Seminar on Indian Railways – Vision 2025

(Organized by Railway Staff College, Vadodara)

VISION 2025: TECHNOLOGY FOR INFORMATION

(A paper by C&IS Directorate Railway Board)

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This paper puts forward a vision for the use of Information Technology in the Indian Railways over the next several years. It touches upon some of the theoretical underpinnings of Information Technology in large organizations. It presents a brief roadmap up to 2025.

Thereafter, the information needs of the various stakeholders in Indian Railways are identified. The information architecture proposed for Indian Railways is described.

Finally, certain recommendations are made for developing human resources for the IT function of the Railways. Characteristics peculiar to IT projects are described. Some of the issues faced while managing IT resources are touched upon.

The annexed documents give details of the components of the information architecture, and contain the approach paper of the C&IS Directorate on the 10th Five Year Plan.

Information Technology and the Indian Railways

Indian Railways has been a pioneer in the use of IT in India. IT was first adopted in the 1960s, when computerized Passenger and Freight Revenue accounting, Operating Statistics, Payroll, and Inventory management were introduced using IBM 1401 computers placed in Zonal data centers.

Later on, a notable success has been the introduction of the Passenger Reservation System (PRS) in the mid-eighties, and its subsequent enhancement to a fully networked application.

The Freight Operations Information System (FOIS) is currently under implementation. It will greatly change the way freight train movement and goods consignments are monitored in the Indian Railways.

However, a concerted effort to introduce IT in all aspects of Railway working has been considerably delayed. This raises fears that we may become laggards rather than leaders in the use of IT.

Often there is a feeling that the Railways as an organization is not ready to absorb high technology. However, if given some thought, it becomes clear that rail transport is inherently a high-tech area. The latest technologies relating to civil engineering, mechanical and electrical engineering, telecommunications, and materials science must be harnessed to run trains effectively, especially in the current competitive scenario.

Similarly, information is a critical resource for train operations. Harnessing Information Technology for effective collection and dissemination of information is not a luxury but rather a necessity for any rail operator. The effective introduction of IT saves costs rather than increasing expenditure in today's competitive environment.

There is no doubt that money can be wasted on trivialities if investments are not properly planned. Therefore a clear vision of the road ahead must be developed.

Spread of IT in the Railways

The spread of IT in the Railways has not proceeded at the pace expected of a pioneer. The size of the Indian Railways makes the introduction of any new technology doubly difficult.

Today, IT is poised to spread rapidly in the Railways, provided it is nourished with the right plans and policies.

The six stages of IT introduction

A well-known theory propounded by Nolan states that every organization follows six stages while introducing IT. These six stages are inevitable, and while their duration can be shortened, none can be eliminated.

Stage no	Stage	Description
1	Initiation	A few pioneers decide to try using IT in their work. Their efforts are often not coordinated with each other and may not have official blessing. They achieve some useful results with IT based systems.
2	Contagion	Other staff members see what the pioneers have achieved and decide to try using IT in their jobs. Its usage grows haphazardly with no central control. Spending on IT grows rapidly.
3	Control	Management realizes the firm is spending a great deal of money on IT. It reacts by putting controls in place. Often, the first step is a restriction on spending. The growth in IT expenditure slows.

4	Integration	As the user community grows—even with controls in place—there comes an appreciation for linking their systems to share data and applications. Networks or other appropriate tools are installed to accomplish this, and expenditures grow again.
5	Data Administration	The organization, now sensitive to the amount of shared data and its value to the organization, establishes management controls over this information resource. This differs from the Control stage because previous controls applied only to the products (hardware, software) themselves.
6	Maturity	The use of IT is an accepted part of doing business in the organization. Procedures have evolved to provide sufficient control without undue user burdens. Expenditures have stabilized to keep pace with evolving products and usage growth.

Relating the six stages to the IR scenario

Unfortunately, the current scenario over the IR does not fit neatly into any one of the above stages. The size and scope of the organization is so large that one stage cannot accurately describe the situation across different functions, or even different geographical areas.

For example, PRS is in the stage of Data Administration. FOIS, when fully implemented, will also reach the stage of Data Administration. Crew management systems are at the stage of Contagion. PC-based information systems at the stage of Control, which has now begun to throttle growth.

Similarly, Southern, Western, and Central Railways are in general at a later stage of development than South-Eastern Railway or NF Railway.

Two-fold role of Information Technology

IT provides a means for increasing the efficiency of the organization. In the Railways also, this will be the case. It is important to distinguish between the two different roles of IT in the organization. They are detailed below.

Role 1: an information highway

One role of IT is to provide information across the organization where and when required, through a number of standard applications that allow capture of information at the point of generation and dissemination of the captured information when and where needed. Applications such as FOIS, PRS, and the MIS applications play this role to some extent, and in future other applications will fill in the gaps.

Role 2: a personal productivity tool

The other major role of IT is as a tool for increasing personal productivity at all levels. Several pre-packaged applications such as Office suites, web-site management, e-mail, etc fall in this category.

Historically, this role of information technology has been ignored, and little effort has gone into providing productivity packages in a planned manner to officers and staff. The effective utilization of these packages is heavily dependent on appropriate training, which again has not been taken up in a planned manner.

However, this role of IT will be increasingly recognized and productivity increases on account of IT tools will become increasingly apparent throughout the organization.

Levels of information systems

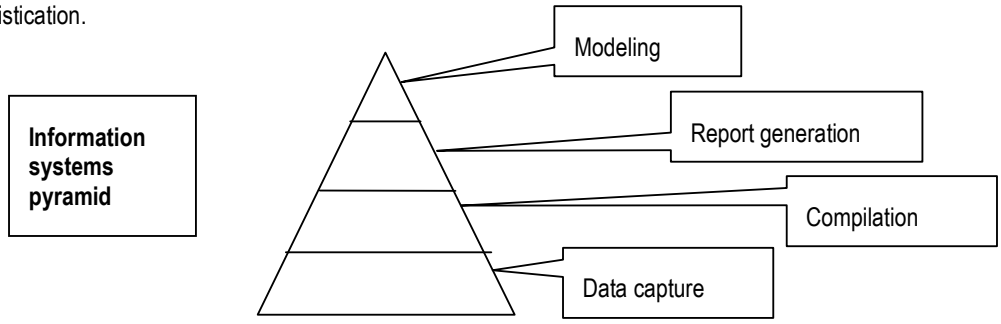
In any organization, information systems can be categorized into levels as given below. Each level has its own importance, and in general a strong base is required at the lower levels to allow the higher-level systems to be effective.

Ultimately, the vision is to ensure that for each organizational function, all these levels are covered by information systems

Level No	Level	Type of system	Description	Examples
1	Operational	Transaction processing system	A transaction processing system helps to streamline operating tasks, and is for the use of frontline field staff.	PRS and FOIS
2	Knowledge level	Office automation system	This is a set of tools to help knowledge workers working in general office environments to streamline their own work.	MS-Office suite is one such popular product
		Knowledge work system	This is a set of tools to help skilled workers working in specialized technical functions to streamline their own work.	Computer Aided Design (CAD) systems
3	Managerial	Management information system	It collects information from the base Transaction Processing systems, collates it, and presents it to management	MIS reports in PRS and FOIS, managerial reports in MIS systems
		Decision Support System	It is designed to provide assistance to a manager in taking a decision. Such a system typically stores only highly summarized data, and allows analysis under different scenarios.	
4	Strategic	Executive Support System	Assists top management in formulating long term policies and plans	Long Range Decision Support System (LRDSS)

Information system pyramid

For each function of the organization, information systems progressively pass through increasing levels of sophistication.



Data capture and collection

This is the lowest level, wherein data is captured as close to the point of generation as possible.

Information collation and compilation

This level is reached as soon as data collection is on a sound footing. The data is compiled in a format meaningful to the user.

Report generation

This level follows from the data compilation stage. Reports are generated in a format (text, graphical) most appropriate for the context in which it is to be viewed.

Modeling and prediction

The final level of sophistication of the information system is reached when, based on the data available, a model can be constructed to carry out comprehensive forecasting by varying operational parameters.

The model can arrive at relationships between different data elements, not readily apparent by other means.

Information architecture

As the use and importance of Information Systems grows in the organization, the need to define the Corporate Information Architecture becomes important.

