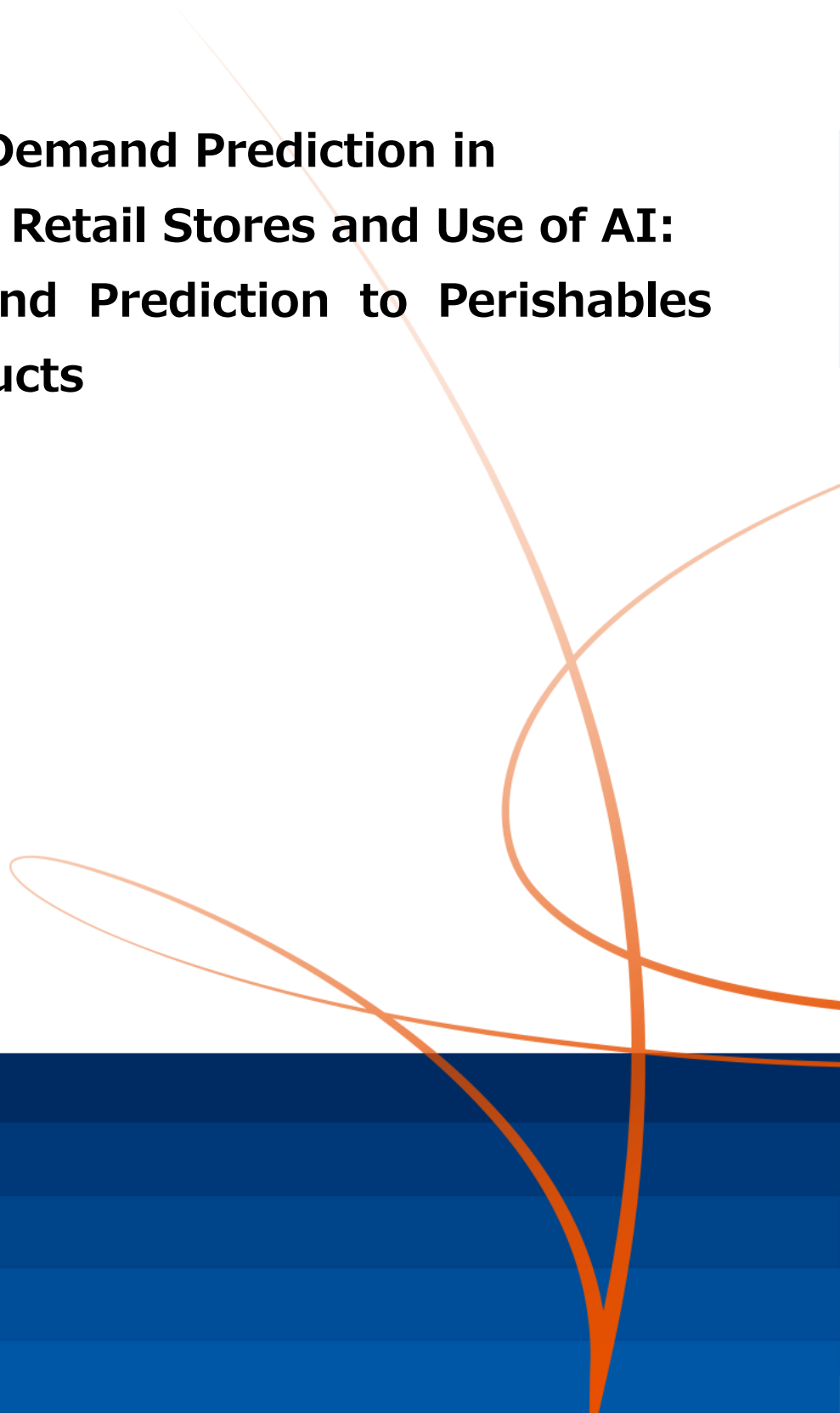


Importance of Demand Prediction in Smaller-Format Retail Stores and Use of AI: Applying Demand Prediction to Perishables and Fresh Products

