

## “The Origin and Future of Species” on Location Services (Concept Evolution Process of Location Services)

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### 1. Introduction

There is a case that a different service is occurred and grows up from an original object by the technical progress in the technology fields. The location service in the field of mobile communications services is one of such services. The primary purpose of the terminal location or the locator is for routing and connecting the communications links. Using the location, a new service has been born. This service is called as “Location Service”. The location services have two categories. One is a service monitoring a position of a target terminal, and another is a service watching the statistical movement of persons with big data of the locations and user’s attribution such as “Sex”, “Age”, “Address”, “Occupation”, etc. I would like to call merely the former as “Location Service”, and the latter as “Location Database Service”. The Location Database Services have become to attract an attention as one of the services with big data in 2010s. This paper shows the process of the concept evolution and the future on the Location Services.

### 2. Technical Aspect of Location Service in the History of ICT

Since Alexander Graham Bell invented the telephone in 1876, many type of the telephone services have developed. The primary telephone service was direct connection from one to one. Next, the switching systems were invented for connection more efficiently with many users. (Table 1)

The primary switching system was a manual type by the operator. After that, the automatic switching systems such as the Step-by-Step (SXS) Switch, the Crossbar (XB) Switch, the

Analog Electronic Switches, and the Digital Electronic Switches have been born. Presently, the telecommunications networks grow up to the system with the Server and the Router using the Internet Technology.

One of the most important functions in the telephone systems is the “Routing” (to select a circuit). For the Routing, “Telephone Number” is necessary. The Number signifies an Identification (ID) of a terminal, and a Location (L) of a terminal in the telecommunications networks.

In the primary switching systems, the logical number (ID) and the physical number (L) were same.

For controlling switching systems, the stored program method and the Common Channel Signaling System (CCSS) were adopted. In this result, it is possible to split “ID” and “L”, and the Vehicle/Mobile phone services or the Intelligent Network (IN) Services have been born. The representative services of the IN Services are “Free dial”, “Tele voting”, etc. PHS is also one of the IN Services. After that, the various location services using GPS and GIS technology are realized and progressed.

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Table 1 Change of Technical Significant of Location

Step	Year	Function	Comments
1	1875~	Telephone Number: ID=L	In the age of Manual Bored SWs, SXS SWs, XB SWs, etc. a fixed telephone number (= [Country Code] + [Area Code] + [Office Code] + [Subscriber Number]) unified with a location. The Individual Signaling System was used for switch control signaling systems between telephone offices.
2	1982~ 1987	Introducing No.7CCSS	No.7 CCSS Network of NTT was established from 1982 to 1987. It is possible to split "ID" and "L".
3	1985~	Introducing IN Service	Free Dial Service has started in 1980s. (NTT)
4	1995~	Location of SW => Location of Base Station	PHS using fixed telephone networks has started in 1995. The Location Monitor Service with PHS has started in 1998. (NTTDOCOMO)
5	1999~	Introducing GPS => Individual Location Data	Mobile phones with GPS have been developed.
6	2010s~	Individual Location Data => Statistical Location Data	Math of location data is used as statistical data.

### 3. History of Location Service

#### (1) Birth of Location Service

[A location monitor system for the mobile terminals was developed by Tokyo Telecommunications Industry (existing SONY) in 1960s, and in the same time, there were the systems with GPS for vehicles such as "Rescue Service" or "E-Call" in USA and in Japan]<sup>[1]</sup>.

The PHS Service has started from 1995, and a development of location service with PHS has been started. NTTDOCOMO started a location service with PHS in 1998. For a reason that the location service with mobile phone has started with PHS, a radius of a cell of a base station for PHS is hundreds of meter. A radius of cell for normal wireless base stations is several km. The mobile phone with GPS was developed in 1999, and the Internet connection from mobile phones, such as "i-mode" by NTTDOCOMO has started also from 1999. After that, the new concepts of the location services were born. One of them is

"Geo-fencing". This service monitors incoming or outgoing terminals in an assigned area. (Table 2 and Fig.1)

#### (2) Birth of Location Database Service

After that, a new concept "Location Database Service" has been born. This service is a monitor of the statistical movement of persons or marketing with the statistical method by the location database. The original concepts of the Location Database Service were proposed as the patent applications that were the Patent Disclosure: H10-47974<sup>[2]</sup> by Sony in 1996, and the Patent Application: 2000-219831<sup>[3]</sup> by the author in 2000.

