

A Privacy Continuum in a Conceptual Framework of Enterprise Privacy Architecture

Yutaka Mizuno, Nobutaka Odake
Nagoya Institute of Technology, Japan

Abstract—This paper examines a Personal Information Trust Service as a conceptual framework of a Personal Data Store to be one of common information models that manage smarter city data and shares information safely across multiple agencies within a city. This conceptual framework proposes a Smart Privacy Platform and an Enterprise Privacy Architecture. The Smart Privacy Platform is an open & close service platform that can be embedded into each smart system. The Enterprise Privacy Architecture is a privacy management model that has four layered services dimension in collection and safekeeping of Personal Identifiable Information (PII). PII in the smart systems can accidentally identify an individual with combining identified and identifiable PII. This paper discusses a privacy continuum as a process model of continuous data minimization of PII in the Enterprise Privacy Architecture. A privacy continuum proposes a solution to reduce risks of accidentally identifying an individual in social services of a smart city.

I. INTRODUCTION

The World Economic Forum 2013 [41] discussed the needs of a new approach of unlocking the value of personal data from collection to usage and how to formulate a user-centered Personal Data Ecosystem. The Personal Data Ecosystem (PDE) is the emerging landscape of companies and organizations that believe individuals should be in control of their personal data, and make available a growing number of tools and technologies to enable this control [5]. To date, Personal Identifiable Information (PII) is managed by enterprises and used inside them. PII has a great potential to solve various social issues, e.g. optimization of electric power consumption, reduction of Green House Gases, and so forth. The World Economic Forum 2013 [41] insisted on the needs of paradigm shift of the personal data management from enterprises to individuals to unlock personal data from collection to usage. The World Economic Forum 2014[42] pointed out a new lens for strengthening trust in Personal Data Service. Personal Data Service or Personal Data Store (PDS) is a service to let an individual store, manage, and deploy their key personal data in a highly secure and structured way [24]. There are two advanced projects in the world. One is Smart Disclosure (US Government initiative); another is Midata (UK Government initiative). In contrast, Japan Government has started to discuss how to unlock PII and formulate the Personal Data Ecosystem in Japan a several years ago.

In Japan, a new type of accounting cloud service had started in 2013. The new accounting cloud service manages account books of individuals and companies on cloud platforms. The accounting cloud service automatically aggregates various transaction data from internet banking,

web services, and so forth. The customers of the account cloud service can manage daily income and expenditure, and confirm a daily settlement of their accounts. One of the accounting cloud services has been growing rapidly and has gathered more than three million customers. Moreover, this paper estimates that the accounting cloud service will gather more than five million customers in a few years. The accounting cloud service manages money that is most sensitive PII for daily activities of individuals and companies. The accounting cloud service is a kind of the Personal Data Service in Japan in nature.

This paper discusses a conceptual model of a Personal Information Trust Service as a Personal Data Service from two aspects: one is a platform development (Smart Privacy Platform); another is an ecosystem formation (Enterprise Privacy Architecture) in Japan. First, this paper explores the accounting cloud service and discusses the factors of its diffusion. Second, this paper illustrates the accounting cloud service as one of the Personal Data Services in Japan, based on findings of the case study. At last, this paper examines a concept model of the Personal Information Trust Service and implicates strategies for its diffusion.

II. LITERATURE REVIEW

In this section, this paper reviews literature, and related works: market strategy, organization management, management of technology, privacy, and social system.

A. Market Strategy

Arthur [1] established a theory of network economy and explained that the network effect increased returns to scale and had characteristics of path independence. The network effect is that the growth of users of a platform increases the growth of profits that derives from the platform. Rochet and Tirole [29] established a theory of two-sided markets. A two-sided (or more generally multi-sided) markets structure is defined as multiple markets in which one or several platforms enables interactions between end-users, and tries to get the two (or multiple) sides "on board" by appropriately charging each side. Eisenmann et al [11] stated that "the platform value to any given user largely depends on the number of users on the network's other side with two-sided network effects" and that "value grows as the platform matches demand from both sides". The two-sided network effect is that the growth of one side users on a platform increases the growth of profits of other side users.

One business model of a two-sided market structure is "Freemium." The term combines two other terms, "Free" and

"Premium". Freemium is a business model by which a product or a service (typically a digital offering such as software, media, games or web services) is provided free from charge, but a premium is charged for advanced features, functionality, or virtual goods [9]. A freemium market strategy combines free-of-charge users and paid users onto one platform. Kumar [18] stated that free features were a potent marketing tool and that the model allowed a new venture to scale up and attract a user base without expending resources on costly ad campaigns or a traditional sales force. Mizuno and Odake [21, 23] surveyed the progressive formation of the best accounting cloud service that had a two-sided market structure and a freemium business model in Japan.

B. Organization Management

Gawer and Cusumano [12] explained that platforms were industry building blocks, which attract other firms' investment and innovation in add-on products or services. They analyzed the competitive strategy of major enterprises from the viewpoint of platform formation and leadership. Platform strategies are concerned with how to manage and integrate the internal resources of an enterprise. Iansiti and Levien [17] examined competitive strategies within the framework of the business ecosystem, which connected seamlessly with various enterprises. The business ecosystem involves managing and integrating the external resources of enterprises.

C. Management of Technology

Rogers [30] had been studying a diffusion of product innovation and had a contribution of the mechanism of diffusion process, by which an innovation was communicated through certain channels over time among the members of a social system. Bass [2] proposed a mathematical diffusion model of innovation. Chesbrough [6][7] developed a concept of Open Innovation. Enterprises can use Open Innovation not only to accelerate and deepen innovation but also to make innovation less costly, less risky, and faster. Chesbrough [8] proposed the four key factors of open service innovation: think of business as a service, co-creation with customers, open innovation, and transformed business models.

An Open & Close strategy is a method of Management of Technology (MOT), which combines internal "Closed" innovation and external "Open" innovation [26]. At the Open & Close strategy, the term "Open" refers to a mechanism to create the strategic technologies and products of the company, while company utilizes the globalization of manufacturing and collects the best knowledge around the world ([26] p.6). The term "Close" refers to a mechanism to make for a pre-determined technical area to protect as a source of value and not to propagate the source of value out of the company ([26] p.7). The Open & Close strategy combines these two mechanisms into one.

