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Industry Cloud - Effective Adoption of Cloud Computing for Industry Solutions

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Industry Cloud - Effective adoption of Cloud Computing for industry solutions

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***Abstract*—Enterprises in many industries start using Cloud Computing for their IT infrastructure services. This adoption of Cloud Computing is a part of the enterprise transformation which is the migration from a legacy IT environment to Cloud Computing. One of major targets is an industry solution which provides a critical business service to their end customers. This paper proposes Industry Cloud which is the enhanced design of Cloud Computing. It efficiently supports industry solutions for enterprise business requirements. The paper describes Industry Cloud with the requirement analysis of industry solutions, the adopted functions, and three use case scenarios in the electronics and retail industry. The contribution of the paper is the analysis of industry wide requirements, the definition of Industry Cloud with a common function among industry solutions and the usage with use case scenarios.**

I. Introduction

Cloud Computing is a major trend in the IT industry since it can construct an efficient IT infrastructure and operation for enterprise IT systems. Many enterprises start strategically adopting Cloud Computing for their IT infrastructures since the operational and capital expense can be optimal for their IT infrastructures, and it makes a better business with Cloud Computing. In the result, Cloud Computing becomes a target infrastructure for a transformation for legacy IT infrastructures.

On the other hand, many industry solutions have been developed and deployed to provide enterprise core business services to their end customers. The industry solution is defined as a computer system which consists of a set of software stacks that can solve a complex business issue in a specific industry. The concept and approach of the industry solution can be widely accepted for many industries such as electronics, retail, finance, telecommunication and other industries [1]. One of major topics in enterprise IT organizations is to migrate those industry solutions on a legacy infrastructure to the Cloud Computing environment since those industry solutions were originally developed as a legacy system for a long time ago, and aren't flexible for customer's business requirements yet. The IT organization would like to get benefits of Cloud Computing for those industry solutions since Cloud Computing is expected to increase their business capabilities with less expense. In addition, Cloud Computing can also accommodate those workloads of industry solutions efficiently. Despite of higher expectations for those industry solutions on Cloud Computing, there was few research study for an architectural framework of Cloud Computing with an industry oriented approach.

The paper proposes "Industry Cloud" which can support those industry solutions efficiently since they are required to provide the service business with the solution to customers for enterprises. Figure 1 shows the layer architecture for Ordinary Cloud which is equal to Cloud Computing and Industry Cloud. In Figure 1, Ordinary Cloud has the hardware, cloud infrastructure layer. There is a workload on top of the cloud infrastructure and the hardware layer. On the other hand, Industry Cloud has the Industry Specific Layer between Cloud Infrastructure and Industry Solution. The layer which is described in this paper provides a common service among industry solutions among multiple industries. The paper consists of the "Background" section which describes the background for Cloud Computing and industry solutions, the "Industry Cloud"section which proposes Industry Cloud which can provide the better service for industry solutions, the "Use case scenario" section which describes three use case scenarios in electronics and retail industry for Industry Cloud, the "Discussions" section which discusses the proposed approach, and the "Conclusion" section which has the conclusion for the paper.

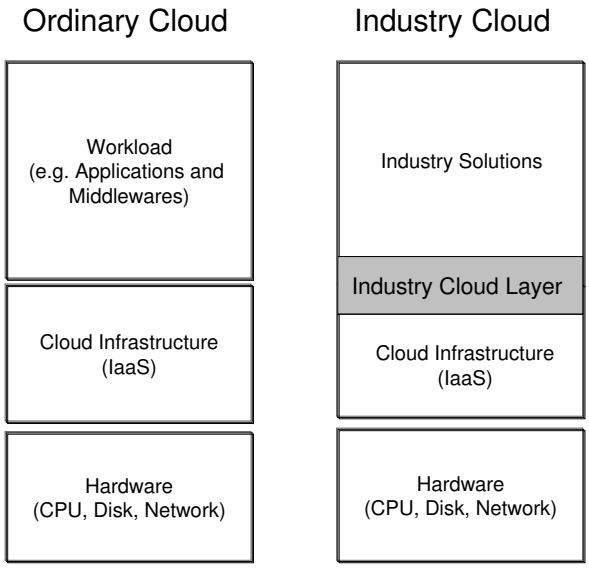

Fig. 1: Ordinary Cloud and Industry Cloud

II. Background and Related Studies

This section describes the background of Cloud Computing and the industry background and also explains the reason why Industry Cloud should be introduced to Cloud Computing.