The Corporate Information Architecture provides the framework within which individual information systems can fit, that is, it defines the broad scope of the component Information Systems and the interfaces between them.

Information Systems Planning

Even after defining all the components of the corporate information system, it is not possible to introduce IT across the organization all at once.

This problem is faced by all large organizations. Therefore the standard procedure is to formulate an Information Systems Plan and review it periodically.

The Information Systems Plan (ISP) or Information Strategy Plan depicts the sequence and time frames of introduction of different IT systems and technologies in the organization.

The ISP must be in line with the organization's Business Plan. A step in this direction has been taken in the Railways with the drawing up of the Xth Five Year Plan recommendations (enclosed in the annexure).

The ISP starts with the identification of the stakeholders in the organization, both external to the organization and internal to it. Thereafter, the information needs of each of the stakeholders are identified.

Next, the information needs are mapped to different components of the overall corporate information system.

These components are then categorized on the basis of importance and urgency, and their introduction into the organization is scheduled. This schedule forms the basis of the ISP. Resource allocation and procurement forms the rest of the plan.

IT in the Indian Railways: a vision for 2025

The vision for Information Technology in the Indian Railways for the next 25 years is to reach the stage where all the information needs of the organization can be met by a comprehensive information highway, available to all internal and external stakeholders. The vision is also to improve personal productivity at all levels by the effective use of this technology.

Four aspects of the vision

A vision will remain abstract unless it is backed up by concrete action on four fronts.

Vision aspect	Description	Current status on Railways

Commitment	The first aspect is a commitment towards the goals articulated in the vision. This commitment begins at the top and gradually pervades the organization	The commitment to obtaining increased value from IT is already available. The interest of top management as well as field officers and staff has been kindled by the IT revolution in the rest of the country. Numerous reports, such as the Rakesh Mohan Committee report, have dwelt on the need to harness IT for efficiency and effectiveness.
Planning	The second aspect is a plan towards achieving the goals articulated in the vision. The plan has to be flexible and practical	A start has been made with the plan document for the Xth five-year plan. This document, which sets out the plan for the next five years, has been annexed to this paper.
Funding	The third aspect is the provision of sufficient funds for the areas articulated in the vision.	The funding for IT (Plan Head 17), which was languishing at about Rs 50 crore per annum for the past few years, has been substantially raised to about Rs 140 crore for the year 2002-03. This is a harbinger of more funding in the coming years, provided the planning work is properly done.
Resources	The resources – hardware, software, networking, and human resources – required to make the vision a reality have to be identified and made available. This aspect is the most difficult to follow up.	As IT becomes more pervasive in the educational curriculum, increasingly greater numbers of Railwaymen are able to serve as resource persons for IT projects. As for the hardware and software, procurement processes are the greatest bottleneck at present. Some of these issues have been addresses by the recent guidelines given by Board for procurement of IT products. The data networks have also been upgraded with the coming of the Railnet, and Railtel Corporation is expected to improve the situation even more.

A roadmap for the vision

The Xth Five-Year Plan document for IT provides a roadmap for the next 5 years, that is, the Xth plan period.

The roadmap for the following years can be roughly divided into the following five-year periods.

Five year period	**Stage**	**Description**
Period 1: 2005 to 2010	Automation	The next few years will primarily see the automation of the existing processes in all the functional areas of Railways. PRS and FOIS already address the automation requirement of their respective areas. The MIS projects and other departmental initiatives also address process automation, and by the end of 2010, process automation will be by and large complete.
Period 2: 2010 to 2015	Synergy	The next stage will be one of synergy, that is, the separate systems put in place will begin to interchange information amongst them, and by the end of this period information interchange will be reasonably automatic.
Period 3: 2015 to 2020	Global acceptance	The third stage will be one in which the databases across the organizational network will find increasing acceptance as authentic sources of information. By the end of this period, information will be available as a matter of course from the information highway.
Period 4: 2020 to	Integration	By this time, the state of technology will probably be very different from today. Delivery of services to customers will be done by methods that are likely to be very different from

2025		today. If we consider that in 1977, no one could have conceived of the spread and utilization of the PRS as it is at present, we may appreciate the situation in 2025. Therefore this five-year period may see a total revamp of the information systems built up in the previous twenty years. These may be replaced by an integrated system covering automation of all internal functions, which will provide information for external customers, and also form the base for information mining, forecasting, and modeling.

Stakeholders and their information needs

An identification of all the stakeholders in the Railways system, and a study of their information needs, forms the basis of a future information systems framework for the Railways. The table below identifies major stakeholder and their information needs, and attempts to relate them to the components of the envisaged Corporate information architecture of the Railways.

External stakeholders

External stakeholders are vital to the Railways' business. Without customers the Railways cannot run, and there is a regulatory framework within which it must run. Therefore the information needs of the external stakeholders must be met through the Railways' IT framework. Of course, to serve up the external stakeholders, the internal IT systems must be very strong.

Today, external stakeholders are increasingly driving the Railways' IT effort, because they need better quality information faster. In the future, this trend is likely to accelerate further, as standards of information availability become even higher.

Internal stakeholders

The most important internal stakeholders are employees in their individual capacity. They need information about their individual status in the organization, and also need to effectively vent their grievances. Employees also need to develop themselves professionally during the course of their career.

Some employees perform a supervisory or managerial role in their work. They need to monitor the work in their area of control. Information is a prime resource for them.

Looked at from another viewpoint, employees are generally internal customers or internal suppliers to others. They are part of one or the other resource cycle, that is, a series of activities that provide a particular resource to an internal customer.

The entire transaction needs to be monitored as well, so that the internal supplier supplies the resource at the right time, and of the right quality.

The major resource cycles are cross-functional. They cut across the traditional functional boundaries at different levels. Inefficiencies because of slow information flow are most evident at these boundaries. Information systems will provide such cross-functional information flows much more efficiently.

No	Resource cycle	Description
1	**Rolling stock**	To run trains, the operations department requires a minimum level of rolling stock. This is provided by the maintenance departments, which in turn require materials and men to maintain the stock. The Stores department procures and stocks material to provide it to its internal customers at the right time at the right place.
2	**Line blocks**	The maintenance departments need availability of track or OHE, for which a block has to be given by the Operating department. It is estimated that 15 to 20% of the line

		to be given by the Operating department. It is estimated that 15 to 20% of the line block time is wasted today in conveying cross-functional information.
3	**Materials**	Almost all departments require materials from the Stores department, sometimes from stock or against direct purchase. This process is also very slow today.
4	**Human resources**	Men are required for all activities and they should be available at the right place at the right time. Crew availability and booking is the best example of this cycle.
5	**Budgeting and expenditure**	All departments require money for their work, but its expenditure must be monitored and controlled. Large amounts of information must flow between the executive and the finance department for this purpose.

Information needs of stakeholders

The information needs of the identified stakeholders and the information systems likely to address these needs are given below. Some of the systems are already in place (in **bold**), while others are in the process of being developed or implemented (in *italics*).

Functional area	**Stakeholder**	**Information needs**	**Information systems**
External stakeholders			
Passenger services	Individual passengers	Availability of train services, fares, terms and conditions, timetable Availability of accommodation, ticketing and reservation Fare refunds Train position and timings	**PRS and related systems** *NTES (train enquiry system), with different modes of service delivery (Internet, IVRS, SMS)* *Internet portal / site*
	Travel and tourism agencies	Tourist trains Bulk bookings	Information portal on the Internet
Freight services	Large consigners and consignees (Steel plants, Power plants, Food / Civil supplies corporation, Coal mines, Fertilizer plants)	Bulk booking, running arrangements Train & consignment monitoring	Information portal on the Internet *Computerized booking of goods* *Consignment tracking (addressed by FOIS TMS)* Electronic interchange of consignment information
	Small consigners and consignees	Booking availability, rates Consignment monitoring	*Computerized booking of goods* *Consignment tracking (addressed by FOIS TMS)*
Rolling stock manufacture	Procurers of rolling stock (export, own-	Specifications, costs, design variations	Collaborative portal