D. Privacy

Laudon [19] discussed privacy protection with a market-based approach and proposed National Information Markets. Tatsumi [36] discussed the economy of a personal information trust and potential of freemium in unlocking the value of personal information in Japan. Nissenbaum [25] developed a model of informational privacy in terms of contextual integrity, and defined as compatibility with presiding norms of information appropriateness and distribution. Solove [34] surveyed taxonomy of privacy and pointed out that privacy had four basic groups of harmful activities: (a) information collection, (b) information processing, (c) information dissemination, and (d) invasion. Schwartz and Solove [31] developed a Personally Identifiable Information (PII) 2.0, as a conceptual model concerning about privacy and a new approach to personal information. Their PII 2.0 model has two new concepts: (a) the key to their model is to build two categories of PII ("identified", "identifiable"), and to treat them differently; (b) their model places information on a continuum that begins with no risk of identification at one end and ends with identified individuals at the other [31]. Cavoukian [3, 4, 5] has been building up the framework of Privacy by Design in formulating the Personal Data Ecosystem. Privacy by Design refers to the philosophy and approach of embedding privacy into the design specifications of various technologies [4]. Pfitzmann and Hansen [28] proposed a terminology for talking about privacy by data minimization.

E. Social System

Giddens [13] had established the theory of structuration in the constitution of society. His theory constitutes three concepts: structure, system, and structuration. In his theory, the 'structure' is regarded as rules and resources recursively implicated in social reproduction; institutionalized features of social systems have structural properties in the sense that relationships are stabilized across time and space ([13] p.25). The 'System' is regarded as reproduced relations between actors or collectivities, organized as regular social practices ([13] p.25). The 'Structuration' is regarded as conditions governing the opportunities or transmutation of structures, and therefore the reproduction of social systems ([13] p.25). His structuration theory is based on the duality of structure. The duality of structure is defined that structure as the medium and outcome of the conduct it recursively organizes; the structural properties of social systems do not exist outside of action but are chronically implicated in its production and reproduction ([13] p.25). The duality of structure is situated between tasks of day-to-day behavior and long term life-planning. The 'Social integration' is regarded as reciprocity between actors in context of co-presence ([13] p.28). The 'System integration' is regarded as reciprocity between actors or collectivities across extended time-space ([13] p.28). Holmlund [15] reproduced human activities across extended time-space as four service dimensions in service process of relationship marketing. Upward [38]

reproduced record keeping activities across extended time-space as a record continuum model in archiving process of record keeping.

Holmlund [16] defined the service dimensions as action, episode, sequence, and relationship as followings. Action is defined as the lowest level and thus the most detailed type of interaction, which consists of individual initiatives. Episodes are defined as several interconnected actions. Interrelated episodes can in turn be correspondingly grouped into a sequence. A relationship comprises all sequences, which in turn comprise all episodes, which in turn consist of all actions. The levels of her model are hierarchical and range from a single individual exchange that takes place within a relationship to the portfolio of relationships of one particular firm [16].

Upward [38] modeled a record continuum with four dimensions as creation, capture, organization, and pluralization in archiving processes. Upward [39] expanded his model to four conceptual models: records continuum, information continuum, information systems continuum, and publishing continuum. His core concept of the continuum model became the record management standard as ISO 15489-2002.

III. METHODS AND MATERIALS

In this section, this paper elucidates research setting, and research design.

A. Research Setting

The main research challenges in managing personal data are the need for common information models and the ability to share information safely across multiple agencies for unlocking the value of personal data from collection to usage. To date, there are few studies dealing with a Personal Data Store and a Personal Data Ecosystem in Japan. This paper examines an accounting cloud service that manages and operates a large amount of Personal Identifiable Information (PII) in Japan. The accounting cloud service develops a cloud platform and formulates a cloud ecosystem to manage and keep a personal account book. The findings in the case study can apply for the development of the Personal Data Store and the formulation of the Personal Data Ecosystem. The goal of this study is to design a concept model of a Personal Information Trust Service as one of Personal Data Service, to examine how to develop the Personal Information Trust

Service, and how to formulate the Personal Data Ecosystem.

B. Research design

This study relies on public archives that include websites, financial reports, industry databases, and publications. Given the early stage of business formation literature and the limited theory on how to formulate an accounting cloud service, this paper uses an exploratory case study research strategy, applying qualitative methods [10] to build explanations over the phenomena. Figure 1 indicates our analytical structure for case studies. This paper adopts the theory of structuration [13] to examine a conceptual model of a Personal Data Service. This paper analyzes the strategic conduct of the accounting cloud service, and tries to reproduce personal data keeping activities across extended time-space.

First, this paper studies an accounting cloud service as a case study and examines business formation, market strategy, and service formation, which affect how to realize business ecosystem formation and platform development of the accounting cloud service. Second, this paper discusses the accounting cloud service as one of Personal Data Services in nature. Third, this paper proposes a conceptual model of a Personal Information Trust Service and a privacy continuum model in the Enterprise Privacy Architecture. Finally, this paper examines introduction of the Personal Data Service to smart systems in a smart city and strategies for its diffusion.

IV. AN ACCOUNTING CLOUD SERVICE IN JAPAN

A. Business Formation of an Accounting Cloud Service in Japan

The service provider of the accounting cloud service has started its business in May 2012. The CEO of the service provider said his business vision on the provider's home page, "In order to support each person's challenge, our company provides user-central financial services to solve his/her financial issues as the monetary fundamental of his/her challenge in neutral and independent way." The accounting cloud service has been growing steadily from its entrepreneurial stage to its progressive stage. The customers of the service have achieved one million in nineteen months and two millions in thirty months. In July 2015, the search volume on Google Trends has increased rapidly, because the company has carried out a joint campaign with the TV program. Figure 2 shows the search volume on the Google Trends.