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NEC Corporation



Executive Summary

Consumer behavior is changing significantly as a result of factors such as aging society, changes in the household structure, technological advances, etc. We live in an age where consumers can choose their retailers depending on the degree of convenience offered. For instance, many consumers choose online or physical stores depending upon the situation, and prefer to buy items such as prepared lunch boxes, delicatessen or other perishables such as daily food items at a nearby store. Many of the retailers are adopting smaller-format stores in addition to reinforcing their online presence, leading to an escalating competition to provide services matching consumer needs. However, there are still many challenges such as product assortment suited to consumer needs, ordering or successful inventory management at smaller-format stores. Existing store systems face challenges while dealing with these issues.

NEC has a rich expertise in the smaller-format-multi-store retail model operations, cultivated through its support to a large number of retailers, especially convenience stores. Furthermore, NEC also possesses numerous cutting-edge technologies such as Artificial Intelligence (hereafter, AI), image analysis technology, etc. NEC leverages this operational expertise and ICT technology to offer solutions that enable successful smaller-format stores suited to individual customer needs. Moreover, NEC also aims to solve social issues such as food waste through its solutions.

This whitepaper discusses NEC's initiatives towards supporting successful smaller-format-multi-store retail model through leveraging solutions of demand prediction and shelf management.

1. Retailers' strategies targeting convenience-oriented consumers

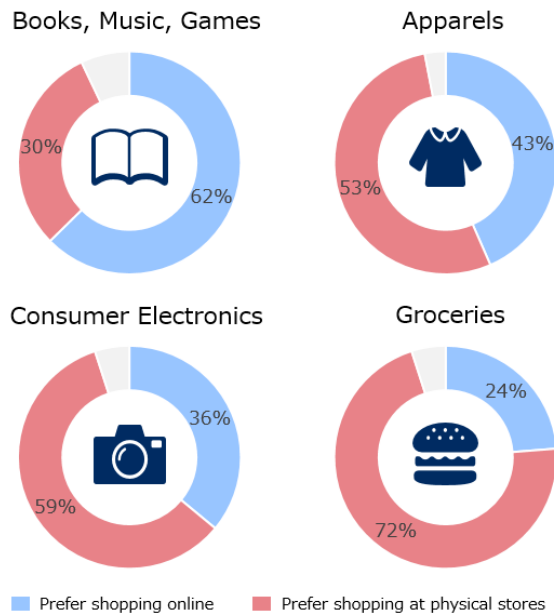
Today, consumers' shopping behavior is undergoing a major change. With the increase in single-person households, aging population, and rising rate of urbanization, consumers are selecting services with increased convenience. Shopping behavior specific to neighborhood stores and e-commerce is especially becoming popular as consumers look for ways to reduce constraints of time and distance. Furthermore, since this type of shopping behavior also varies depending on the product attributes and the specific needs at any given time, the behavior becomes highly diversified. In order to gain the patronage of convenience-oriented consumers, retailers must provide consumer-driven services and sales methods.

1-1. Shifting towards a shopping behavior that combines online and physical stores

The spread of internet and mobile devices, along with the advances in ICT technology, have resulted in the increased use of e-commerce. This in turn has led to an increasing number of consumers choosing from or combining online and physical channels. According to a survey, approximately 62% of the respondents said they preferred online channel to buy books and music, as these products become increasingly digitalized; on the other hand, approximately 72% of the respondents voiced their preference for physical stores for buying groceries¹. In other words, we have entered an era where consumers are able to use online or physical stores depending on the type of products and lifestyle and select a more convenient option.

¹ PwC "Total Retail Survey2016" (2016)

Figure 1: Preferred shopping channels by product category



Moreover, one of the reasons behind the increasing preference for buying groceries from physical stores is the rising demand for food items such as lunchboxes and delicatessen meant for immediate consumption. In the US, supermarket sales showed a year-on-year growth of approximately 2%, while delicatessen sales showed a particularly high growth of approximately 9% in 2016². In other words, there’s a trend where consumers buy products meant for immediate consumption at physical stores, indicating continued importance of physical stores as retail channels in future.