Functional area	Stakeholder	Information needs	Information systems
manufacture	your-own-wagon)	Monitoring delivery	
Civil works	Private siding customers	Design collaboration Project monitoring	Collaborative portal
Maintenance services	Rolling stock maintenance customers	Costs Progress monitoring	Collaborative portal
	Private sidings	Progress monitoring	Collaborative portal
Government	Parliament	Questions	Automatic messaging system connected at the back-end with an internal system for monitoring responses and follow-up
	Ministry of finance	Budget Expenditure	*Budget preparation system* Expenditure monitoring system
	Planning commission and other Ministries	Plans Coordination	Collaborative portal
	Civil administration (Police, district administration)	Unusual occurrences requiring co-ordination	Messaging system
Suppliers / contractors	Material suppliers	Requests for information, tenders, purchase orders Monitoring delivery	Information portal
	Service contractors	Contract terms, validity of contracts Progress of contracts	Collaborative portal
Supply chain collaborators	Freight consolidators	Movement planning Train monitoring Consignment tracking	Collaborative portal Consignment tracking with electronic exchange of consignment tracking data
	Ports	Movement planning, train monitoring, logisticsunit tracking	
	Postal services	Train monitoring, postal tracking	
Regulators	Courts	Consumer actions	Legal information base

Functional area	**Stakeholder**	**Information needs**	**Information systems**
	Pollution control boards	Effluent levels	Information portal
	Land use regulators	Land use data	
Internal stakeholders			
Functional area	Stakeholder	Information needs	Information systems
Subsidiary organizations	CONCOR / KRCL / IRCTC	Train operations and interchange information Other operating information Policies, rate structures	Collaborative portal Electronic exchange of operational data Electronic exchange of financial data
	RITES / IRCON / Railtel	Policies Financial data	
General operations management	Employees as managers	Monitoring of routine work (daily positions, monthly reports) Information for planning Benchmarks and best practices information	*MIS systems at zonal and divisional level for collection and collation of information* Portals for benchmarking and best practices knowledge pool *Planning systems ranging from simple forecasting to ESSs such as LRDSS*
	Employees as internal customers and internal suppliers	Resource availability Target dates / times for service delivery Monitoring cross-functional activities	Cross-functional monitoring and control systems
Personnel management	Employees in their individual capacity	Service records and salary details Grievance redress Housing database Special assignments and deputations Railway news and directions Knowledge pool Training and development	Information portal *CD / other media based training programs* *Discussion board*

Functional area	Stakeholder	Information needs	Information systems
	Employees as members of unions / associations	Progress of dispute resolution Cadre status and planning Policies	Information portal

An organization-wide Information Architecture

The information framework of the Railways will ultimately consist of separate systems that form its components, linked together by well-defined interfaces. The interfaces will define the content and form of the information flowing between the components.

Each component can hence be modified when needed without affecting the other components. In addition, modifying the interface alone could change the information elements flowing between any two components. This would make the information framework very flexible as well.

Each component will meet the information needs of each stakeholder, external or internal, identified earlier.

For the first ten or so years, the Information Systems focused on the external customers will remain separate from the ones focused internally. Gradually, these will become integrated, so that the information from the internal systems is, when appropriate, automatically fed to the customer.

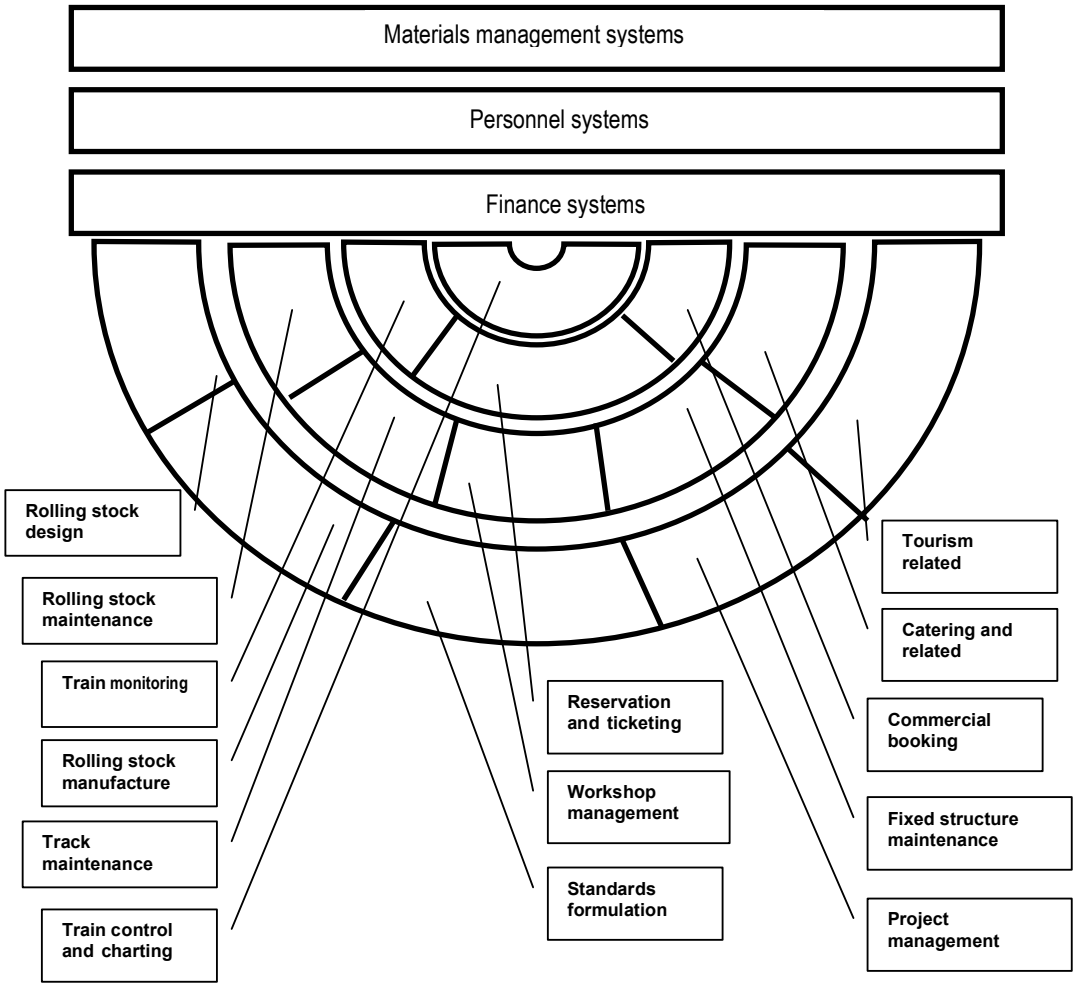
Components of the information architecture

At a conceptual level, the core component of the architecture is the train operation system, consisting of train control and charting. A shell surrounds this core, consisting of train monitoring on one side, and commercial functions on the other. The next shell consists of infrastructure maintenance, such as maintenance of rolling stock and track, catering and related functions, and workshop management.

Beyond these areas are supporting functions such as rolling stock design and manufacture, management of new Railway projects, formulation of standards, tourism related activities.

The finance function, human resources functions, and materials management support the entire set of components.

The conceptual framework is depicted diagrammatically below, and given in detail in the annexure.



Components of the Information Architecture of the Indian Railways

IT resource backbone

To reach the stage of rapid expansion of IT systems in the Railways, a backbone of IT resources is required to be set up. The backbone comprises of the components mentioned below.

Data network

Today, by far the most important IT resource needed is an integrated communication network.

The communication network should provide seamless movement of information from one location to the other, without the system developer having to concern himself about the details of the network.

The fragmented and disparate networks in use today: voice, PRS, FOIS, Railnet, should merge without delay into one integrated network, running on a mix of physical media if so needed.

The lack of a data network with sufficient bandwidth and reach is the single biggest bottleneck for effective deployment and utilization of IT in the Railways today.

Groupware application

The e-mail system presently available on Railnet should run on the integrated network in the form of a groupware application, allowing documents to move electronically based on pre-defined business rules.

Personal productivity will improve tremendously if reliability of this application becomes high.

Intranet

The Railnet today provides a good platform for the Corporate Intranet. However, the power of the Intranet will be unleashed only when all users feel confident enough to share information over it using the user-friendly web-site deployment tools available today.

GIS system

The GIS system will be used to visualize the results of the different components of the Information framework of the Railways. It will work in the two ways given below.

