A DEALER NETWORK SYSTEM IN THE AUTOMOTIVE INDUSTRY

by

Mr. Kawin Chalermroj

A Final Report of the Three - Credit Course
CE 6998 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
in Computer and Engineering Management
Assumption University

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The Graduate School of Assumption University has approved this final report of the three-credit course. CE 6998 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

This project examines the network system development plan, which concentrates on automotive industry. This system will not just concentrate on a single automobile brand name but it acts as a central networking system where each automobile industry can use as a central information transfer media.

An overview and future trend of Thailand's automotive industry is given in order to give a brief idea of the current and future status of automotive industry. A research of existing networking infrastructure was conducted to identify the most appropriate media and networking system for distributed database system. Massive amounts of sensitive information are stored in each business location. The move toward distributed database system increases the chance of security violations. Many security issues are discussed in order to affirm maximum security at all levels.

The feasibility study section covers economic, technical, and operational issues. The main focus is on the economic feasibility where the detail project associated costs are given.

Recommendation to the project gives an idea on the project expansion on to other businesses. This project is just a brief overview of the network system in automotive industry. There are many parts of the project that can be further studied in detail.

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I. INTRODUCTION

1.1 Significance of IT toward Automotive Industry

Latest communication and computer technologies have influenced many businesses to manage their information toward database management systems. Automotive industry is one of the rapidly growing businesses in Thai economy. With the aid of efficient information transfer media, the company can accomplish both effectiveness and efficiency. Moreover, customer satisfaction will also be achieved.

Currently, daily transaction is mostly carried out by traditional method: fax, mail, and telephone. Automotive business involves a lot of such interactions and transactions among the head offices, dealers, and customers. These transactions are done daily and involve many locations in every part of the country. There are several automobile companies that implement database technology with online transaction but it just covers a small scale, which is only the central region. Why wouldn't they implement this system to cover every region? The answer to this question is simple, it is mainly because the investment cost is very high.

1.2 Problems

Since the economic crisis in 1997, small automotive companies that invested in Thailand, Detroit of Asia, are either closed down or facing a huge lost. Under the current economic situation, it is very hard for small automotive companies to penetrate through the market. Small companies are taken over by big ones. As being evidence, the remaining companies have to have support from their mother companies in order to survive through the crisis.

The economic is believed to be on the growth side. To provide brand variety for automotive consumers, there should be opportunity for new investment from other automotive companies in Thailand. What confident factor do these companies have in order to invest or start their marketing in Thailand?

It takes time to gain customer loyalty in Thailand. With modern technology that I am about to propose, it reduces investment burden for these small companies. The efficiencies of data communication would also enhanced.

1.3 Research Objectives

The objective of this project is to develop a network system plan, which concentrates on automotive industry. This system will not just concentrate on a single automobile brand name but it acts as a central system where each automobile industry can use as a central information transfer media. The technique of distributed database management systems will be applied to this system. Massive amount of sensitive information is stored in each business location. Users from different locations within the network can easily access the data without knowing where the data is physically located. The reason that I choose this distributed database management system over centralized ones is that of its scalability. However, the move toward distributed database system increases the chance of security violations.

1.4 Scope

This project focuses on dealer network system that acts as a central information transfer media, which allows the assessment from many automotive companies.

II. LITERATURE REVIEW

2.1 Evolution of Distributed Databases

Since 1970s, the practice of organizing data under a central point of control had become commonplace. In an effort to overcome the unmanageable situation of applications maintaining and generating data, most corporations organized their data into "centralized" database system. This centralized system portrays several significant characteristics, namely, free of duplications and inconsistencies and managed by a single database management system under the control of a central database administrator. This practice gave the management a secure gold over corporate data, and concurrently gave the company's diverse internal organizations the illusion of being in control of their own data. For corporate decision-makers, gathering data was a simple process of querying the databases residing on the corporate mainframe.

For the past recent years, physical makeup of corporations, organizations and government activities, has changed from centralized ones toward a distributed structure. The distributed physical architecture of these organizations demands that the information architecture also be distributed, embracing the concepts of open system. As a consequence of this distribution lies the requirement to distribute and manage the corporate data. Evolving from this need, the database technology and network technology has now produced one of the software engineering technology called distributed database technology.

A distributed database is a collection of multiple, logically interrelated databases distributed over a computer network (Bell 1992) A distributed database management system (DDBMS) is a software system that permits the management of distributed data making the distribution transparent to the user (Stamper 1994). A distributed database is more reliable and more responsive than a centrally located and controlled database.

Outgrowing data storage resources or computing power does not necessitate moving up to the next expensive mainframe. Distributed database technology allows affordable and incremental hardware growth (Wawrzusin 1992).

In the summer 1987 publication of InfoDB, C. J. Date proposed twelve rules that apply to a distributed database. Summarized, the rules are as follows:

(1) Local Autonomy: Each site maintains local privacy and control of its own data; users that commonly share data can have it located at the site where they work.

(2) No Reliance on a Central Site: The operation of the database does not depend on any single site; each site in the network runs local applications independently of the other sites, or globally on data at remote sites; no single DBMS is more necessary than any other.

(3) Continuous Operation: The distributed database should never require downtime; planned activity should not require a shutdown.

(4) Location Independence: Users and/or applications should not know, or even be aware of, where the data is physically stored; instead, users and/or applications should behave as if all data was stored locally.

(5) Fragmentation Independence: Relational tables in a distributed database system can be divided into fragments and stored at different sites transparent to the users and applications.

(6) Replication Independence: Data can be transparently replicated on multiple computer systems across a network.

(7) Distributed Query Processing: The performance of a given query should be independent of the site at which the query is submitted.

(8) Distributed Transaction Management: A distributed system should be able to support atomic transactions.

(9) Hardware Independence: A distributed database system should be able to operate and access data spread across a wide variety of hardware platforms.

(10) Operating System Independence: A distributed database system should be able to run on different operating systems.

(11) Network Independence: A distributed database system should be designed to run regardless of the communication protocols and network topology used to interconnect various system nodes.

(12) Database Management System Independence: An ideal distributed database management system must be able to support interoperability between DBMS systems running on different nodes, even if these DBMS systems are unlike (heterogeneous).

2.2 Reasons for Distributed Databases

Distributed databases are more reliable, provide faster data access, reduce communications load, and allow for upward scaling of hardware. Some of the motivations for developing a distributed database consist of a distributed organizational structure demands distributed data, a need to generate global applications based on pre-existing database, a requirement to reduce communications costs, and increased performance or reliability demands.

A DDBMS is homogeneous if the same DBMS occurs at each site regardless of the hardware and operating system (Hansen 1996). In order to select the right DDBMS, to develop an optimum distributed design, the database system designer must have knowledge regarding each feature and be able to tradeoff to effectively match implemented features to the specific data needs to be supported.

2.3 Distributed Database Technology

As in centralized databases, regardless of the underlying data model, the fundamental issue of distributed databases is transparency. In a centralized database, transparency refers to data independence whereas in distributed database, transparency refers to the data and to the network.

Other than the issue of transparency, another main issue is local autonomy. Each distributed database must be wholly independent; operating system, administration, and resident databases.

2.4 Distributed Databases Architecture (Wawrzusin 1992), (Hansen 1996)

Architectures that exist in a distributed database system include physical components of hosts/servers, data models, and schema used to integrate various independent databases. The structure of distributed database is shown in Figure 2.1.

2.4.1 The Server/Host

The architecture of a distributed database permits larger database support on a collection of host equipment of varying capacity and performance levels. Each site in a network executes both local application programs and distributed database management functions. Computers range in size from personal computers to powerful workstations.

One of the strong points of distributed database technology is the ability to incrementally add host power to a database structure. The design of data allocation to hosts must take the characteristics of each host into consideration to ensure the most efficient operation of the distributed database system. A frequently used portion of the database should not be allocated to a host with inferior performance characteristics.

2.4.2 The Network

The communication networks connecting each site cooperating in a distributed database are mostly one of these three types.

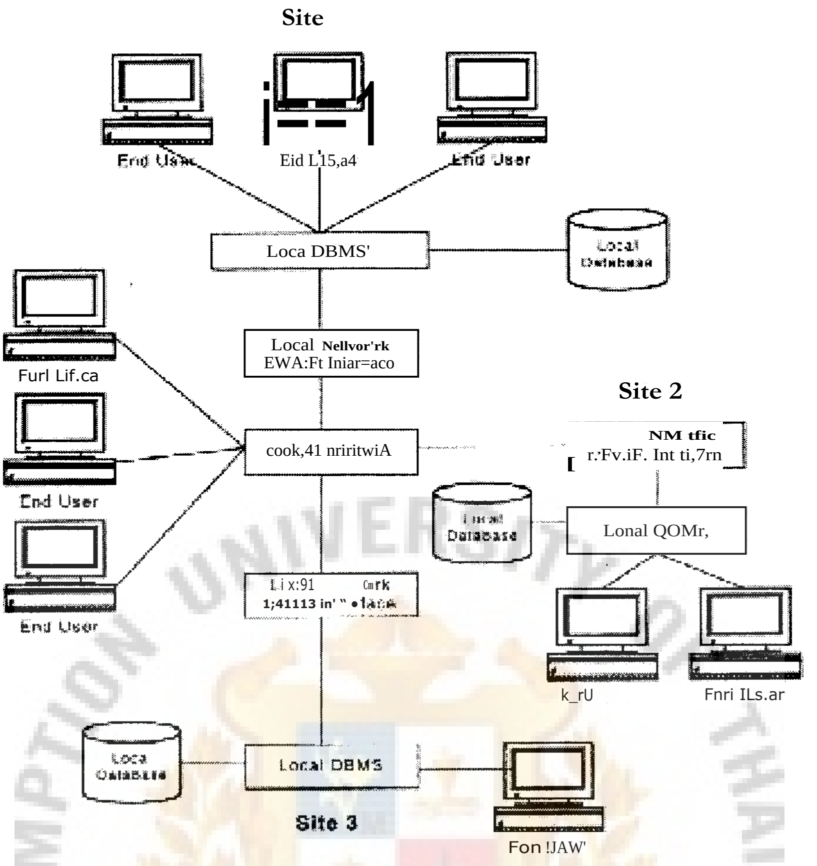

Figure 2.1. The Structure of a Distributed Database.