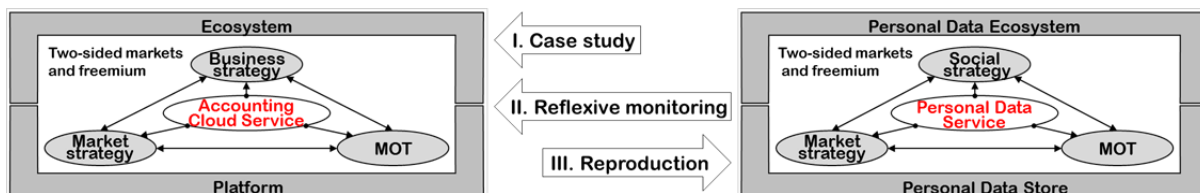


Figure 1. Analytical structure (Source: Authors)

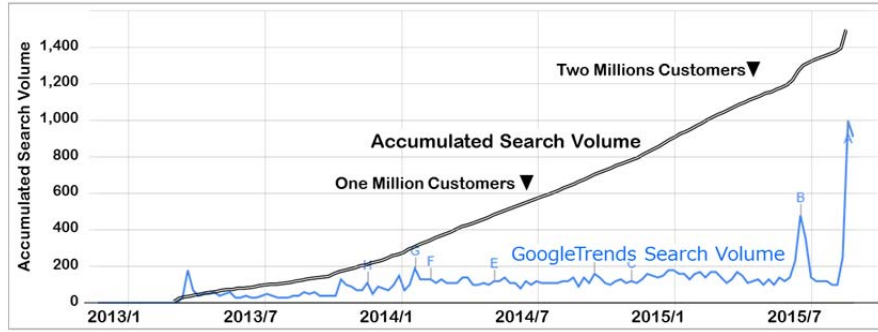


Figure 2. Accumulated search volume (Source: Authors)

The service provider combined a cloud service with smart-phone applications into one cloud service platform. Before this cloud service had appeared, accounting services were provided by ASP(Application Service Provider) services or smart-phone applications separately. Table 1 indicates comparison of the ASP and the accounting cloud service.

Once users had registered the accounting cloud service, they used to access the service via a smart-phone application or a bookmark on an Internet Browser, they did not search the service on search engines (e.g., Google). The search volume of the service name can estimate the adopters of the accounting cloud service. This paper employed the Bass diffusion model [2] and estimated a log-range forecast with accumulated search volume on the Google Trends. Figure 3 indicates the growth of adopters of accounting cloud service.

The constant p is the coefficient of innovation and the q is the coefficient of imitation. The result of estimation shows us that the maximum value of adopters will be about 5,020 million users. In May 2014, the customers have achieved a critical mass of diffusion. The entrepreneurial stage of the accounting service meets the period of innovators and early adopters. The progressive stage meets the period of early majority.

Figure 4 summarizes the business formation of the accounting cloud service. The growth drivers of the service are numbers of aggregation accounts and associated services. In June 2015, the company announced that the service had finished developing the interfaces to manage all the Japanese banks.

TABLE 1. FIVE ATTRIBUTES OF INNOVATION IN THE ACCOUNTING CLOUD SERVICE (Source: Authors)

Attribute	Previous services	Innovation of accounting cloud service
Relative advantage	<ul style="list-style-type: none"> ·ASP services had only paid services for companies. ·ASP services (or smart-phone applications) could not aggregate bank data and had a few associated services. 	<ul style="list-style-type: none"> ·The accounting cloud service can aggregate transactions and receipts automatically. ·Individuals can confirm their daily balance sheets of family finances on PC or smart-phone.
Compatibility	<ul style="list-style-type: none"> ·Personal computers and smart-phones are already diffused. 	<ul style="list-style-type: none"> ·Individuals need not to prepare new devices. ·Individuals can use the accounting cloud service easily.
Complexity	<ul style="list-style-type: none"> ·Users of ASP services had needed accounting knowledges. 	<ul style="list-style-type: none"> ·Individuals can easily retrieve own account book via smart-phone any time anywhere.
Trialability	<ul style="list-style-type: none"> ·ASP services were used only on PC. ·Most of ASP service did not offer trial software. 	<ul style="list-style-type: none"> ·Individuals can easily setup smart-phone application via application store on net. ·Individuals can try service for free. ·Individuals can hold own data and continue service for migrating free to premium service in low price.
Observability	<ul style="list-style-type: none"> ·It is difficult to observe neighbor's accounting book easily. 	<ul style="list-style-type: none"> ·Individuals can easily observe neighbor's accounting book on smart-phone without reserve.

Formula: $Result \sim m * (1 - \exp(-(p + q) * period)) / (1 + q/p * \exp(-(p + q) * period))$

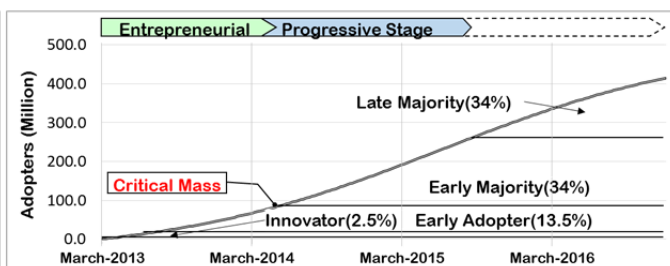
Parameters:

Estimate Std. Error t value Pr(>|t|)
 p 1.583e-03 6.670e-05 23.74 <2e-16 ***
 q 1.953e-02 8.218e-04 23.77 <2e-16 ***
 m 2.788e+03 1.705e+02 16.35 <2e-16 ***

 Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 17.28 on 124 degrees of freedom

Number of iterations to convergence: 10
 Achieved convergence tolerance: 8.104e-06



(a) Result of the Bass diffusion model (The R Language)

(b) Number of adopters

Figure 3. Growth of adopters of the accounting cloud service (Source: Authors)

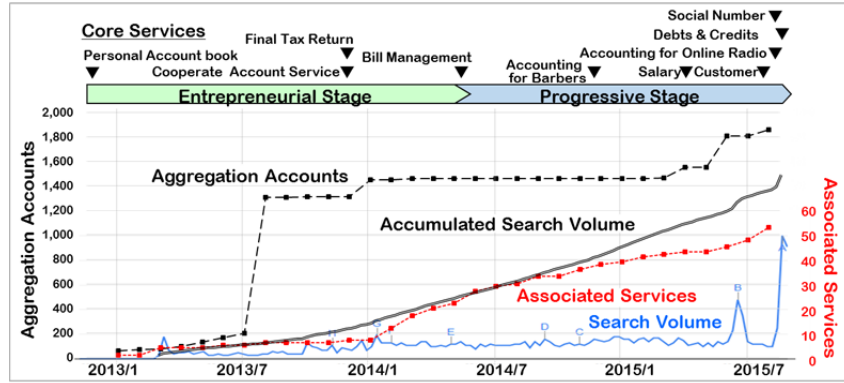


Figure 4. Business formation of the accounting cloud service (Source: Authors, Based on [23])