1-2. Growth of smaller-format stores

Pricing is an important consideration for the consumers for choosing physical stores to buy groceries, however, proximity of the stores is also an important consideration³. Moreover, the number of consumers buying at a physical store more than thrice a week is increasing⁴, indicating that convenience-driven consumers

tend to shop at a nearby store with higher frequency. In order to respond to such type of shopping behavior, smaller-format stores continue to increase as a way to circumvent restrictions on the opening of large stores in the urban areas with high land prices. For instance, in response to consumer demand for prepared meals, Carrefour has opened 639 smaller -format stores called “Carrefour City”, with a focus on food-to-go delicatessen items. Furthermore, Sainsbury has developed smaller-format stores with a wide selection of delicatessen under the “Sainsbury’s Local” brand, and is testing these stores mainly in the urban areas. On the other hand, as a part of its pursuit of improved convenience, Morrisons has partnered with Amazon to launch services in urban areas, that allows consumers to place their orders online and collect deliveries from stores. In other words, increase in the number of smaller-format stores and pursuit of better convenience will continue in future as retailers try to attract consumers who buy at a nearby store with high frequency.

Table 1. Examples of smaller-format stores roll-out strategy and store delivery collection business models

Company	Efforts
Increase in number of smaller-format stores	
Carrefour (France)	Introduced “Carrefour City” as an urban convenience store in 2010. Product assortment mainly includes food-to-go delicatessen, and had opened 639 stores by the end of 2016.
Sainsbury (UK)	Opened smaller stores “microstores” of about 100m ² for a test run in 2015. Product assortment includes approximately 1,000 items focusing on ready-made meals such as salads and sushi. Announced the possibility of expanding to about 1,000 stores.
Service enhancements by leveraging the internet	
Morrisons (UK)	Morrisons has partnered with Amazon to launch a service that will allow consumers to place online orders for groceries that are in stock in urban area stores and collect deliveries from stores.
Amazon (America)	Announced the opening of “AmazonGo”, a smaller-format store with product assortment focusing on groceries and fresh foods for the Prime members. By leveraging the e-commerce payment platform, Amazon has introduced a store that does not require checkouts.

Source: Company Websites, The Guardian, Euromonitor data (2016)

² Technomic “U.S. Food Industry Universe Forecast” (2016)

³ BIGinsight “Monthly Consumer Survey (2012)

⁴ IGD “Shopper Trends” (2012)

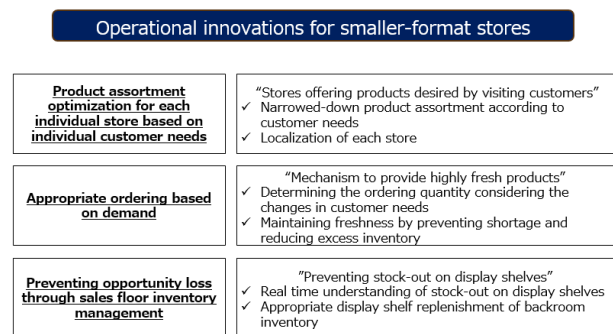
2. Product assortment and ordering operation innovation for a successful smaller-format store management

In order to create smaller-format stores that get consumers' vote of confidence and are operated efficiently at the same time, it is necessary to adopt management strategies that are different from those used for larger stores. For instance, from a store operations perspective, a store with limited space will consequently have limited items for display as well as for inventory. Therefore, a mechanism is needed to help increase the product turnover by enabling a product assortment matching the needs of visiting customers, and achieving optimal ordering. Furthermore, it may be difficult to cook inside the store due to staff or space restrictions. In such cases, perishable items that require cooking are usually cooked at a different location and then delivered to the store, requiring optimal ordering and inventory management in addition to improved product turnover rate. Furthermore, as competition is expected to intensify, retailers will be required to provide various services with lesser number of staff in order to improve cost competitiveness, leading to increased work load per person. Moreover, as convenience-oriented consumers tend to purchase items at nearby stores, rolling out stores in the consumer's neighborhood would eventually result in opening of multiple stores. However, rolling out smaller-format stores in a multiple-store format, leads to an increased amount of data to be analyzed. As compared to the larger stores, data items such as data related to events within each store's respective trade area increase, leading to finer granularity.