(1) High bandwidth, low delay "Ethernet": local area network

(2) Lower bandwidth, higher delay, longer range packet, switch networks: "Arpanet"

(3) Lower bandwidth, lower delay point to point leased circuit

The analysis of the total network system must also include an analysis of any bridge, router, and gateway hardware and software. As the number and types of hosts on a network and the number of local area network comprising a system increase, the ability of the bridges, routers, and gateways to handle traffic efficiency must be carefully selected.

2.4.3 The Data Model

A collection of conceptual tools for describing data, data relationships, data semantics, and consistency restraints, a data model can be one of these three types;

(1) Object based logical model

(2) Record-based logical model

(3) Physical data model

Object-based logical models characterize flexible structuring capabilities and allow explicit specification of data constraints. The entity-relationship (E-R) model is an example of object based logical model. An E-R diagram is illustrated by Figure 2.2.

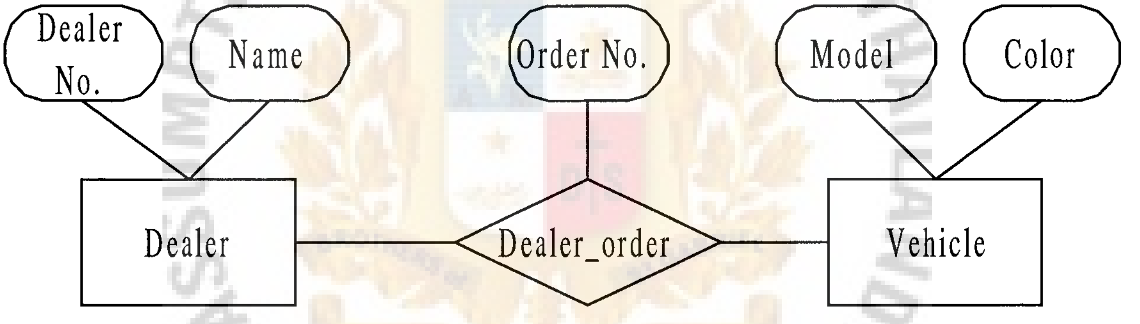

Figure 2.2. E-R Models of Dealer Order.

Record-based logical models describe data at conceptual and view level. The relational model, a record-based logical model, represents data and the relationships between data as a collection of tables. Figure 2.3 shows dealer order as a relational model.

The network model is another type of record-based logical model. It represents data by a collection of records and represents relationship among data by links. Figure 2.4 shows network model for dealer order.

Dealer No.	**Name**	**Order Number**
D1	Peter	20
D2	George	33
D2	George	65
D4	Michael	99

Order Number	**Model**	**Color**
22	XY234	Silver
33	XJ123	Gold
65	XJ124	Black
99	XS111	White

Figure 2.3. Relational Model of Dealer Order.

D1	Peter	22	XY234	Silver
		33	XJ123	Gold
D2	George			
		65	XJ124	Black
D4	Michael	99	XS111	White

Figure 2.4. Network Model of Dealer Order.

Physical data models describe data in the lowest level. They are not very popular and are not considered appropriate in the context of distributed databases.

2.4.4 The Schema

Schema describes database, as it is stored. It described physical characteristics such as format, storage location, and access paths, and defines the logical structure of the databases.

In a centralized database, the schema is the global view of the database in terms of which all user views.

In a distributed database, schema integration refers to the way users logically view the distributed data. DDBMS is either homogeneous or heterogeneous. There are two kinds of schemas; the global schema and the local schema. The global schema defines all of the data in the system where local schema defines the data at the local sites.

The conceptual problems associated with the schema are embodied in the data dictionary. If it is kept at a single site there then exists a single point of failure. If replicated at every node, then every change in its information requires a change at every site. Some DDBMSs employ an approach in which each site maintains its own local catalog, which the system searches for each reference to a table. This method saves in the maintenance effort but generate overhead network traffic (Hansen 1996).

2.5 Features of Distributed Database versus Centralized Database

There are five different features between distributed database and centralized database: Centralized Control, Data Independence, Reduction of Redundancy, Security, and Scalability/Expandability.

2.5.1 Centralized Control

Distributed Database: Database control cannot be done at a single site. The database is scattered around each site on the network. Data administrator of each site will be responsible for the data of each local site, which matches with 'Local Autonomy', rule number one of C. J. Date.

Centralized Database: Database control can be done at a single site. The database is kept at a single site. This centralized control guaranteed of data precision, duplication avoidance, and high security.

2.5.2 Data Independence

Distributed Database: All data is independent from the application program. Each program works as if the existing database locates at a single point. The user cannot tell the different between these two database systems.

Centralized Database: Similar characteristic to distributed database, all data is independent from the application program. A modification of data in the database system does not effect the application program.

2.5.3 Reduction of Redundancy

Distributed Database: Duplication of data in the database exists in order to enhance the capability of the system. For example, if a particular data set is kept at two sites, in the case of one site is down, the same data in another site can be retrieved.

Centralized Database: There is no duplication of data because the same data is not permitted to have more than one copy and obviously the storage space is limited. Each data is applicable for applications although it is in the same file or record.

2.5.4 Security

Distributed Database: The method in ensuring security is more complicated because users from different locations can access through many sites in the system.

Centralized Database: Security issue is simpler to control because the database is kept at a single point. Only authorized person can access through the database.

2.5.5 Scalability/Expandability

Distributed Database: In case of many users accessing to the database at the same time, servers at various sites can reduce the load and consequently provide faster service to the users.

Centralized Database: The only way to handle many users is to change the capacity of the system, which is very expensive.

2.6 Requirements of a Database System

(1) Concept of a transaction (unit of consistency and reliability),

(2) Huge, persistent, complex data shared among users, and

(3) Nontrivial integrity constraints must be satisfied by the shared data of the database system.

2.6.1 Transaction Management

A user accesses a database system by executing a program, called a transaction. A transaction is a sequence of read and write operations on the database. It is the unit of user interaction with the database system. A transaction maintains database consistency, even when several transactions are running concurrently (the problem of concurrency control). The system must ensure that a transaction either runs to completion or does not run at all. The system must ensure that in a case of system failure all partially completed transactions are either undone or are run to completion (failure recovery).

The operating system should support mechanisms to facilitate the implementation of the following properties in transactions:

(1) Concurrency control,

(2) Atomic commit, and

(3) Failure recovery.

2.6.2 Support for Complex and Persistent Data

A database system must support definition, efficient manipulation, and efficient storage on secondary devices of files with complex structures. Thus, an operating system must efficiently organize a file on secondary storage.

2.6.3 Buffer Management

Database systems are dominated by heavy I/O accesses and I/O traffic is usually a bottleneck. Data must be cached in buffers in the main memory to speed up the transactions. Thus, a database system requires mechanisms to perform the following operations efficiently: search the buffer to see if a page is present; select a page for replacement; and locate and retrieve the needed data page from secondary storage.

2.6.4 Transactions

A transaction is the unit of user interaction with the database. We assume the following properties about a transaction:

(1) A transaction preserves the consistency of a database.

(2) A transaction terminates in finite time.

If a transaction modifies at least one data object, then it is called an update transaction, or an update. Otherwise it is called a read-only transaction, or a query. The set of data objects that are read by a transaction are referred to as its read set and the set of data objects that are written by it as its write set. When transactions try to access the same data object then there is a conflict. A transaction is executed by executing its actions one by one from the beginning to the end.

III. RESEARCH METHODOLOGY

3.1 Project Plan

The main focus of this project is on automotive industry. Therefore, an overview of future automotive trend is recommended to capture the growth in this industry. The automotive industry is one of the major routes taken by developing countries on their way to becoming industrialized. If the trend is evident in a high growth rate in this industry, then, the feasibility of this project is on the positive side.

There are several areas to be covered in this project. The most important one is to conduct a study on the existing infrastructure in Thailand that can cover the requirement of the project. The most cost effective one will be chosen provided that it must comply with distributed database system technology.

After the network infrastructure has been selected, the network layout would be the immediate approach to a distributed database system. How many distributed sites should there be in order to cover effective information transfer needs of every region in Thailand? There is no exact answer to this question. The solution provided in this project is just a preliminary stage proposal.

Once the network layout is completed, the next step is to study the requirements of each site, which include distributed sites and dealer sites. The hardware requirements will be specified in each site along with their estimated cost, which bases on the available technology. In association with cost, other related costs will also be taken into consideration in the feasibility section.

In the overview of Thailand's Automotive Industry part, the research will dictate the significant of this industry toward the development of Thailand's economy.

The existing infrastructure related to the development of database system in automotive industry is gathered from many sources. They do not only cover an automotive industry but they also cover other industry as well.

With the available information on the infrastructure, a new concept of dealer network system will be proposed. The estimate cost including hardware, software, and other incurred cost will be evaluated in order to find the feasibility of the project. The detail of software development is very sensitive for many manufacturers. Therefore, I will just mention the rough cost of the software.