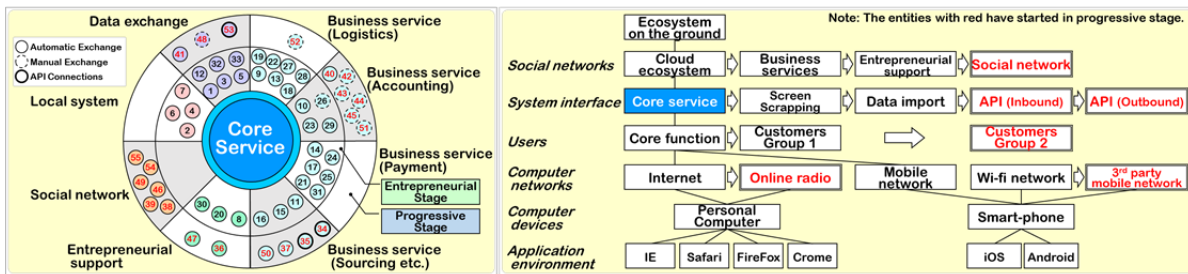
B. Service structures of the accounting cloud service

The accounting cloud service consists of a core technical area and three open areas. The closed core area is an accounting function in the cloud service. The open areas include local systems, data exchange interfaces, and associated services. Figure 5(a) shows the service diagram. The service number is in a chronological order. The services with red color have started in a progressive stage. The local systems include Internet browsers and smart-phone applications, which had connected at first in an entrepreneurial stage. The data exchange interfaces include an account aggregation process, data file import interfaces, and application programming interfaces. The associated services include logistic services, accounting services, payment services, crowd sourcing services, and entrepreneurial supports by professional persons such as a

licensed accountant. The service provider has been building its services step by step as next: (a) core service, (b) local systems, (c) data exchange interfaces, (d) associated services, and (e) entrepreneurial support partnerships. The ecosystem of the accounting cloud service has been expanding its services into both horizontal and vertical directions. Figure 5(b) shows the layered ecosystem formation.

C. Factors of Diffusion of the Accounting Cloud Service

This paper discusses the factors of diffusion of accounting cloud service in four aspects that include core innovations, communication channels, a social system, and a cultivation of trust between provider and users. Table 2 summarizes the factors of diffusion of the accounting cloud service in each stage.



(a) Service diagram

(b) Layered ecosystem

Figure 5. Service diagram and layered ecosystem (Source: Authors, Based on [23])

TABLE 2. SUMMARY OF FACTORS OF DIFFUSION (Source: Authors)

Factors	Entrepreneurial Stage	Progressive Stage
Lead customer group	Yuppie ages	Middle ages
1) Innovation	·Auto-aggregation of various transactions ·Association of various cloud services	·New partnerships of business formation with banks ,credit firms, and broadcasting media
2) Communication channel	·Face to face communication between customers ·Application store of smart-phone	·Volume sellers ·Television program
3) Social system	·Diffusion of internet-banking ·New small business promotion act	·New Social Security and Tax Number System ·Dissemination of FinTech
4) Cultivation of trust	·Disclosure of provider’s activities ·Observation of service level agreement	·Enriches of support programs ·Fairness and neutrality of service

A communication channel is the means by which messages get from one individual to another [30]. Early adopters of the accounting cloud service in the entrepreneurial stage are yuppie ages who work as specialists in urban areas and have wills to create new business. Early majority in the progressive stage is middle ages who have a roll to improve their accounting processes. The communication channel of the entrepreneurial stage includes the application stores of a smart-phone and face to face communication of friends and neighbors. The channel of progressive stage includes volume sellers, face to face support by the service provider, and television programs of mass media.

A social system is defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal [30]. The Japan government introduced a new small business promotion act in the entrepreneurial stage in March 2014, and a new Social Security and Tax Number System in the progressive stage in October 2015.

The service provider has been operating its cloud service in a fair manner and cultivating trust with its customers. The provider did not cause a serious interruption of its service, refunded its service fee at its slight service disorder under the service agreement, and enriches its customer's support programs continuously.

D. Strategies for a Cloud Service

The accounting cloud service has two specific strategies. One is its open & close service platform, and another is its spiral market strategy.

(a) Open & close service platform

This case shows us that a service provider should build one single platform with a cloud service and a local system

such as smart-phones. The service provider has been improving the platform with closed innovation and connect the platform to other cloud services with open service innovation. The service provider has been expanding network paths as more neutral and system environment as more environmental independent. This case shows us that a service provider should cultivate a service ecosystem to associate other cloud services. The service provider has been expanding a successive service innovation to associate other cloud services with chain of path dependence. Figure 6(a) shows the open & close service platform and its strategies.

(b) Spiral market strategy.

This case shows us that a service provider should adopt a spiral market strategy that realizes economies of scale and economies of scope alternately. The economies of scale realize a low price service. The scope of economies realize higher quality service. The service provider has been exploring and exploiting service innovation with its each customers' group alternately and step-by-step. The circles of spiral market strategy has been building up one knowledge base as big data to improve its services and realize agglomeration economies step-by-step. Figure 6(b) shows its spiral market strategy.

As a result of this case study, the accounting cloud service realizes the open & close service platform and the spiral market strategy. These two strategies can leave room of inviting its new customer group and service group with effect, and create new additional business domain step-by-step. These two strategy can realize economies of scale, economies of scope, and then agglomeration economies. Therefore, these two strategies can realize sustainable growth of the cloud service.