In order to have such successful operations, and maintain consumer loyalty towards stores,

it is important to establish a mechanism that prevents any increase in work load. Therefore, to resolve such issues, it becomes necessary to leverage ICT to improve demand prediction accuracy and physical inventory management, thereby enabling optimized product assortment and ordering for each individual store, without increasing the work load.

Figure 2: Operational innovations for smaller-format stores



2-1. Product assortment optimization for each individual store based on individual customer needs

The most important and fundamental requirement for convenience-oriented consumers is to get their desired products every time they visit a store. However, smaller-format stores have smaller sales floors, making it difficult to have a large product assortment and making it necessary to narrow down the product assortment. Furthermore, as the sales area becomes smaller, the consumer attributes become more prominent, resulting in more defined differences among stores. In such cases, it is not possible to consider the product assortment by each store type. It becomes necessary to change the product display quantity and have an optimized product assortment for each individual store. In other words, it becomes necessary to analyze the

individual consumer trend by each store, and carry out product assortment localization for each store according to the consumer needs.

2-2. Appropriate ordering based on demand

As discussed previously, consumers prefer buying groceries at physical stores, and the demand for ready-for-immediate consumption products such as lunchboxes and delicatessen is especially increasing. Additionally, as the consumer needs for these products vary depending on various factors such as store location, surrounding environment, weather etc., the ordering is required to be based on the needs of individual consumer visiting respective store rather than a mechanical replenishment of products in order to provide fresh products to the customer without fail. If the store has a kitchen, then it would be possible to adjust the displayed item quantity by preparing those items inside the store itself. However, in case of smaller-format stores, usually there is insufficient space for a kitchen, making it necessary to adopt measures such as switching to a centralized kitchen format. In such cases, failure to execute optimized ordering based on consumer demand variation prediction for each store can lead to opportunity loss due to item stock-out or wastage loss due to excess ordering. Moreover, there is also the risk of losing consumer trust by offering not-so-fresh products resulting from excess inventory.

2-3. Preventing opportunity loss through sales floor inventory management

In addition to an appropriate ordering in accordance with the consumer demand variations, it is also important to maintain shelf inventory stocked with products desired by consumers every time they visit the store. However, the work load of the staff at smaller-

format stores is heavy as they are required to perform multiple tasks, making it difficult to physically monitor item stock-out on display shelves in real time. Moreover, if the logical inventory management relies solely on data, it can create situations of actual inventory stock-out on the sales floor. For these reasons, it becomes imperative to monitor the shelf items constantly and replenish the items immediately or revise the data as a part of store operations. Especially, in case of smaller-format stores, it is extremely important to increase the accuracy of inventory management at the sales floor as there is limited inventory and display space.

3. NEC's Initiatives

Although, ICT-driven automatic ordering systems have been adopted by many retailers in the past, such systems have faced issues in their adoption in a smaller-format-multi-store retail model because these automatic ordering or replenishment systems catered to the items with a longer shelf life. As a result, automatic ordering was used widely for hard goods and processed food items, but has not been used for perishable items. Perishable items need to be sold within a short period of time due to their short shelf life, making it essential to take into account a variety of complex factors such as consumers' store visit trends, weather and events in the store's neighborhood for a highly accurate demand prediction.

Furthermore, in case of traditional product assortment, it is common to categorize stores in accordance with the unique characteristics of the region or the trading area, and then decide a planogram by store type. However, in case of smaller-format stores, retailers are expected to improve product assortment in addition to the freshness of products by optimizing product assortment for each individual store, and by making seasonal changes in the products or introducing new products. Moreover, such

product assortment management becomes even more challenging in case of multi-store retail model.