A. Background of Cloud Computing

In this subsection, Cloud Computing is formalized and defined, and we explain the challenges for Cloud Computing with referenced research studies. Cloud Computing has a wider meaning within the IT industry in general since many organizations in enterprises have a different expectation and perspective for Cloud Computing. It refers to both the applications delivered as services over the Internet and the hardware and systems software in enterprise data centers that provide those services [2]. It has three compelling use cases: (1) Service demand varies with a time and the system has to support its demand. (2) IT resource demand is unknown in advance. For example, the Web site needs to support a spike for the demand. (3) Scale-out

workload would like to run on Cloud Computing to be finished with multiple faster processors. National Institute of Standards and Technology (NIST) defines Cloud Computing with five essential characteristics, three service models and four deployment models as an architectural model [3]. Those five essential characteristics are on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. Those three service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Those four deployment models are private, community, public and hybrid cloud which are the deployment pattern for Cloud Computing. In the architecture of Cloud Computing, there are five major components which are Cloud Consumer, Cloud Auditor, Cloud Provider, Cloud Carrier and Cloud Broker [4] [5]. This paper is mainly focused on architecture components of Service Orchestration and Cloud Service Management in Cloud Provider since those components are relevant to industry solutions, and they are also a part of Common Cloud Management Platform (CCMP) for the cloud management architecture [6]. In addition, Cloud Computing can appeal less capital and operational expenses because the infrastructure can be constructed with a statistical multiplex of hardware and software stacks among workloads and also different customers. The automation technology for the systems management and the shared hardware and software stacks can provide an efficient infrastructure for the enterprise IT operation. Cloud Computing has a challenge IT theme for the IT outsourcing service in enterprises since it is a emerging paradigm shift from a legacy support and business structure to a structure of Cloud Computing [7]. As another aspect of Cloud Computing, the open source for Cloud Computing is to provide cloud services with open sources and standards [8], and the number of Cloud Computing deployment is increased with the open source setup. If Cloud Computing with the open source will be used for enterprise services with industry solution, the production level service is required for Cloud Computing. In addition, there is the initiative for Cloud Computing to build the efficient infrastructure for research projects [9].

On the other hand, the business for Cloud Computing is a perfect competition environment [10]. It is a similar market with milk, gasoline, airline seats, and cell-phone service which are characterized by a number of supplier behaviors aimed to avoid the downsides of the perfect competition. With the result of the perfect competition, Cloud Computing usually does not meet those enterprise requirements for a deterministic behavior. It causes less quality service and function for enterprise customers which would like to get the production level quality of service for Cloud Computing. It is a major reason to be an inefficient operational support for industry solutions on Cloud Computing. This is a strong reason to build the infrastructure of Cloud Computing for industry solutions. Cloud Computing has much perceived benefits for industry solutions, and its users perceive the promised benefits for Cloud Computing [11]. Here is the list of benefits and challenges for industry solutions on Cloud Computing.

- Scalability: Practitioners perceive it as a high desirable quality for Cloud Computing.
- Availability: Cloud Computing users would like to receive the continuous availability of resources and services such as system availability over 99.9%.
- Security and compliance: Practitioners strongly perceive the security concern as a barrier resulting in the hesitance of public cloud adoption in enterprises, which causes especially in government, healcare industry and e-commerce. The topic is a challenge to adopt Cloud Computing for those industries.

In addition to the list, practitioners also claim to receive benefits mainly from the hardware side, and expressed their concerns with a regard to pricing structures and licensing models. They also raise the issue of the hosted platform, which should be enhanced with the functionalities of the platform, and can increase their productivities.

B. Industry Background

This subsection describes the background for industry solutions, and the reason to adopt Cloud Computing with industry specific functions. In manufacturing companies, there are several issues that are raised for conducting their service business [12]. Those concerns are (1) Service business model, (2) Quality and productivity of service, (3) Estimation and valuation of service, (4) Building management system of service business, (5) Developing curriculum of business planning and managing for service business. Those manufacturing companies would like to introduce a new service business with solving those concerns with a new IT infrastructure such as Cloud Computing. In telecom industry, Cloud Computing has a potential opportunity to improve the service business. Companies in the telecom industry would like to apply the industry solution for a business intelligence to the business activity, and the solution should be based on on Cloud Computing [13].