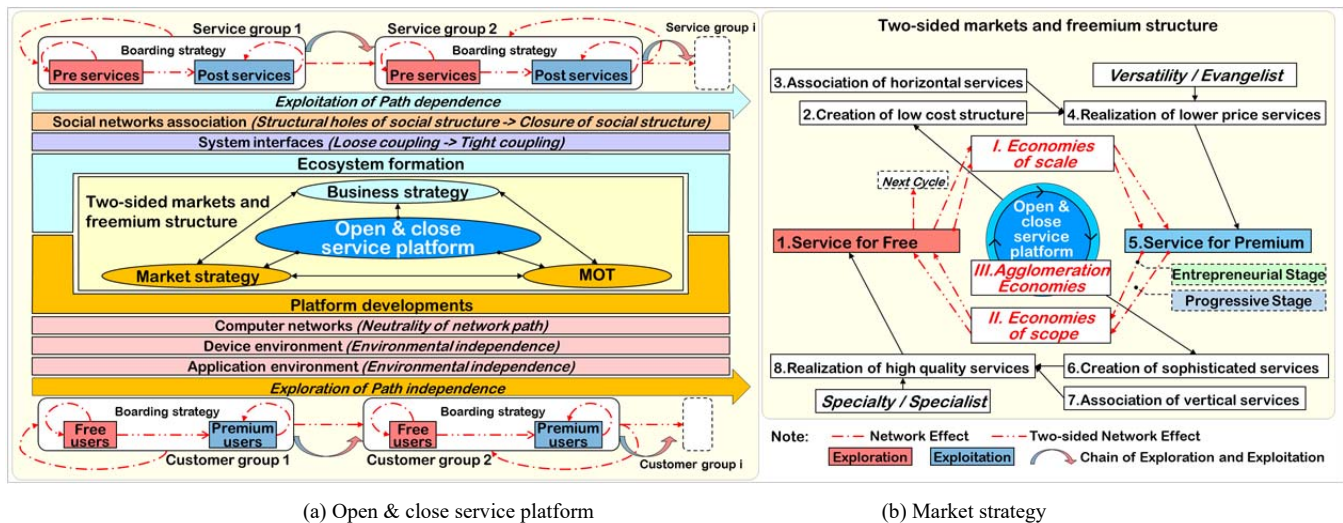


Figure 6. Open & close service platform and Market strategy (Source: Authors, Based On [22])

V. ACCOUNTING CLOUD SERVICE AS A PERSONAL DATA SERVICE

In this section, this paper illustrates the accounting cloud service as a Personal Data Service.

A. Background of Personal Data Service in Japan

In December 2010, Japanese government announced the promotion of all individuals, companies, and government offices have to manage the social security and tax number. In January 2016, the social security reform has started. A leak of the social security and tax number is strictly punishable by a law. In August 2015, the account cloud service has started new service that collects, manages and disposes social security and tax number with identification card on the accounting cloud service platform. In January 2016, the Act on the Protection of Personal Information was revised. Above all else, the time has come for us to share and use anonymized PII without the agreement of data subject.

To date, individuals provide their PII to the service providers. The service providers store and manage PII inside them to provide their service. At the public sector of Japan, official service providers will be able to share and use PII in future, because of the promotion of the social security and tax number by the Japanese Government. However, in the private sector, private service providers have difficulties to share and use PII, because the private service providers are prohibited to sell or share PII outside of purpose of user's permission by the Act on the Protection of Personal Information (Japanese Act No. 57 of May 30, 2003). Moreover, the private service providers cannot use the social security and tax number to share PII by the Act on the Use of Numbers to Identify a Specific Individual in the Administrative Procedure (Japanese Act No. 27 of May 31, 2013). Thus, common information models, which manage smarter city data and share information safely across multiple agencies within a city, needs above everything else.

B. Impact of the Accounting Cloud Service

The customers of the accounting cloud service lightheartedly register their sensitive PII on the cloud services, e.g. daily transaction of bank account, purchase data on the net-shops, and receipt data at the store. The accounting cloud service contains over three billion settlements of daily accounts of its customers. The Japanese Government annually surveys household economy circumstances that investigate items related to household conditions and items pertaining to specific consumption each month of approximately 30,000 households in a year. The Japanese Government also quarterly surveys the unincorporated enterprise economy circumstances that covers approximately 4,000 unincorporated establishments in manufacturing, wholesale and retail trade, accommodations and food services or providing services in Japan. Thus, this case shows us that the database of the accounting cloud service has an enormous potential as a big data has.

Slovic [32] mentioned as next: (a) lay people sometimes lack certain information about hazards, and (b) however their basic conceptualization of risk is much richer than that of the experts and reflects legitimate concerns that are typically omitted from expert risk assessments. Starr [35] mentioned as next: (a) acceptability of risk from an activity is roughly proportional to the third power of the benefits for that activity, and (b) the public will accept risks from voluntary activities that are roughly thousand times as great as it would tolerate from involuntary hazards that provide the same level of benefits [34]. Thus, this case shows us that individuals who will register their PII on a cloud service are also growing, when the benefit of the cloud service goes beyond the acceptance risk of the divulging of PII.

The accounting cloud service manages PII in nature. The salary payment management service in the accounting cloud service refers the social security and tax number in the social security and tax management service. The accounting cloud service contains login information of associated services and aggregates various financial information from associated cloud services. The accounting cloud service uses the big data for improving their services and offers monetary information for their customers. To date, the accounting cloud service does not provide the big data for the third party usage, because it is necessary for the third party usage of the account data in the cloud service to have his/her permission for using his/her PII. The promotion of third party usage of the big data will involve high quality of official and personal services. Whereof, the needs for social and system infrastructure of the third party usage of PII will arise rapidly in the smart system in the future.

C. Accounting Cloud Service as one of Personal Data Store

The World Economic Forum [41] insisted on the needs of new approach of unlocking the value of personal data from collection to usage. The World Economic Forum [42] discussed a new lens for strengthening trust in three points of view: transparency, accountability, and empowerment. As transparency, a Personal Data Service should focus on engagement and response to provide individuals with insight and meaningful control ([42] p.4). As accountability, a Personal Data Service should orient the value chain (front-end to back-end) with risks being equitably distributed ([42] p.4). As empowerment, a Personal Data Service should distribute the shared incentives for empowering individuals and the value closer to the source of data production (the individual) ([42] p.4). The World Economic Forum [43] discussed the importance of two types of data context: objective variables, and subjective variables. The objective variables include type of data, type of entity, device context, collection method, and data usage ([43] p.4). The subjective variables include trust in service provider and value exchange ([43] p.4). The Personal Data Service should realize the objective variables and subjective variables.

Figure 7 indicates the similarities of structure of the accounting cloud service and the Personal Data Store. The

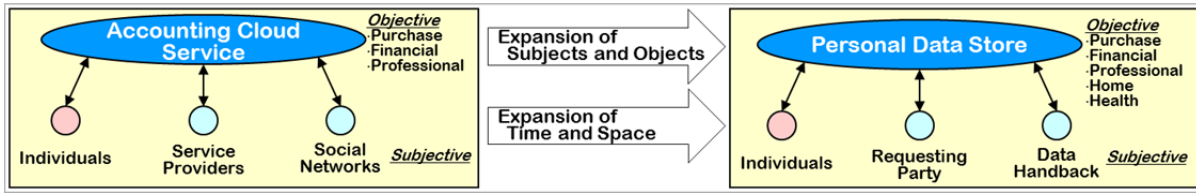


Figure 7. Similarities of structure of the accounting cloud service and Personal Data Store (Source: Authors, Based on [41])

accounting cloud service has been storing PII of purchase, financial, and professional service. Then, the accounting cloud service works as one of Personal Data Stores. The Personal Data Store should manage and store PII of purchase, financial, professional, home, and health. Thus, the accounting cloud service should expand objects and subjects in the future. The open & close service platform of the accounting cloud service can expand customer groups and associated service groups easily. The accounting cloud service should expand objects and subjects, and can be one service of the Personal Data Store.

