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Estimating the impact of PSTN migration: the case of eastern Japan

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Abstract:

In this research, we estimated the number of possible subscribers of the public switched telephone network (hereafter, referred to as “PSTN”) in the future of Japan based on the public data, and evaluated the alternatives as the candidates for the migration by comparative analysis, with respect to the definition of PSTN from the regulations in Japan.

As the result of this analysis, the number of those subscribers in Japan will decrease to around 7.1 million households in 2030. Despite the telecommunication operators’ effort to provide their own NGN, 6.8 million subscribers will remain using PSTN. Then, 0.3 million households of them are going to live in the area where the telecommunication operators will not expand their own optical fiber network if the designation of the universal service on telecommunication service will not be reformed.

The result also revealed the difficulties of migration from PSTN because the regulation for PSTN did not justify many of the alternatives including Metal IP Phone, IP phone using optical fiber, CATV, MVNO using LTE.

Keywords:

PSTN migration, universal service, IP telephone, Telecommunications regulation, broadband

1. Background

In recent years, the telecommunication industry in Japan has considered the migration of PSTN. That consideration has contained the population decline in Japan, especially rural area. However, the telecommunication regulations in Japan have not caught up yet on the latest situation, and this estimation has reduced willingness to invest the telecommunication infrastructure turning into optical fiber.

Although there is a large amount of policy research on telecommunication regulations, the research covering the evaluation of impact for migration based on the estimation the number of possible subscribers of PSTN in the future of Japan seems to be little. It is the reason that the authors of this paper have thus far advanced their analysis.

2. Earlier research

At first, we would like to discuss prior research related to this analysis. Earlier research relevant to this study includes that in the area known as the policy research on telecommunication regulations, as well as empirical studies relating to the migration of PSTN.

Mitomo (2015) has outlined the policy research on telecommunication regulations in “A Proposal for a Sustainable Broadband Service in Rural Japan,” a study relating to a framework for the provision of a universal service aimed at solving the various issues inherent in community informatization in Japan. It has shown the possibility to deploy the broadband service as the holistic infrastructure for telecommunication in rural Japan.

Mitomo and Tajiri (2010) has reviewed “provision of universal service and access over IP networks in Japan”, a research on the universal service system, a regulatory framework and its governance that guarantees nationwide access to basic telephone service over PSTN and the migration to IP networks.

However, these researches did not directly cover the evaluation of impact for migration based on the empirical estimation the number of possible subscribers of PSTN. Such estimates have been attempted by the Ministry of Internal affairs and Communication, Japan (2015).

3. Definition of PSTN by regulations

In order to estimate the number of subscriber and to evaluate the alternatives, the authors have clarified the definition of PSTN under the telecommunication regulations in Japan. The regulation of PSTN is set as the universal service by Article 7 (Provision of Universal Telecommunications Service) of the Telecommunications Business Law in Japan.

This definition is also detailed as the Specified Telecommunications Service, a service having a significant influence on the interests of users in light of their content, scope of users, etc, by Article 21 of the law and the Regulations for Enforcement of the Telecommunications Business Law. It is a basis that PSTN in Japan is under the price-cap regulation.

The technical requirements of PSTN are also set by the regulations, and it is separated from IP phone. According to the regulations for enforcement of the law, the service of PSTN has to be provided from the facility only for fixed service including transmission line and terminal. On the other, the service of IP phone needs to use the facility for the Internet Protocol and optical fiber.





The charges and its framework of PSTN are set as the Specified Telecommunications Service by the Regulation for Enforcement. In the use of the migration from PSTN, IP phone must be provided at a moderate price from PSTN.

4. Comparative analysis of alternatives for migration

There are possible 4 alternatives to migrate from PSTN today; Metal IP Phone, IP phone using

optical fiber, CATV, MVNO using LTE. However, the Information and Communications Council at the Ministry of Internal affairs and Communications, Japan (hereafter, referred to as “MIC”), has already determined that Metal IP phone will be a complement to migration, and thus be excluded from the empirical candidates. The comparative analysis of alternatives is below:

Table 1 Comparative analysis on technology and regulation of alternatives for migration