In addition, there is a good revenue generation opportunity for brokering new services of Cloud Computing which is bundled with their network connectivity to current or new customers [14]. In chemical and petroleum industry, the industry solution needs a business agility such as rapid response to diagnose and exchange a real-time information and other relevant data sources [15]. In automobile industry, the supply chain management can leverage Cloud Computing to enhance an interoperability between stakeholders, and improve the efficiency for the supply chain [16]. Cloud Computing is also effective for the bioinfomatics industry since those companies in the industry have a strong requirement for analyzing a large amount of data on a production level computing environment [17]. Cloud Computing can be applied to this computing environment to manage and process data in bioinfomatics companies. In the consumer products industry, Cloud Computing can provide the benefits of the approach in context of the demand driven business analytic solution that provides demand signals of the retail supply chain to Consumer Product manufacturers [18].

In addition to those major industries, the business value for Cloud Computing is also emerging for star-up and Small and Medium Business (SMB) companies in both B2B and B2C markets. For example, there is a use case for the usage of Cloud Computing on the textile and apparel industry with the roots of a successful value creation and increased competitiveness [19]. Public and government organizations in the government industry are trying to adopt Cloud Computing, but they are often stalled to deploy it with concerning for major security requirements [20]. The threat for security is the intrusion for the government IT infrastructure and to copy a sensitive information of the government system to outside of their organizations. As a service model, in addition to the IaaS model for Cloud Computing, Platform as a Service (PaaS) model which can support the set of requirements for Cloud Computing enabled industry solutions in an enterprise has been introduced [1]. It can be applied to those industry solutions in telecommunication, chemical and petroleum, financial and healthcare industries.

In the result of our investigations for related studies in industry solutions for Cloud Computing, it is effective and valuable for industry solutions in major industries but there is no common architectural framework for Cloud Computing for those industry solutions. In addition, the efficient deployment and operational model which can add the business value for industry solutions is required for Cloud Computing. It should provide higher value business services of enterprises to their customers. The architecture for the industry oriented cloud should support those industry solutions. Since industry solutions provide enterprise services with a core business application in general, they are required to support the production level service on Cloud Computing. It means that Cloud Computing should support the flexible resource provisioning, the continuous and sustainable service, the support for multiple customers in the instance, and the security and compliance requirement as a basic function. The multi-tenant capability for Cloud Computing can support multiple tenants in the same solution instance [21]. Those functions are mandatory provided as a core service of Industry Cloud. In addition, a common requirement for Cloud Computing in the specific industry should be supported by Industry Cloud.

III. INDUSTRY CLOUD

Industry Cloud is defined as the instance of Cloud Computing and can support the business service with industry solutions effectively. It provides better business services for their end customers than a generic Cloud Computing. The strength of Industry Cloud is a better functionality to provide a better quality of the enterprise service business which means to provide the production level service. Figure 2 shows the requirement analysis of industry solutions for Cloud Computing. Before the industry solution is on-boarding to Cloud Computing, the requirement analysis for the industry solution should be investigated. Those requirements for Cloud Computing are categorized as a grade of the level from a common requirement to a customer unique requirement. Here is the category list for the requirement in Fig. 2 :

- Common requirement for all Cloud Computing infrastructures : This category is a common requirement for all Cloud Computing. Those functions for the requirement should be provided by the ordinary Cloud Computing. For example, those functions are virtualization, provisioning and service catalog for Cloud Computing. They are a part of Industry Cloud, but aren't described in the paper because they are referred at the related works.

- Common requirement among industry solutions : This is a common requirement among all industry solutions. The requirement should be covered by Industry Cloud. For example, those industry solutions need the production level service which is supported by Industry Cloud.
- Common requirement within the single industry : This is the requirement in the same industry but not multiple industries. For example, the healthcare industry needs the specific security and compliance requirement for the IT system (e.g. HIPAA). It should be supported as an option of Industry Cloud since it is the requirement for the industry.
- Requirement for the specific industry solution (Common among customers) : This is the requirement for the specific industry solution but not other industries. Once the industry solution is installed and operational, the requirement is supported by the customization of Cloud Computing.
- Specific customer requirement (unique requirement for the customer) : It is a customer specific requirement, and can be only applied for one specific customer and not multiple customers nor industries. The requirement is supported by the additional software development or the customization for Cloud Computing.