Resource location

Resources will be mapped on the GIS system for subsequent retrieval. For example, the details of track, OHE, other fixed structures, level crossings etc have to mapped once on the GIS to retrieve them whenever required, for example during an accident.

Analysis and visualizing

The results of analysis carried out on geographic parameters will become more understandable if depicted on the GIS. Since most of the analysis done on the data will be related the country's geography, mapping of the results will be of immense help while taking decisions.

Product database

The product database will be a unified database covering the product lifecycle from conceptualization and design, through raw material selection and procurement, to manufacture / procurement, to inventory stocking, to use, maintenance, and finally the end-of-life and scrapping.

The product database will be a unified resource for all materials in use in the Railways, and will cover both the design cycle (that is from design to manufacture / procurement, and finally to phasing out of the product), and the production or procurement cycle (that is, the status of the product from its manufacture / procurement to its final scrapping).

Cycle	Deals with	Covers	Examples of information retrievable from the database

			from the database
Design cycle	Conceptual product	Conceptualization, design, specification, where-used information, procurement policies for raw material or finished product, stocking policies, production information, maintenance instructions, and scrapping policies	Engineering drawings Specifications Engineering changes Cut-in dates Standard cost Stocking policies Design life Scrapping policies
Production / procurement cycle	Physical product	Procurement of raw material, production of the product, inventory position, tracing information for positive recall, and related areas	Estimated annual requirement Uncovered / covered dues Items in stock Production / procurement cost Average life

Diagnostics

In all equipment, whether fixed assets or rolling stock, self-diagnostic equipment will be increasingly used, allowing the concept of "condition based maintenance" instead of the present concept of scheduled maintenance.

This will be a source of major efficiency for the Railways maintenance organizations.

Human resources

By far the biggest obstacle in the Railways' IT strategy so far has been the lack of emphasis on adequate human resources. Despite having a large pool of talented manpower, no committed effort has been made to familiarize them with IT related concepts.

The need is not so much for programmers and hardware experts, but of persons who understand the broad technologies available today, their capabilities and limitations, so that they can conceptualize the use of the technologies in their work areas.

The need is also of persons who can effectively use the personal productivity tools provided to them by desktop computers. In the absence of proper training, even the computing resources available today is not used to its potential.

Fortunately, the social conditions prevailing today are such that even without any support from the Railways, many of our employees are very familiar with IT concepts and possess good IT skills. Such persons need to be deployed to speed up the use of IT in the organization.

Education and training

Several areas of education and training need to be addressed by a long-term training policy.

Educating managers

The first and foremost need is to educate managers to appreciate the capabilities and limitations of IT. Managers further act as catalysts for the use of IT in their places of work.

Training end-users

Those persons working directly on custom-built applications need end-user training. End-user training is essential to keep such applications working effectively.

IT architects and contract managers

A pool of IT architects needs to be maintained by the Railways in order to be able to plan out the structure of large Information Systems for effective development and implementation.

Similarly, contract managers specializing in TI contracts are needed to monitor IT projects outsourced to contractors. Without effective architecting and contract management, IT projects are almost always doomed to fail.

In-house software developers

Certain requirements such as small, ill-defined systems cannot be outsourced completely. Therefore a pool of in-house software developers, aware of the gamut of technologies available, is required. This pool of developers should work mostly on proof-of-concept and prototype systems.

Content developers

As the need for publishing information on data networks goes up, the need for content developers will also grow. These content developers will be required to create information content on the network suitable for effective network sharing.

System administrators, Database managers, and Network managers

As the number of server-based applications increases, the administration of these applications will become important. Hence a focused program for creation of system administrators and database administrators will become essential.

As a result of the development of these applications, the number of network devices and sub-networks will proliferate all over the Railways. It is important to ensure that network management issues do not hamper this process of proliferation and the attendant information sharing. Hence training of a pool of suitable network managers is required.

A “virtual cadre”

Whenever a new technology has appeared before the Railways, human resources have been inducted by creating a cadre in a vertical fashion across the organization.

IT does not really lend itself to such a structure. The mundane tasks of coding programs and maintenance of hardware and software can be easily outsourced. On the other hand, domain knowledge is vital.

Many information systems are cross-functional. Domain knowledge from several functional areas is required to conceive and implement them effectively.

Alongside that, it is not possible to exercise control over the development, implementation and maintenance of the applications without an overall knowledge of hardware, software and networking.

Therefore for each IT project, a small project management team is needed, comprising of persons with both IT and domain knowledge.

A database of resource persons

The best approach to this staffing problem is to create a database of IT “resource persons” who can be mobilized when needed for individual IT projects. These resource persons will themselves gain experience and knowledge as they progress from one project to another.

Managing the "virtual cadre"

Carefully designed training programmes for members of the "virtual cadre" will ensure that the Railways retains a pool of knowledge within itself, in tune with the technology trends, but nonetheless in synch with the requirements on the ground.

The database would be centrally updated to reflect the changing composition of the resource pool, including updating the skill-sets of each person periodically.

Academic collaboration

Collaboration with academic institutions of good standing is needed to ensure that the IT effort of the Railways remains on track with innovative and appropriate projects being taken up to address its IT needs. Such collaborations, entailing the setting up of specialized centers catering to Railways' specific needs in the participating institutions, will lead to a two-way movement of expertise.

Academic expertise is essential to envision new areas of application of technology. Railways' own expertise is needed to ensure that such efforts remain practical. Therefore a select group of Railwaymen and researchers in the IT field, with moderation by experienced academics, can ensure development of appropriate technologies and applications for the Railways.

Such a collaboration will provide the much needed research effort needed to tap the technology to the maximum possible extent without wasting resources on unfocused activity.

Such collaboration will also provide higher IT education for selected Railway managers, thus enlarging the pool of IT expertise within the railways. The concept of a "virtual cadre" of trained IT experts, ready to be deployed for IT projects in their original field of work, can then become a reality more easily.

Although the Railways will have to incur some initial and recurring expenditure on such collaborations, the returns may be very high if carefully followed through.

Managing IT projects

The key to a rapid build up of information systems in the Indian Railways is fast and effective conception and execution of IT projects. Such projects consist of systems studies, project estimation, software development, selection and procurement of hardware and software, and finally implementation and integration of the system.

As of today, the Railways have had a few resoundingly successful IT projects and several failures. Fortunately, so far the cost of the failed projects has not been high, and the learning from these projects has been well worth the cost.

But now, we stand poised to rapidly execute IT projects thanks to our learning in the area. Recently laid down guidelines have kept in mind the peculiarities of executing IT projects.

The stages in development and implementation of an IT project are as given below.

Experimentation

The preliminary stage of any IT system is the stage of experimentation. Different prototype systems may be created using the simple tools available today, and pooling the experiences gained in this phase can freeze the scope of the system.

Conceptualizing the project

After the experimentation phase comes the conceptualization phase, in which the overall implementation methodology is fixed and the scope examined for completeness.

Overall architecture of the system is also determined in this phase.

Sizing the project

A difficult but nonetheless essential step is the sizing of the project. Without sizing, we cannot arrive at an accurate budget and time estimate.

Standard sizing methods

The end-user community follows certain standard sizing methods today (for example Function Point Analysis). Other methods are also evolving to size software projects.

The size is converted to an effort estimate based on certain standard methods (for example COCOMO).

All these methods depend heavily on certain empirical factors, worked out for different platforms and organizations over several projects, and to that extent are uncertain.

In software projects, a variation from the estimate of +/- 20% is considered acceptable!

Setting up a metrics database

Since the sizing and estimation of software projects is so dependent on empirical factors, it is important to develop a database of metrics, that is, a database of the actual size and effort of a project, and compare it with the estimate.

This metrics database will give an insight into later projects and make their estimation more accurate.

Executing the project

Project execution in case of IT projects is also different from other projects. The scope can never be as precisely defined, technology changes very fast, and estimates are far more inaccurate than for other projects.

Estimates and outlays

Estimates can vary greatly with the size of the project. There is a concept of “diseconomy of scale” which leads to a much greater effort for large projects than for small projects. Estimates and outlays must take this factor into account.

There is also a comparatively small window for the project completion. Crashing the project or delaying it unduly, both carry a large risk of failure. An IT project is very much a social project as well, since it normally changes the way in which people work and think.