	 Metal IP Phone (Core NW : IP)	 IP Phone Using Optical Fiber	 Cooperation with CATV Operator	 LTE MVNO
Audio Signal	Analog	Digital		
Access Line	Wired			Wireless
	Metal	Optical Fiber	Coaxial Cable	
Phone Number	Standard Fixed Phone Number:0AB-J			Standard Fixed Phone Number:0AB-J (Premised on Using VoLTE)
Equipment Requirements of Basic Telecommunications Service	Fulfill the Requirement		Fail to Fulfill the Requirement (Not All Transmission Lines are Optical Fiber)	
Basic Charge Requirements of Basic Telecommunications Service	Fulfill the Requirement	Fail to Fulfill the Requirement (Provided as an option of broadband service)	Have a High Probability of Fulfill the Requirement	
Service Area	Nation Wide	Rural Areas are Not Provided	Some Areas are Not Provided	Nation Wide
Additional Capital Investment (for PSTN Operator)	Need (Already planned)	No Need : Inside the service Area of Fiber Need : Outside the Service Area of Fiber	No Need	No Need

As we have already mentioned at section 3, PSTN is defined as the Universal Telecommunications Service and the Specified Telecommunications Service by the regulations. It expects that the charge and the usage cost of alternatives of migration should be reasonable, at least similar to latest PSTN.

All of operator providing alternatives do not open the usage cost to public, and hence we have compared for each service in the assumption that the usage cost is not beyond the latest expense.

And then, we have assumed the standard model of charge which a subscriber uses 2-minute-talk multiplied by 48 times per month, based on the report issued by MIC.

Table 2 Comparative analysis on latest cost of alternatives for migration

(¥: JPY)
















							
		PSTN	Metal IP Phone	IP Phone Using Optical Fiber	Cooperation with CATV Operator	LTE MVNO	
* It is approximate because there are no clear numbers	Within Message Area	¥8.5	¥8.5	¥8	¥8	¥80	
	- 20km	¥20					
	-60km (Toll Area)	¥20					
	Over 60km And Toll Area	¥30*					¥15* (Toll Area)
	To Cell Phone	¥32					
Num of Calls (/month)	Within Message Area	18*	41	41	25*	48	
	- 20km	5*					
	-60km (Toll Area)	2*					
	Over 60km And Toll Area	16*					16*
	To Cell Phone	7					

Table 3 Comparative analysis on outlook for future cost of alternatives for migration

	 PSTN	 Metal IP Phone	 IP Phone Using Optical Fiber	 Cooperation with CATV Operator	 LTE MVNO
Basic Charge (/month)	¥1,700	¥1,700	(¥1,700)	¥1,330	¥1,600
Call Charges (/month)	¥997	¥573	¥552	¥664	¥3,840
Total	¥2,697	¥2,273	(¥2,252)	¥1,994	¥5,440 (¥2,450 with Option)
Note	<ul style="list-style-type: none"> Using highest expense 			<ul style="list-style-type: none"> Possible set sales including TV and/or broadband 	<ul style="list-style-type: none"> Data included. Some operators providing Limited Free Charge of
Outlook for future costs	 Upside	 Upside	 Downside	 Sideways	 Downside

5. Estimation for future charge of PSTN

The charge of PSTN in regulation is calculated by the Basic Rate Index. This indexation is using price in 2000 as 100, and shows the maximum of charge by each year. It is defined as:

$$\begin{aligned} &\text{Basic Rate Index (Current)} \\ &= \text{Basic Rate Index (Last Year)} \times (\text{CPI} - X + \text{Exogenous Factors}) \end{aligned}$$

CPI: Consumer Price Index

X: Productivity Improvement Prospect

X is using the mix factor productivity to set the value. It is considered by the “study group of the operation for price-cap” at MIC, and this study group revises the value every 3 years. From 2000 to 2012, they determined “X = CPI” and Exogenous Factors set as 0. However, in 2015, X was changed to 0.4 due to price increase. As a result, the Basic Rate Index has become 102.1, and it

enables the basic charge as a maximum of JPY 1,786.

Without X, the Basic Rate Index is depending on CPI. It means that the basic charge is in proportion to CPI if X is fixed. The Japan Center for Economic Research provides the forecast of CPI as below:

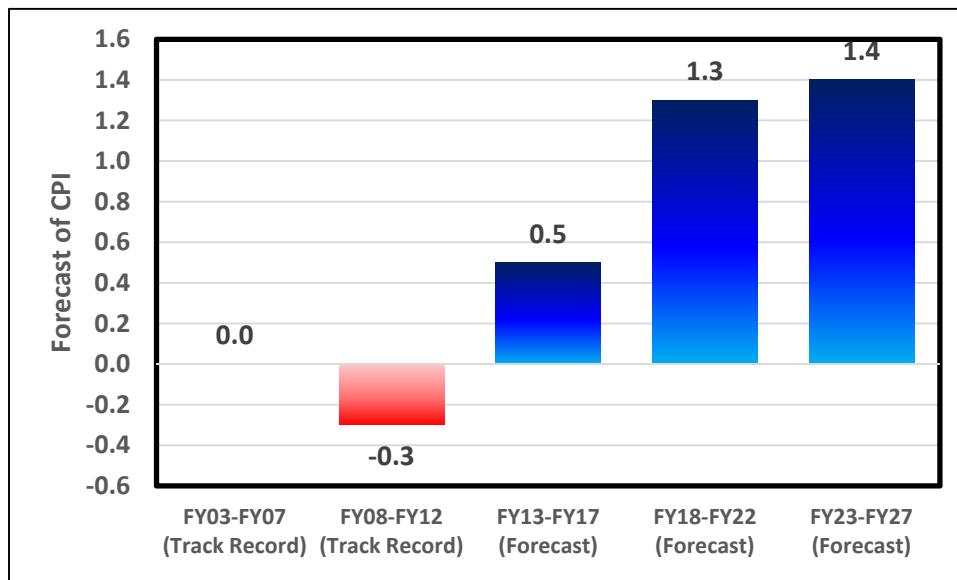


Figure 4 Forecast of CPI

Here, we assume that CPI set as 1.4% and X as 0.4 in the future. As the result of estimation, the maximum of basic charge in FY2030 will be beyond JPY 2,000.

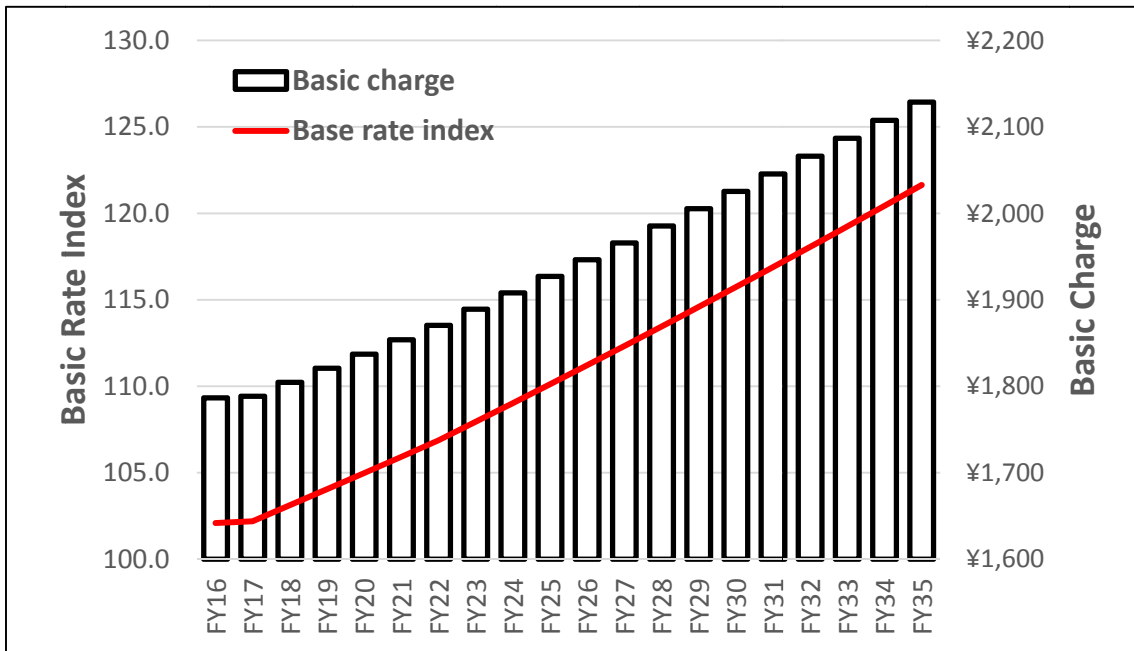


Figure 5 Forecast of Basic Charge and Base Rate Index

6. Estimation of PSTN Subscribers in eastern Japan

The number of PSTN subscribers is decreasing. From 2004 to 2015, PSTN using metal line was canceled by 13.2 million subscribers as below:

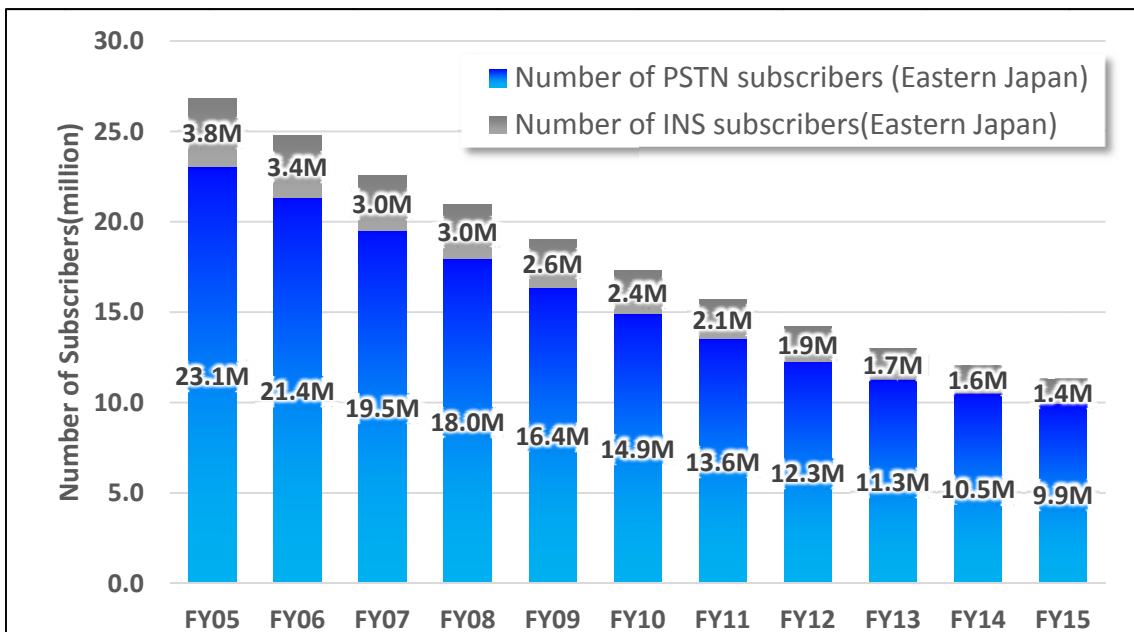


Figure 6 Trends of PSTN subscribers

On the other, the rate of reduction by year is also diminishing as below:

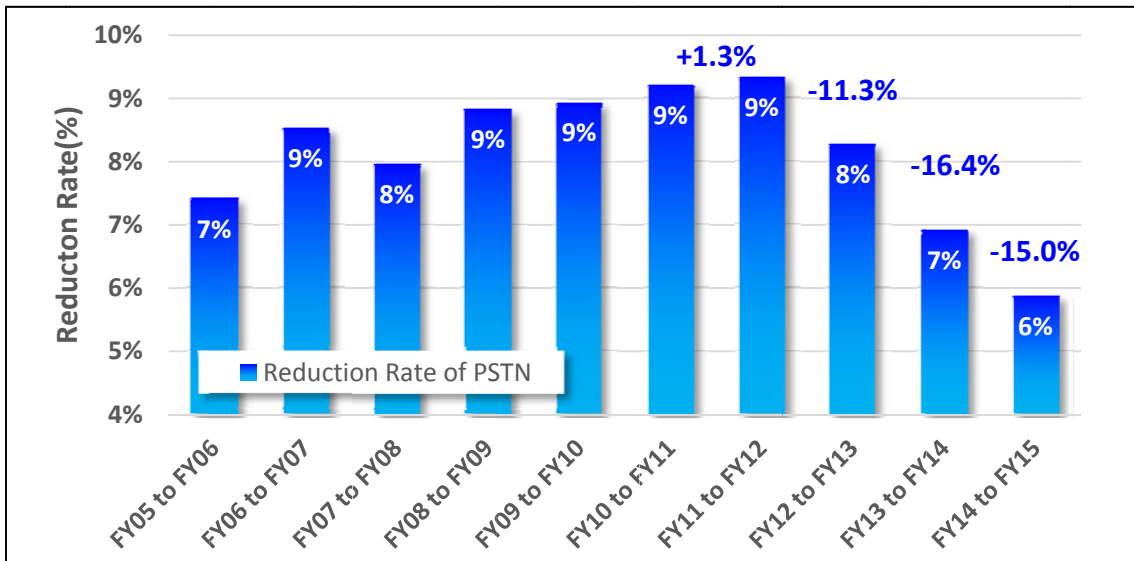


Figure 7 Trend of PSTN Subscriber Reduction Rate

In the case to assume that the reduction rate will be stable as average of the latest 5 years, the forecast of reduction rate in the future will be set 10.3 percent.