NTTDOCOMO supplied the statistical location data of smartphones to ZENRINDATACOM, which has developed a location service system "KONZATU TOUKEI (Confusion Statistics)" in 2010. Moreover, NTTDOCOMO has developed a new system "Mobile Spatial Statistics" in 2013. Also, HONDA has developed a system "Traffic Actual Data MAP" using car navigation system in 2010s.

Table 2 Classification of Location Services

No	Category	Area	Terminal	Objective	Flow of Location	Flow of Message or Contents
1	Monitoring	definite (Own Area)	Own Terminal	Confirming Own Location	Originating Terminal => NW => Originating Terminal	NW => Originating Terminal
2		Indefinite	Assigned Terminal	Child or Old Person	Originating Terminal => NW => Third-party	NW => Third-party
3	Information Search Type	definite (Own Area)	Own Terminal	Research in Own Area	Originating Terminal => NW => Third-party	NW (or Third-party) => Originating Terminal
4	or Information Push Type	definite (Assigned Area)	Own Terminal	Research in Assigned Area	Assigned Area => NW => Originating Terminal	NW(or Third-party) => Originating Terminal
5	Geo-fencing (1)	definite (Assigned Area)	Own Terminal Assigned Terminal		Originating Terminal => NW => Third-party	NW=> Third-party NW=>Door System
6	Geo-fencing (2)	definite (Assigned Area)	Indefinite	Watch Indefinite Terminals in Assigned Area	Originating Terminal => NW => Third-party	NW (or Third-party) => Own Terminal
7	Geo-fencing (3)	definite (Assigned Area)	Indefinite	Statistic Data	Originating Terminal=>NW =>Third-party	(Statistic Data)
8	Geo-fencing (4)	definite	Indefinite	Watch between Areas	Originating Terminal=>NW =>Third-party	NW => Third-party
9	Geo-fencing (5)	Indefinite	definite	Transfer Service	Originating Terminal=>NW	