Refining the estimates

IT project estimates have to be refined throughout the life of the project. At each stage of execution, the project has to be validated and the estimate re-worked. The current policies in the railways do not allow such frequent revision of the cost without heavy delays. These policies need a change so that IT projects can be completed quickly.

Closing the project

IT projects usually suffer from “scope creep”. The project never gets closed since the functionality is never covered in toto.

Therefore precisely defined project closing criteria have to be defined.

Post-implementation review

A review of each IT project must be done after a few months of completing implementation to observe the performance. The post-implementation review serves as a good method to make future successes more likely.

Managing IT resources

IT resources are different from other resources. Some of the resources are purely intellectual, while the tangible assets lose their value very rapidly. This section discusses the current and future trends in managing these resources.

Architecture

A difficult resource to manage is the architecture of the different IT applications. The architecture undergoes changes as new technologies arrive and old ones become obsolete.

Maintaining configuration control (versions) of the architecture is therefore important.

Procurement

Procurement of hardware and software is different from most other procurements in the Railways. In hardware, rates go down, rather than up, with time. Therefore hardware procurement should be postponed till the last minute.

On the other hand, rates of software are going up, so the foregoing argument does not hold for software.

One approach is to partner with large IT vendors to obtain a long-term commitment from them, especially for software. This can be effective in providing expertise and low rates to the Railways.

Leasing of infrastructure is another option to reduce immediate cash outflows.

Replacement of assets

Obsolescence of IT assets is very high. Only a carefully designed and executed project can retain its hardware beyond a few years. The cost of obsolescence must be worked out in the concept stage, and stratagems to enhance the life of hardware and software must be put in place.

One insoluble problem is about what is to be done with the released hardware. Should it be discarded outright? Can it be reused for certain non-critical applications? Can injecting a dose of technology give a lease of fresh life to the assets?

Leased systems usually do not have the problem of replacement, since the lease agreement itself addresses the replacement issue during the duration of the lease, and at the end of the lease period.

Operation of IT systems

IT systems need diverse skills for proper operation. System administration, database administration, network management are essential skills, which may not be available.

Outsourcing of the operations is an alternative that can be considered in the future, when the market for these services matures.

Maintaining IT applications

Hardware maintenance includes minor upgrades to keep it capable of running newer versions of the software.

Software maintenance includes upgrades to the software platforms.

Application software maintenance is different from other maintenance functions. Apart from bug fixes, it includes minor enhancements to the software to take care of changes in functional requirements. Over the life of the application, the underlying processes undergo continuous changes, and these changing requirements are taken care of during the application maintenance.

Security considerations

Security of data and applications will become vital as strategic functions begin to depend increasingly on Information systems.

Security starts with physical security of data centers and physical data stores to prevent unauthorized entry and damage to them.

Data has also to be secured against program faults and inadvertent or malicious deletion. Remotely located backups should be kept to minimize the impact of damage to the site in the event of a mishap.

Similarly, application software may be attacked by inadvertent or malicious modifications, or attacks over the network or through the intranet or the Internet, depending on the connectivity provided.

As systems become more sophisticated, authentication and non-repudiation of messages to the database becomes important. Finally, the systems should be auditable, so that any attack on the programs and data can in the worst case be detected after the fact.

Application audit

As applications become all pervasive, a regular audit of the applications becomes important. The following areas are addressed by the audit:

- Does the application meet with the originally conceived set of requirements?
- Does the application contain built-in security measures?
- Are the hardware and software platforms optimized for the application?
- Is configuration management (version control) of the application being properly done?
- Can the latest technologies be used to extend the lifecycle of the system?
- Does the application conform to the latest road-map for the organization?

Conclusion

An attempt has been made to develop a road-map for the future growth of IT in the Indian Railways. Conditions today are ripe for us to obtain the benefits of IT, since general awareness of the technology is high, and its benefits have been proven.

A commitment to utilize IT appropriately in the organization already exists. Funding has been increased in this year, and should not be a major constraint in the future.

Therefore the organizational thrust should be to ensure that resources are allocated wisely, in a planned manner, the vision concretized, and followed through.

ANNEXURE 1

Train operations

Train control

Control charting

Train monitoring

Tracking of rolling stock

Train timetabling and scheduling

Accident management

Re-routing and re-scheduling

Route capacity determination

Commercial functions

Passenger

Passenger reservation

Today the PRS system provides a very vital service to the individual passengers, who are major external stakeholders.

With increasingly diverse interfaces, such as the Web, the PRS will provide even better services.

Ticketing

Other ticketing such as unreserved tickets and monthly tickets will also be computerized, providing “anywhere anytime” services to the passengers.

Passenger movement analysis

This will be an internal system to track the movement and other details of the passengers from the data generated by the PRS and other ticketing systems. Analysis of this data will allow services to be optimized.

Freight

Goods booking

Consignment tracking

Freight traffic analysis

Disputes and claims

Rolling stock production

Design

Managing production

Production planning and control

Materials management

Human resources management

Costing

Sales and product distribution

Warranties

Positive recall of parts

External sales and exports

Sale documents

Invoice generation and payment realization

Rolling stock maintenance

Locomotives

Passenger stock

Freight stock

Special rolling stock

Track machines

OHE maintenance cars

Workshop management

Fixed asset maintenance

Track maintenance

Maintenance schedules and monitoring

Materials and scrap

Track parameters

Failure trends

Bridge maintenance

Maintenance schedules and monitoring

Materials and scrap

Bridge parameters

Failure trends

OHE maintenance

Signaling maintenance

Buildings and other civil assets

National housing database

Engineering workshop management

Managing Railway projects

Feasibility studies

Survey

Designing fixed structures

- **Track formation**
- **OHE**
- **Station buildings, platforms**
- **Yard layouts**
- **Signaling layouts**

Project monitoring

Personnel management

Recruitment

Employee payment system

- **Employee leave accounting**
- **Retirement benefits**

Personnel management information system

- **Recruitment**
- **Training**
- **Service records**

Cadre management

Materials management

Product lifecycle management

Materials database

Procurement and material sourcing

Scrap management

ANNEXURE 1

Financial management

Budgeting and expenditure control

Accounting

Leasing and financing

Pre- and post- financial analysis of projects / investments

Costing of activities and operations

Assets management

Railway security

Securing personnel access

Managing criminal databases

Wagon seal monitoring

ANNEXURE 2

INFORMATION TECHNOLOGY

Xth FIVE YEAR PLAN (2002 - 2007)

Information Technology has always been in a continuous process of very rapid change. As such forecasting 7 years ahead is nearly impossible. This chapter attempts to identify what the Indian Railways need to do in order to take the best advantage of this rapidly changing field without directly identifying the technologies that may exist over the same time-frame.

1 HISTORICAL BACKGROUND

1.1 Indian Railways have been old users of Information Technology – since the 60's when the Railways had invested into IBM Autocoder, subsequently replaced by IBM 1401s and so on. The areas that were computerised first were, predictably, related to financial management.

1.2 Later these applications were migrated onto Unix boxes. At around the same time projects were started which took a more holistic view at the core operations of the Indian Railways – thus came into existence the Passenger Reservation System (PRS) project and the Freight Operations Information System (FOIS) project.

1.3 The PRS project began in 1983 with VAX mainframes being installed in New Delhi on Nov. 1985. Over the next five years four more PRS centers were opened at Mumbai (1986), Kolkata (1986), Chennai(1987) And Secunderabad (1990). PRS facilities are now available at locations that include even non-railhead centers like state capitals of North East region, Srinagar, Andaman & Nicobar Islands, Lakshadweep Islands, etc. By 1999 all the PRS centers had been networked together and the facility of obtaining reserved accommodation from any station to any station at any counter had been implemented. These five PRS centers along with more than 600 reservation centers account for over 96% of the reserved accommodation provided by the Railways. The system is handling 800,000 reservation transactions per day, in addition it handles 700,000 direct passenger queries using the Internet, 200,000 Enquiries using the telephone based enquiry system (IVRS) and additionally queries on enquiry counters. The software being used CONCERT (Country Wide Enhanced Reservation and Ticketing system) is internally developed and is based around the Reliable Transaction Router (RTR) product from Compaq. The availability of reserved accomodation is growing at roughly 6 – 8% every year and the PRS system needs to keep pace with that.