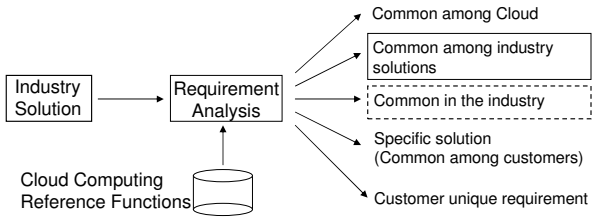

Fig. 2: Requirement analysis for the industry solutions

With the background of Cloud Computing and industry solutions and the requirement analysis in the paper, five core functions with Cloud Computing can support to provide the production service with industry solutions. They are (A) Scalability, (B) Availability, (C) Multi-tenant capability, (D) Isolation and segregation and (E) Common requirement for the specific industry. Industry Cloud should support them in addition to functions of the ordinary Cloud Computing.

A. Scalability

When the number of transactions for the industry solution is increased, industry solutions need additional IT resources (e.g. CPU, memory, disk and network) to accommodate them. In this case, there are two types of scalability which are scale-up and scale-out type. The scale-up type is to simply increase those sizes of IT resources for the industry solution. For example, provisioning of the number of virtual CPU is increased from 2 to 4, or the virtual memory size is increased from 4GB to 8GB. There is a upper-limit for the scale-up type with a specification of the physical hardware. The software of the industry solution can usually manage the scale-up configuration without any software update. On the other hand, the scale-out type is to increase the number of resources such as VMs for the industry solution when the addition IT resource is required for those increased transactions. The industry solution should provide the scale-out configuration since the configuration change is required to include the additional IT resource. As the example of the scale-out type, when the industry solution needs the additional processing power, one additional VM is attached to the configuration of the industry solution. It is a part of the front-end processing VMs, therefore the processing power can be increased for the industry solutions.

B. Availability

Industry solutions need the production level support to provide the business services. The availability is one of non-functional requirement for Industry Cloud. The key measurement metrics for the availability is Service Level Agreement (SLA) between the service provider and the customer. To provide the better SLA, the back/restore, the disk mirroring and Disaster Recovery (DR) should be provided on Cloud Computing. Figure 3 shows the configuration of the backup/restore, the disk mirroring and the DR function for Cloud Computing. To keep the sustained SLA, those functions are applied to Cloud Computing. In Fig. 3, the backup/restore and the disk mirroring function is to copy the actual disk storage data to another disk storage or magnetic tape with a regular basis (e.g. daily and weekly basis). Once the storage data are corrupted or deleted, the backup data are restored to the storage, and the industry solution is resumed at the backup status. The storage data are copied to another storage in the different physical unit at the different datacenter location. The DR function has the capability to continue the service of the industry solution. There is a standby setup for the computer and the storage in the different datacenter in Fig. 3. This standby setup for the industry solution is the same configuration as the primary setup. Once the industry solution in the primary setup has a failure at the disaster event, the solution in standby setup is started and provides the sustained business service to their customers. Since the storage data are synchronized between the primary and secondary location, the standby setup can be smoothly taken over and provide the business service to their customers.