In our opinion, the unlocking personal data from collection to usage mean the reintroduction of the duality of structure between tasks of day-to-day human activities and long term life-planning with social integration and system integration without privacy invasion of each data subject. The accounting cloud service has been inviting individuals and companies onto its service platform to create a chain of coherent services, and has been operating its services with transparency, accountability, and empowerment. Thus, the business model of the accounting cloud service can be one of role model of the Personal Data Store. Because the perspective of the accounting cloud service has limitation of time and space, the accounting cloud service as one of the Personal Data Store should expand time and space in structuration of a conceptual model of the Personal Data Service.

VI. A CONCEPTUAL MODEL OF ENTERPRISE PRIVACY ARCHITECTURE

In this section, this paper examines a conceptual model of a Personal Information Trust Service that adopts two-sided market structure and freemium business model. This paper tentatively names Mandala the conceptual model of the Personal Information Trust Service. The naming of Mandala has no deep meaning.

A. Key Concepts of Mandala

(a) Two-sided market structure and freemium business model

Mandala is a conceptual model of a Personal Information Trust Service that adopts two-sided markets structure and freemium business model (Figure 8(a)). Mandala is a cloud service that exchanges PII, and provides smart-phone applications for individuals and Application Programming Interfaces for enterprises. The individuals can register and manage own PII via the smart-phone applications. The enterprises can register and only refer customer's PII via the Application Programming Interfaces. The customers of Mandala are categorized into three groups: free users, premium users, and corporate users. Mandala associates with other open & close service platforms of pre services and post services. Mandala realizes coherent service chain with path dependence under one single sign-on. Mandala has four users groups; primary source group, secondary source group, primary user group, and secondary user group (Figure 8(b)). The primary source group provides own PII. The secondary source group provides PII that they store in their institutions. The primary user group uses partialized PII for providing services for data subject of PII. The secondary user groups uses minimized PII for social welfare.

Because two-sided markets structure and freemium business model has a vulnerability of its profitability, the key strategy of diffusion of Mandala is its customers' boarding strategy onto the service. The case study of the accounting cloud service teaches us the importance of boarding strategy. The boarding strategy (Figure 8(c)) is a well-structured sequence of its customers to invite onto its service. At first, Mandala service invites the primary source group (free users) to utilize the network effect, and next invites the primary use group, the secondary source group, and the secondary use group step-by-step to involve the two-sided network effect. This boarding strategy can realize the spiral market strategy as previously shown in Figure 6(b).

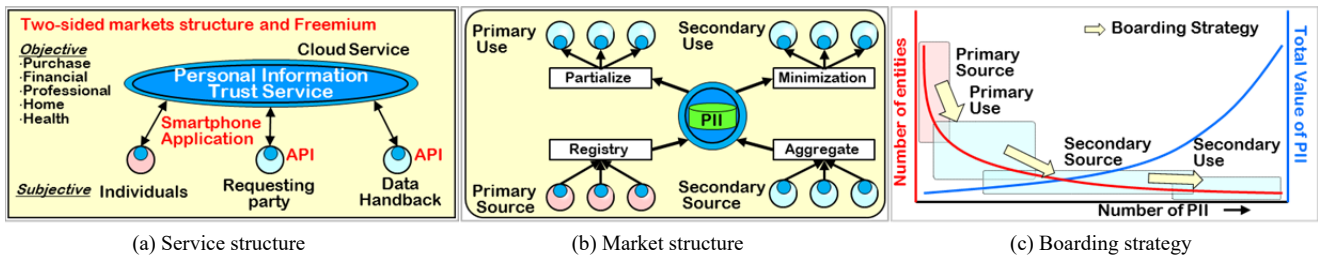


Figure 8. Service structure, market structure, and boarding strategy (Source: Authors)

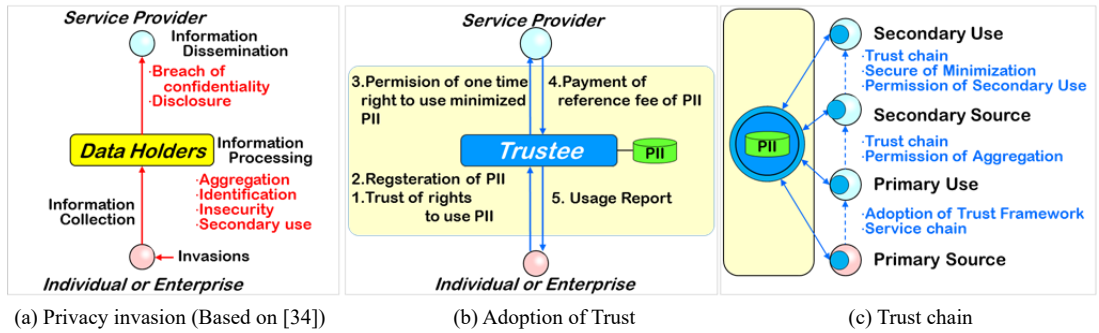


Figure 9. Trust framework in the Enterprise Privacy Architecture (Source: Authors)

(b) Trust framework

Each individual has bounded rationality and does not have ability to choose the best tools or services to hold his/her PII. Moreover, each individual has limited ability and resources to manage own PII in hard days of daily life. Thus, individuals have necessity to entrust own PII to a Personal Data Store. The cyberattack to the data holder that stores PII is two types; one is privacy invasion from inside and another is from outside. Upton & Creese [37] discussed the causes of growth of insider cyberattacks. The attacks involving connected companies or direct employees pose a more pernicious threat, and insiders can do much more serious harm than external hackers can, because they have much easier access to systems and a much greater window of opportunity. Data holders have risks of privacy invasion in information processing (aggregation, insecurity, and secondary use) and information dissemination (breach of confidentiality, disclosure, and illegal identification) with the taxonomy of privacy (Figure 9(a)).

