

A DATA CENTRE APPROACH

Santosh Kumar Pattanayak, Dy.Chief Manager (IT), East Coast Railway

Gone are the days of mainframe computers and the batch processing of data offline in a centralized EDP setup. With the advent of client-server architecture in mid 1980s and prolific development of networking technology in 1990s and thereafter, the IT scenario world over has changed quite significantly. The onset of the 21st century has witnessed rapid growth of internet-driven browser based technology that is fast taking over most of the back-office applications in a centralized Data Centre while making a paradigm shift from the conventional client-server platform linked to distributed architecture. Online processing of data and dissemination of information to all and sundry in a widely dispersed organizational set up cutting across national and international boundaries have since been the order of the day. Information and Communication Technology (ICT) is changing very fast, so also the IT resource requirement of an organization that strives hard to keep pace with its changing needs based on improved business processes.

Be it a small business enterprise or a global corporate giant, all business activities are now operating on a multi-layer networked environment driven by the powerful ICT tools. Government sectors too are not far behind as most of them are embracing ICTs in a big way to improve on their productivity linked to service delivery. The average Indian scenario encompassing all sectors is no different from the global trend. However, there is something amiss with the Indian Railways (IR) - the largest public sector in the country. While ICTs in IR has made commendable strides in certain areas of service delivery like passenger reservation-PRS, unreserved ticketing-UTS, train operation-FOIS etc. during past two decades or so, its internal productivity is yet to reach an acceptable level of efficiency with yawning gaps in its efforts to achieve sustainable level of office automation. Notwithstanding the efforts made by some of the zonal railways and production units to chart out their own roadmap of computerization (office automation), it is high time that IR takes the real initiative at the apex level to plan and implement a centralized IT resource platform (Data Centre) with adequate scalability, interoperability and manageability so that integrated office applications (equivalent to the ERPs in the corporate sector) transgressing the departmental barrier will soon redefine IR's new IT landscape.

Can it just be a wishful thinking, when East Coast Railway has already come up with a prototype of Data Centre to dovetail into a larger schema of IR?

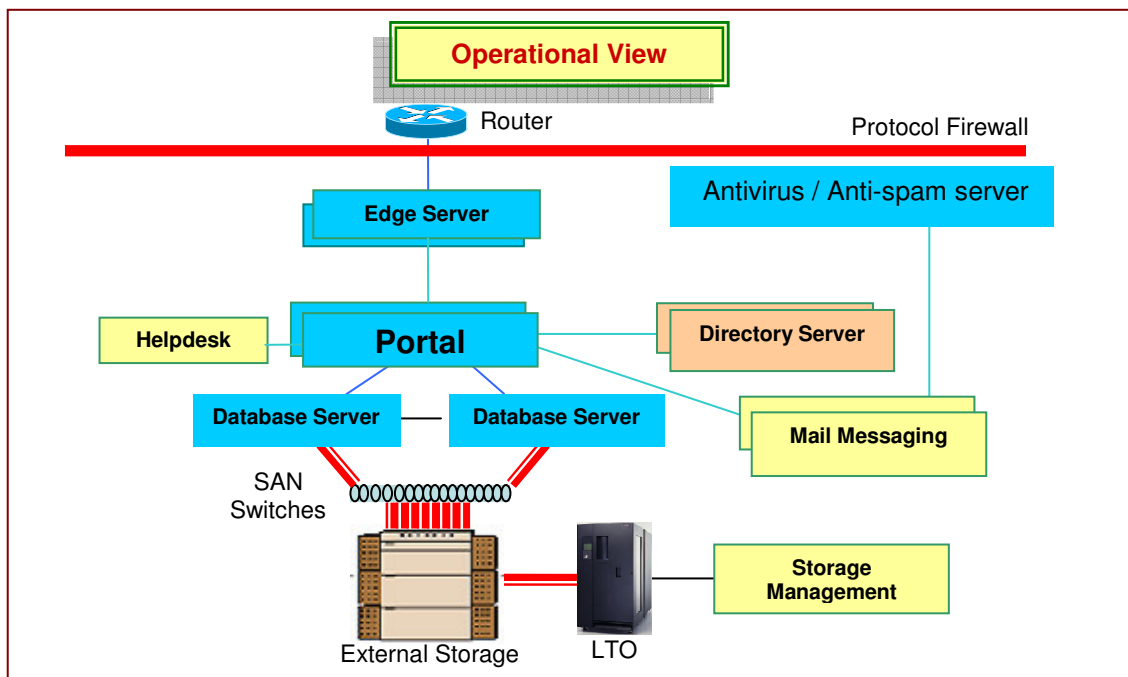
The embryonic railway that has earned the epithet of **'The Sun Rise Railway'** ever since its operationalisation in April'2003, is all set to cause a flutter as the state of the art ECoR IT (Data) Centre has almost come to fruition about a month back with the successful deployment of the hardware & networking equipments and implementation of

