DESIGN OF DATA CENTER'S HIGH RELIABILITY IN LARGE AGRICULTURAL ENTERPRISE

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Abstract: It's necessary for the large agricultural enterprise to construct a stabile and reliable network environment and a powerful Data Center. In this paper, the constructing of high reliability in Data Center will be discussed according to the requirements of large agricultural enterprise; an effective solution will be presented that adopts structural redundancy and double VPN in the aspect of network and application. This solution has been carried out effectively in practical application, and proved that it is an exercisable example for the constructing of Data Center in large agricultural enterprise.

Keywords: large agricultural enterprise; data center; high reliability

1. INTRODUCTION

Usually, Data Centers are constructed in large industrial enterprises, banks, telecom, portal sites, etc (Gao GQ, 2004) (Wan XJ et al., 2003), but the application in agricultural enterprises is somehow unusual. The reasons are that the information basis of agricultural enterprise is weak in PR China and that the constructer is limited by person, finance and environment etc. One example is Guangdong Wen's Food Corporation, which is a national leader enterprise of

agriculture, and has more than one hundred branches or sub-companies, every branch has constructed Local Area Network and application system severally, but the information communication is poor between headquarters and branches. As a result, "Information Island" appeared, the statistic and feedback of enterprise information is delayed, it is not helpful to establish and implement decision.

Thereby, this enterprise decided to construct Data Center based on Internet in order to manage data centrally and to serve branches. In the beginning, Data Center needs to build up a reliable network system, and then construct the application software based on the network. As constructors of this project, the authors think that large agricultural enterprise (especially large livestock-breeding enterprise) has characteristics as following:

1) Wide and interlocal location: large enterprise has many branches and they are located in wide area, even the whole country;

2) Out-of-the-way site for connecting: agricultural enterprises, especially livestock-breeding enterprise, always locate in the rural area where is far away from city or town, and the telecom establishment usually not good enough, this make it more difficult for network connection;

3) Various types of user: although the production bases are always in rural area, but its main market and clients are located in the edge of cities or towns. there are various types of user and connection mode.

The above characteristics make it more difficult to build up Data Center of agricultural enterprise. The main task is to ensure the reliability of network, consequently to ensure the steady running of enterprise business across wide area and out-of-the-way locations.

2. RELIABILITY OF DATA CENTER

The characteristic of Data Center is "centralized data and distributed application", its importance for enterprise is obvious. When designing the Data Center, the requirements of enterprise shall be thought over in aspects of business, management and technology. The design will have certain foresight as well as keeping stabile, so advanced and accredited technology is adopted, the system should be implemented step by step (Gao GQ, 2004).

Arregoces et al (2003) thought that three aspects should be considered when designing Data Center:

1) Scalability: supporting fast and seamless growth without major disruption;

2) Flexibility: support new services without a major overhaul of its infrastructure;

3) High availability (HA): having no single point of failure and should offer predictable uptime.

Authors of this paper think that the reliability of Data Center includes three aspects as following:

1) Reliability of environment. The environment of computer rooms in Data

Center should be satisfy with corresponding national standards or constraints, such as temperature, humidity, dust, fire protection, thunderbolt prevention, grounding, weight bearing, power supply, illumination etc. Main measures include: installing air-conditions to ensure constant temperature and humidity in computer rooms; setting gas fire system in network rooms and server rooms, and water-spray fire system in monitor rooms and test rooms; preparing plenteous backup electric power (Kieffer S et al., 2003).

2) Reliability of network. The reliability of network is the hardware base of Data Center's reliability; it is related not only with performance of devices and topology, but also with environment of communication network (Luo PC et al., 2000). Network with high reliability will be redundant and having no single point of failure, so as to support various applications and ensure system safety (Jiang WJ et al., 2000).

3) Reliability of application. Apart from reliable function of software itself, optimization is needed according to characteristic of hardware during designing, operating system and topology of server cluster are also pivotal for reliability.

Large agricultural enterprise depends on network and relative application system increasingly in routine producing and official business. No doubt, Data Center can decrease cost of producing and increase advantage of competition for enterprise, but in malfunction befallen case, it might confuse the producing and management of enterprise, and cause unnecessary lost, so it is important to pay more attention to reliability of Data Center. The reliability of network and application is analyzed in this paper, and a solution for constructing Data Center with high reliability will be presented.

3. THE DESIGN OF NETWORK RELIABILITY

The principal objective of Network Reliability is fault-tolerance (Jiang WJ, Xu YH 2000). The way of fault-tolerance is to seek regular points of failure, make them robust with redundancy, so as to shorten fault time of network furthest. It has two principles as following: parallel backbone and double network centers. For Data Center of enterprise, the key measures are redundant network topology and connection mode.