Laudon [19] discussed privacy protection with a market-based approach. Tatsumi [36] discussed a personal information trust in Japan in perspective of economy. This paper examines a personal information trust in perspective of an open & close service innovation. The Trust framework (Figure 9(b)) defines that a settlor transfer one’s trust property to a trustee with a trust agreement or a will, and the trustee administers or disposes of property in accordance with a certain purpose and conducts any other acts that are necessary to achieve such purpose (Trust Act, Japanese Act No. 108 of December 15, 2006). The trustee has an obligation to administer or dispose of a trust property with due care of a

prudent manager, due of loyalty, and duty to segregate property. The adoption of personal data trust can prevent the breach of confidentiality, insecurity, and illegal identification because of due care of a prudent manager, due of loyalty, and duty to segregate property (Figure 9(c)). Enterprises do not store PII inside and refer it each time when they use it. Whereof, the risk of insider cyberattacks can reduce.

(c) Information system and privacy continuum

An ICT technology can aggregate various type of data source and builds up as big data. PII has two categories of "identified" and "identifiable" data. Because the big data contains a mixture of different level of "identified" and "identifiable" data and treats them the same. Thus, PII in the big data can accidentally identify an individual with using the big data. Therefore, the big data should contain well-structured and well-normalized PII that cannot identify an individual accidentally.

Mandala introduces the service dimension [16] of relationship marketing into front-office system to invite individuals and collect day-to-day human activities. At the same time, Mandala introduces the archival dimension [38] of record continuum model in back-office system to solve social problems with user experience of day-to-day human activities. Figure 8 shows our conceptual model of privacy continuum in Mandala. This model integrates the front- and back- office system, and synchronizes archival dimension with service dimension. This model can aggregate the same level of minimized PII and avoids the accidental identification of data subject. Table 3 shows the time, space, and regionalization in the Enterprise Privacy Architecture.

TABLE 3. TIME, SPACE, AND REGINALIZATION (Source: Authors)

No	Service Dimension	Archival Dimension	Data Subject	Time-Space	Regionalization
1	Relationship	Pluralize	Society	Decade, Century	Whole Area
2	Sequence	Organize	Community	Month, Year	Wide Area
3	Episode	Capture	Family	Hour, Day, Week	Narrow Area
4	Action	Create	Individual	Second, Minute	Limited Area

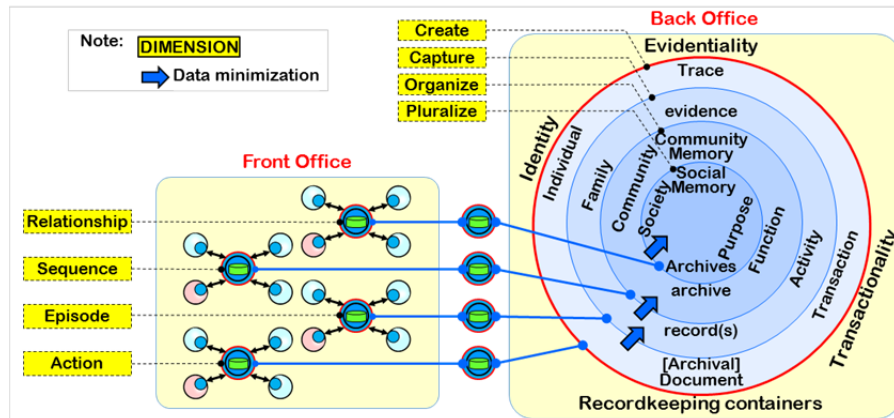


Figure 10. A privacy continuum model (Source: Authors, based on [16], [38])

The most important thing is how to protect privacy of data subject inside the back office. Customers of Mandala can manage aggregation of source data. Mandala treats "identified" and "identifiable" data differently to place them on a continuum that begins with no risk of identification at one end, and ends with identified individuals at the other. To avoid accidentally identification, Mandala proposes a set of norms of systematical data minimization in each archiving process. For example, PII in 'Action' of service dimension in front-office aggregates and stores in the 'Create' of archival dimension in back-office (Figure 10). PII of individual routinely minimize and stores inside a numbered account of family data in the 'Capture' of archival dimension. This privacy continuum realizes not only the synchronization of collection and use of the same level of minimized PII, but also the chain of systematical data minimization between different level of archival dimension. This privacy continuum can be one method of systematical privacy protection. Figure 10 shows the conceptual model of privacy continuum.

B. Key Concept of Smart Privacy Platform

(a) Service outline

Mandala manages PII instead of busy individual and has an obligation to observe due care and prudent management, loyalty, and segregation of property in administering or disposing of trust property. The corporate customers, which use the PII in Mandala, do not store the PII inside the company and refer the PII each time when they use it. Mandala manages the risk of identifiability of each individuals to avoid insecurity and accidental identification of individuals. It introduces Data Minimization Methods, which manage anonymity, unlinkability, undetectability, unobservability, and pseudonymity of the PII applying the method of Privacy by Design. It can provide the PII, which is managed its risk of identifiability, to the requesting party and data handback. The service of Mandala needs the permission by Law and has an obligation to be certified by Privacy Certification Authority. This service has an obligation to be periodically audited by Privacy Certification Authority that include information security engineer, certified public

accountant, attorney, and audit institute. The service of Mandala is punishable by law and pays penalties to its customers in case of the violation of their obligations.

Most of conventional Personal Data Stores are intended primarily for safekeeping and protection of PII; they do not focus on considering much about the privacy continuum with their associated services. Individuals, who are always busy every day, should take the initiative in managing their PII and may spend their resources in using these conventional Personal Data Stores. The economic benefits of the users of these stores are less than the acceptable risk and cost. Because the service of Mandala adopts the two-sided markets structure and freemium business model, it may provide its service cheaper than conventional Personal Data Stores. Therefore, the economic benefits of the users of the service can be greater than the acceptable risk and cost.

(b) Service process

When a lead user (primary source group) selects the core services (pay-per-use), option services (e.g. data backup services, Service Level Agreements, and so on), and associated services (secondary source group, e.g. auto-aggregation service, and so on), he or she decides the permission of donation of the third-party usage of his/her minimized PII. The selection of optional functions and associated services may increase the service free, and the donation of the third-party usage of his/her PII can decrease the service fee. The corporate customer (primary use group) selects core service, option services, associated services, and the permission of use of the minimized PII. The selection of use of the minimized PII may increase its payment and can realize low cost structure for individuals.