three reengineered online SDT applications viz. PRIME, AFRES & MMIS. Built on robust and centralized server architecture, the system is all-pervasive with its Wide Area Network (WAN) connectivity extending through a 2Mbps OFC backbone to all its three divisions viz. Waltair, Khurda Road & Sambalpur, Carriage Repair Workshop (CRW) at Mancheswar and stores depot units viz. Electric Loco Shed (ELS) Diesel Loco Shed (DLS) at Visakhapatnam. The versatility of the system, coupled with the innovative approach with which it has been designed and implemented by CRIS is first of its kind in IR, as none of the other zones including the established ones who are pioneers in the field of electronic data processing, can boast of embracing this new technology under their belt. Possibly, this prototype of ECoR will set a new benchmark for other zonal railways, as Railway Board may soon take a cue from its success to emulate the new technology in a large scale so as to derive optimum benefits from its widespread IT infrastructure.

Besides the inherent advantages and benefits like centralized management/maintenance of IT assets i.e. hardware, software and networking, efficient use/allocation of hardware, seamless transfer of data from a centralized database, reduced TCO, simplified back up & restore etc. over the conventional Distributed Server Architecture, the ECoR IT (Data) Centre facilitates running of multiple applications from the same platform by using browser based technology (J2E). Such a novelty built into the system enables multiple users to access the applications from several remote locations around the same time either through the private domain (Intranet) or the public domain (Internet). In the near future, the new system in place is expected to usher in a new era in the railway's working environment by bringing in the element of discharging one's duty from anywhere outside the office premises.

SALIENT FEATURES:

A. HARDWARE PROFILE:



All the hardware except for the PC terminals which are deployed at the user end at different locations are housed in a centralized server room in the IT (Data) Centre at Rail Vihar, Bhubaneswar (Hqr).

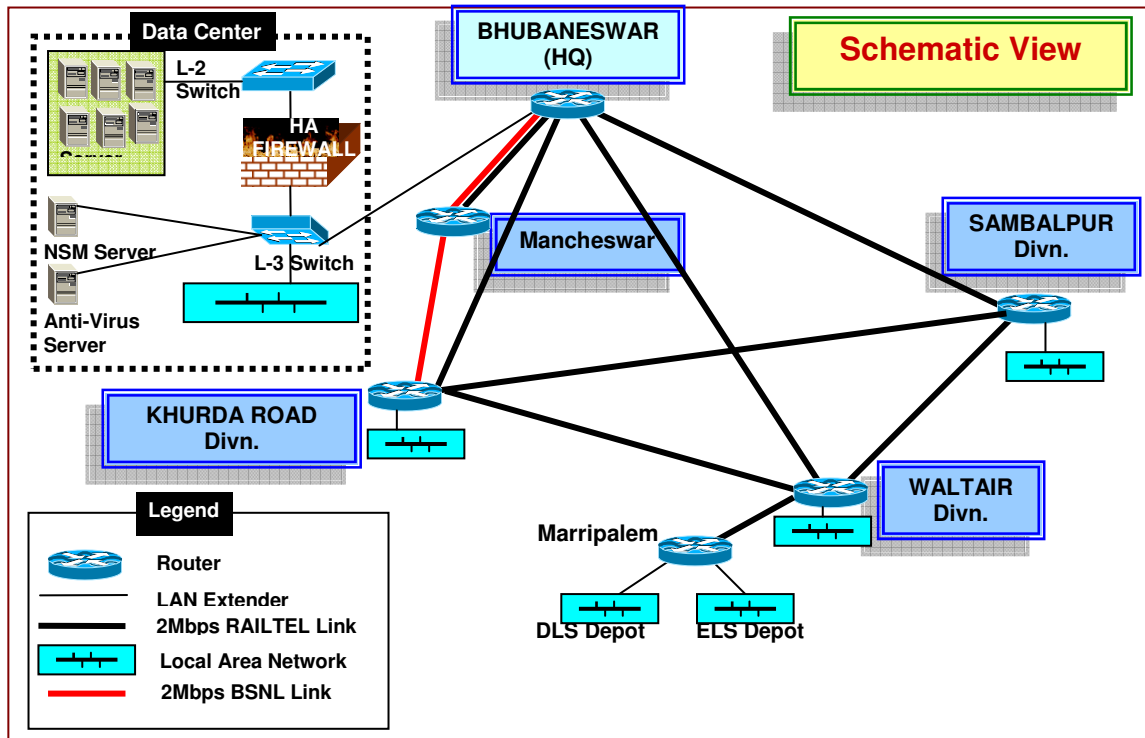
- i. The core of the hardware comprises of 2 (two) **P-series RISC** (Reduced Instruction Set Computers) Servers and 11 (eleven) **X-series IBM** Servers, which are neatly filled into two separate 42U modular racks.
- ii. While the RISC Servers (P-Series) are meant to handle the all important production activity encompassing database and applications, the Opteron Servers (X-Series) are earmarked for peripheral & support activities to the production servers, as outlined hereunder.
 - a. **Edge Server (2nos.)** - To mediate the communication between the client and P-series servers while authenticating/authorizing user level access.
 - b. **LDAP** (Light Weight Directory Access Protocol) **Server (2nos.)** - To authenticate user at application level through a defined protocol.
 - c. **Mail Server (2nos.)** - To implement mail activities at user level including receipt/transfer of documents/files etc.
 - d. **Antivirus Server (1 no.)** - To implement/update antivirus software automatically on the user terminals (connected remotely) at regular intervals.
 - e. **Antispam Server (1 no.)** - To implement/update antispam software so as to protect the RISC servers from spam.
 - f. **TSM** (Trivoli Storage Manager) **Server** - To define and implement data back up policies, both for the application & mail data.
 - g. **Firewall Server (1 no.)** - To define and block unauthorized access of users to the RISC server.
 - h. **NSM (Network System Management) Server (1 no.)** – To implement NSM software for monitoring networking activities on a real time basis.
 - i. **Help Desk Server (1 no.)** – To implement ‘Help Desk’ software to manage infrastructure availability and raise service level.