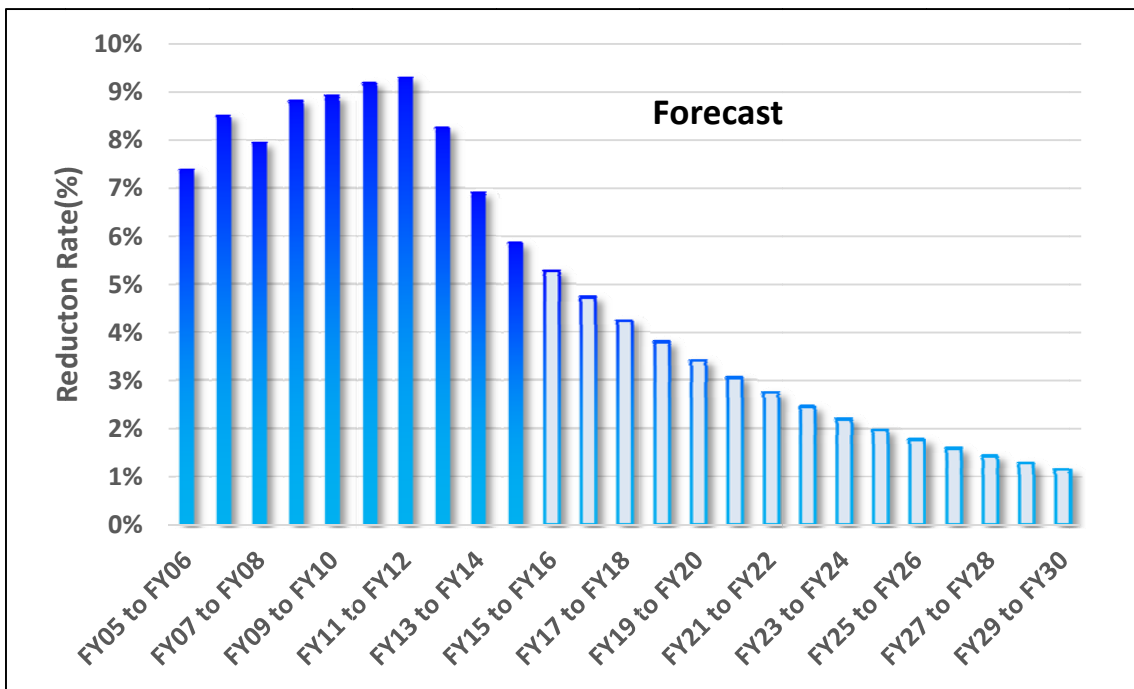


Figure 8 Forecast of PSTN subscriber reduction rate

Here, we have used the reduction rate to estimate the number of subscribers using metal line,

and thus the total subscribers of PSTN and INS are estimated as 7.1 million. It means that the 27.3 percent of whole subscribers (25.9 million households) in eastern Japan will remain the service of PSTN.