After the database system is defined along with preliminary setup of the hardware and software, feasibility analysis will be conducted on economic feasibility, technical feasibility, and operational feasibility. The main focus will be on the economic feasibility where an assumption is made on an example model to portray a clear concept of the project.

IV. CURRENT PRACTICES OF DATABASE APPLICATION IN THE AUTOMOTIVE INDUSTRY

4.1 Overview and Future Trends of Thailand's Automotive Industry

(Chaithirapinyo 2000)

The automotive industry is one of the major routes taken by developing countries on their way to becoming industrialized. This is mainly because it paves the way for a large number of related and connecting industries. Thailand is no exception. The government's support and promotion of this industry can be traced back to 1961 when the first automobile assembly plants were constructed in the country. Policy and procedure are set to facilitate the process in which the automobile industry will grow from the assembly plant stage to the production stage with the following step-by-step goals.

(1) To replace the import of automobiles and motorcycles with the assembly of these vehicles in local factories.

(2) To transform the existing and future assembly factories into production factories.

(3) To promote the construction of new factories and the expansion of existing factories which produce parts and components for automobiles and motorcycles.

At present, there are 14 automobile assembly companies with a capacity of more than a million vehicles per year. There are 5 motorcycle assembly companies with a capacity of 2.08 million vehicles per year. 90% of automobiles sold in Thailand are locally assembled at a total value of 100,000 million bahts. Export of automobile parts and components valued 9,918 million bahts in 1999. The number of CBU automobiles which were exported to overseas markets in the same year was 125,702 vehicles with a value of 50,187 million bahts. Mitsubishi was the largest exporter with 60,988 cars. It was followed in rank by Ford, Mazda, Toyota, Honda, Isuzu, Nissan and Volvo. The number of motorcycles exported was 32,288 vehicles at a value of 8,492.43 million bahts.

In 1999, 573,905 units motorcycles were sold locally while 32,288 were exported at a value of 1,069 bahts. Export of parts and components was worth 1,183 million bahts. Leading the pack was Honda, which exported 188,618 CBU and OEM sets, followed by Suzuki, Kawasaki and Yamaha.

There are 300 companies which produce OEM parts and components for the automobile assembly plants. Another 500 produce other types of parts. The work force is approximately 200,000 strong and consists of personnel in the automobile and motorcycle assembly industry, the staff of the parts and components production industry, and the sales personnel of dealer companies.

When compared to the automobile markets in other developing countries, the Thai market seems more limited. Sales figures are low, considering the size of the population. This can be attributed to three main reasons. Cars are an expensive commodity because of the high tax rate. The largest sector in the country's economy is still agriculture. Which needs more vehicles the new foreign exchange rates has decreased the value of the baht. Before the economic crisis hit the country in 1996, Thailand used to rank first in automobile sales among the ASEAN countries. Now, it ranks second after Malaysia.

4.2 Automobiles Sales in ASEAN Countries (Chaithirapinyo 2000)

Economic recession and the flotation of the value of the baht have gravely affected the automobile industry in Thailand. The domestic automobile market suddenly shrunk. Sales for the year 2000 is anticipated to be only 280,000 vehicles for the domestic market and 180,000 vehicles for the export market. This means that factories are operating at only 40% of their capacity. Automobile industry operators try to help themselves by increasing their production for export. However, the government has yet to help with more measures to stimulate the domestic market because consumers still have the need to purchase automobiles but they have difficulty finding financing services. These measures are urgently needed.

Table 4.1. Automotive Sales in ASEAN Countries.

	1996	1997	1998	1999
Thailand	589,126	363,156	144,065	218,330
Malaysia	364,811	404,831	144,232	288,210
Indonesia	332,035	386,711	58,198	94,023
Philippines	161,823	145,128	81,062	74,282
Singapore	36,915	34,812	37,493	49,282
Others	19,114	18,792	12,788	12,906

(1) Stimulation of the domestic market

(a) Decreasing the VAT

(b) Decreasing personal income tax

(c) Decreasing the income tax of juristic entities

(2) Promotion of export

(3) Support for human resources development

(4) Support for R&D

However, the recovery of the Thai economy is expected to be gradual and will take more time on its ascent from the slump. It is anticipated that it will be another years before domestic sales return to 600,000 vehicles per year (1993 figures). Yet this will still depend on the following factors:

(1) FOREX security

(2) Decreased interest rates

(3) Government's budgetary position

(4) Domestic stock market

(5) Price of fuel slump in the sales of auto

4.3 Existing Database Systems

Due to the small scale of networking infrastructure and limited investment capital of each automotive manufacturer, the existing database system is centralized one where data is kept at a single site. Database control can be done at a single site where data precision, duplication avoidance, and high security are guaranteed. The limitation of centralized database system is high cost in system capacity expansion. Each automotive manufacturer is independent of one another. Among the existing automotive brands, only a few of them invest in a large scale in their database system.

Under the current economic problem, it is very risky to invest a large sum of money in the database system alone. Therefore, distributed database system has not yet been implemented in Thailand. The existing infrastructure for database management system found in automotive industry is Virtual Private Network, X.25, and Frame Relay.

4.3.1 Virtual Private Network (VPN)

A virtual private network, or VPN, uses encryption and tunneling to connect users or sites over a public network, usually the interne. In comparison, a private network uses dedicated lines between each point and is usually a more expensive solution. VPNs connect a remote client or branch office to a corporate network by going directly through another network. The "other" network can be any public network, but as the internet is the most widely used public network in place today, it is the one most typically used for this purpose. The secure connection across the Internet appears to the user as a private network communication-despite the fact that this communication occurs over a public network-hence the name Virtual Private Network.

Because they provide secure communications across a public network, VPNs are often referred to as tunnels. Here is how tunneling works. VPN messages are given special header information that identifies them as VPN traffic. These messages are then routed through the Internet to a destination corporate server. To protect sensitive corporate data from hackers, the message is also authenticated and, optionally, encrypted. Once the packets reach their destination, the additional header information is discarded and the data is forwarded to its final destination. This entire process is called tunneling.

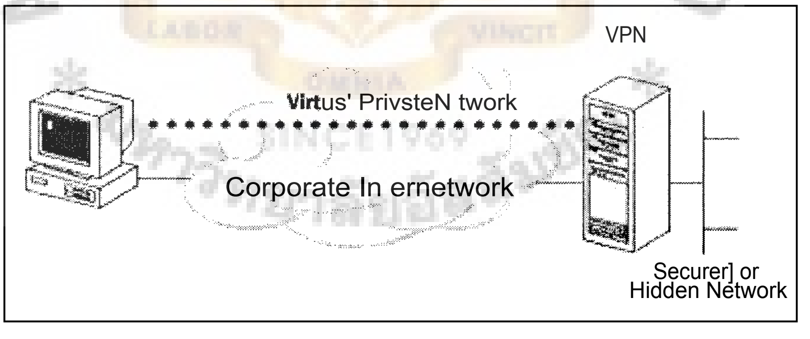

Figure 4.1. Virtual Private Network Connectivity.

From the user's perspective, the VPN is a direct connection between the user's computer and a corporate server. The intermediate role played by the internet is irrelevant to the user because it appears as if the data is being sent over a dedicated private link. VPN technology works identically for connecting corporations to branch offices or other companies.

Other than VPN network type, there are another two types of network, which are region node network and star network. These two networks do not gain popularity in Thai industry due to their high cost and limited scale of users. If the economic of scale is high, the users will benefit in high speed networking at a lower cost. Figure 4.2, Figure 4.3 and Figure 4.4 illustrate these three types of network system respectively.

The pros of VPN network are characterized by its very low cost and low risk of technology changes where the cons are unanticipated problems and the internet line connected are always busy. The pro for region node is that it incurs the lowest cost among the three network types. The cons are lost of HOP count, high delay time, many point of failures, and low quality of voice. In a start network, high quality of voice is achieved with low delay time but the investment cost is very high. The network cost comparison is shown on Table 4.2. The detail of network cost is provided by Mr. Virachai, Assistant Manager of Information Technology Office in a leading automotive company.

Table 4.2. Network Cost Comparison.

	VPN Network	Region Network	Star Network
Initial Cost (bahts)	5,000,000	40,000,000	60,000,000
Monthly Fee (bahts)	150,000	1,500,000	2,500,000