- iii. All the servers have redundancy built into each of the pairs so that in case of failure of one the other takes over automatically without disrupting their respective functional activities. In addition, the scalable architecture of the servers ensures high availability, reliability, flexibility, manageability and security to the system as a whole.
- iv. A dedicated Storage Area Network, separate from that of LAN and WAN, finds its place in the same 42U rack to which the RISC Server is fitted. It comprises of two parts viz. SAN switch and external storage device that is shared with different servers including the RISC servers through the SAN switch.
- v. The data storage capacity of the SAN device is as high as 2 terabyte, which can take care of all future requirements of ECoR when multiple online applications will be handled simultaneously. At present, however, the capacity utilization is to the extent of 1168 GB with placement of 8 (eight) hot swappable discs with 146 GB capacity each.
- vi. A Linear Tape Option (LTO) drive is made available to the system via the SAN switch and programmed through the TSM server with well-defined policies to take periodic data back up from the Production Server.

vii. Hardware – Technical Specification:

- a. **P-series RISC Server (IBM P550)** : 64 Bit, 2 CPUs scalable to 4 CPUs, 16 MB Cache/CPU, 1,30,000 tpmc scalable to 2,60,000 tpmc, 16 GB ECC RAM expandable to 64 GB 2 x 4 GBPS FCHBA card; OS – IBM AIX 64 Bit.
- b. **X-series Server (IBM X-3655)**: 64 Bit, Dual Opteron processor, 2MB Cache/CPU, 4GB ECC RAM expandable to 32 GB, 1 FCHBA card; OS – Linux/Windows 2003.
- c. **SAN Storage (IBM DS 4000)**: 4GB Fiber Channel Host Port – 8 Nos., multi-path (load balancing and fail over), multi OS support – Disk capacity 8 x 146 GB; Dual redundant hot swappable.
- d. **LTO Gen-3 Drive (IBM)**: 20 slots with auto loader facility, bar code reader; cartridge capacity – 400 GB.
- e. **PC Terminal (ACER)**: AMD Athlon-64, 2MB Cache, 512 MB SDRAM, 100 GB SATA HDD, OS: Windows XP.