3.1 Redundant network topology in Data Center

In order to ensure business persistent, the network must be persistent, especially in interlocal agricultural enterprise having distributed applications. Network is charged with transferring business data, business will be break down if network broken. In large agricultural enterprise, users connected with Data Center by several types, which were shown in Tab. 1.

Tab. 1. User types of Network Connection

User type	Mode of network connection	Bandwidth
Corporation headquarters	Intranet in Corporation	100M
Suburb branch	FDDI	2M, 10M
Out-of-the-way branch	ADSL, modem	<2M
Mobile or sporadic user	ADSL, wireless, modem	<2M

The types of connection are various, and the quality of connection is often not controllable (except Intranet in Corporation). So, the emphasis is made to ensure the reliability of Intranet and response for various connections in order to avoid network breaking, Network topology in Data Center is suggested like in Fig. 1.

To ensure the reliability of connection with Internet, double network redundancy is adopted for fault-tolerance, i.e., two communication links that provided by different telecom providers were used at the same time. Even if one of the redundant links have malfunction, business can connect with Internet by the other link. Synchronously, the pivotal network devices might also be redundant, such as IPS (Intrusion Prevention System), Switches, VPN (Virtual Private Network) Firewall and Main Switch.

IPS up-connects with two communication links, and down-connects with Switches. Switches connect crosswise with Firewall. Firewalls achieve high reliability via VRRP (Virtual Router Redundancy Protocol), Firewalls down-connect with Main Switches. Between Main Switches, the interface of VRRP with TRUNK is set up. In such architecture, Firewall can be load-sharing or redundant backup, and redundant backup is more frequently. When users connecting with VPN, Switch will build a Tunnel with one of the Firewalls that connected crosswise, and switch to another redundant Firewall if the former Firewall faulting. If the former Switch faults, the client VPN device will route to the other communication gateway automatically, and connect with other Firewall through another good Switch. Limited by Firewall's ports, Firewalls don't connect crosswise with Main Switch, and actually, it is not necessary to connect crosswise. Main Switch is used as VRRP, and TRUNK port is used to connect two Main Switches, this TRUNK port will not fail even when one of Main Switches faulting. Thus, Firewalls are ensured to connect with Main Switch reliably (Liang XJ et al., 2004) (Stallings W, 2006). Tab.2 shows the strategies of Network Reliability in Data Center.

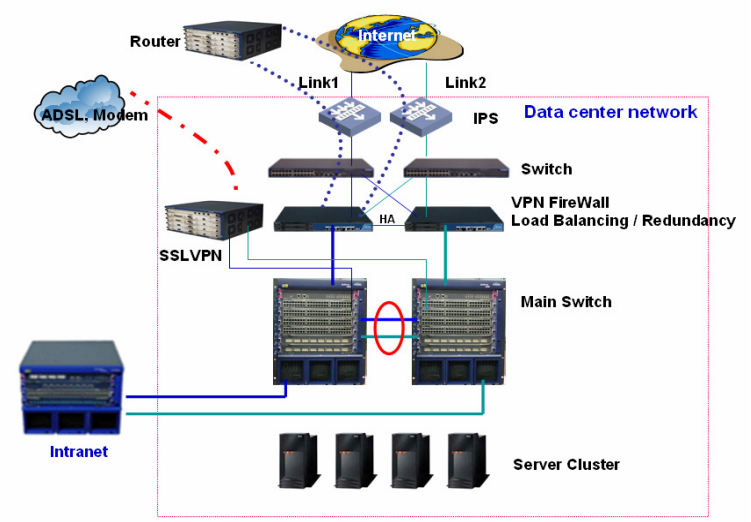

Fig. 1. Network topology in Data Center

Tab. 2. Strategies of Network Reliability in Data Center

Item	Strategy of high reliability
Communication link	FDDI provided by different telecom providers, two gateways, route to the other gateway automatically when former gateway faults;
IPS	Up-connect with communication link and down-connect with Switch, prevent intrusion;
Switch	Down-connect crosswise with Firewall, route to the other gateway automatically and connect with Firewall when the former Switch faults (i.e. former link break down);
VPN Firewall	Up-connect crosswise with Switch, adopt VRRP between two Firewalls, VRRP chooses the other Firewall to connect with Main Switch when the former Firewall faults;
Main Switch	Two Main Switches up-connect with Firewalls respectively, but connect with each other through VRRP and TRUNK, Firewall connect with the other Main Switch through TRUNK when the former Main Switch faults;

Tab. 3. Mode of client VPN connection

User type	Mode of network connection	Mode of VPN connection	Connection device
Corporation headquarters	Intranet in Corporation	None	None
Suburb branch	FDDI	GRE (Generic Routing Encapsulation), IPSec (Internet Protocol Security)	Router, firewall
Out-of-the-way branch	ADSL, modem	SSL(Secure Socket Layer)	IE, client plug-in
Mobile or sporadic user	ADSL, wireless, modem	SSL	IE, client plug-in

3.2 Strategy of double VPN connection

Besides the reliability of device and link in network level, clients' connection might also be redundant. Double VPN is set up, end-user will choose VPN Tunnel and route automatically according to the state of network link, and submit VPN connecting requirement.