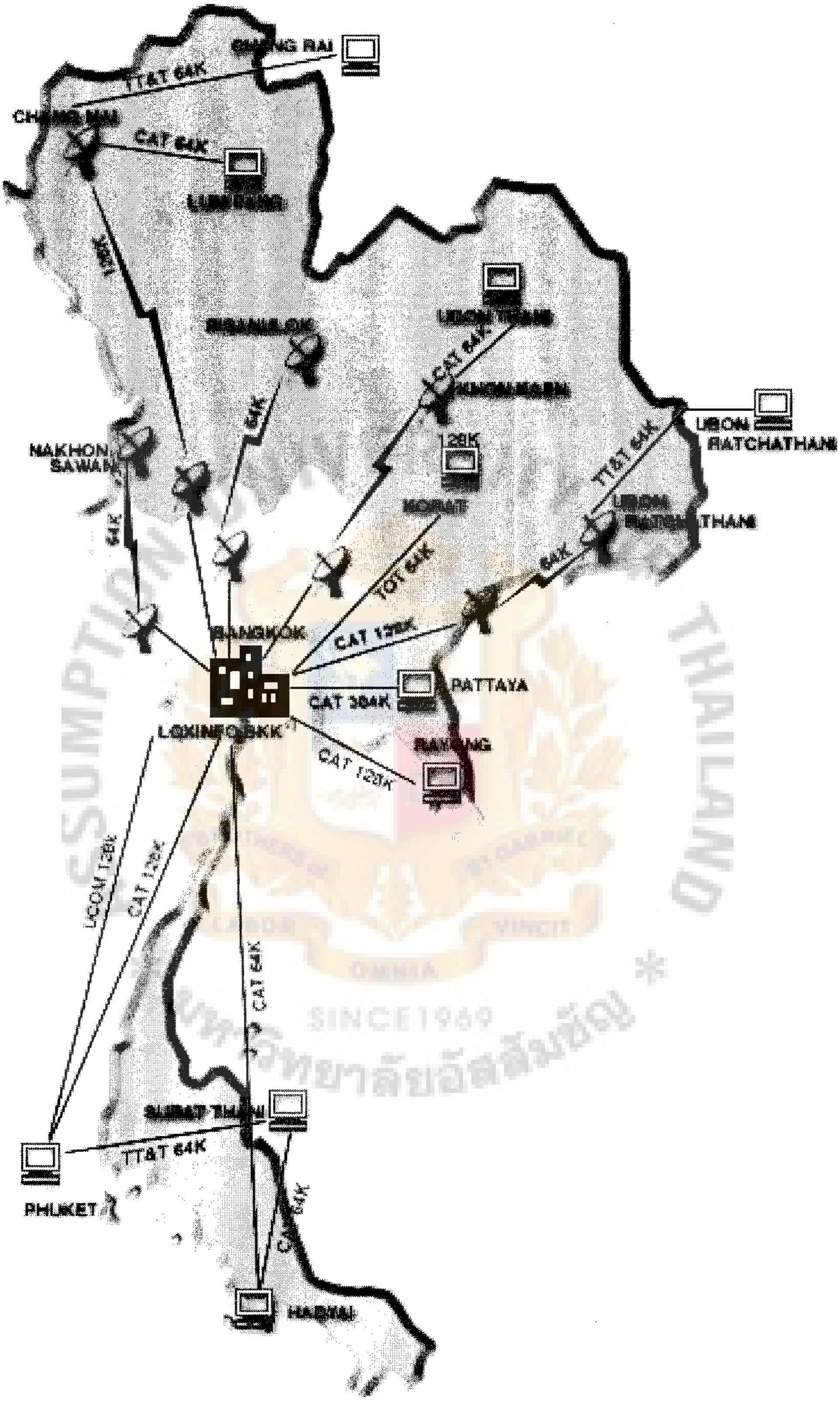

Figure 4.2. VPN Network.

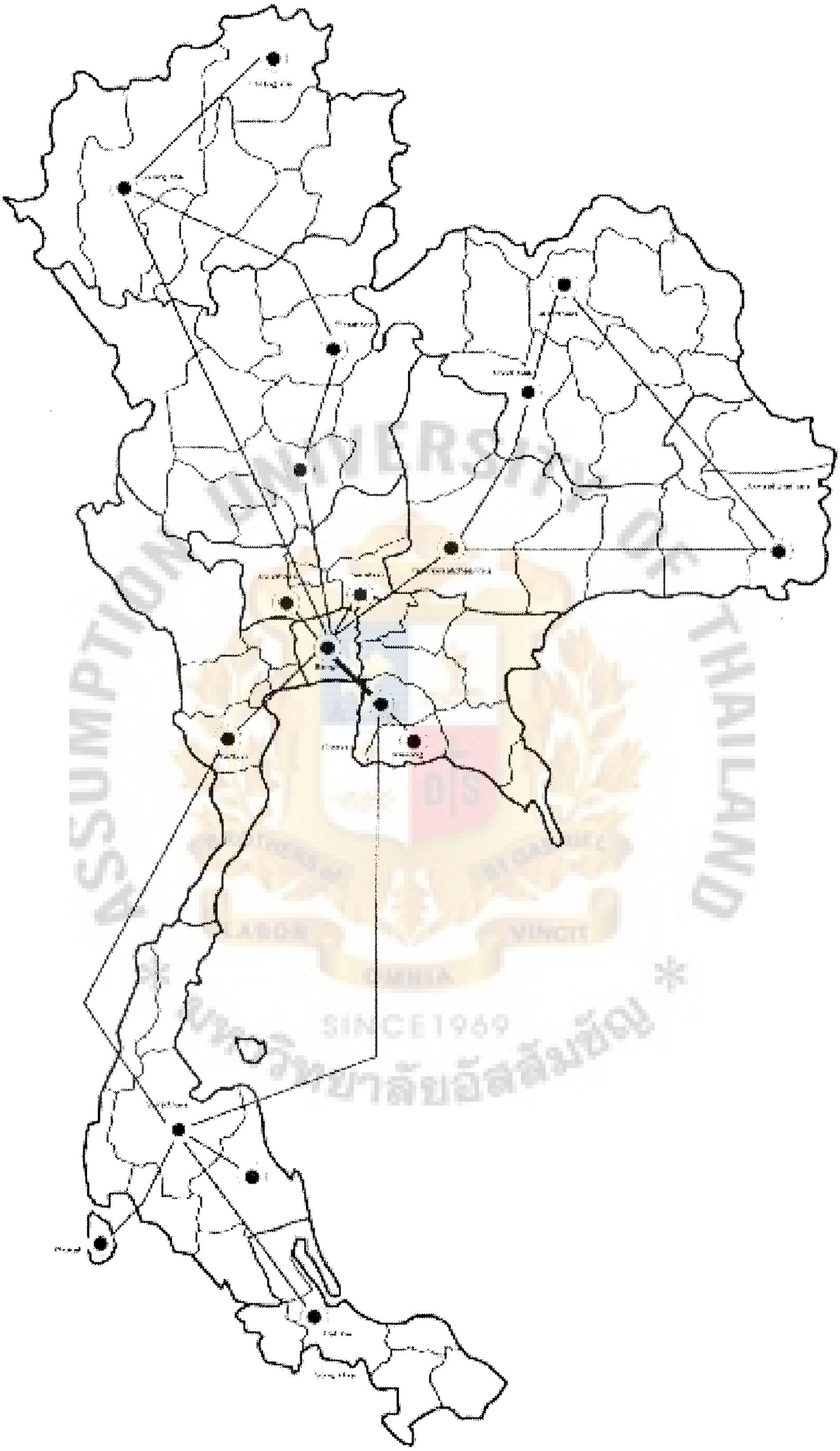

Figure 4.3. Region Node Network.

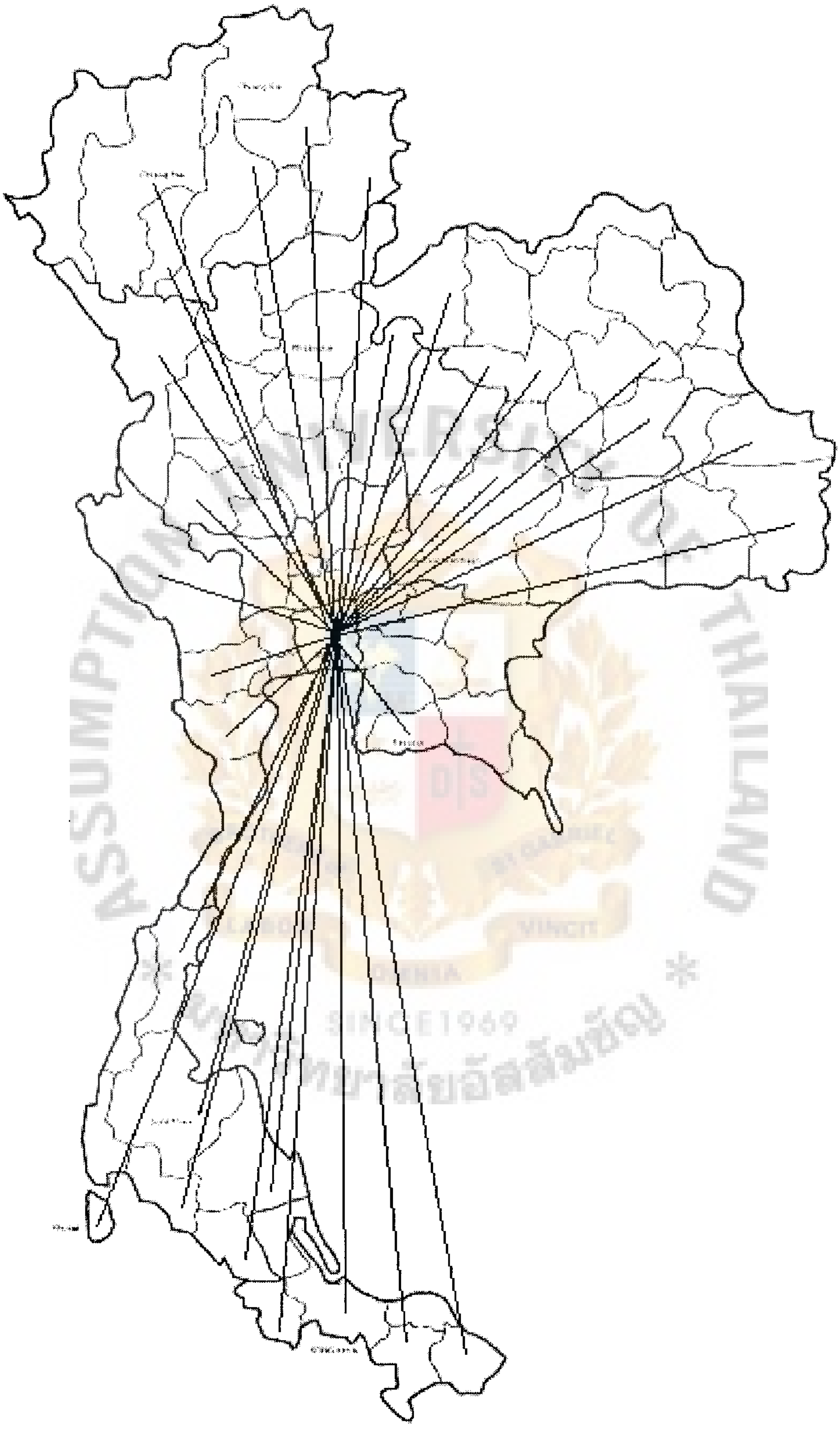

Figure 4.4. Star Network.

