a reality of this type of “display of the future,” DNP will further refine the technologies that we have been cultivating all along, and continue working to provide new value.

**Preventing reflection of external light from an OLED display**



High contrast can be maintained by having an electrode inside the OLED display absorb reflected sunlight or other external light

# Medical Information Processing Technologies

## Developing businesses and technologies with medical doctors and technicians in mind —Applying printing-based technologies in response to demand for medical information services

Amid today's "ultra-aging" society, DNP has undertaken to develop products and services that support consumers' health maintenance.

We aim to synergize our P&I strengths with other technologies, including biotechnology, in order to expand our life science businesses.

● Life science businesses that DNP is developing:

Medical supplies	Medical image processing	Preventative medicine	Regenerative medicine
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### Expanding businesses related to medical information systems

As one of the life science business fields that DNP is developing, medical image processing makes use of advanced information processing technologies that DNP has developed in its printing business. We have formed a capital and business alliance with PSP Corp., a major player in Japanese medical imaging management systems, with whom we are collaborating especially to promote a picture archiving and communication system (PACS).

PACS performs total management of all of the digital images recorded in hospitals, whether by X-ray, CT, MRI or other equipment, and makes the images available to all of the hospital's departments. In particular, radiologists need to be able to view a large number of these types of images within a short time, in order to make timely diagnoses. A PACS supports doctors in making image-based diagnoses by providing a wide variety of image processing functions.

### Using image processing technologies developed through printing to create support functions for image-based diagnosis

To date, DNP has made use of its strengths in image processing technologies to develop image processing LSIs capable of reproducing natural-looking colors that are gentle on the eyes and can correct distorted images. In addition, we have been collaborating with Tokyo Medical and Dental University to research and develop image analysis technologies for using MRI images of eyeballs to investigate causes of pathologic myopia, which is common among Japanese people.

We plan to further develop these technologies in order to create computer-aided diagnosis (CAD) systems to support diagnosis of breast cancer and other diseases by automatically analyzing image data obtained from X-ray, CT or MRI, etc. As we progress in this development, we also intend to work to improve the accuracy of automatic analysis by adding 3D imaging, artificial intelligence, and machine learning functions.

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### Remote medical imaging diagnostic support services that contribute to regional medical care

In the field of community medical care, CAFI (Center for Advanced Functional Imaging in medicine) Corporation, a DNP subsidiary, that is developing a remote medical imaging diagnostic support business. The background of this business is that there is a shortage of radiologists throughout Japan, and the number of images to be checked has been growing dramatically as diagnostic imaging equipment has become faster and more advanced, thus increasing pressure

on image-based diagnosis systems.

Our remote medical imaging diagnostic support business uses information technology to help relieve this pressure by transmitting images recorded in local hospitals and clinics to radiology specialists in remote locations and then returning diagnostic reports. By handling patients' very important and confidential information through our DNP Kashiwa Data Center, which has advanced information security functions and a highly secure network environment, we ensure the safety of data exchanges between local medical facilities and radiologists and provide specialized environments for the reading of image data by radiologists.

