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The Globalization of Automotive Network Infrastructure: ENX Moves toward the East

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Abstract

This paper is focused on the network infrastructure of the automotive industry in Europe. Some of the network infrastructure entities of the automotive industry, such as the Automotive Network eXchange (ANX), European Network eXchange (ENX), Japan Network eXchange (JNX), are well known. There are not many articles concerning ENX, though articles concerning ANX and JNX occasionally appear. In this paper, after a review of the historical development of ENX, the current state of ENX is analyzed. Automotive enterprises in Europe are developing on a global scale. According to past studies, using the communication infrastructure like ANX and ENX has significant advantages over individual networks in terms of cost and management. ENX is already used in 19 countries within the EU and 12 countries out of the EU. ENX received a request from car makers that have developed the business in Turkey recently. Then ENX Association approved Turk Telekom, which was the Certified Service Provider (CSP) of ENX for Turkey. There are European OEMs and suppliers in Turkey.

Turkey is the 17th largest car producer in the world. Looking to the east of Turkey, India is the world's 7th largest producer of cars, China's is number one, and ASEAN, including Thailand, is 14th in the world; Malaysia is 22nd in the world, and Indonesia is the world's 23rd largest automobile producer. In these places, there is no network infrastructure such as ANX and ENX. There is JNX in Japan, which is the 2nd biggest producer of cars in the world, KNX in South Korea, which is 5th in the world, and AANX in Australia, which ranks 28th in the world.

I will discuss issues related to the expansion for ENX in India, China, and ASEAN. There are two possible ways for ENX to expand. One is the way in which it expanded into Turkey. ENX would certify the carrier in those countries as CSPs. BT Infonet and Verizon Business provide the global coverage service for TPs of ENX. Since this case has already been experienced in Turkey, the problem seems to be small. The other is the way in which INX in India, CNX in China and SENX in ASEAN, and ENX were founded by linking those network systems.

Introduction

Great deals of data and documentation have been exchanged by various means among original equipment manufacturers (henceforth OEM) and suppliers in the automotive industry. For instance, data concerning specifications of parts, CAD data on the stages of production and development, and order and shipping data are now widely circulated. In recent years, electronic data interchange (EDI) has shortened lead time at each stage of development and ensured the security of sensitive data. The development of EDI is a historic innovation for standardization and sharing of information.

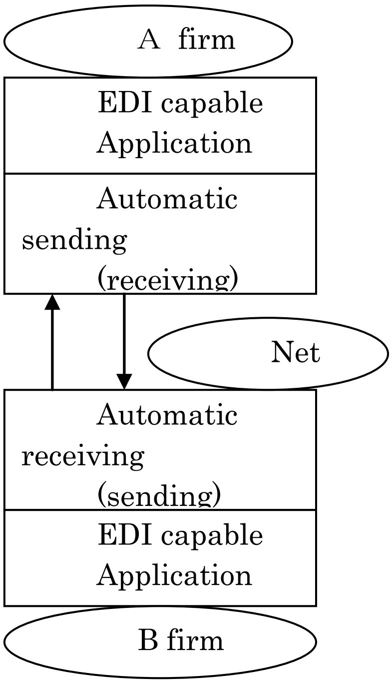
This paper is focused on the communication infrastructure of EDI in Europe. It is confirmed that automobile enterprises in Europe are cooperating in this area and developing globally. The ENX (European Network eXchange), a common communication infrastructure used by the European automobile industry, has been made available recently in Turkey. Plans are being proposed to overcome barriers to the enhanced use of ENX in India, China, and Southeast Asia in the future.

1. Framework of EDI Analysis

Hill and Ferguson (1989) defined EDI as follows: "Electronic Data Interchange (EDI) is the movement of business data electronically between or within firms (including their agents or intermediaries) in a structured, computer-processable data format that permits data to be transferred without rekeying from a computer-supported business application in one location to a computer-supported business application in another location" (para 8). This is illustrated in Figure 1. In many cases, this form of EDI has been done between OEM and Tier One suppliers in the automotive industry. The reason is that this method is suitable when large amounts of data are sent and received at high speeds with the secure. It is necessary to decide the communication protocol and the data format beforehand in order for this form of EDI to proceed smoothly.