4.3.2 X.25 Network

X.25 Packet Switched networks allow remote devices to communicate with each other across high speed digital links without the X.25 Packet Switched networks allow remote devices to communicate with each expense of individual leased lines. Packet Switching is a technique whereby the network routes individual packets of HDLC data between different destinations based on addressing within each packet.

The protocol known as X.25 encompasses the first three layers of the OSI 7-layered architecture as defined by the International Organization for Standardization (ISO) as follows:

(1) Layer 1: The Physical Layer is concerned with electrical or signaling. It includes several standards such as V.35, RS232 and X.21.

(2) Layer 2: The Data Link Layer, which is an implementation of the ISO HDLC standard called Link Access Procedure Balanced (LAPB) and provides an error free link between two connected devices.

(3) Layer 3: The Network Layer which provides communications between devices connected to a common network.

X.25 Packet Layer Protocol (PLP) and is primarily concerned with network routing functions and the multiplexing of simultaneous logical connections over a single physical connection.

The user end of the network is known as Data Terminal Equipment (DTE) and the carrier's equipment is Data Circuit-terminating Equipment (DCE). The X.25 PLP permits a DTE user on an X.25 network to communicate with a number of remote DTEs simultaneously. Connections occur on logical channels of two types:

(1) Switched virtual circuits (SVCs): SVCs are very much like telephone calls; a connection is established, data are transferred and then the connection is

released. Each DTE on the network is given a unique DTE address which can be used much like a telephone number.

(2) Permanent virtual circuits (PVCs): a PVC is similar to a leased line in that the connection is always present. The logical connection is established permanently by the Packet Switched Network administration. Therefore, data may always be sent, without any call setup.

To establish a connection on an SVC, the calling DTE sends a Call Request Packet, which includes the address of the remote DTE to be contacted. The destination DTE decides whether or not to accept the call (the Call Request packet includes the sender's DTE address, as well as other information that the called DTE can use to decide whether or not to accept the call). A call is accepted by issuing a Call Accepted packet, or cleared by issuing a Clear Request packet.

Once the originating DTE receives the Call Accepted packet, the virtual circuit is established and data transfer may take place. When either DTE wishes to terminate the call, a Clear Request packet is sent to the remote DTE, which responds with a Clear Confirmation packet.

The destination for each packet is identified by means of the Logical Channel Identifier (LCI) or Logical Channel Number (LCN). This allows the PSN to route the each packet to its intended DTE.

X.25 relies on the underlying robustness of HDLC LAPB to get data from node to node through the X.25 network. An X.25 packet makes up the data field of an HDLC frame. Additional flow control and windowing are provided for each Logical Channel at the X.25 level.

Maximum packet sizes vary from 64 bytes to 4096 bytes, with 128 bytes being a default on most networks. Both maximum packet size and packet level windowing may be negotiated between DTEs on call set up.

X.25 gives you a virtual high quality digital network at low cost. It is economical for the same reason that it is usually cheaper to use the mail than to run your own postal service: there are tremendous savings to be made if multiple parties share the same infrastructure.

In most parts of the world, X.25 is paid for by a monthly connect fee plus packet charges. There is usually no holding charge, making X.25 ideal for organizations that need to be on line all the time. Another useful feature is speed matching: because of the store-and-forward nature of Packet Switching, plus excellent flow control, DTEs do not have to use the same line speed. So you can have, for instance, a host connected at 56kbps communicating with numerous remote sites connected with cheaper 19.2kbps lines.

X.25 has been around since the mid 1970's and so is pretty well debugged and stable. There are literally no data errors on modern X.25 networks.

X.25 does have some drawbacks. There is an inherent delay caused by the store-and-forward mechanism. On most single networks the turn-around delay is about 0.6 seconds. This has no effect on large block transfers, but in flip-flop types of transmissions the delay can be very noticeable. Frame Relay (also called Fast Packet Switching) does not store and forward, but simply switches to the destination part way through the frame, reducing the transmission delay considerably.

Another problem for the networks is a large requirement for buffering to support the store-and-forward data transfer. One of the reasons that Frame Relay is so cost effective is that storage requirements are minimal.

X.25 is a data pump: there has to be some higher level that is making sense of the bits. There are standards for allowing certain applications to make use of X.25. Among them is IBM's QLLC protocol that defines how SNA traffic can be carried over X.25 networks. X.25 and TCP/IP are similar in that they are both packet switched protocols. However, they differ in a number of areas:

(1) TCP/IP has only end-to end error checking and flow control, while X.25 is error checked from node to node.

(2) TCP/IP has a much more complicated flow control and window mechanism than X.25, to compensate for the fact that a TCP/IP network is completely passive.

(3) The electrical and link levels are tightly specified in the X.25 specifications, while TCP/IP is designed to travel over many different kinds of media, with many different types of link service (e.g. Ethernet, Frame relay, X.25, ATM, FDDI, etc.).

4.3.3 Frame Relay

Frame Relay is a simplified form of Packet Switching similar in principle to X.25 in which synchronous frames of data are routed to different destinations depending on header information. The biggest difference between Frame Relay and X.25 is that X.25 guarantees data integrity and network managed flow control at the cost of some network delays. Frame Relay switches packets end to end much faster, but there is no guarantee of data integrity at all. It is cost effective, partly due to the fact that the network buffering requirements are carefully optimized. Compared to X.25, with its store and forward mechanism and full error correction, network buffering is minimal. Frame Relay is also much faster than X.25: the frames are switched to their destination with only a few byte times delay, as opposed to several hundred milliseconds delay on X.25.

Frame Relay uses the synchronous HDLC frame format up to 4kbytes in length. Each frame starts and ends with a Flag character (7E Hex). The first 2 bytes of each frame following the flag contain the information required for multiplexing across the link. The last 2 bytes of the frame are always generated by a Cyclic Redundancy Check (CRC) of the rest of the bytes between the flags. The rest of the frame contains the user data. There are four key considerations in a frame relay network.

(1) Virtual Circuits

(2) Data Integrity

(3) Flow control and Information rates

(4) Status polling

Packets in virtual circuits are routed through one or more Virtual Circuits known as Data Link Connection Identifiers (DLCIs). Each DLCI has a permanently configured switching path to a certain destination. Thus, by having a system with several DLCIs configured, you can communicate simultaneously with several different sites. Currently, only permanent virtual circuit connections are supported. This means that all DLCI connections are set up by the network provider at subscription time.

There is no data integrity in frame relay. The network delivers frames, whether the CRC check matches or not. It does not even necessarily deliver all frames, discarding frames whenever there is network congestion. Thus it is imperative to run an upper layer protocol above Frame Relay that is capable of recovering from errors, such as HDLC, IPX or TCP/IP.

In practice, however, the network delivers data quite reliably. Unlike the analog communication lines that were originally used for X.25, modern digital lines have very low error rates. Very few frames are discarded by the network, particularly at this time when the networks are operating at well below design capacity.

There is no flow control on Frame Relay. The network simply discards frames it cannot deliver. When you subscribe, you will specify the line speed (e.g. 56kbps or Ti) and also, typically, you will be asked to specify a Committed Information Rate (CIR) for each DLCI. This value specifies the maximum average data rate that the network undertakes to deliver under "normal conditions". If you send faster than the CIR on a given DLCI, the network will flag some frames with a Discard Eligibility (DE) bit. The network will do its best to deliver all packets but will discard any DE packets first if there is congestion. Many inexpensive Frame Relay services are based on a CIR of zero. This means that every frame is a DE frame, and the network will throw any frame away when it needs to.

Frame Relay provides indications that the network is becoming congested by means of the Forward Explicit Congestion Notification (FECN) and Backward Explicit Congestion Notification (BECN) bits in data frames. These are used to tell the application to slow down, hopefully before packets start to be discarded.

One advice is to always accept the highest CIR that your provider will give you for free, but never to pay for a higher CIR until you are absolutely sure that your data is being discarded. There is evidence that some public networks cannot even measure your Information Rate, although that does not stop them for charging for a CIR.

The Frame Relay Customer Premises Equipment (CPE) polls the switch at set intervals to find out the status of the network and DLCI connections. A Link Integrity Verification (LIV) packet exchange takes place about every 10 seconds, which verifies that the connection is still good. It also provides information to the network that the CPE is active, and this status is reported at the other end. About every minute, a Full Status (FS) exchange occurs, which passes information on which DLCIs are configured and active. Until the first FS exchange has occurred, the CPE does not know which DLCIs are active, and so no data transfer can take place.

There exists various standards for the Status Polling function. The oldest, the Link Management Interface (LMI), was a temporary standard adopted by manufacturers prior to the international standards bodies getting their standards out. It is supposed to have disappeared when the official ANSI T1.617 Annex **D** (known as ANSI or Annex D) standard came out, but it has acquired a life of it's own. A newer standard, Q.933 has also been approved, largely to accommodate Switched Virtual Circuits, when these become available.