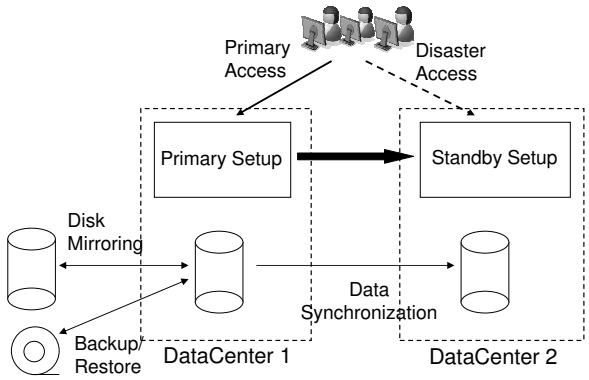

Fig. 3: Backup/Restore, Mirroring and Disaster Recovery

C. Multi-tenant capability

Figure 4 shows two deployment configurations of multi-tenancy which are a single and multiple tenants for industry solutions. In Fig. 4 (a), the configuration shows a single instance of the industry solution for a single customer. The industry solution can be multiple instances to be deployed to support multiple customers. In this configuration, there is no multi-tenant capability for the industry solution instance. Therefore, multiple instances for the industry solution on Cloud Computing is required to support multiple customers. In Fig. 4 (b), the configuration is a single instance for the industry solution to support multiple customers. In this configuration, multiple customers can be run on the single industry solution at the same industry. In result, the solution is only one instance but needs a scalability to support a large number of end users. The difference between Fig. 4 (a) and (b) is a multi-tenant capability with a isolated environment among those customers.

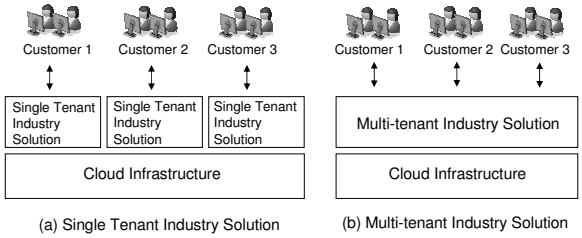

Fig. 4: Single tenant and Multi-tenant for industry solutions

D. Isolation and segregation

Industry solutions need the production level service with the right level of isolation and segregation among customers. Since Cloud Computing is a shared infrastructure among customers, the VM is a isolation point on the shared hardware. The hypervisor can maintain the isolation among those VMs.

They don't have any internal connectivity and needs the network connection to connect each other at VM. On the other hand, Figure 5 shows the isolation for the industry solution among customers. In Fig 5, multi-tenant industry solution should support the isolation of data and process among customers within the same solution. The operation and the management should be separated among those customers. For example, there is the logging function within the infrastructure, those log records should be separately stored for those customers or designated to the specific customer. Those log records are often used for the management or audit activity of the infrastructure.

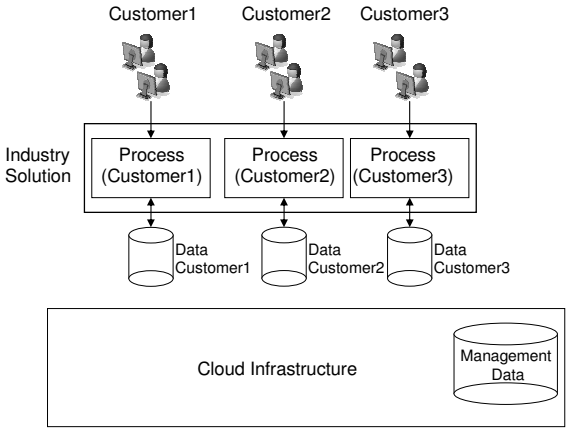

Fig. 5: Isolation and Segregation

E. Common requirement within the specific industry

There is a requirement for the specific industry but its requirement doesn't need other industries. There is an industry lead standard which defines interaction protocols and specifications which are related to back-end services. Those enterprises in the industry are industry forums or alliances within the same industry. For example, Smart TV Alliance defines the specification for Smart TV appliances [22]. It includes the definition and specification of the client-server interaction with the Web browser. The requirements defined by SmartTV alliance are the SmartTV specific ones but can be a common requirement among those manufacturers in the electronics industry.

In addition, there is an industry wide requirement within the same industry. For example, the healthcare industry has to follow the rule of Health Insurance Portability and Accountability Act (HIPAA) which should be applied to the IT system in healthcare organizations [23]. The IT system including the industry solution in the healthcare industry should follow this rule and guideline. When there is a target for the specific industry, the standard rule and guideline in the industry should be investigated and adopted for Cloud Computing.

IV. Use case scenario

This section describes three use case scenarios which describes Industry Cloud with industry solutions in the electronics and retail industry effectively.

A. Electronics Industry

In the electronics industry, Consumer Electronics (CE) manufacturers are producing the hardware products for consumers in general. They design and develop those consumer electronics products and sell them to consumers as a manufacturer product. The industry is well aligned to the product business. On the other hand, their product lines are already matured for those consumers. It means that many electronics companies in emerging countries can make the same function of those products for their consumers since the technology is now a component base and they can buy the technology component from hardware parts vendors as a component. Therefore, those manufacturers in the electronics industry is a competitive market. In this result, Cloud Computing for the electronics industry is expected to drive the value chain increasingly toward valued service business with the industry solution [24].