NEC has a long and successful track record of deploying store systems for not only convenience stores but also other retail formats. The store operation expertise achieved over the years allows NEC to offer best suited solutions for operating various types of retail outlets.

Furthermore, NEC leverages its proprietary AI and cutting-edge image analysis technologies in addition to its store operation expertise to overcome various challenges mentioned in the preceding chapters. This enables NEC to provide demand prediction, individual store-based product assortment, ordering and shelf monitoring solutions suited to the needs of each customer.

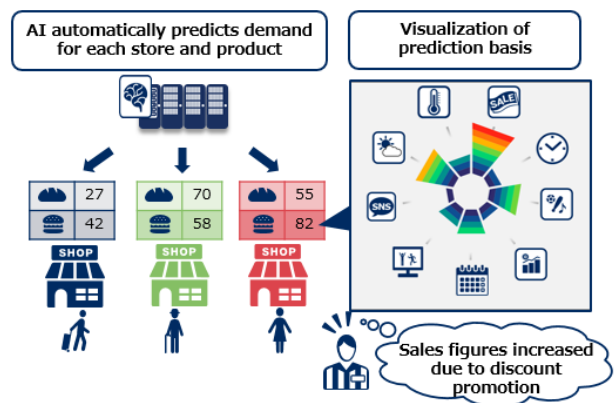
3-1. Demand prediction based on NEC's proprietary AI technology

NEC offers demand prediction solution suited to smaller-format-multi-store retail model. This solution uses NEC's original AI technology⁵ of "heterogeneous mixture learning technology" and enables demand prediction best suited to perishables and fresh products in a smaller-format-multi-store retail model. This solution has two main features. Firstly, it enables automatic demand prediction based on various factors that may affect sales such as weather conditions, events, day of the week, stock-out time, disposed goods, etc. in addition to the sales performance history. Secondly, in addition to the demand forecasting, it also calculates the recommended ordering quantity for each store by taking inventory movement into account. These features allow retailer's headquarters to carry out bulk ordering for each store without increasing operational work load and yet

achieve localization for each store. In case of ordering at the individual store level, these features enable improved ordering accuracy and standardization without increasing the work load. Moreover, visualization of forecast basis helps the store staff to carry out store system operations with a clear understanding. For example, if the predicted quantity is bigger than the estimate, it is possible to check the factors contributing to such a prediction, and decide whether or not to use the predicted quantity without any modifications.

Thus, all these above-mentioned features improve the ordering accuracy through operation localization at each store, thereby preventing stock-out situations and reducing wastage loss. In fact, a certain retailer has succeeded in reducing the perishables and fresh products wastage loss by approximately 40% by taking advantage of this solution.

Figure 3: Demand prediction and automatic ordering by leveraging AI



3-2. Improved product assortment by leveraging analytics engine for individual customer and product attributes

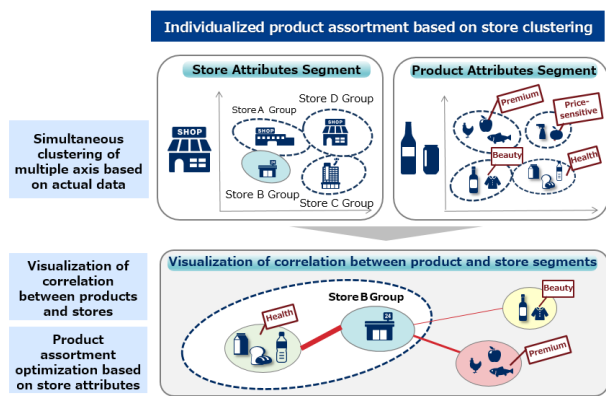
NEC has developed an analytics engine that uses NEC's proprietary AI technology to analyze correlations between membership

⁵ NEC The Wise

demographics and product attributes. For example, it becomes possible to form a conjecture regarding individual customer's demographics and correlated item or product category. This analysis allows visualization of correlation that cannot be discovered by a human, and helps to combine this information with sales information to optimize product assortment. As a result, it becomes possible to make changes to product assortment such as seasonal product changes or introduction of new products.