Frame Relay is used mostly to route Local Area Network protocols such as IPX or TCP/IP. It can also be used to carry asynchronous traffic, SNA or even voice data. Its primary competitive feature is its low cost. In North America it is fast taking on the role that X.25 has had in Europe: the most cost effective way to hook up multiple stations with high speed digital links.

Frame Relay networks do not yet have the reliability of X.25 networks. Expect problems with new installations. You cannot take any features for granted. At the time of writing, some public networks do not even support Status Polling properly. This makes it difficult to find out whether remote links are up or not.

In general, the newer the network, the better the implementation. For instance, one of the best Frame Relay networks around is in Poland, while some of the pioneer US networks are still struggling with older equipment.

4.4 Existing Applications

The application associated with automotive industry includes but not limited to the following:

(1) Order Entry Status

(2) Emergency Order

(3) Approval Requirement

(4) Assign Increase Entry

(5) Assign Increase 1st Approval

(6) Assign Increase Final Approval

(7) Order Cancel

(8) Order Update

(9) Order Inquiry

(10) Hidden Stock Reports

(11) Accessory Order Reports

(12) Exist Delivery Notes Cut Date

(13) Exist Delivery Notes Date Inquiry

(14) Non Exist Delivery Notes Cut Date

(15) Non Exist Delivery Notes Cut Date Inquiry

(16) On Hand Inquiry

(17) Inventory Report

(18) Credit Warning

(19) Monthly Credit Report

(20) Production Plan

(21) Production Actual

These applications are just an example of the available applications in the current transaction in an automotive industry. There are more than one hundred different applications. The detail of these transactions will not be described because the scope of the project is concentrated on the network system.

V. FEASIBILITY ANALYSIS OF DISTRIBUTED DATABASE SYSTEM

5.1 Characteristics of Selected Database System

By comparing the existing infrastructure, frame relay network seems to be the most appealing choice. The network delivers data quite reliably. Unlike the analog communication lines that were originally used for X.25, modern digital lines have very low error rates. Very few frames are discarded by the network, particularly at this time when the networks are operating at well below design capacity. The most cost efficient way to hook up multiple stations with high-speed digital links. The data on frame relay network runs at real time, which means that when there is data modification or data updating practices, every site on the network will also be notified concurrently.

As for the network design, a distributed one is preferred over a centralized one. Ethernet local area network is selected as the communication networks connecting each site, which is characterized by its high bandwidth and low delay information transfer. In case of many users accessing to the database at the same time, servers at various sites can reduce the load and consequently provide faster service to the users. It also enhances future database expansion. Although the initial cost will be more expensive than the centralized database system but in a long run it is worth the investment. The selected network design is illustrated by Figure 5.1. Four nodes represent the main sites where the data is distributed to dealers from the nearest site location.

The most critical issue in a distributed database system is security. There are many levels of security, which will be described in detail later in this chapter.

There are many hardware and software associated in this system. The hardware cost is based on the current technology where software cost is just an estimated value. Other costs involve are recurring cost and development cost.

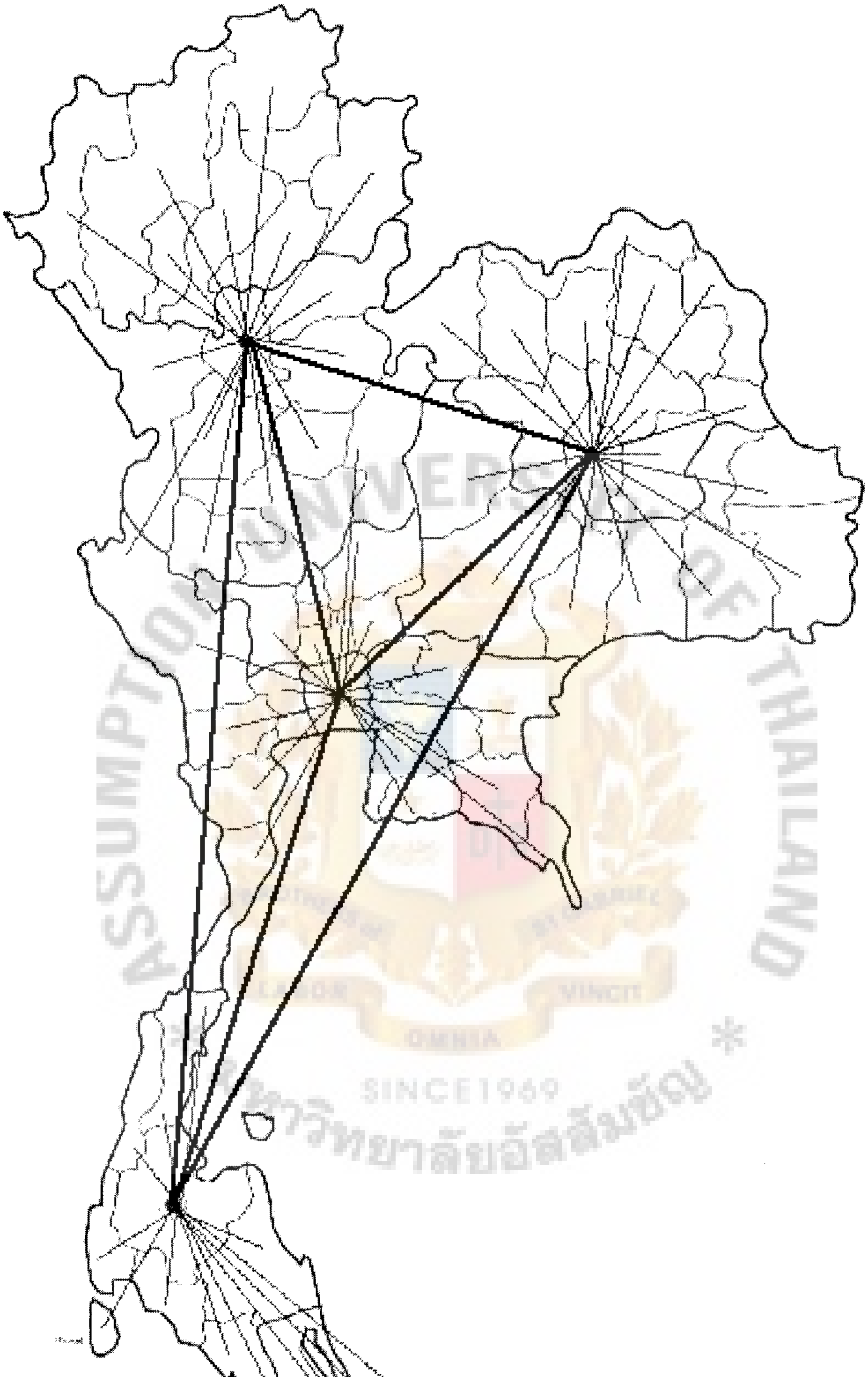

Figure 5.1. Distributed Database System Network.

5.1.1 Hardware Cost

The details of hardware and software costs are supplied by Mr. Virachai, Assistant Manager of Information Technology Office in a leading automotive company. The hardware associated in this project consists of the hardware for four main sites where the distributed network configuration is located and hardware for minor sites.

Each main site will contain similar hardware requirement. The estimated requirement of hardware in each site includes a server, a router, a switch, four hubs, database storage, two personnel computers, two UPS, and accessory equipment such as rack, shelf, cable, and wiring. The total cost of hardware for four main sites is estimated at 22,360,000 bahts as illustrated by Table 5.1.

Table 5.1. The Hardware Cost Associated with Four Main Sites.

No.	**Hardware**	**Unit**	**Cost / Unit (bahts)**	**Total Cost (bahts)**
1	Server	4	2,500,000	10,000,000
2	Router	4	300,000	1,200,000
3	Switch	4	400,000	1,600,000
4	Hub	16	35,000	560,000
5	Database storage	4	2,000,000	8,000,000
6	PCs	8	60,000	480,000
7	UPS	12	10,000	120,000
8	Others (rack, shelf, cable, and wiring)	4	100,000	400,000
			TTL	**22,360,000**

The hardware for each minor site includes a personnel computer, a router, a UPS, and other accessories. The estimated cost is 420,000 bahts as shown in Table 5.2.

Table 5.2. The Hardware Cost Associated with Each Minor Site.

No.	Hardware	Unit	Cost / Unit (bahts)	Total Cost (bahts)
1	**PC**	1	60,000	60,000
2	Router	1	300,000	300,000
3	UPS	1	10,000	10,000
4	Others (rack, shelf, cable, and wiring)	1	50,000	50,000
			TTL	**420,000**

5.1.2 Software Cost

The software cost is similar to hardware cost, which consists of software for four main sites and software for each minor site.

The software requirements include MS Office 2000 Professional, Windows 2000 Server License, SQL Server 2000, and DB2. These software packages are estimated at 8,072,000 bahts, which cover the requirements for four main sites. The detail of the software is shown in Table 5.3.

Table 5.3. The Software Cost Associated with Four Main Sites.

No.	Software	Unit	Cost / Unit (bahts)	Total Cost (bahts)
1	MS Office 2000 Professional	8	14,000	112,000
2	Windows 2000 Server License	8	45,000	360,000
3	SQL Server 2000	8	200,000	1,600,000
4	Database (DB2)	4	1,500,000	6,000,000
			TTL	**8,072,000**

The software requirements for each minor site MS Office 2000 Professional, Windows 2000 Professional License, and Dealer Network System. The estimated software cost for each minor site is 40,500 bahts as shown in Table 5.4.

Table 5.4. The Software Cost Associated with Each Minor Site.