1.1 The FOIS project had its genesis in 1982. It was expected to provide the Indian Railways the following –

- To develop an integrated operations information system
- Improve monitoring of railway operations on a rake-wise basis.

- Improve monitoring of allied Commercial activities at terminal locations.
- Optimise the utilisation of Railway Assets such as Wagons, locos etc.

The project was originally based on a Canadian software called 'TRACS'. Experiments with which were carried out till 1995. That year a review committee, called the 'IIT Committee' was appointed to review the project. In 1998 the committee among other things recommended scrapping of the extant basis of the project to be replaced by *de novo* development. The development then revolved around a new Rake-based philosophy using RDBMS technology and a centralised server philosophy. Phase I (Rake Management System – RMS) has been completed. Phase II (Terminal Management System – TMS) is to be completed by 2003.

2 REVIEW OF IXTH PLAN –

2.1 Passenger reservation System –

During the IXth plan all locations with 1000 or more reservation transactions per day were planned to be covered. The actual achievement is much better – locations with 200 or more reservation transactions per day were covered and 271 locations were computerised.

Interlinking all the PRS centers was also planned for and was completed along with successful migration of the application from IMPRESS to CONCERT, which was developed in–house by CRIS. At the same time the Y2K problem was successfully tackled and no problems were faced in the period.

Innovative methods of Information disbursement using various media have been started. Indian Railways implementation of automated telephone enquiries (Interactive Voice Response System) has got kudos from across the world. In addition, use of touch screen based direct passenger enquiries as well as Internet–based enquiries into the core database has also been successfully started.

2.2 Freight Operations Information System –

Based on the mid–term review of the FOIS project indicating a need to start, for all practical purposes, *de novo* the project has effectively been restarted in 1998. Since then 2 core modules – RMS (Rake Management System) and TMS (Terminal Management System) have been successfully tested.

RMS has also been implemented in the field across the country and as such is fully operational. Field level testing of TMS software has been started and TMS deployment is expected to be completed by 2003.

2.3 **Workshop computerisation** – This work is in 2 phases consisting of 16 and 15 workshops respectively. Out of this the first phase has been completed and the next phase is to be done in the

2002 – 2003 time–frame.

2.4 **Stores Computerisation** – 10 major Stores have been computerised with 15 more expected to be computerised by the end of the plan. Most of the Zonal Purchase Offices have been computerised, the remaining are also expected to be done by the end of the plan.

2.5 **Divisional Computerisation** – This is one of the areas where the Railways has not done very well. 22 divisions have been covered with more than 40 yet to be covered possibly under the MIS project.

3 VISION STATEMENT

Indian Railways shall inculcate a culture of using Information Technology intrinsically in its day-to-day working so as to provide cost-effective solutions to meet with its customers, and its own requirements and expectations

4 GUIDING PRINCIPLES FOR IT ENABLING – Flowing from the above Vision Statement, the future course of action on IT in the Indian Railways must rest on three guiding principles -

4.1 ***Evangelising, experimenting and spreading IT*** into areas hitherto not looked at.

4.2 ***Collaborating, corroborating, reviewing and finally consolidating*** the knowledge gained in areas where some work has been done. The pooled knowledge should form the basis for a single common core that can be implemented by anyone using whatever hardware/ software that they wish and all the individual components would still gel together.

4.3 Finally, ***creating infrastructure*** in the form of organisational structure, lines of control, delegation of powers, technical standards etc. that would enable the above to happen.

5 LONG TERM STRATEGIES

5.1 **One Person, one Computer** - One of the most common metrics used to measure the level of adoption of IT within an organisation is 'PC penetration' or more generally 'computer terminal penetration' measured as PCs or terminals per staff. Excluding the PRS segment, the Railways, rate poorly by this metric. In the next Five Year Plan, all 15,000 officers and 1,41,000 Supervisors should have access to a computer at their place of work. It is also expected that most of these terminals would be in the form of PCs.

Assuming a metric of around 2 staff per terminal (assuming some are in shift duty and excluding LR & RG), this would imply that around 80,000 PCs/ terminals are required over five years at roughly 16,000 PCs/ terminals per year. This, in turn, implies that the Railways would incur revenue expenditure of approximately Rs 125 Cr per year on new sites and assuming a 5 year life for PCs, another 25 Cr on replacement account – a continuous total revenue expenditure of roughly 150 Cr per year on PCs/ terminals or roughly 15 Cr per zone per year of revenue expenditure.

This extremely high level of investment raises 2 issues – one, that using PCs as front–ends is extremely expensive as compared to using dumb terminals, which cost roughly ¼th, and secondly, the financing models involved can make a major difference on the costs involved. Railways currently purchases in odd lots – leading to a lower level of discounting. There are large price advantages that can be gained by quickly going in for enterprise level pricing agreements. These shall be extremely critical in cost cutting exercises and earlier the better, i.e., lower the cost over the lifecycle.

5.2 **Event driven Applications** – Any event should trigger of the connected applications to handle the situation. The Railways need to move in a big way to automation of routine functions and free the available staff for more value adding functions. For example, in case a consignment is lost then all the routine actions that can be undertaken to locate the same should automatically be initiated by the computer systems. Only those cases which cannot be handled by the computer should be handled by the staff directly - the number of such case would fall, but the resources required per case would be much larger and the available staff would be fully utilised. This also implies that all related systems are connected together and are in a position to share information.

5.3 **Data capture/ Data cleaning** – the need to re-enter data at various stages or at different locations must vanish. The need to avoid the Garbage In, Garbage Out phenomenon is critical from the very outset. This is especially true if the Railways are to quickly computerise in order to improve overall systemic efficiencies. Entered data, once checked for errors, must become part of a global data archive and must form the basis of all future transactions for that item. The simplest way to implement this would be to create very strongly typed back-end databases.

5.4 **Interface Standardisation** – Further, not only is there a need for the databases need to be strongly typed there is an even more critical need to strongly type the *interfaces* between databases' - possibly through the Application Programming Interfaces (APIs) or simply using standardised table/ field definitions and leaving the system expansion/ APIs to be designed later. All these designs must be audited by an external body, i.e., people not directly involved in the development of the application or in its use. Interface standardisation has an indirect fallout on platform standardisation – platform being defined as the combination of hardware and operating system and in some cases the core application. There has been a proliferation of platforms in use in the Railways, now more than ever is there the need to undertake platform rationalisation cum standardisation.

5.5 **Transparent Resource Sharing** – All system resources shall be shared and visible across the system on-line to authorised users. Simultaneously, a culture of cooperation and corrobation needs to be established across the organisation. This would make it possible for people across the organisation to share ideas and build on each other's ideas and finally act in concert towards a common purpose. Transparency is extremely important in order to achieve data reliability.

5.6 **Establishment of an authoritative historic data resource** – As large amounts of authentic and historic data become available, these should form part of a central data repository. This data resource should form the basis for strategic analysis and decision making. Establishment of this data resource early would give rich dividends to the Railways in due course.

5.7 **Process and Communication optimisation** – Optimisation by way of simplification, right-sizing etc of the existing manual processes to make them amenable for computerisation would be a major step in the right direction. Standardisation in operational procedures vis–a–vis computerisation automatically allows for system integration. Once system integration is achieved, getting people to talk to each other directly without intermediaries is the next step. Communicating bad news from the customers, whether internal to the railways or external, is surprisingly hard to do in a conventional organisation. Establishing direct lines of communication to capture, analyze and capitalise on the feedback shall be necessary. This communication optimisation is as important as functional process optimisation and unlike functional workflow, normally does not have clear-cut flow patterns. Allowing for direct communication in a strongly hierarchical organisation is tricky and IT is a major enabler in this, especially with the anonymity in communication that it offers.

5.8 **End user empowerment** – The combination of good quality data, good quality interfaces and good quality applications enables staff in making better decisions. Consequently, this improves the overall quality of management and consequently shall benefit the full system. Further by broad-basing operations of all data and associated systems and handing them over to the user communities for operation shall increase the acceptance of these into what is currently a fragmented scenario.