Web systems are becoming popular nowadays, as the capability of exchanging data via Internet websites (for instance, SupplyOn in Germany) continues to grow. This type of data exchange is called Wed-EDI (see Figure 2). To distinguish it from Wed-EDI, current EDI came to be called *Classic* or *Classical EDI*. They are the same in that they are both systems in which electronic data is exchanged on telecommunication lines. However, the difference between the two lies in the way each defines the author's aspect. Classic EDI is the system in which the data processed by an EDI capable application is automatically sent and received. Communication protocols and the data format must be determined beforehand for communication to proceed smoothly in this form of EDI.

On the other hand, Wed-EDI is the system which a person accesses a Wed-EDI site via a terminal, needing at least a browser to start the application. The person need only click the buttons on the screen, follow instructional prompts on the screen, and input data on the screen. The results are printed as necessary. The application software is offered by Web-EDI vendors as a service, which is called Software as a Service (SaaS). However, as a minimum function, the user who has submitted the order and the shipment data via fax or some other means makes a request for the digitalization of data. The business software for the personal computer will be operated in the background in this type of system and synchronize with Wed-EDI as necessary.



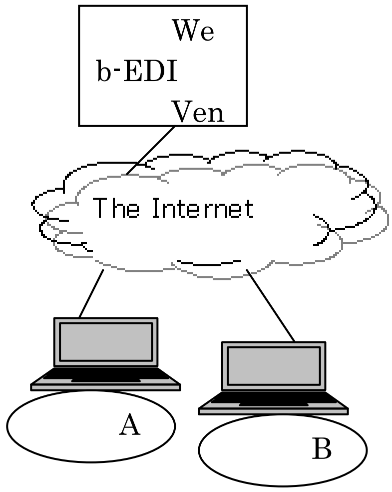


Figure 1
Classic EDI
(The author creates)

Figure 2
Web-EDI
(The author creates)

The author studied EDI in the automotive industry in the United States, Japan, and South Korea before the widespread use of the Internet and through empirical research demonstrated that for Tier One suppliers in these countries, it was basically necessary to maintain individual telecommunication lines for communication with OEMs (Ichida, 1997, 1999, and 2001). At that time, a three-layer structure (Table 1) of the EDI was used and enhanced; it will be used in this study as well.

Table1

Three Layers of EDI Analysis

Application
Data
Network

The bottom layer concerns security and protocols of the telecommunication line. The middle layer chiefly concerns the format of data within the EDI. The upper layer concerns the EDI-capable application programs, such as conversion software for data format or Enterprise Resource Planning (ERP). Web-EDI has essentially the same three-layer structure as classic EDI. The network at the bottom layer is the Internet. As for the application in the upper layer, the minimum software needed is a browser. Application software is operating on the Web-EDI site that the user access is offered to the user as a service. This is called the Software as a Service (SaaS). The user need not know the data format. No IT expertise is needed to use Web-EDI. The user easily becomes accustomed to the operation, which is similar to shopping online. However, there is a situation in which the Web-EDI user wants to batch-process in coordination with its own information system, including order and shipping data, etc. The reason for this is that data input is efficient. Some venders of Web-EDI, such as SullyOn, can satisfy such a demand. In such cases, the user should consider the data format.

OEMs had originally decided individually on the protocol specifications for the network and the data format of initial EDI in the automotive industry. However, at industry level, a standard was requested because the various specifications at the individual corporate level made it difficult for EDI to spread. The discussion continues even now about the standardization of the data format in the automotive industry at organizations such as Verband der Automobil Industrie (VDA) in Germany, Groupement pour l'Amélioration des Liaisons dans l'Industrie Automobile (GALIA) in France, The Society of Motor Manufacturers and Traders (SMMT) in the U.K., Asociación Española de Fabricantes de Automóviles y Camiones (ANFAC) in Spain, and Organization for Data Exchange by Tele Transmission in Europe (ODETTE), which covers Europe. In addition, an international standard at the global level is being discussed by the United Nation EDI Standardization Group. Data standardization has been discussed by the United Nations besides these streams. The results are open to the public through the United Nations/Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT). The three layer structural model is applied to Classic EDI and Wed-EDI is shown in Table 2. However, a concrete example of the data format and network target is the one mainly used by the European automotive industry. The installation and removal of Web-EDI is easy. On the other hand, Classic EDI is built-in its own information system, so it is continued as long as there is no big change reason. My hypothesis is that Classic EDI is one of factors which form a continuous, long-term relationship between OEM and suppliers. The relation between the enterprises is not deeply analyzed in this paper.