There are the traditional and digital convergence model in the electronics industry. In the traditional model, contents providers create their contents, service providers distribute their contents to customers and electronics manufacturers provide hardware devices for those customers. The distinction among their roles is clearly defined and those organizations have a different value proposition at each role. On the other hand, in the digital convergence model, electronics manufactures would like to integrate back-end service providers to provide the better services to customers. The digital convergence in the electronics industry has a business transformation. Therefore, the enterprise in the electronics industry would like to provide the business service with the industry solution.

As an another aspect, the function of the network connectivity for those appliance products just start being adopted. One of typical appliance products is a television equipment which can be connected to the server through the network. It calls SmartTV which can retrieve the contents on the network. The SmartTV equipment becomes a part of the network device for the service business, and customers can navigate and retrieve their favorite contents from servers. Those consumers can watch movies and recorded video clips as on-demand basis, online shopping, online gaming and also just check Web contents using the television equipment. In the result, the television manufacturer's business model is transforming from consumer products to get the service business with SmartTV products. This transformation to service business is moving faster than those manufacturers expect, and they would like to take a lead to provide a new service business around their appliance products with the adoption of Cloud Computing.

Figure 6 shows the logical architecture of SmartTV solution. In Fig. 6, SmartTV clients get access to the SmartTV Portal Server and the portal server redirects to the independent contents server or the same contents server of SmartTV Portal Server. In result, the contents for SmartTV are provided by either server. The contents service from SmartTV Portal Server should be provided on Cloud Computing. In the SmartTV solution, there is a set

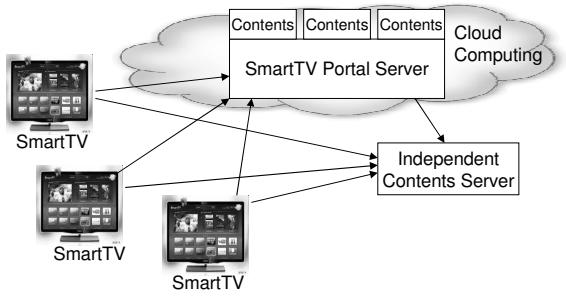

Fig. 6: Logical Architecture for SmartTV on Cloud

of requirements for Cloud Computing. **Scalability:** The SmartTV solution needs to increase IT resources (e.g. CPU, memory, disk and network) to keep the sustainable response time when the number of connected SmartTVs is increased. When a big event such as Olympic and World Cup Soccer game is held, a large number of SmartTV clients are connected to the SmartTV Portal Server and also Contents Servers. Since the SmartTV solution can be configured with the scale-out setup, the addition resource for the scale-out configuration can be provided to accommodate those TV clients. **Availability:** The SmartTV service should provide 24 hours and 365 days service to customers and has ideally no down time for the service. Therefore, the high availability service for Cloud Computing is mandatory required for SmartTV. The backup/restore service is not enough to support the continuous sustainable service to SmartTV customers since Recovery Point Objective (RPO) and Recovery Time Object (RTO) aren't met for the requirement of SmartTV. Therefore, the Disaster Recovery (DR) function provides the dual software stacks between two datacenters. **Multi-tenant capability:** The service provider for SmartTV would like to support multiple TV manufacturers on the same SmartTV solution. It requires multi-tenant support for the industry solution on Cloud Computing. In multi-tenant environment, those tenants for TV manufacturers can provide the same service to their customers and get the advantage of the shared solution infrastructure. **Isolation and Segregation:** The isolation is to be logically separated among those TV manufacturers since they provide different contents for their TV production. The isolation is also applied to the administrator access of the TV manufacturers for Cloud Computing. For example, the administrator for customer 1 should get

access to the contents for customer 1 and no other contents access. **Common requirement for the specific industry:** The SmartTV alliance defines the industry standard for SmartTV, and many TV manufacturers start adopting the standard [22]. Industry Cloud for the electronic industry should support the standard.