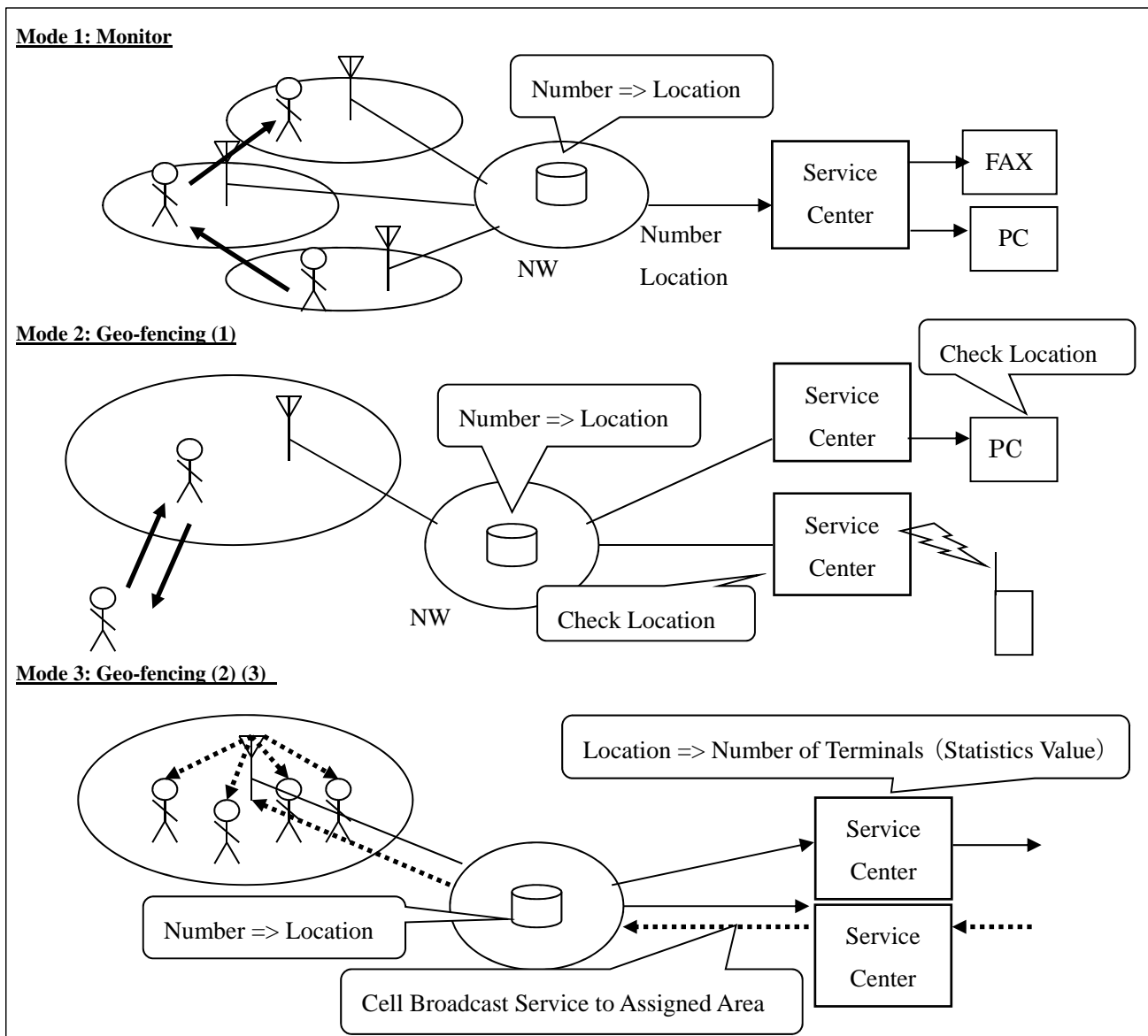


Fig.1 Mode of Location Services

(3) “Marketing Service System Using Location of Mobile-Phone” (Patent Application : 2000-219831)

- Marketing Research Service: To estimate the number of persons in the assigned area with the 1<sup>st</sup> DB of location data in the assigned area for marketing research. It is possible to screen with the 2<sup>nd</sup> DB of the personal data

such as sex, age, address, occupation, etc. (Fig.2)

- Traffic, Event and Festival Congestion Information Services (Fig.3)
- Person Movement (Action) Research Service: for the disaster by the Civil Service