Table2 *Three Layers of EDI Analysis Applied to Classic EDI and Web-EDI*

Three Layer	Classic EDI	Wed-EDI(Minimum)
Application	EDI capable Application	Browser (Application by SaaS)
Data	VDA, OETTA, UN/EDIFACT	User un-known
Network	ISDN, ENX	The Internet, ENX

Source: author

The network of the automotive industry began at the individual corporate level, and has developed a common infrastructure at the level of the entire automotive sector. The development of the data format is a topic for later discussion; the communication network of the automotive industry is the focus of this paper.

2. Development of Communication Infrastructure in the Automotive Industry

Computers first connected OEM and specific Tier One suppliers through telecommunication lines in the 1960's, and the data exchange was first conducted in the United States (Ichida, 2007). Toyota Motor Company had been exchanging data with Tier One suppliers such as DENSHO online by means of the TOYOTA Network System (TNS), which has been in operation since the early 1970s and has established especially deep relationships. However, there were a lot of juridical restrictions to the exchange of data processed by computer via telecommunication lines at that time. Through the liberalization of the communications industry, including privatization of Nippon Telegraph and Telephone Public Corporation, OEMs been able to procure parts from suppliers online (Ichida, 2006).

The Internet, the use of which had been limited to military affairs, science, and the research, was finally made available for businesses in 1988. The Automotive Industry Action Group (AIAG) developed the Automotive Network eXchange (ANX) using the Internet and started aiming toward the communication infrastructure of the automotive industry of the United States in 1995. The pilot project of the ANX was completed in 1998, and real service began operation in October of the same year (AIAG). The goal of ANX was to sufficiently stimulate the automotive industry in other regions. The communication infrastructure of the automotive industry in the each country following the framework of ANX started operations in about 2000; ENX in Europe started in 1999, Japan Network eXchenge (JNX) in Japan started in 2000, Australian Automotive Network eXchange (AANX) in Australia started in 2000, and Korean Network eXchange (KNX) in Korea started in 2001. Discussion of the role of communication infrastructure in the automotive industry rose among scholars and researchers when the number of Trade Partners (TP) began to increase.

Wolak (1999) developed the mechanism of ANX and applied it to TPs as OEMs and suppliers. He also forecast that ANX would bring revolutionary profits to electronic dealings. Cassivi, Lefebvre, & Le He (2000) also expected ANX to become the platform of the supply chain, from the research and development of the United States automotive industry to the design, manufacturing, delivery, and customer service. Henseler et al. (2008) noted that ANX and ENX seem “to be an ideal foundation for the required highly available communication infrastructure” (p. 312) when the automatic recognition system using the RFID tags in supply chain products is used.

At the beginning of the 2000s, ANX, ENX, JNX, AAAX, and KNX participated in the Global Network eXchange (GNX) Assembly Conference, which aimed at addressing issues in the communication infrastructure of the global automotive sector. At this point, the interconnection among ANX, ENX, JNX and others had not yet materialized. TPs, which use both types of infrastructure, have not participated, even though ANX and JNX have coordinated their schedules since 2003 (ANXeBusiness Asia-Pacific, 2004). In 2010, after the tie-up of ENX and ANX, the author was able to attend the signing ceremony. OEMs and suppliers are developing business on a global scale, so it is natural to want to be able to use EDI anywhere on Earth. In the next chapter, the problem of ENX's contributions to a global communication infrastructure in the automotive industry will be analyzed based on the current status of ENX.

3. The History and Current State of ENX

3.1 History of ENX

There are few academic articles focusing on individual European countries of the ENX, according to a similar pilot case conducted by Wolak (1999) regarding the above-mentioned ANX. However, Wakabayashi (2000) of the Japan Automobile Manufacturers Association, Inc (JAMA) described the situation of ENX in November 1999. This situation demands further scrutiny.