In large agricultural enterprise, possible modes of client VPN connection are various and Tab. 3 shows several connection modes.

In corporation headquarters, users don't need VPN connection; it is needed by corporation branch and other users. VPN connection of corporation branch is just discussed here. If only IPSec connection is adopted, the high reliability of double VPN will not be realized. The reason is that IPSec itself can't route automatically in common device, i.e., device can't route to another VPN Tunnel when one of VPN Tunnels unavailable. If only GRE connection is adopted, route can be achieved automatically, but security prevention will be lack. Thereby, IPSec is suggested to be integrated with GRE in this paper. GRE Protocol encapsulates message of some network-level protocols (such as IP, IPX), and make these encapsulated message able to be transferred in another network-level protocol. GRE is the third level Tunnel protocol of VPN, and a technology called as Tunnel is adopted between different levels of protocol. Tunnel is a virtual point-to-point link, and can be regarded as a virtual interface supporting point-to-point link, this interface provides a thoroughfare to transfer encapsulated message. The message will be encapsulated and de-encapsulated in two ends Tunnel. An IPX message encapsulated in IP Tunnel has the following format:

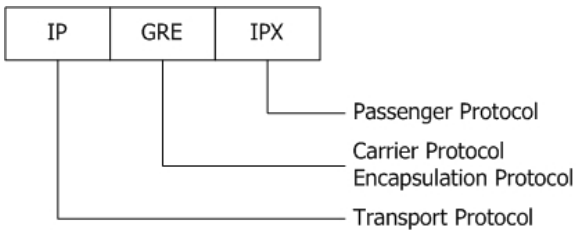

Fig. 2. The format of massage transferred in Tunnel

When actualizing double VPN, two Tunnels are set up, their target addresses are corresponded with certain gateway of different links. One Tunnel is the preferred route, normally it will be chosen automatically. If this Tunnel is detected to be unreachable, the other Tunnel will be switched to, thus double VPN connection is actualized. Actually, target address of message can be recognized when de-encapsulated after GRE encapsulates route data. But GRE itself can't transfer message safely. In order to transfer message safely, the data will be encapsulated by GRE at first, and then the encapsulated message will be encrypted by IPSec. Fig. 3 is the description of GRE integrated with IPSec.

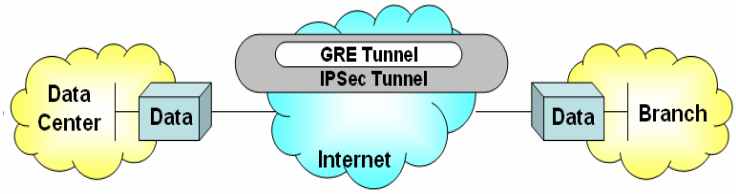

Fig. 3. GRE-IPSec Tunnel

4. THE DESIGN OF APPLICATION RELIABILITY

Data Center based on WEB requires server has high performance of real-time and throughout, it will receive clients' requests reasonably and response in a short time, Cluster is an effective way to implement high performance for WEB server(Lin C, 2000) (Zeng BQ et al., 2004). Server Cluster System consists of multi congener or heterogeneous servers. It offers transparent services and fulfills tasks cooperatively. It has the following advantages: avoiding temporary halt when updating server's software and hardware; joining or exiting of single server will not influence the whole cluster; avoiding single point of failure; high usability, reliability, performance and expansibility; transparent load-balance.

Application Reliability can be guaranteed by Server Cluster in this paper. Fig. 4 shows the topology of Server Cluster, Server Cluster is behind Main Switch usually consist of Database Server, Application Server and Disk Array.