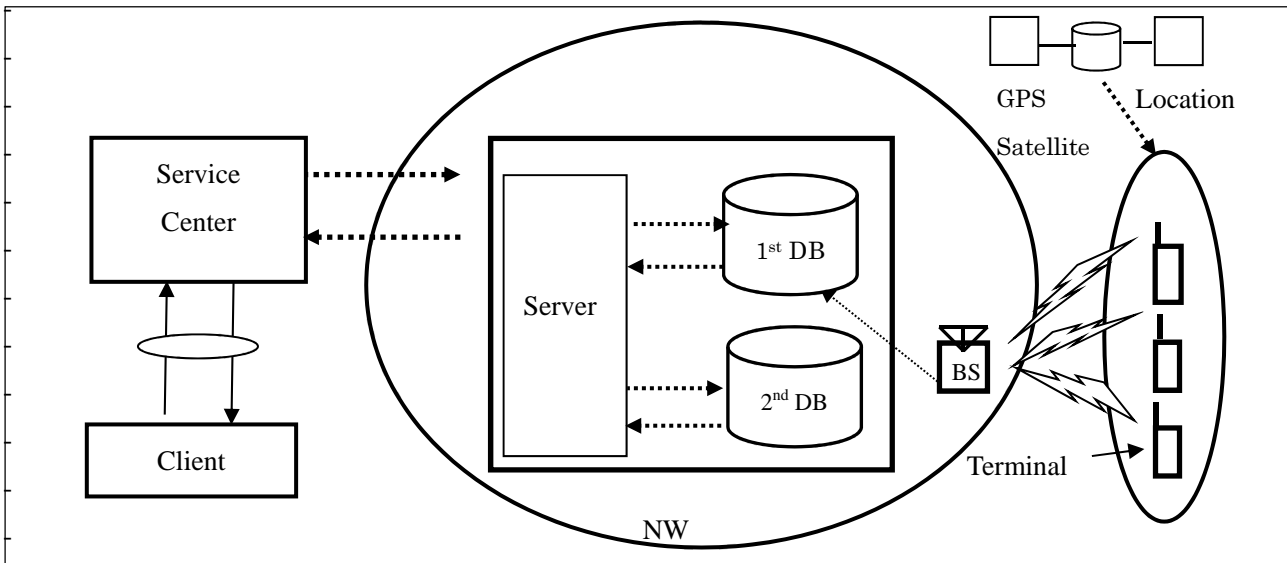
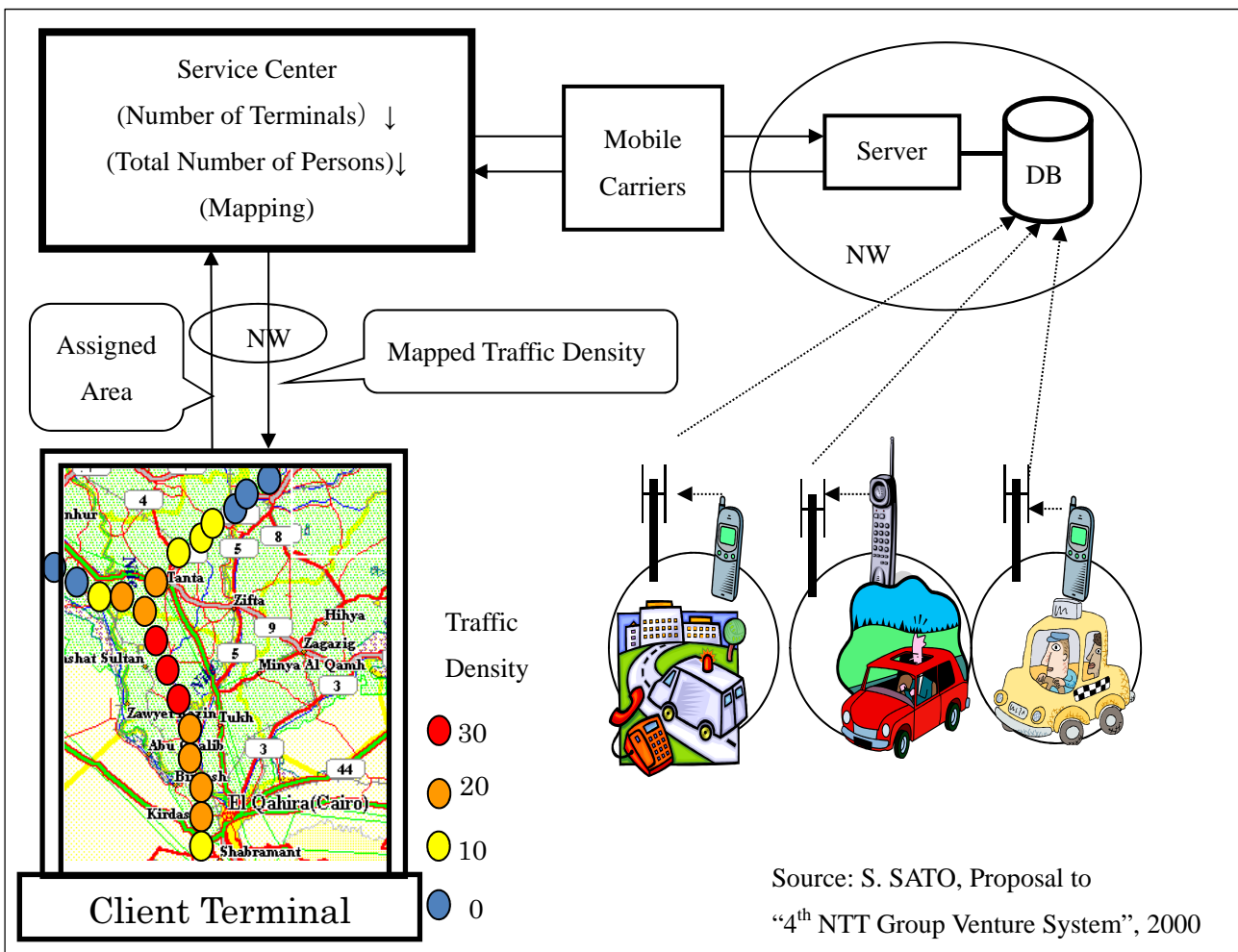


Fig. 2 Service Sequence (Patent Application: 2000-219831)



Source: S. SATO, Proposal to "4<sup>th</sup> NTT Group Venture System", 2000

Fig. 3 Example of Location Database Service (Traffic Information Service Using Mobile Location)

**(4) Evolution of Location Services**

Provided that the Location Services using individual data is “the First Generation (1G), and the Location Database Services using the Big-data is “the Second Generation (2G)”, the Integrated Location Database Service using the big data of the various fields is “the Third Generation (3G)”. One of key-words in 3G is M2M<sup>[4]</sup>.