5.9 **E-Governance** – The life of customer of IR, whether passenger or trader or supplier needs to be simplified by using web technology in a big way. Online availability of customer–related forms, querying facility related to consignments, reservations, complaints, compensations, payments, procurements etc. via the medium that the Internet/ web would go a long way towards building healthy customer relationships.

5.10 **IT Security** – With larger usage of computers in critical Railway functioning, the dependence on databases will increase manifold and simultaneously their vulnerability to attack by hackers etc. Railways will also have to address issues related to National Information Security Plan including threat perceptions. Information Security technologies, Critical Minimum Information Infrastructure (CMII), level of information security and legal procedures to ensure Information Security along with steps to ensure awareness, Training and Research in Information Security, will have to be addressed and suitable mechanisms developed over next few years for existing as well as proposed IT systems.

5.11 **Web Technology** – Web having emerged as the most powerful medium of communication with enormous reach at most economical price, Railways will have to look at this option for information dissipation and collection of information from/ to and amongst its internal and external customers. Any expenditure in this area is bound to give excellent results/ returns.

5.12 **R&D in IT Technologies/ External Technical Audit** – With the rate of change of IT being so rapid, several projects have and are continuing to work on older technologies. There is a need to identify core technologies and their utilisation with which the Railways need to familiarise themselves. For this purpose a sum of around Rs 10 Cr per annum be set aside within the Computerisation budget as Research grant to be spent exclusively on investigating developmental technologies, bench–marking exercises including third party audits, deployment simulations, technology based consultancy/ trials/ studies etc. These studies/ exercises would generally not be having a quantifiable Rate of Return and thus need different treatment. Without them the Railways will always be one step behind – which must not happen. The following areas need to be investigated further, since they are likely to have a major impact on the way Railways design and implements IT –

5.12.1 IPv6 – The latest version of the most commonly used networking protocol in the world. This version is currently available in the market and offers much to the Railways by way of security and prioritisation of network traffic called Quality of Service (QoS) differentiators.

5.12.2 Data Mining – This technique of multi–variable analysis using very large data resources is critical for correct decision making.

5.12.3 GPS/ GIS – Global positioning systems coupled with Geographical Information Systems can be major enablers in optimally utilising the rolling stock.

5.12.4 XML data exchange – Extensible Markup Language has become the glue for tying multiple data resources together and allows for inherently incompatible data formats to be exchanged.

5.12.5 Thin Cients – These have the capabilities of solving some of the problems of high MTTF, MTBF and MTTR that are associated with PCs.

5.12.6 PDAs – These low cost, light weight portable information resources are major enablers for decision making, data collection while on the move or from remote areas.

5.12.7 Facilities Management – With the knowledge gap increasing, literally, on a daily basis regarding IT operations, facilities management can easily provide guaranteed response times irrespective of the load factors at lower lifetime costs

than if the Railways tried to do everything itself.

5.13 **Private Sector Involvement** – IT is a field which is highly dynamic – the requirements change very quickly driven by the user requirements as well as the change in technology. Railways with their highly bureaucratic system of decision making coupled with the absence of lifetime costing techniques are poorly equipped to tackle the rapid changes in the requirements of IT Infrastructure or in the utilisation of the infrastructure itself. Historically, the Railways have tried to overcome this by making guesses into its requirements and over–planning accordingly. None of this has actually had much success. The primary reason for this is the gestation period of each project – most of the projects have been managed internally and the time for each project to move from initial concept to prototype to production is so long that, invariably, the basis of each project changes drastically over this time period and the project never really fructifies. There is a need – a need to foresee, a need for speed. This capability is not really available in the Railways – the private sector has some of this resource and needs to be involved in a much bigger way.

The involvement of the Private Sector can be in several areas –

- Field surveys to establish as–is process models that can form the basis of further work.
- Technological forecasting based on Railways' requirements.
- Project Management based on Service Level Agreements.
- Outsourcing of IT infrastructure via leasing, facilities management, networking and network management etc., possibly based on Service Level Agreements.
- Code management.

While the above can be done in the form of separate contracts it would be preferable to establish long–term relationships with industry leaders and both parties invest into each other trying to work proactively and utilising their individual strengths.

6 **SHORT TERM STRATEGIES** – In order to achieve the above long term targets there is a need to set up some basic infrastructure that then form the basis of jump starting the next stage. Some of the important ones are –

6.1 **Internal Technical Review/ Audit** – There have been too many cases of IT related works where the proposed scope of work was corrected and in fact, commonly enhanced, at Board's level while the anticipated cost was simultaneously reduced. A system of technical review/ audit of all large works, i.e., costing more than Rs One Crore, must therefore, be started immediately involving the user department, the coordinating agency for the work and C&IS Dte. Such reviews also allow for knowledge management, standardisation of applications etc. Priority must be given to works with high anticipated value. Each review should be done with a fixed time frame of roughly three months per project.

6.2 **Technical concurrence** – A corollary to technical review/ audit is that the results need

to disseminated and enforced across the organisation. This shall lead to some degree of rationalisation, standardisation and normalisation of applications across the organisation. In order to achieve this – Centralised technical concurrences be given by C&IS Dte only for cases where the software component (excluding operating systems) is high.

6.3 **Delegation of Powers** – It is critical at this juncture to accelerate the availability of computers within the Railways. As such, all quantitative restrictions on PC purchase need to be lifted. Management control should be through budget and not quantitative limits. Not only must there be delegation, there must be clear targets on their utilisation and sufficient follow–up to ensure that any issue is resolved quickly. As said before, there is a need – a need for speed.

6.4 **Electronic Information Exchange** – Internet and e-mail must be provided to all PCs with senior scale and above officers. All low level operational units such as yards, maintenance depots must also be provided with some form of electronic information exchange. E–mail is the cheapest method of providing direct communication channels across the organisation. This way anyone with a problem can get help/ encouragement/ advice from within the organisation directly.

6.5 **Rationalisation of Accounting Heads** – The non–availability of methods to correctly reflect revenue expenditure on IT is leading to an absence of expenditure control. There is, therefore, need to rationalise accounting of all revenue expenditure on IT. This would then allow for better management of all costs – capital and revenue on IT, in turn, leading to better utilisation of Information technology.

7 PROJECTIONS FOR LARGE PROJECTS

7.1 **Passenger Reservation System** –

7.2 Expansion of computerized reservation terminals is an ongoing process. It is proposed to add approximately 90 stations every year through the X^{th} Five year plan period. The estimated expenditure to extend these facilities will be Rs.10.00 crores every year.

7.2.1 Disaster Management for PRS is an extremely important issue. The estimated expenditure to implement the proposal will be around Rs.25.00 cores over the entire plan period.

7.2.2 Other projects related to PRS such as Data Warehousing, Internet-based booking etc. are expected to fructify during the plan. The estimated implementation costs for these projects are Rs.15.00 crores over the full plan period.

7.2.3 The PRS equipment is under heavy use and by the norms of the industry need replacement every five years. The total funds required for replacement of PRS equipments and others will be Rs.20.00 crores over the plan

period.

7.3 **Freight Operations Information System** – The entire FOIS project cost is Rs.427.00 crores. Phase I (RMS) has been completed, Phase II (TMS)expected to run up to 2003. Various media will be used for exchange of data between field and hub centers. The funds requirements in the Xth Five Year Plan shall be Rs. 125 Cr, leftover portion of Rs. 427 Cr. In addition, there would be an additional requirement for replacement of some of the equipment installed between 1999 to 2002 of around Rs.50 crores. Thus the total funds requirement works out to be around 175 Cr. over the plan period.

7.4 **Management Information System** – Implementation of a computer based, integrated, Management Information System (MIS) on the Indian Railways has been taken up to assist managers at all levels of management. To begin with, Development and implementation of Management Information System has been taken up on the headquarters officers of Northern, Central and Southern Railways and Delhi, Mumbai and Chennai Divisions respectively on these Railways. In order to complete the MIS project in a time bound manner, the work of developing the MIS applications for various departments namely Civil, Electrical, Mechanical and S&T as also service departments like Medical, Vigilance and Security have been entrusted to these three Railways. Implementation of entire MIS Project is likely to require Rs. 45 Cr during the Xth Five Year Plan.

7.5 **Research & Development** – R&D into upcoming technologies which may be useful to the Indian Railways is proposed at around 10 Cr per year, a total of Rs. 50 Cr over the full plan period.