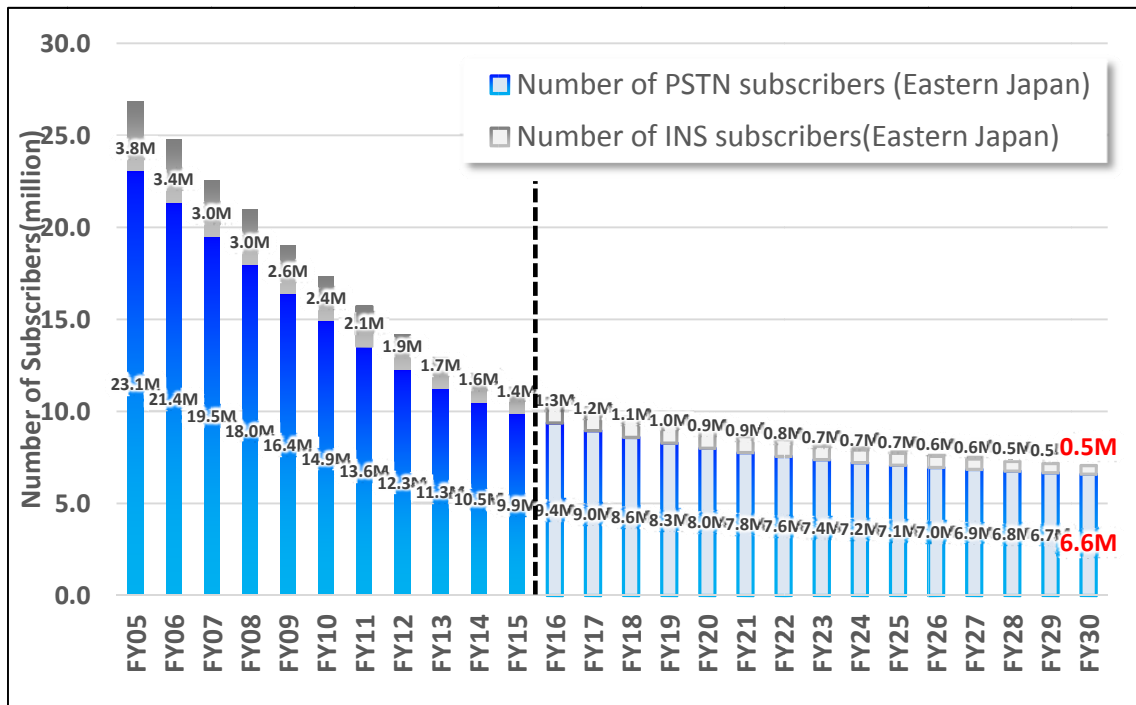


Figure 9 Forecast of PSTN subscribers

7. Estimation of PSTN Subscribers by prefectures in eastern Japan

The number of households is in proportion to decrease in population in Japan, and it will peak out from 2020. However, the number of households in eastern Japan seems to be stable from 2010 to 2030 due to population concentration in urban areas.