The Smart Home solution in the electronics industry is also described as a use case scenario [25]. Figure 7 shows the SmartHome solution on Cloud Computing. In Fig. 7, there are two Smart Home houses which have home gateways (Home GW) between the home appliances and the back-end Smart Home server for the industry solution. The Smart Home solution provides an intelligent control to manage those home appliances remotely, and a home automation which means those appliances should process the housework or household activity automatically. Since there are a lot of home appliances with different network connectivities, the internal network among those home appliances is critical to support Smart Home services to customers. Those services for Smart Home are mainly entrainment and convenience, health and wellbeing, safety and home security, and energy management at home. In addition to the home intelligent control and automation, the value added service for Smart Home is provided using the activity log and customer's behavior which can be analyzed with data analytics. In the Smart Home solution, the back-end service such as data storage for home appliances, the analysis and browsing for captured data, and a single interface to control those home appliances is also required.

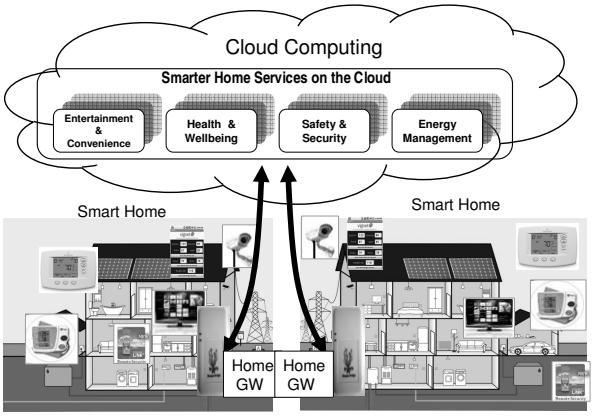

Fig. 7: Solution for SmartHome on Cloud

Here are the requirements of Smart Home for Industry Cloud: **Scalability:** There are two types of accesses to the Smart Home server. One is the access of end users to control and manage home appliances. For a large number of end users access, the scale-out setup can be configured to increase the IT resource. It is the same configuration for Web end users. Other access is home appliances and home gateways to send their data to the Smart Home solution. Since those home appliances can send their appliance data directly to the server or the home gateway. When the home gateway gathers home appliance data, the home gateway sends it to the server behalf of those home appliances. When the number of home gateway or appliance is increased, an additional VM on Cloud Computing can be attached to receive the large amount of data from home gateway or appliances. **Availability:** The Smart Home solution requires a usual availability to provide the service. Therefore, the function for the backup/restore and the disaster recovery service for Cloud Computing can be applied to the industry solution. **Multi-tenant capability:** The Smart Home solution should support multiple electronics manufacturers on the same solution infrastructure. Therefore, multi-tenant support is required to support them. **Isolation and segregation:** The Smart Home solution is processing data for multiple appliances which are owned by end users at home. In addition, it should support multiple electronics manufacturers. Industry Cloud supports the production level of isolation for Smart Home among appliances, end users and electronics manufacturers. **Common requirement for the specific industry:** The SmartTV alliance defines the industry standard for Smart Home in the alliance working group [22]. In addition to the SmartTV alliance, the Energy Conservation and Homecare Network (ECHONET) which is the industry consortium also defines the industry standard for Smart Home [26]. Once the Smart Home solution in the electronics industry is adopted on Industry Cloud, those standards should be supported since they will be a common requirement for service providers in the electronics industry.

B. Retail Industry

In the retail industry, the industry solution for the retail supply chain has become a top priority for Consumer Products [18]. In the retail supply chain, the Demand Driven Business Analytics (DDBA) becomes much traction among many retail companies. The DDBA solution provides services to manage information from the shelf back to the supplier. The key component in the solution is Demand Signal Repository (DSR) that should be robust with a centralized database. The database should stores, harmonize and normalize a large volumes of demand retail data which contain point-of-sale data, wholesale distribution data, inventory movement, promotional demographics, market demographics, third-party market content and customer loyalty data. The analytics for the retail data can support better decisions for the area of the category management, the joint value creation, the vendor-managed inventory, the trade promotion management, the supply chain management and the promotion management in the retail industry.