The personal customer registers his/her PII via personal computer or smart-phone application. The corporate customer refers the PII via API inside its legacy system in the company. Mandala collects, aggregates, and store the PII automatically from associated services. It should systematically summarize and minimize the PII for the purpose of the third-party usage with his/her trust agreement.

The third-party service provider (secondary use group)

asks the Mandala provider for the third-party usage of minimized PII and explains the purpose of PII use. When the Mandala provider makes a judgement decision with trust agreement, the third-party service provider makes contacts that include user agreement, non-disclosure agreement, and prohibitory resale with the provider every time when they use minimized PII.

When the contact expires, the provider disposes all the contactors' trust properties. All the transactions of whole life cycle of PII exchange are automatically kept on the management service as records of PII usage. The Mandala provider has an obligation to disclose the records of PII usage all day long on its customer's service portal.

C. Introduction to a smart city

Mizuno & Odake [22] surveyed current status of smart systems and case studies of privacy protection platform in Japan. They clarified the situation of smart systems in Japan as follows: (a) Smart Grids and Smart Intelligent Transport Systems had been progressing steadily, (b) there were few smart systems for people and communities, and (c) promotion groups of smart city are developing smart system platforms, e.g. Smart Grid Platforms, Smart Mobility Platforms. Figure 11(a) shows placement of de-centralized conceptual model of placement of Mandala service on the future situation of core smart system platform.

Figure 11(b) shows the strategies for diffusion of Mandala service. The Enterprise Privacy Architecture can affect the formulation of Personal Data Ecosystem; the Smart Privacy Platform can affect the development of Mandala service. In order to formulate the Personal Data Ecosystem, the market strategy exploits associated services with path dependence and manages the benefits, risks, and trust. The market strategy realizes the strategic long stories with privacy continuum. The MOT co-operates with the marketing strategy and develops the Mandala service. In order to develop the Personal Data Store, the MOT explores privacy protection technology with path independence. The MOT manages technological risk and rock-in, and integrates the open & close service innovation and technologies.

VII. CONCLUSION

This paper discussed a conceptual model with a Personal Data Store in two perspectives. One was a development of a Personal Data Service; another was a formation of a Personal Data Ecosystem in Japan.

First, this paper studied the accounting cloud service and discussed the factors of its diffusion. The accounting cloud service adopts two-sided markets structure and freemium business model. It has been growing steadily and has gathering about three million customers. It manages a large number of PII inside its service platform and builds up big data in financial sector. The factors of its diffusion are its spiral market strategy and its open & close service platform to create a chain of coherent services.

Second, this paper discussed the accounting cloud service as a Personal Data Service in Japan. The accounting cloud service builds up big data and exchanges PII with various associated cloud services. The accounting cloud service works as a Personal Data Service in nature. The Personal Data Service needs long-term and nation-wide perspectives. When these accounting cloud services become one of Personal Data Services, it is necessary for them to expand time and space of their services.

At last, this paper examined a Personal Information Trust Service named Mandala. Mandala introduces the service dimension at front-office and the archival dimension at back-office. Mandala service synchronizes these two dimensions in its service process and realizes continuous data minimization in creating big data. This privacy continuum model can avoid accidentally identifying an individual in the social services of smart city.

Therefore, Mandala service can be one of common information models that manage smarter city data and share PII safely across multiple agencies within a city.

The originality of this work is to propose a conceptual model of the market-based approach of privacy protection in perspective of system modeling.

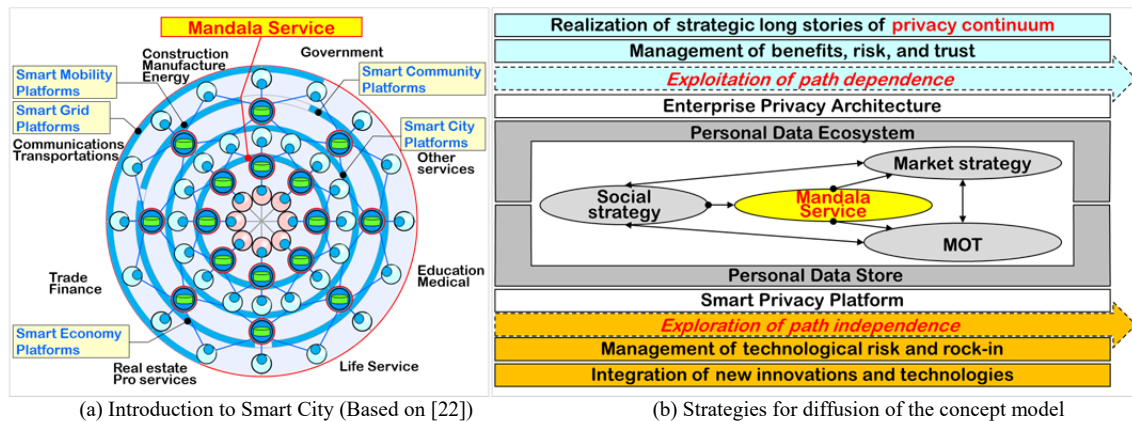


Figure 11. Applied model and its strategies for diffusion (Source: Authors)

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KEY TERMS AND DEFINITIONS

- Aggregation:** The combination of various pieces of data about a person
- Anonymity:** The subject is not identifiable within a set of subjects, the anonymity set
- Breach of confidentiality:** Breaking a promise to keep a person's information confidential
- Disclosure:** The revelation of truthful information about a person that impacts the way others judge her character
- Insecurity:** Carelessness in protecting stored information from leaks and improper access
- Items of interest:** IOIs. E.g., subjects, messages, actions, and so on.
- Pseudonym:** An identifier of a subject other than one of the subject's real names
- Pseudonymity:** The use of pseudonyms as identifiers.
- Secondary use:** The use of information collected for one purpose for a different purpose without the data subject's consent.
- Undetectability:** The attacker cannot sufficiently distinguish whether it exists or not.
- Unlinkability:** Within the system (comprising these and possibly other items), the attacker cannot sufficiently distinguish whether these IOIs are related or not.
- Unobservability:** Undetectability of the IOI against all subjects uninvolved in it and anonymity of the subject(s) involved in the IOI even against the other subject(s) involved in that IOI.

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