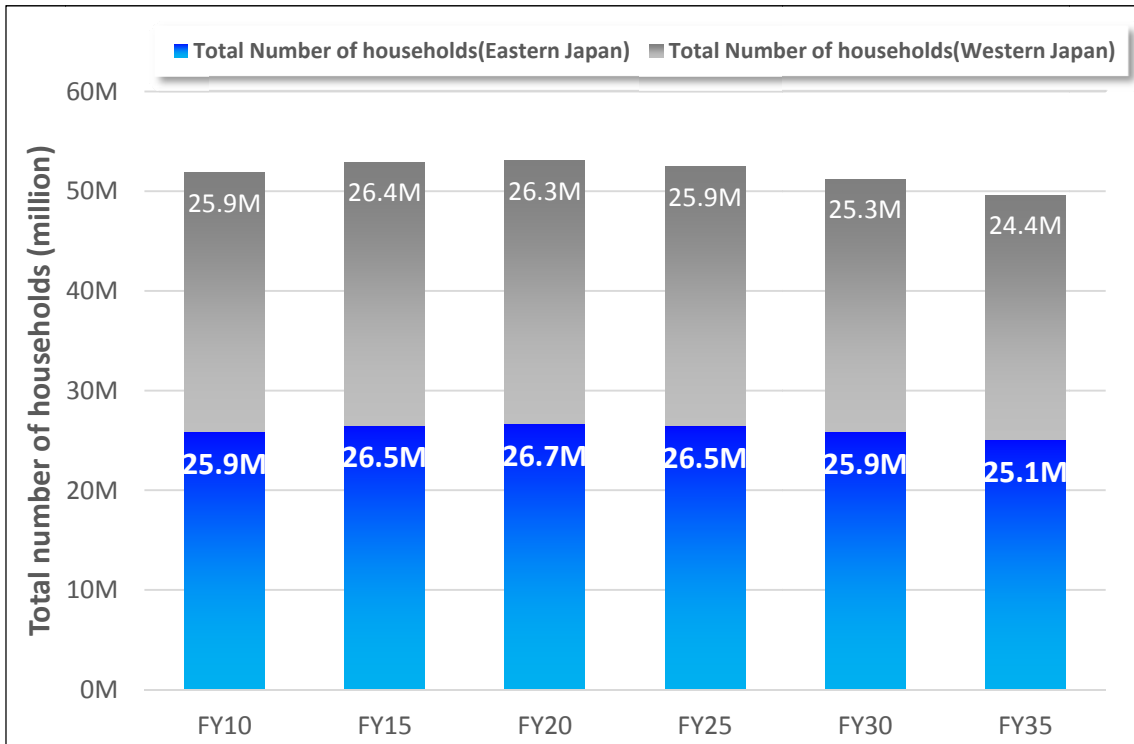


Figure 10 Forecast of household numbers

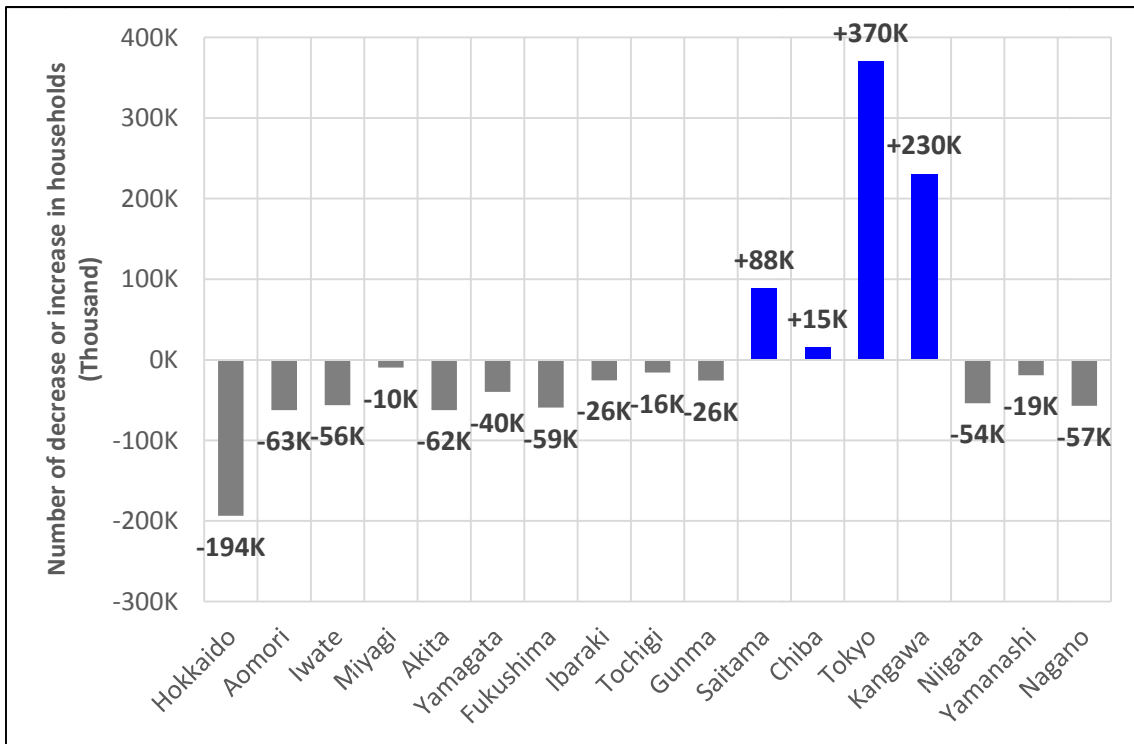


Figure 11 Number of households that increase or decrease from 2010 to 2030 (by prefecture)

In the context of the telecommunication, the urbanization means the possible subscribers of the broadband internet access services will be increase.

On the other, the service provider has already open the coverage of feeder point for optical fiber to the public, and thus it will be presumed in this estimation as the coverage of optical fiber providing to households as below:

Table 12 Coverage rate of feeder point for optical fiber

	The coverage of feeder point
ordinance-designated city and prefectural capital	98%
City population more than 100,000	97%
Other	89%

The following steps are the structure of estimation under the consideration of population dynamics in 2030.

1. Obtain data on the number of households, population and city by mesh within a radius of 500 meters from a national census in 2010.
2. Provide category in the order of Table 12 from data as obtained.
3. Add the number of households in population order from large until the coverage fulfills.
4. Aggregate the coverage of optical fiber providing to households by prefectures (Table 13) and by service area (Table 14) in 2010.
5. Multiply by the coverage of optical fiber providing (Table 12) to households by prefectures, and then, separate the number of households from 2010 to 2030 between inside/outside service areas (Table 15).
6. Calculate the number of households in 2030 for inside/outside service areas (Table 16).

Table 13 Cover rate of optical fiber by prefecture

	Cover Rate of Optical Fiber
Hokkaido	94.4%
Aomori	91.0%
Iwate	79.3%
Miyagi	91.4%
Akita	85.1%
Yamagata	86.8%
Fukushima	84.2%
Ibaraki	91.4%
Tochigi	88.0%
Gunma	92.8%
Saitama	98.7%
Chiba	96.9%
Tokyo	99.9%
Kanagawa	99.5%
Niigata	88.0%
Yamanashi	93.7%
Nagano	90.1%

Table 14 Number of households in service area and out of service area of optical fiber in 2010

	Number of households Inside the Service Area of Optical Fiber	Number of households Outside the Service Area of Optical Fiber
Hokkaido	2,288K	137K
Aomori	467K	46K
Iwate	384K	100K
Miyagi	824K	78K
Akita	332K	58K
Yamagata	337K	51K
Fukushima	607K	114K
Ibaraki	994K	94K
Tochigi	656K	90K
Gunma	701K	55K
Saitama	2,809K	38K
Chiba	2,434K	77K
Tokyo	6,395K	6K
Kanagawa	3,817K	20K
Niigata	738K	101K
Yamanashi	307K	21K
Nagano	716K	79K