No.	Software	Unit	Cost / Unit (bahts)	Total Cost (bahts)
1	MS Office 2000 Professional	1	14,000	14,000
2	Windows 2000 Professional License	1	6,500	6,500
3	Dealer Network System	1	20,000	20,000
			TTL	**40,500**

5.1.3 Other Costs

Other than hardware and software cost, there are other costs involved in this project such as development cost and recurring cost. The initial system development cost is estimated at 20,000,000 bahts. The development includes hardware and software set up in four main sites and main applications required.

In each project, the application development cost of 5,000,000 bahts is charged in order to develop the supporting application to different project environment. For example, the application requirement for Volkswagen may not be the same, as the one required by Audi. Therefore, this cost involves application adjustment to suit with each automotive brand.

However, this cost is based on the assumption that the transaction by each automotive manufacturer is similar. A modification in the application can be made from the prototype application. Therefore, the modification cost is much lower than the development cost. The initial system development cost and application development cost are illustrated in Table 5.5.

Table 5.5. Development Cost.

No.	Development	Total Cost (bahts)
1	Initial system development	20,000,000
2	Application (per project)	5,000,000

Once the project runs, there must be a recurring cost to the project. For the four main sites, these costs include software maintenance, system maintenance, frame relay rental, and operating cost. The total recurring cost is estimated at 19,680,000 bahts per year as shown by Table 5.6.

Table 5.6. Recurring Cost Associated with Four Main Sites.

No.	Recurring	Unit	Cost / Unit (bahts)	Total Cost (bahts)
1	Software maintenance	4	120,000	480,000
2	System maintenance	4	1,200,000	4,800,000
3	Frame relay rental	4	1,200,000	4,800,000
4	Operating	4	2,400,000	9,600,000
			TTL	**19,680,000**

The recurring cost associated with each minor site is similar to those incurred in the four main sites but at a lower rate. The cost of frame relay rental charge depends on how far the dealer node is away from the network infrastructure provider. The shortest path will be chosen. Therefore, the rental charge at each site will vary directly to the distance. The estimated total cost is 336,000 bahts per year as shown in Table 5.7.

Table 5.7. Recurring Cost Associated with Each Minor Site.

No.	Recurring	Unit	Cost / Unit (bahts)	Total Cost (bahts)
1	Software maintenance	1	6,000	6,000
2	System maintenance	1	60,000	60,000
3	Frame relay rental	1	150,000	150,000
4	Operating	1	120,000	120,000
			TTL	**336,000**

5.1.4 Cost Summary

The summary of all cost in this project is summarized by Table 5.8. These costs are classified into the cost associated with four main sites and each minor site.

Table 5.8. Total Cost Summary.

No.	Items	Total Cost	Remarks
Cost associated with four main sites			
1	Hardware for four main sites	22,360,000	One time cost
2	Software for four main sites	8,072,000	One time cost
3	Initial system development	20,000,000	One time cost
4	Application development	5,000,000	Per project
5	Recurring cost	19,680,000	Per year
Cost associated with each minor site			
1	Hardware for each minor site	420,000	One time cost
2	Software for each minor site	40,500	One time cost
3	Recurring cost	336,000	Per year

5.2 Feasibility Study

All projects are feasible given unlimited resources and infinite time (Pressman 1992). The assessment of project feasibility is a required activity for all information systems projects and is potentially a large undertaking. Although the specifics of a given project will dictate which factors are most important, most feasibility factors are represented by the following categories: Economic, Technical, Operational, Schedule, Legal, Contractual, and Political.

5.2.1 Economic Feasibility (Hoffer 1999), (Thuesen 1993)

Most techniques used to determine economic feasibility encompass the concept of the time value of money. It refers to the concept of comparing present cash outlays to future expected returns.

A break-even analysis will also be included in the economic feasibility. The objective of the break-even analysis is to discover at what point benefits equal costs. To conduct this analysis, the NPV of the yearly cash flows are determined.

The costs incurred in this project include Hardware, Software, and Other Costs. In order to study on the feasibility of this system, an example is used to simulate the situation.

<u>Example:</u>

The following data is provided: Five automotive companies are implementing a dealer network system. The information of each company is summarized below:

(1) Company A: 30 dealers

(2) Company B: 35 dealers

(3) Company C: 25 dealers

(4) Company D: 12 dealers

(5) Company E: 40 dealers

Solution:

One time cost

Hardware for four main sites	22,360,000	bahts
Software for four main sites	8,072,000	bahts
Initial System Development	20,000,000	bahts
Application Development (5,000,000@5)	25,000,000	bahts
Hardware for each minor site (420,000@142)	59,640,000	bahts
Software for each minor site (40,500@ 142)	5,751,000	bahts

Recurring Cost

Main site	19,680,000	bahts
Minor site	336,000	bahts

The cost that five automotive companies have to pay at the project start up is application development cost, and hardware and software for each minor site, which is equal to 25,000,000 + 59,640,000 + 5,751,000 = 90,391,000 bahts. In order to have a better view of this figure, the cost break down below will demonstrate the cost incurs by each company. These costs do not include the service charge per dealer, which will be described later in this chapter.

Company A

Application development cost	=	5,000,000	bahts
Hardware Cost (420,000@30)	=	12,600,000	bahts
Software Cost (40,500@30)	=	1,215,000	bahts
Total Cost	=	18,815,000	bahts
Cost / Dealer (18,815,000 / 30)	=	627,167	bahts

Company B

Application development cost	=	5,000,000	bahts

Hardware Cost (420,000@35)	14,700,000	bahts
Software Cost (40,500@35)	1,417,500	bahts
Total Cost	21,117,500	bahts
Cost / Dealer (21,117,500 / 35)	603,357	bahts

Company C

Application development cost	5,000,000	bahts
Hardware Cost (420,000@25)	10,500,000	bahts
Software Cost (40,500@25)	1,012,500	bahts
Total Cost	16,512,500	bahts
Cost / Dealer (16,512,500 / 25)	660,500	bahts

Company D

Application development cost	5,000,000	bahts
Hardware Cost (420,000@ 12)	5,040,000	bahts
Software Cost (40,500@ 12)	486,000	bahts
Total Cost	10,526,000	bahts
Cost / Dealer (10,526,000 / 12)	877,167	bahts

Company E

Application development cost	5,000,000	bahts
Hardware Cost (420,000@40)	16,800,000	bahts
Software Cost (40,500@40)	1,620,000	bahts
Total Cost	23,420,000	bahts
Cost / Dealer (23,420,000 / 40)	585,500	bahts

The total cost at the project start up is equal to - 22,360,000 - 8,072,000 - 20,000,000 = -50,432,000 bahts.

Recurring cost which is on the yearly basis at the main site and minor sites equal to —19,680,000 — 336,000 = -20,016,000 bahts.

The yearly cash flows are calculated by subtracting both the one time cost and the present values of the recurring costs from the present value of the yearly benefits. The overall net present value of the cash flow reflects the total cash flows for all preceding years. In order to meet breakeven point within five years. A discount rate of 5% is chosen as it is slightly more than the present deposit interest rate, which is around 2%. The calculation below demonstrates the method in achieving the service charge per dealer in order to breakeven in five years.

Annual worth = -50.432.000 (A/P, 5%, 5) — 20,016,000

= -50,432,000 (0.2310) — 20,266,000

= -31,665,792 bahts

The full detail of the calculation is shown in Table 5.9.

Therefore the service charge per dealer in order to meet the breakeven point is equal to 31,665,792 / 142 = 222,998 bahts per year or 18,583 bahts per month. As the number of user increases, the service charge per location will proportionally reduce.

5.2.2 Technical Feasibility

The purpose of assessing technical feasibility is to gain an understanding of the organization's ability to construct the proposed system. This analysis should include an assessment of the possible target hardware, software, and operating environments to be used as well as system size.

It is important to note that all projects have risk and that risk is not necessarily something to avoid. Yet, it is also true that, greater return on the investment occurs in a riskier project. Also, risks need to be managed in order to be minimized. The potential consequences of not assessing and managing risks can include the following outcomes:

(1) Failure to attain expected benefits from the project

A Dealer Network System Calculations on Benefits and Costs.

Cash Flow Decription	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Net economic benefit		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Discount rate (12 %)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
PV of Benefit	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
All of benefits	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
One -time costs	[illegible]						
Recurring Costs	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Discount Factor (12 %)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
PV of Recurring Costs	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
All of Costs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Overall NPV							-146,355,796
Overall ROI (Overall NPV / NPV of all Costs)							0.256302299
Break-even Analysis							
Yearly NPV Cash Flow	[illegible]	11,095,262	10,567,127	10,064,132	[illegible]	[illegible]	
[illegible]	[illegible]	-39,336,738	-28,769,611	-18,705,478	[illegible]	[illegible]	

Actual break even occurred at year 5

(2) Inaccurate project cost estimates

(3) Inaccurate project duration estimates

(4) Failure to achieve adequate system performance levels

(5) Failure to adequately integrate the new system with existing hardware, software, or organizational procedures

Security Issues in Distributed Database System (Pfleeger 1997), (Mensching 1991) is considered to be the main technical feasibility of this project.

There is a primary method of protecting the various parts of the system from being used by unauthorized individuals or to do unauthorized works. In addition to restricting access to the system, the data sets, and the programs, the access control function should also be able to record all events concerning system access. This record provides an audit trail to use in those situations where the system has been used improperly. There are several objectives of access control:

(1) Uniquely identify users desiring to use the system.

(2) Verify the identity of each user before allowing entry into system.

(3) Determine which resources are to be protected.

(4) Establish level of resource access for each user or group of users.