The connection between the domestic and the international network was discussed in around 1997 by the Interim Task Force (ENX-ITF) in each country in Europe in response to AIAG of the United States having tried the ANX project in 1995. The European Steering Committee was subsequently established in enterprises and organizations in October, 1999, including the twelve OEMs of Audi, BMW, DaimlerChrysler, Fiat, FORD, OPEL, PSA, Renault, Saab, Scania, Volvo, and VW, as well as four suppliers of Aceralia. Siemens, Bosh, Michelin and four Automotive Manufacturers Associations: SMMT in the U.K., VDA in Germany, GALIA in France, ANFAC in Spain. The standardization organization ODETTE also joined the Steering Committee.

VDA was initiated and operated in Germany in March 1999, after the pilot project, which had been executed from October 1998 to February 1999, was completed. There were 35 TP companies as of November 1999 including the OEMs of Audi, BMW, and Daimler-Chrysler, and suppliers. Deutsche Telekom supplied the network. GALIA was initiated in France, and the OEMs of Renault and PSA, as well as eight suppliers executed the pilot project from January to May of 1999. Renault cooperated with EQUANT Co., and France-Telecom cooperated with the PSA. Germany and France began interconnection tests and completed verification in July 1999. The pilot project in Spain was executed from December 1998 to March in 1999, and the pilot was continuing at the time November 1999. TPs were two OEMs, those for Citroen-Hispania and Nissan Motor Iberica, as well as four suppliers and engineering companies. The network used schedule of British Telecom and UU-Net in Britain while preparing for the pilot project. The organization (Overseer of ENX) that managed the entire ENX had not been set up as of November 1999. Therefore, a telecommunications provider to support the network was not yet introduced for Certified Service Provider (CSP) of ENX.

ENX Association was established by Audi, Bosch, BMWs, Daimler, Fiat, Ford, Karmann, MAN, Opel, Porsche, PSA, smart, VDO Automotive, Volvo and Volkswagen, the National Automotive Association, ANFAC, GALIA, SMMT, and VDA in July 2000. The purpose for the establishment of the ENX Association is "to develop and operate standardized communications services for the European automotive industry as well as other sectors. It serves to securely exchange development, production control and logistic data. The ENX Association is the organisational roof of the entire ENX concept and engine of the further development" (ENX, 2010a). This description shows that the ENX Association is the overseer, playing a key role of the development of ENX, its operation, and its promotion.

3.2 Current state of ENX

Katz and Shapiro (1985) described situation regarding Network Externality as follows: “There are many products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the good. There are several possible sources of these positive consumption externalities” (p. 424). The concept of Network Externality is also called Network Effect. Gilder formulated Metcalfe's law about similar phenomenon as follows: “In this era of networking, he is the author of what I will call Metcalfe's law of the telecosm, showing the magic of interconnections: connect any number, ‘n,’ of machines - whether computers, phones or even cars - and you get ‘n’ squared potential value.” (Gilder, 1993, para 6). In effect, the value of the network rises when the number of participants on the network increases. Therefore, it is necessary to analyze the number of TPs participating in the ENX.

The total number of participating TPs, according to the listings found on the ENX website, was 1002 on May 20, 2010, and 1603 on August 24th of the same year. Classification of participating TPs by country is shown in Table 3. The number of TPs grew suddenly by more than 50% because ENX and ANX joined forces on July 8, 2010. Actually, the number of participating TPs from the United States increased from 4 to 539, and Canadian TPs increased from 0 to 38. The number of participating TPs in ANX will be referenced, though the current number of TP’s participating in ANX has not been made open to the public recently. The number of TPs participating in JNX was 2094 as of August 30, 2010[1]. However, if a company has registered in a different state and/or country, it is counted as another TP in ENX and ANX. It is necessary to note that there is a different standard because JNX came to count multiple enterprises as a single TP in 2010. All TPs participating in JNX has been connected. However, the state of TP in ENX includes three stages of participation: "connected," "registered," and "order is placed." Many TPs which have joined from the United Stand and Canada are counted as being at the "registered" or "order is placed” stage now because ENX has only recently partnered with ANX. It is assumed the number of TPs include these at earlier stages of participation because TPs at either of those stages will be connected sooner or later.