**Table 15 Number of decrease or increase in households
in service area and out of service area of optical fiber from 2010 to 2030**

	Number of decrease or increase in households Inside the Service Area of Optical Fiber	Number of decrease or increase in households Outside the Service Area of Optical Fiber
Hokkaido	-183K	-11K
Aomori	-57K	-6K
Iwate	-45K	-12K
Miyagi	-9K	-1K
Akita	-53K	-9K
Yamagata	-35K	-5K
Fukushima	-50K	-9K
Ibaraki	-23K	-2K
Tochigi	-14K	-2K
Gunma	-24K	-2K
Saitama	+87K	+1K
Chiba	+15K	+0K
Tokyo	+370K	+0K
Kanagawa	+229K	+1K
Niigata	-47K	-6K
Yamanashi	-18K	-1K
Nagano	-52K	-6K

**Table 16 Forecast of households numbers in service area and out of service area of optical fiber
in 2030**

	Number of households Inside the Service Area of Optical Fiber	Number of households Outside the Service Area of Optical Fiber
Hokkaido	2,105K	126K
Aomori	410K	40K
Iwate	339K	88K
Miyagi	815K	77K
Akita	279K	49K
Yamagata	303K	46K
Fukushima	557K	105K
Ibaraki	971K	92K
Tochigi	642K	88K
Gunma	677K	53K
Saitama	2,897K	39K
Chiba	2,449K	78K
Tokyo	6,764K	6K
Kanagawa	4,046K	21K
Niigata	691K	94K
Yamanashi	289K	20K
Nagano	664K	73K
Total	24,898K	1,094K

8. Analysis Results

Because the distribution of remaining households using metal area is not opened to public, this analysis used the number of general distribution of households, and thus 27.3 percent of total households will live in where the metal line will be remained. Therefore, the numbers of possible subscribers using in metal line are as below:

Inside the service area of optical fiber : $24,898\text{K} \times 27.3\% = 6.8\text{M}$

Outside the service area of optical fiber : $1,094\text{K} \times 27.3\% = 0.3\text{M}$

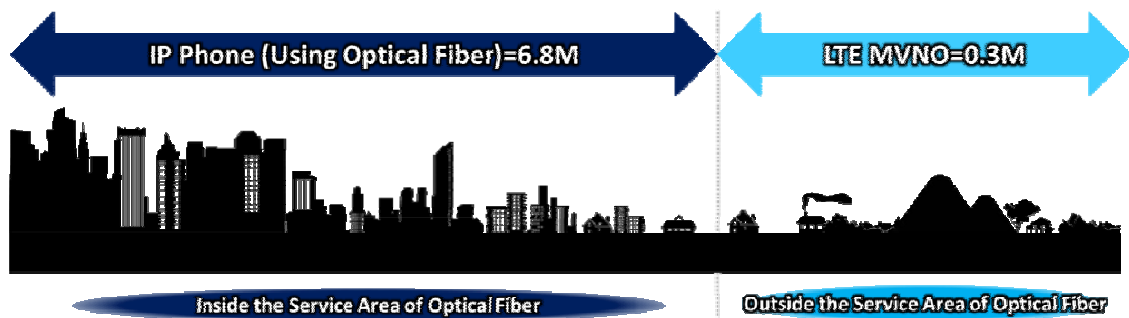


Figure 17 Number of possible subscribers using in metal line

9. Conclusion

PSTN is designed not only by the technology but the telecommunications regulations in Japan. It is the reason that the migration of PSTN needs to consider about the regulations and framework include the universal service. In that context, there are no alternatives which are able to adapt the regulations.

Although IP telephone using optical fiber has problems on their charge and service area to adapt the regulations, it will become a candidate of migration if the charge of PSTN will be increase and thus fill the gap against the regulation.

In order to adapt the regulation for IP telephone using optical fiber, the expansion of service area will be needed. However, it needs the added investment for unprofitable areas, and thus the telecommunications operators seem to concern the balance of risk and benefit, and the reform of regulations on PSTN as a universal service.

From the point of view of the capability of technology, MVNO using LTE seems to be a reasonable candidate to introduce a fast-pass to the PSTN subscriber. Although it does not adapt the regulations as well as other alternatives, the Information and Communications Council at MIC (2017) has reported the regulator to consider the possible use.

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