(5) Associate level of access to resources with individual users.

(6) Record all accesses to protected resources.

(7) Immediately notify security of any attempted security violation.

(8) Have a system that is flexible, allowing different levels of protection.

(9) Have a system that allows rapid changes in status of both users and resources.

In a distributed database system, the security of data in each site is under the responsible of the local DBMS. Remote users that are penetrated through the database may cause database insecurity. Therefore, the security issue is very important in the distributed database networking system. There are three main categories under distributed database security:

(1) Identification and Authentication

(2) Distribution of Authorization Rules

(3) Encryption

Databases are often logically separated by user access privileges. The DBMS can require rigorous user authentication. For example, a DBMS might require a user to pass both specific password and time-of-day checks. This authentication is in addition to authentication performed by the operating system. Typically, the DBMS runs as an application program on top of the operating system. This means that it has no trusted path to the operating system, and it must be suspicious of any data it receives, including user authentication. Thus the DBMS must do its own authentication.

Normally, the authorization rules are kept at the site that contain relevant data. However, in a distributed system, these rules must be copied to every existing site in order to authorize independently. There are many authentication levels in a distributed database system such as administration level, maintenance level, executive level, and user level.

Data sets must be protected from unauthorized entry. Users do not directly deal with data sets; instead programs will do the processing. There are two approaches to protecting data sets. One method is to grant the user access and thus grant all of that user's program access. The second method is to grant access to specific application programs. In either use, the type of access allowed must be specified. This can include the ability to read only the information or to read and update or to read, update, delete, create, and add.

Access control software can be in either of two forms. It can be a stand-alone software system that controls all of the data sets on the system. In this case, it is called by an operating system access method, whenever a file is to be opened. If the user or program is in the access table and is requesting functions that are allowed, then access is granted. Otherwise the access method is not allowed entry to the file, and the access method terminates with an error condition.

Another method of implementing access control is to have the security designed in a specific systems software package. For example, most database management systems have their own imbedded security. In these situations, the security of the DBMS will only cover the data sets under the control of the DBMS. To have comprehensive security, it is necessary to have both stand-alone high-level access control and control built into each of the critical systems software components.

It is very important that each layer of the security system not only restricts access to the data sets, but also records all uses. This creates an audit trail that can be used to reconstruct the events that occurred if security is broken.

The most powerful tool in providing computer security is coding. By transforming data so that it is unintelligible to the outside observer, security professionals can virtually nullify the value of an interception and the possibility of a modification or a fabrication.

Encryption is a process of encoding a message so that its meaning is not obvious. Decryption is the reverse process: transforming an encrypted message back into its normal form. Encryption provides confidentiality for data. Additionally, encryption can be used to achieve integrity because data that cannot be read generally also cannot be changed in a meaningful manner. Furthermore, encryption is the basis of some protocols, which are agreed-upon sequences of actions to accomplish some task.

If sensitive data is encrypted, a user who accidentally receives sensitive data can not interpret the data. Thus each level of sensitive data can be stored in a table encrypted under a key unique to the level of sensitivity.

5.2.3 Operational Feasibility

The purpose of operational feasibility is to gain an understanding of the degree to which the proposed project will likely solve the business problems or take advantage of the opportunities outlined in project identification study.

For a project motivated from information system planning, operational feasibility includes justifying the project on the basis of being consistent with or necessary for accomplishing the information system plan. It is important to have a clear understanding of how an information system will fit into the current day-to-day operation (Hoffer 1999).

As mentioned in the objective of the project, this network system applies to variety brands of automotive manufacturers. Over the past 5 years, many small automotive manufacturers are diminishing from the market due to the down turn of the economic problem. An overview of future trend of Thailand's automotive industry proves that there is a chance for new corners in this business.

As a new comer, the business strategy will start from a small scale. This proposed project is one of the alternatives that these new automotive manufacturers can make use of in achieving high quality of information transfer. Some of these brands consist of manufacturers from America, Europe, German, Italy, and others such as SAAB, Kia, Alfa Romeo, Skoda, Jaguar, Lotus, etc. However, this proposed project is not very economical for manufacturers that already invest a large amount of money in their networking system such as Toyota, Isuzu, etc.

The obvious questions that every automotive manufacturer has in mind are that "Is it worthwhile to change the routinely transaction of paper work form into this new technological system?" or "Do the consequences worth the investment?" If there is no change, then there is nothing to compare with. People always resist to change. As the purpose of the operational feasibility is to seek the degree to which the proposed project will likely solve the business problems. The answer is definitely 'YES' it will reduce the amount time spent on routinely work that results in an improvement of the work efficiency.

There will be no lead-time in sending and receiving information because this system runs at real time. The transaction can be done in a simpler and more effective way. The move toward paperless business and concern for environmental issue are the subsequences of implementing this project. In a long run, it is worthwhile to invest in this project, not only because it improves the work efficiency but also to keep updated with modern technology and to be competitive as others do.

VI. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The data processing requirements of today's decentralized corporations together with advance in both database and network technologies has led to the emergence of distributed database technologies. A distributed database is a collection of multiple, logically interrelated databases distributed over a computer network. It is more reliable and more responsive than centrally located and controlled databases; data can be entered where it is generated, data at different sites can be shared, and data can be replicated giving users the option of accessing copies of data in the event of a site or network failure.

The fundamental issue of distributed databases is transparency, which refers to both the data and the network. Managing transactions in a distributed database environment requires dealing with concurrency control, system reliability, and the efficiency of the system as a whole. The development of distributed database technology is stimulating the development of new applications that require support for distributed data. Advanced office automation systems, computer aided design systems, and knowledge based systems are three that profit from the ability to share data across a network of computers.

The overview and future trends of Thailand's automotive industry summarized the market situation of automotive industry in Thailand. There is a tendency of future growth in this market.

The existing database system in Thailand's automotive industry in centralized one due to its low usage volume. The available networking infrastructures are Virtual Private Network (VPN), X.25, and Frame Relay. Each of these networks has unique characteristics, both pros and cons, depending on the usage purposes. There are other kinds of network with better technology but they are not available in Thailand.

The characteristic of selected database system is based on frame relay network, as it seemed to be the most cost efficient network. The data on frame relay network runs at real time, which means that every time data is updated, every sited on the network will also be notified concurrently. Ethernet local area network is selected as the communication networks connecting each site, which is characterized by its high bandwidth and low delay information transfer.

Three feasibility study issues are conducted: economic feasibility, technical feasibility, and operational feasibility. The main focus is on economic feasibility study section that gives a brief idea on the investment term of the project. There may be other costs incurred when there is an actual implementation of the system. However, this study is based on the existing technologies, infrastructures, and possibility of networking design. Technologies are rapidly changing. They developed so fast that the proposed concept might be outdated in the next four to five years. It is evidenced that higher number of dealer nodes would result in a lower cost per dealer.

This project is very attractive for new automotive manufacturers with low sales volume such as manufacturers from America, Europe, German, Italy, and others such as SAAB, Kia, Alfa Romeo, Skoda, Jaguar, Lotus, etc. The feasibility section was clearly shown that the initial cost in setting networking system is very high. It is not worthwhile for a small automotive manufacturer to put in a large sum of investment capital. A much lower cost per dealer is being offered with high quality of transaction of information by this project. However, for a large automotive manufacturer such as Toyota, Isuzu, etc., this project may not be very economical as they already invest a large amount of money in their networking system.

6.2 Recommendations

The research in this project does not include a full detail of the programming software to manage and support distributed database system. The detail of application programs has to be further analyzed to comply with the system software. The software part is considered as another major part of distributed database system. This can be an extension of this project. While concentrating on the programming software, there may be a new developed infrastructure to replace the existing one.

Security issue is another critical part of every project. It is very essential to keep the data secured. I did not describe in deep detail about security in network system because the scope of security issue is very broad. This issue is recommended to be further studied in full detail. There should be a specific research on this topic alone. There are always hackers penetrating through the system, no matter how secure that system is. Therefore, new security systems are being generated in order to prevent these hackers.

There is a need to further discuss on the infrastructure layout. An on-site survey is a must before implementing the project with the consideration on the possibility of infrastructure layout with its surrounding environment as well as associated investment cost. The location of four main sites proposed in this project may not optimum locations after the survey. With further survey on the minor dealer nodes, there can be more than or even fewer than four main sites in order to optimize the infrastructure cost from one location to another.

Most importantly, other than up-to-date technology and available infrastructure, is the readiness of all manufacturers to make a move toward an information technology era. A vision toward future technology, adaptation time to new transaction technology, and system investment are the variables in implementing this project. The success of this project has to be initiated from the top management down to the operational workers where the executives must have vision toward future technological requirements to be competitive in the market.

By focusing on future possibility, where the scale of this system expands widely, not only small automotive manufacturers would be interested in making use of this proposed system but large manufacturers would also be attracted. The major attraction is focusing on its consistently high quality information transfer with low cost at high usage volume. The distributed system is designed to handle future expansion in the network capacity. Therefore, it does not limit itself to a certain number of users.

The distributed database system does not only limit to automotive manufacturers. The network system can be applied to many industries. The related industry that I can think of is automotive local part makers. This refers to the transaction among part makers and automotive manufacturers as well as among the part makers themselves. Large amount of data transaction is carried out each day mostly consisted of routine transaction. The daily transaction carried out by them is still in paper form: fax, mail, etc.

The main purpose of this project starts by focusing on the domestic business. Once the distributed database system gains popularity in Thailand, overseas business transaction can be easily done by all manufacturing sizes, not only limited to large companies. Other than automotive industry, the technology of distributed database system is applicable to many industries that involved a lot of transactions.

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