It is possible to create the New Location Services with the

Big-data that is originated by the interchange from Machine to Machine throughout the human beings.

In the future, if it is realized to split “ID” and “L” of the IP Address, it will be called as “the Fourth Generation (4G)”.

The diversity of the Location Services will expand more widely, and become a new field in the Service Science. The evolution of Location Services is shown in Table 3 and Fig. 4.

**Table 3 Evolution of Location Services**

Generation	Year	Phase	Service
1G	1998~	Point	<u>Location Retrieval Service</u> > ”IMADOKO SEARCH (Now Wherever Service)” (NTTDOCOMO, 1998) <u>Information Push Type Service</u> > PHS Service (1995) > Mobile Telephone with GPS (1999) > Internet Access Service: ”i-mode” (NTTDOCOMO, 1999)
		Line	<u>Bus Operation Service</u>
	2007~	Plane	<u>Limited Area Cell Broadcast Service</u> > “Early Warning for Earthquake” (2007) <u>Geo-fencing Service</u>
2G	2010~	Line	<u>Location Database Service</u> > “TUUKOU JISSEKI MAP (Traffic Actual MAP)” (HONDA, 2010) > “KONZATSU TOUKEI (Confusion Statistics)” (NTTDOCOMO+ZENRINDATACOM, 2010)
	2013~	Plane + Personal Data	<u>Location Database Service</u> > ”Mobile Spatial Statistics“ (NTTDOCOMO, 2013) > ”Local Government Sightseeing Actual Research” (KDDI+COLOPL, 2013)
3G	2016~	Plane + M2M <sup>[4]</sup> Data	<u>Integrated Database Service</u>
4G	202x~	Splitting ID and L’ of IP Address	<u>New Generation Location Service</u> by splitting “ID” and “L” of IP Address in NEWGN <sup>[5]</sup>