Thanks to the mobile-driven membership services, E-receipts, etc., customer information will become more organized and will be collected more intensively. NEC believes that such membership information can be leveraged not only for loyalty programs but can also be used effectively towards product assortment so that customers' desired items will be available whenever they visit the store.

Figure 4: Optimized product assortment by leveraging AI

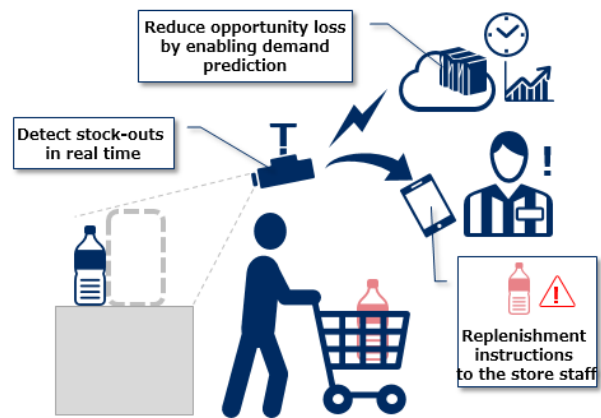


3-3. Shelf monitoring using cutting-edge image analysis technology

Headquarters is able to collect information such as items sold at a store, inventory, etc. for all the stores through ICT equipment such as POS. However, if there's a stock-out for some reason, it is necessary to accommodate opportunity loss for the duration of stock-out period in the demand prediction calculations. Item-by-item management allows retailers to

calculate opportunity loss in theory from the time of stock-out; however, situations where actual shelf inventory and inventory data do not match can pose problems. To deal with such problems, NEC offers shelf monitoring solution that leverages cutting-edge image analysis technology to help analyze shelf display images and monitor shelf stock-out status in real time. By capturing the accurate shelf stock-out time and linking it with demand prediction system, a more accurate demand prediction becomes possible. Furthermore, an alert notifying the store staff about stock-out on sales floor in real time helps to prevent a situation where a product is available in the backyard inventory but not on the store shelf. Such stock-out prevention helps to improve customer satisfaction.

Figure 5: Preventing stock-out and opportunity loss by image analysis



4. Conclusion

Convenience-oriented consumers are opting for nearby stores to shop for perishables and fresh products that tend to have shorter shelf life. Retailers are responding to such consumer orientation by shifting to a smaller-format-multi-store retail model in order to continue as the 'retailer-of-choice'. Such smaller-format-multi-store retailers now need to successfully reduce opportunity and wastage loss by carrying out product assortment, ordering and

inventory control at the individual store level. However, traditional ICT-driven demand prediction systems or automatic ordering methods face hurdles while dealing with product assortment at each individual store level or in case of demand prediction for perishables and fresh products.

NEC offers demand prediction, shelf monitoring and product assortment optimization solutions that leverage NEC's rich retail expertise on smaller-format store operations, developed through its experience of supporting numerous retailers. In addition to this retail expertise, NEC also leverages its original AI and cutting-edge image analysis technologies to these solutions that help to reduce opportunity loss and wastage loss while improving operation quality and reducing operational burden, all at the same time. This contributes significantly to improving customer satisfaction and to the overall smaller-format-multi-store retail model management. Furthermore, reduction in the wastage loss also contributes towards reducing food wastage which is a social issue.

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Company Overview

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Business Overview:

NEC has been a leader in the field of industrial technology, and we have been a driving force behind the development of cutting-edge technologies in the three areas of computing, network, and software solutions. We have been also promoting various research and development initiatives that look into the future in the advanced areas of data science and artificial intelligence (AI).

As a 'Value Provider' we are focused on the values of "Safety," "Security," "Efficiency," and "Equality" through our Solutions for Society business, as we work to solve social issues from a global angle with the ultimate goal of helping people live more prosperous lives.

Brand message:

"Orchestrating a brighter world"

NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow. We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs. Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.