7.6 **Rolling Stock Maintenance Infrastructure** – There are several projects on for computerising providing Decision Support Systems for the Maintenance Infrastructure for Rolling Stock, e.g.., workshops, wagon maintenance depots, Diesel Loco Maintenance organization etc. These projects are expected to cost Rs. 55 Cr over Xth Five Year Plan period.

7.7 **Divisional Computerisation** – Computerisation of the remaining 40 or so Divisions is expected to cost around Rs.15.00 crores over the Xth Five Year Plan period.

7.8 **National Inventory Management System** – While the work of Computerisation of Purchase offices and Store depots is at different stages of implementation on various Zonal Railways, there is a need to look at Inventory management globally. This would entail computerization of 150 major Stores depots and some purchase offices along with major procurement centres of the Civil Deptt is planned to be taken up during the Xth Five Year Plan. The estimated cost to computerize Stores operations is estimated to be Rs. 20 crores.

7.9 **National Train Enquiry System** – Work underway. The project of NTES has been implemented on all Zonal Railways for providing on-line real-time train running position to public through various interfaces such as IVRS, Station announcement System, etc. To start with this system was commissioned on the PRS hardware. Now the regular

hardware has been procured and is under installation. The project needs expansion to cover major/medium size railway stations on Indian Railways.

7.10 **Control Office Computerization** – Some Divisions of Indian Railways have made an attempt to computerize the set of control charting activities. A uniform Control Office System is being developed for Divisions incorporating advantageous features of all the charting systems developed by Divisions and more. This can be a project with private sector involvement. The project will be implemented on all Divisions in the Xth Five Year Plan at an expected cost of Rs 15 Cr.

7.11 **Crew Management System** – The project is under formulation. Once the requirements and specifications are crystallized the work will be proposed for sanction. Entire Indian Railways will be covered in the Xth Plan period and is expected to cost around 10 Cr.

7.12 **Miscellaneous** – Number of computerization works are underway in different areas of railway working. In addition to these works some of the projects are in planning stage. It would require Rs. 60 Cr during the next plan period to complete these works. A brief discussion of these project is given as under –

7.12.1 Hospital Information Management System – Work is underway for implementation of Hospital Information Management System on Eastern, North Eastern, Northeast Frontier, South Central, & Western Railways. Upgradation of HMIS has also been undertaken by Southern, South Eastern & Northern Railways.

7.12.2 Coaching Refunds – Work underway. The application developed by CRIS for computerization of Coaching Refunds is under field trial on South Central Railway. The facility will be commissioned after successful completion of field trials. After the pilot project is proved successful, the computerization of Coaching Refunds will be undertaken on all Zonal Railways.

7.12.3 Parcel Office Computerization – The work of computerization of parcel in Delhi and Kokata area. Similar projects to computerize parcels on all Indian Railways are proposed to be taken up in the Xth Five Year Plan.

7.12.4 Coaching Computerization – The project is under formulation stage. Once the requirements and specifications are crystallized the work will be proposed for sanction. Entire Indian Railways will be covered in the Xth Plan period.

7.12.5 Integration of Networks and setting up of Central Data Resource – With the development of independent systems coming up across the Railways as well as at various functional levels, the need to build a central data resource center which is connected/ networked to all these independent data centers becomes extremely important. This shall be set up under the C&IS Dte within Railway Board and shall fulfill the Data mining requirements for Decision

support.

7.12.6 E–Governance/ Web enabling – Work on this area is a natural consequence of or a natural extension to the above works. Moving internal systems on to computerised platforms allows for better accessibility of the very same information to the Railway consumers. For e.g., as Control Offices get computerised the same information is becoming available to passengers in the form of mimic diagrams on Stations which show the progress of trains using the very same computerised database that is being used by the train controllers. The same information is also being put up on the web for other non–colocational passengers/ family/ friends being able to see. Many such works are on as "proof–of–concept" projects. These projects are expected to become fully operational during the Xth Plan.

8 FUNDING OF IT PROJECTS

8.1 **Current Situation** – Capital expenditure (in Crores) under the Computerisation head has been as indicated below –

Year	Total Capital Expenditure	IT Capital Expenditure	%age of IT
VII Plan	16549.11	183.71	1.11
VIII Plan	32306.53	189.42	0.59

ANNEXURE 2

Year	Total Capital Expenditure	IT Capital Expenditure	%age of IT
IX Plan	47245.37	237.51	0.50

8.2 The actual expenditures and their percentages in term of the capital outlay in the last 10 years is shown in the graph. It is clear from the above that expenditure on IT has actually been ***falling*** in

the Indian Railways as a percentage of the total plan expenditure across the 5 year plans. In percentage terms it has only once reached the 1% mark and averages a measly 0.55%! Bulk of this expenditure has been into 2 areas only – the Passenger Reservation and the Freight Operation Information Systems. This goes against the general trend across the industry to invest more into IT in order to reap the advantages of operational efficiencies that it offers.

1.2 In addition to the above, the revenue expenditure is 'guesstimated' at between 200 to 300 Cr currently. This includes maintenance expenditures, salaries, other running expenditures etc. Thus the total expenditure on IT would be between 250 to 350 Cr per annum. This would indicate that there is considerable scope for optimisation, especially in the revenue segment. Importantly, far more control is required on the overall expenditure that just the capital portion – which is always in short supply.

1.3 The non-availability of capital for the development of IT Infrastructure is likely to become a major factor in IT *not* resulting in any major increase in operational efficiencies. In this context, the possibility of using revenue funds for development of IT infrastructure by out–sourcing using contracting services such as leasing, facilities management etc., based on Service Level Agreements (SLAs) becomes important.

1.4 **The Future** – Regarding future funding there are three scenarios –

1.4.1 *Scenario I – No change in current funding levels* – This would imply between 200 to 250 Cr. of capital funding available through the Five Year Plan. This is against a requirement of around Rs 500 Cr. required for the Railways to achieve decent levels of computerisation in only the core areas. The shortfall is therefore around 300 Cr. This is a fairly plausible situation and some advance planning towards maintaining infrastructural investments is necessary. Additionally, the availability of funds under revenue head would also be a major problem, especially since nearly 150 Crs is required on account of PC/ terminals alone.

The options in such a situation are few – primarily out–sourcing of the infrastructure is the only solution. This method has some major advantages – one, at the end of the contract period the Railways gets an option to upgrade the infrastructure. Secondly, since the payments are linked to the quantity and quality of the service, the Railway does not pay for services not rendered Railways tends to save money. Third, sizing of the infrastructure is not done – currently the infrastructure is based on wild estimates at say, 8 years from date and systems are purchased which 'may' be required. There is no scientific method to do sizing over such long periods, so it is effectively a shot in the dark. In case of out–sourcing Railways primarily pays for what it uses. The flip side of out–sourcing is that it can be at times logistically difficult and payments must be done on–time.

1.4.2 *Scenario II – Capital Funding of around 100 Cr per year* – In this case availability is at around 500 Cr. This is a relatively comfortable situation and the only catch would be the availability of funds under revenue head.

1.4.3 *Scenario III – IT Funding @2–3% of capital budget* – This is based on the Govt. of India recommendations by the Expert Group on 'Computerisation of the Information on Personnel and Citizen's Service' which was approved by the Cabinet Secretary and accepted by the Planning Commission. Assuming a capital plan size of Rs. 11,000 Cr. every year this would imply an IT plan size of approximately Rs 300 Cr. of capital every year. Such levels of fund availability would primarily go towards enhancing the scope of the above projects.

2 CONCLUSION

It has been argued in some forum that the Railways does not need to adopt IT in a big way – if it has survived for so many years without IT Infrastructure then the infrastructure is simply not required. However, this view simply ignores the fact that improving operational efficiency is the only possible way to improve the profitability of the Railways since line capacity improvements cost much, much more. The reverse argument is that since line capacity saturation is a fact of life, all investments should only flow into that area. Unfortunately, this argument assumes a very static view of line capacity – actually line capacity utilisation fluctuates quite a lot throughout the day/ season/ year and IT can easily help optimise the actual situation. ***IT is the only enabling method available that can allow for the most cost–efficient optimisation of Railway resources, including line capacity – now or in the foreseeable future.***