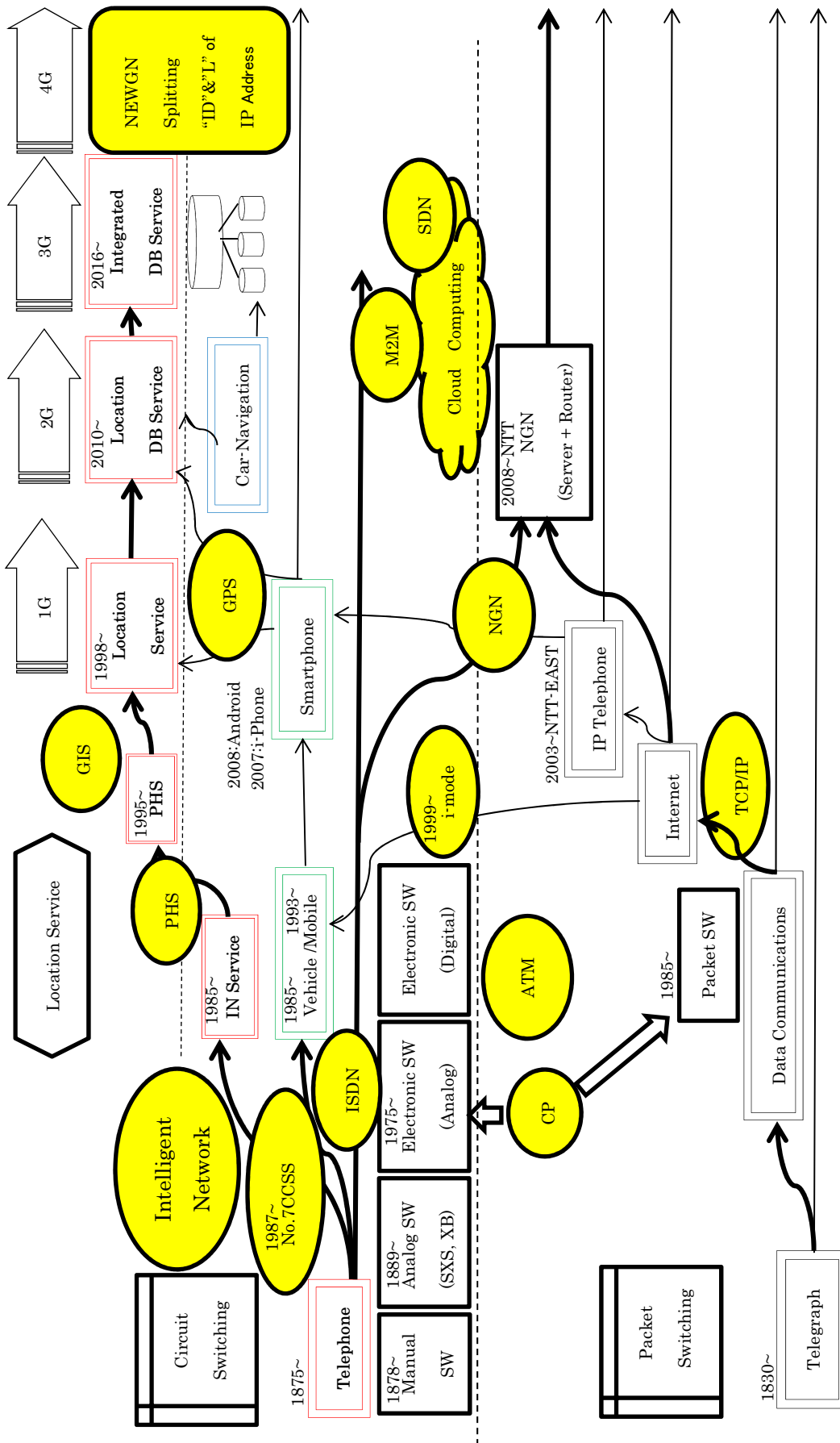


Fig. 4 Evolution of Network Services

#### 4. Conclusion

In 2010s, various services of the Location Database Service are put into practical use such as "Traffic Actual Data MAP (HONDA)", "Mobile Spatial Statistics (NTTDOCOMO)", etc.

Especially, the simulation of person movement was noticed at the North Japan Earthquake on 11 March 2011.

Another, the information on the Traffic Actual Data MAP (HONDA) of traffic jam was effective in the huge disaster.

This paper expresses the concept evolution process of the Location Services and the Location Database Services from PHS Service-in in 1995 to 2000 with my proposal on this field.

It is no exaggeration to say that the concept of the Location

Database Services was completed by 2000. However, it was necessary more than 10 years by putting them into practical use.

In this period, the data processing technology has been progressed and the outline of using the location database in the disaster was made clearly.

Epoch-making of Location Services was the innovation of the N0.7 CCSS and split of "ID" and "L". This innovation made the diversity of telephone services such as mobile phone, IN Services, etc.

If it is realized that "ID" and "L" of IP Address are separated, a diversity of Location Services is going to expand more widely, and to become a new field in the Service Science.

- Biology: Asexual Living Things => (Splitting ♂ · ♀) => Sexual Living Things (Diversity of Species)
- ICT (in present): Telephone Number => (Splitting "ID" and "L") => Location Services
- ICT (in future): IP Address => (Splitting "ID" and "L") => More Diversity of Location Services

#### References

- [1] Tetsuma SAKURAI, Teruo HAGINO, Yoshitake SUZUKI, Yutaka NISHINO, "A Super Compact Terminal with Position Information Service Capability" (IEICE, Vol.82, No.4, pp.397-403, Apr. 1999)
- [2] Japanese Published Unexamined Patent Applications, "Location Monitor System, Location Monitor Method, Location Collection System, Location Collection Method and Communication Equipment for Vehicle" (Patent Disclosure: H10-47974, Applicant: Sony, Inventor: Seigo ITO)
- [3] Japanese Published Unexamined Patent Applications, "Marketing Service System Using Location of Mobile-phone" (Patent Application: 2000-219831, Applicant: S.SATO, Inventor: S.SATO)
- [4] MIC, "ICT Growth Strategy by M2M" (Ministry of Internal Affairs and Communications HP, Nov. 27, 2013)
- [5]NICT, "New Generation Network Architecture AKARI, Conceptual Design" (NICT, 2010, <http://akari-project.nict.go.jp/>)