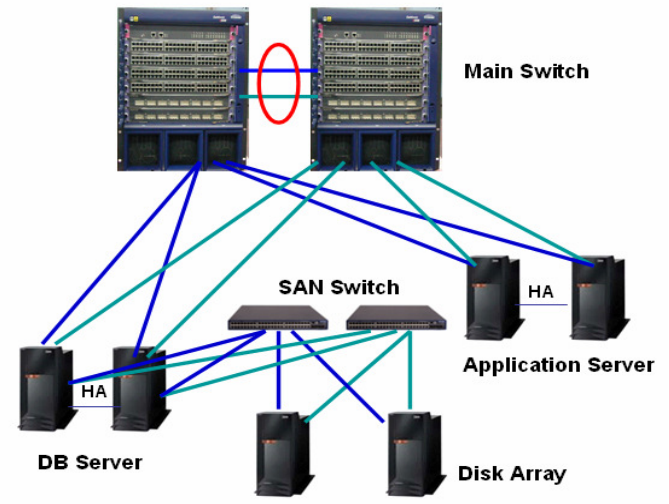

Fig. 4. Topology of Server Cluster

Main Switch down-connects with Application Server and Database Server. For high reliability and high-speed transference, two Switches will connect crosswise with four servers, and network port shall be colligated if possible,

which means multi Ethernet adapters in one server is colligated to form an Ethernet port having higher bandwidth.

Multi links ensure Application Server to access Database Server reliably, Application Server and Database Server themselves will achieve High Availability in system level, and be set up according to different Operating System and application. Additionally, data and files in Data Center will be stored in Disk Array, Database Servers transfer data with Disk Array through SAN (Storage Area Network). Two SAN Switches backup each other and down-connect crosswise with the controller of two Disk Arrays, up-connect crosswise with FDDI adapter of Data Server. System-level mirror is implemented in two Disk Arrays. One Disk Array is located in Data Center, and the other in computer room of another building, this strategy of disaster-backup on different locations could be complex but quite effective.

Clients access Application Server, the fault of single Application Server and communication link were considered. Application Servers request data from Database Servers, Database Server itself is high reliable with backup storage. Data in Database store in Disk Arrays, two arrays mirror each other. Data is transferred in independent SAN; there is no single point fault in the path from servers to disk arrays. Under the control of multi-path balance software, data stream will be loaded balancedly when paths no problem, once a path faults, all of I/O will switch to another path for accessing, and after the problem path is resumed, data stream will be loaded balancedly again. SAN is highly reliable under such design. Tab.4 figured the strategies of Network Reliability in Data Center.

Tab. 4. Strategies of Application Reliability in Data Center

Item	Strategy of high reliability
Application Server	Achieve High Availability by backup, multi link up-connect with Main Switch
Database Server	Achieve High Availability by backup or parallel accessing, multi link up-connect with Main Switch, multi link connect with SAN Switch
SAN Switch	Achieve High Availability by backup, multi link connect with Database Server and Disk Array
Disk Array	Mirror, multi link connect with SAN Switch, storage in different site

5. ANALYSIS OF RELIABILITY

The design of reliability in Data Center has taken several aspects into account, such as management, technology personnel, financing, information security and telecom establishment, this paper focus on the reliability of network and application.

Luo PC et al (2000) thought that there are two evaluations of reliability for communication network: Invulnerability and Survivability. Invulnerability

involves the reliability of network under purposive destroying, so it emphasizes particularly on the reliability of topology, always being used to evaluate army's network. For enterprise network, purposive destroying is hardly probable, so Invulnerability is seldom evaluated. Survivability involves the reliability of network under random failure (or being destroyed), it covers the concept of Network Robust, such as dynamic route, fault resume, prevention and redundancy etc, so Survivability was always evaluated. At the present time, hardware devices have been quite reliable, and been easy to inspect even faulting. In real running, system failure was infrequently caused by the malfunction of network devices, so designer of Data Center has concerned about the business performance of network, such as throughout and delay, i.e. how to ensure Application Reliability.

Take example for Guangdong Wen's Food Corporation (a national leader breeding enterprise), the above strategies were actualized when constructing Data Center, and high reliability of system is achieved. The frequent fault of network in routine, including device fault and link fault, were prevented thanks to redundant system framework. Double VPN solves the problem of link intermittence in client level, and keep business 24 hours running. In server level, cluster is adopted reasonably, links are highly reliable, and the speed of cluster switching is fast when single point failure, so the Data Center never intermits business in routine running due to fault. This shows that the above strategy of high reliability is reasonable and feasible.

6. CONCLUDING REMARKS

The primary goal of constructing Data Center is the centralized data management for uniform service, the design of reliability is essential guarantee for stabile running. For large agricultural enterprise, especially breeding enterprise, its characteristics of trade are wide area, distributed branch, out-of-the-way location, various user and complex mode of connection. All of these cause difficulties for constructing Data Center and ensure high reliability of network and client application.

Network Reliability and Application Reliability were analyzed based on practice. Network Reliability was achieved by redundant link, device, VPN and adapter, cooperated with VRRP, GRE, IPSec technologies of Switch, Firewall, router, etc. Application Reliability was achieved by redundant links between servers, server cluster and mirror of Disk Array. Based on these strategies of reliability, the loss caused by single point failure will be reduced effectively.

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