Table3 *Number of TP Participating in ENX by Country*

Country	2010.5.20	2010.8.24
Austria	10	10
Belgium	8	8
Brazil	1	1
Canada	0	38
Croatia	1	2
Czech Republic	3	6
Denmark	2	4
Finland	2	4

France	242	244
Germany	646	664
India	1	1
Ireland	2	2
Italy	11	13
Japan	1	1
Liechtenstein	1	1
Luxembourg	1	1
Monaco	2	2
Netherlands	10	10
Poland	1	1
Portugal	1	1
Romania	1	1
Russia	1	1
Slovakia	1	1
Slovenia	2	2
South Africa	1	1
Spain	16	16
Sweden	5	4
Switzerland	6	6
Turkey	7	6
United Kingdom	12	12
United States	4	539
Total	1002	1603

Source: the author's classification based on ENX listings.
(http://www.enxo.com/yp/index.php?language=english)

There are many TPs in Germany, and the rapidly increasing number stands out. The number of German TPs participating in ENX increased more than 200 each year from 2007 to 2009. The number of individual connections by OEMs has also increased (Table 4). Tier One suppliers can still be expected to increase, but I would suggest that ENX does not sufficiently promote for Tier Two and Tier Three. At first, ANX, ENX, and JNX expanded mainly in the automotive sector. Now, ENX is available for use in the banking sector and the French defense sector. This suggests that ENX is recognized as applicable to the communication infrastructure needs of wide-range of business because types because of its safety, availability, and the reliability across disparate communities.

Table 4 *Number of Individual Connections of ENX by OEMs*

	2007.4	2008.10
Renault	219	387
Daimler	161	272
BMW	117	186
Audi	206	306
Volkswagen	209	308
Ford	88	114
PSA	216	258

Source: (ENX, 2008)

4. Globalization of ENX

ENX differed from ANX and JNX, in that when it was established, it was composed of multiple countries. At first, because there were many different countries involved, there was sufficient time to test the necessary interconnectivity of the telecommunications provider. Now, the CSPs are as follows: BT Infonet and Verizon Business offer their ENX service on a global scope. That includes countries with incumbent service provider like Germany, France, Spain and Turkey.

T-Systems offers ENX services to Germany-based companies within Germany and various other countries. Orange Business Service offers ENX services to France-based companies within France and various other countries. Telefónica Empresas offers ENX services to Spain-based companies within Spain and various other countries, and Türk Telekom offers ENX services to Turkey-based companies within Turkey. There two CSPs (IDC and Numlog) in France that resell Orange Business Service (ENX, 2010b).

4.1 To Turkey and to the East

Türk Telekom was certified as the CSP of ENX in 1998. Looking at the number of TPs in different countries, there are 19 EU member states in addition to the 12 member countries. Countries outside the EU are geographically located in Europe, such as Croatia, Liechtenstein, Monaco, and Switzerland, as well as Brazil, Canada, India, Japan, Russia, Turkey, and the United States. However, Turkey is a significant addition. The country comprises 5% of Europe and joined The European Union Customs Union in 1996. It may be listed among EU member countries.

Automotive production in Turkey began in 1967. Production in 2009 made it the 17th largest producer in the world, just ahead of Italy (OICA, 2009). There are 15 OEM companies registered in the Turkish automotive manufacturers association, OSD. ENX has decided to expand business in Turkey at the request of Renault, PSA and Ford, which produce cars in Turkey (ENX, 2008). As of the end of August 2010, Turkey has six TPs in ENX. There are four suppliers (Componenta Dokumculuk Tic. Ve San. AS, FARPLAS Oto Yedek PARCALARI IMALAT ithalat ve ihracat AS, KIRPART OTOMOTIV PARCALARI AS, STANDARD PROFIL OTOMOTIV AS) one engineering firm (MAP Havacilik Enerji ve Elektronik Ticaret ve Servis AS), and an IT service firm (Sim Sistem Bilisim Hizmetleri Limited Sirketi).

OEMs used VAN to communicate with suppliers before ENX extended business into Turkey. Some OMEMs still use VAN. It is forecast that the ENX connection with Tier One suppliers will increase in the future. It is said that there are more than 900 automotive suppliers in Turkey. According to the results of the author's long-term research, the integration of infrastructures such as ENX, ANX, and JNX, has had a significant effect in terms of cost reduction and lower management for the Tier One suppliers who trade with two or more OEMs. From Turkey to the east, there are many countries that produce cars. For instance, India is the world's 7^{th} largest producer of cars, China's is number one, and ASEAN, including Thailand, is 14^{th} in the world; Malaysia is 22^{nd} in the world, and Indonesia the world's 23^{rd} largest automobile producer (OICA, 2009). European OEMs and many suppliers are now advancing into these countries and areas. The Network infrastructure of automotive industry in these countries has not yet been surveyed. However, Japan, which is the world's 2^{nd} largest car producer, has JNX; South Korea, which is the world's 5^{th} largest, has KNX, and Australia ranked 28^{th} in the world, has AANX. It has already been mentioned that those countries already have automotive communications infrastructure modeled on ANX in the United States.