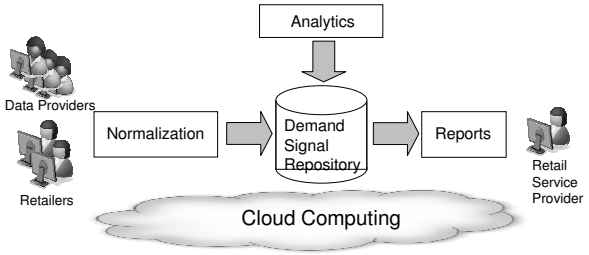

Fig. 8: Logical Architecture for Retail DDBA solution

Figure 8 shows the logical architecture for the DDBA solution. It provides a collaborative processing activity among consumer product manufacturers and their associate retail customers. Once those retailers and data providers upload their data to the server, it is normalized and clean-up for the master database. The solution can analyze the data to improve their business processes such as demand forecasting, new product introduction, on shelf availability, and order to cash. Consumer product manufacturers can get the analysis results with key performance metrics and alters which are generated by the solution. The requirements for the DDBA retail solution for Industry Cloud are listed below: **Scalability:** The solution analyzes several kinds of retail data, processes and manages a large amount of data quickly. Since the solution has the IT resource requirement for CPU, memory, disk and network, Industry Cloud supports requested resources for the solution. In addition, when the solution gets the result with less process completion time, the analytics component required much CPU power. **Availability:** The solution provides the continuous service to customers and needs the production level for the availability. The back/restore and DR functions should be provided by Industry Cloud. **Multi-tenant capability:** The solution has multi-tenant capability to reduce operation and management costs. Industry Cloud supports the multi-tenant capability for the solution on the infrastructure level such as the log management and the authentication. **Isolation and segregation:** The retail data for the solution should not be shared among customers since the solution is multi-tenant setup and each customer has the business data. The production level of the isolation is required for the retail data. **Common requirement for the specific industry:** For example, Association for Retail Technology Standards (ARTS) defines the industry standards for the retail industry [27]. Industry Cloud should follow the requirement if the retail company requires it. In addition to those requirements, there are other requirements for this industry solution: (1) Rapid on-boarding of new retailers and consumer products. (2) Ability to plug in different types of analytic solutions and providers. (3) Provide the customized reporting for those jobs. Those requirements should be supported as a function of the specific industry solution, which is a part of Industry Cloud.

V. Discussions and Conclusion

The section describes the concerning and limitation for the proposed approach for Industry Cloud, and also concluding remarks. In the paper, Industry Cloud is applied to the electronics and retail industry. The discussion is whether the proposed approach can be also applied to other industries. Since those functions with Industry Cloud can be common among industries, and support the production level service for industry solutions, Industry Cloud

can provide the same level of services for other industry solutions. Those industry industry solutions should be evaluated with Industry Cloud. If there is the specific requirement for the industry solution and it isn't supported by Industry Cloud, its function for the requirement should be provided by the outside of Industry Cloud. Because it is the specific requirement for the industry solution. If the requirement is common among multiple industries, it is supported by Industry Cloud. In this case, the customization or additional function development is required to support the requirement in addition to those functions of Industry Cloud.

There are the service model which are IaaS, PaaS and SaaS for Cloud Computing. Since Industry Cloud is functional customization of Cloud Computing for industry solutions, the SaaS delivery model is also related to Industry Cloud. The SaaS delivery model can be only adopted when many customers would like to use the application service at the same infrastructure. On the other hand, Industry Cloud can be applied to the specific industry solution.

The infrastructure of Cloud Computing includes the Business Support Services (BSS). The usage accounting and reporting functions are also used for industry solutions if the enterprise provides its service business to their customers. The usage accounting captures the usage activity data from each customer and accumulates it to the database. It usually provides the account usage for multiple users, and the reporting function is usually based on data for those account usages.

There is an emerging technical topic for Big Data management and analysis on Cloud Computing [28]. They can be a part of an application function for Industry Cloud if the industry solution requires the BigData processing and its analysis. Therefore, it is an optional function for Industry Cloud and should be required with the specific application which needs to process a large amount of data. Industry Cloud may employ the Big Data processing and analytics when they are required for the service of the industry solution.

The paper proposes Industry Cloud that enhances the ordinary Cloud Computing to support industry solutions effectively. It shows the requirement analysis, the definition and three use case scenarios that Industry Cloud can be applied to. In addition, it describes that Industry Cloud can be applied to other industries than those use case scenarios.

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