4.2 Global challenges to the east

In this section I will discuss issues related to the expansion for ENX in India, China, and ASEAN. There are two possible ways for ENX to expand. One is the way in which it expanded into Turkey. ENX received requests from European OEMs and suppliers and would certify the carrier in those countries as CSPs. BT Infonet and Verizon Business provide global coverage service for TPs of ENX. Since this case has already been experienced in Turkey, the problem seems to be small. However, if domestic OEMs and suppliers and non-European OEMs and suppliers do not participate, questions remain as to whether or not to maintain the existing telecommunications infrastructure of the country's automotive industry. The other is the way in which INX in India, CNX in China and SENX in ASEAN, and ENX were founded by linking those network systems. ANX and ENX (if they may be called xNX collectively) use Internet technology in various ways. But the entire organization is not managed via the Internet; rather, xNX in the presence of each Overseer, is the principal form of management. The Overseer coordinates between CSPs and provides a smooth interaction between CSPs and TPs and among TPs when disputes arise. AIAG was the Overseer of

ANX initially. AIAG sold ANX to a private company, SAIG, in 1998. ANX was then resold to the private equity investment firm, One Equity Partners (OEP), which owns it now. ANX eBusiness Corp. manages and operates ANX. Therefore, the Overseer of ANX is a private company, ANX eBusiness Corp.

The Overseer of ENX is the ENX Association. It is composed of Europe's leading OEMs (Audi Bosch, BMW, Daimler, Fiat, Ford, Karmann, MAN, Opel, Porsche, PSA, smart, VDO Automotive, Volvo and Volkswagen) and Automotive Manufacturers Associations (ANFAC, GALIA, SMMT and VDA). The Overseer of JNX is JNX Center, which belongs to the Japan Automobile Research Institute (JARI). The JNX Steering Committee, which consists of the Japan Automobile Manufacturers Association, Inc (JAMA), the Japan Auto Parts Industries Association (JAPIA), JARI, TP representatives, and academic experts, decides operating policy based on neutrality and fairness. Whether this Overseer can be founded in India and China is one of most pressing issues. It is said that there are 20 OEMs in India and more than 100 OEMs in China. The issue is whether or not standardization in these countries will be integrated domestically. Though the telecommunications infrastructure and standard data format have been established, standardization will not work if they do not maintain compliance.

It may be difficult to construct a common network for the automotive industry in car-producing countries such as Thailand, Malaysia, Indonesia, and the Philippines. However, the complementary scheme of auto parts in the region, beginning in 1987 with the ASEAN Brand to Brand Complementation (BBC) scheme, the ASEAN Industrial Cooperation (AICO) scheme, the Common Effective Preferential Tariff (CEPT), the ASEAN Free Trade Area (AFTA) has been proven successful in these cases. The possibility of developing automotive network infrastructure in this area remains. Such development may draw upon the experience and multilateral adjustment capability of ENX.

If ENX maintains its central role in the automotive industry, then an increase of Tier Two and Tier Three TPs will be required. Therefore, it is necessary for ENX to continue providing easy connection, easy operation, and killer applications on the Web.

Conclusion

In this article, I have overviewed the communications infrastructure of the global automotive industry, with particular focus on ENX, and have analyzed the current situation. The results suggest that issues will arise when ENX extends to the broader global industry, especially in Asia; I proposed solutions. It took ten years to achieve the partnership between ENX and ANX. I hope to achieve a global network infrastructure for the automotive industry within ten years.

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researcher of the College of Commerce, Nihon University, during the half of the year from April, 2010academic year that began in April, 2010.

Note

1. The TPs of JNX can be found in the Yellow Page of JNX Center's website. But, recently some TP appeared to reject on the Yellow Page. Thus, the total number the Yellow Page of TPs is not correct. So I have confirmed the number of JNX's TP at the time of the 31st August 2010 to the person in charge of JNX center.

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