B. NETWORK ARCHITECTURE:



- i. Built on a partial mesh and star topology, the Wide Area Network connects the IT (Data)Centre at Bhubaneswar with five other widely dispersed locations over the ECoR territory viz. Mancheswar (Workshop), Sambalpur, Waltair & Khurda Road (all three divisions) and Marrিপalem (ELS & DLS Depot units in Waltair Divn.).
- ii. The 2Mbps Railtel OFC characterized by connectivity through alternate path with ring protection, serves as a robust backbone with fail-back DOT connectivity (2Mbps) at the vulnerable sections of failure connecting Bhubaneswar, Mancheswar and Khurda Road. Such an arrangement by and large ensures sufficient redundancy for each of the location so that link failures remain few and far between.
- iii. Each of the locations/sub-location, in turn has their own LAN set up on star topology that gives the last mile connectivity to the working terminals (PCs) through structured UTP CAT-6 cabling.
- iv. The network connectivity from the server racks to the LANs/WANs at different POPs is established through a series of high end managed switches, modems and routers fitted into a 45U open rack. The exchange end locations at Mancheswar,

Waltair, Khurda Road and Sambalpur are provided with 24U closed racks to house the modems, switches and routers meant for the WAN link with Data Centre. For activating the LAN connectivity at the user ends, switches are kept in 12U wall mounted rack connecting to the WAN rack at the exchange end. At other locations wherever the distance from the exchange is more than 100 mtrs., a pair of LAN extenders has been provided at both the ends to activate the LAN connectively e.g. ELS & DLS with Mairipalem Exchange (Waltair).

- v. With 2 Gigabyte Ethernet Port in the advanced router, data transmission through the 2Mbps OFC is very fast, which is quite an improvement in data communication compared to the existing PRS and UTS network. As such, data transmission over the network on end-to-end basis is achieved through TCP/IP protocol wherein each item on the network i.e. Servers, SAN device, Routers, Switches, Modems, LAN extenders, PCs etc. has been assigned an IP address that by and large follows a well-defined pattern. Such a nomenclature makes the network highly scalable that can accommodate more number of POPs whenever required.

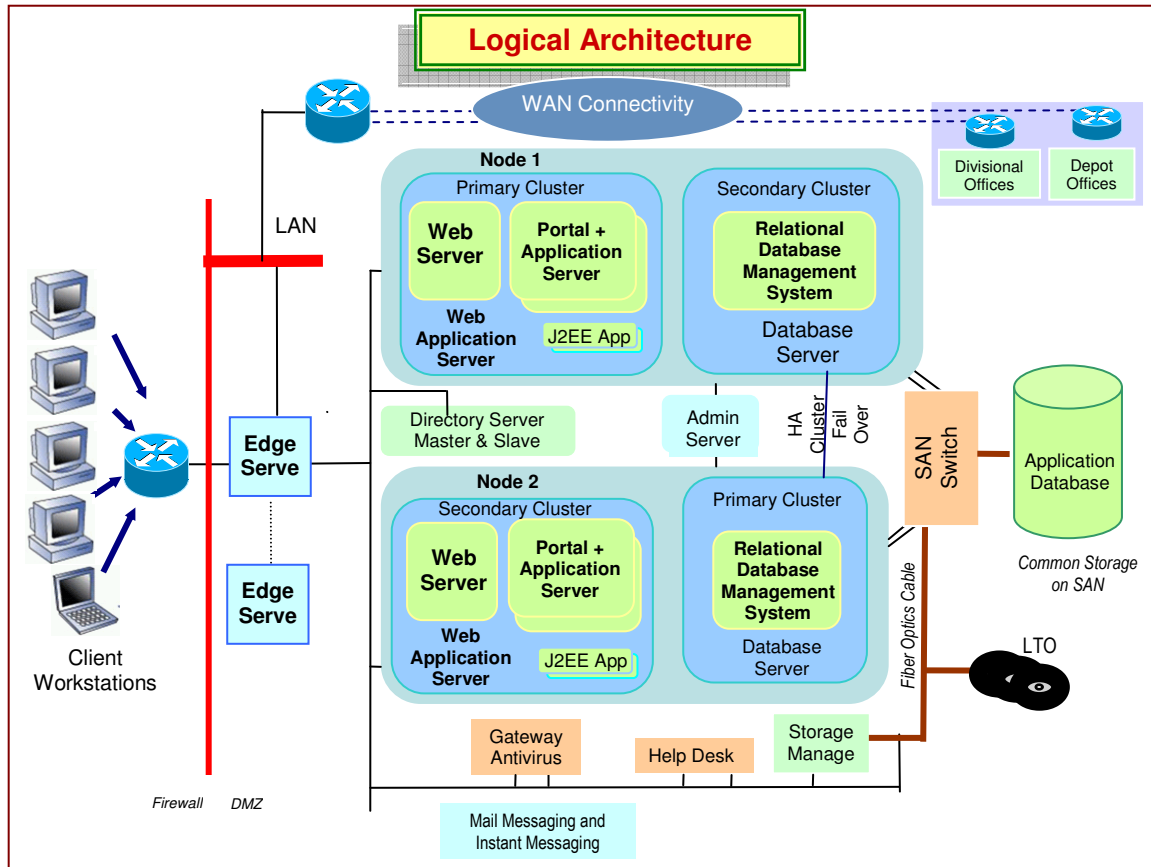
vi. Network equipments - Technical specification:

- a. **Layer 3 Switch (H3C S5600):** 24 Nos. 10Base-T/100Base-Tx/1000Base-T auto-sensing ports complying to IEEE 802.3, IEEE 802.3ab standard, supporting half duplex mode, full duplex mode and auto-negotiation on each port to optimize bandwidth, minimum of 30 GBPS forwarding bandwidth at layer 2 and layer 3 switching fabric.
- b. **Layer 2 Switch (H3C S3100) :** 24 Nos, 10/100 Base Tx auto-sensing ports complying to IEEE 802.3u standard, supporting full duplex mode and auto-negotiation on each port., 2 Nos. 10/100/1000 Base Tx auto-sensing ports complying to IEEE 802.3, IEEE 802.3u and 802.3ab standard, minimum of 08 GBPS aggregate switching fabric.
- c. **Router (H3C NSR):** Modular configuration, 02 Nos. 10/100 Base Tx port as per IEEE 802.3u specifications, Fast Ethernet port with support full duplex capabilities, 8 Nos WAN supporting V.35 interface.
- d. **LAN Extender(Atrie 5300):** Supports speed upto 2 MBPS for distance coverage upto 5 km. on 0.5mm dia single pair cable.; Supports speed upto 144 KBPS for distance coverage upto 8 km. on 0.5mm dia single pair cable., 4 Nos of 10/100 base T Ethernet port (IEEE 802.3u compliance).
- e. **Firewall (H3C F1000):** 1:1 redundant mode with following High Availability (HA) features, full failover of Firewall and VPN Sessions,

Active/Passive fail over design with load balancing capabilities, user license of 500.

- f. **2Mbps Modem (Atrie) -V.35&G.703:** Conform to TEC specifications no.IR/DCA-18/02, June 1999 or to TEC Specifications no.IR/DCA -18/03, IEEE 802.3 Ethernet 10/100 Base Tx interface.

C. SYSTEM INTEGRATION & FLOW:



- i. The entire system works on a three-tier logical architecture wherein users at field units/Division/Zonal railway offices access the SDT application via browser interface. While the function of tier-1 with database as backend and that of tier-2 with application as the middle end are handled by the RISC server with the help of logical partitioning (LPAR) on the CPU, tier-3 function culminates at the user facing end on the PC terminal.
- ii. The above architecture provides the horizontal as well as vertical scalability and high availability configuration with no single point failure. In addition, the 3-tier architecture provides high level security solution covering firewall, role based

- user authentication, which interalia ensures security at application network and physical level respectively.
- iii. RISC hardware configuration with partitioning feature at about 1,30,000 tpmc (scalable to 2,60,000 tpmc) rating per CPU acts host to web portal, application and database servers. The hardware servers with 1 (one) CPU each (expandable to 2 CPU) is clustered with standard HA cluster using two nodes in active-active mode to handle the application server and database load. While node-1 becomes the primary cluster for web and application server and hot standby for the database server, node-2 by default functions as the secondary (hot standby) cluster for web and application server, and primary cluster for database server achieved by HA cluster mechanism.
 - iv. The user request received from client workstation moves over the LAN and WAN frame work to the Data Centre and enters the Demilitarized Zone (DMZ) after being screened through the firewall. The request then gets forwarded by the load balancing server or application switch to the active HTTP server, which has been configured in active-passive mode to ensure high availability of the solution. Initially, the forwarded request reaches the primary (active) Web server that in turn forwards it to the Portal server. In case of non-availability of Primary Web server, the request from Edge server finds its way to the secondary Web server.
 - v. At this point of time, the information about the registered users stored in the LDAP (Light Directory Access Protocol) server, which comes bundled with portal server, gets authenticated. Only after being authorized by the LDAP server, the user request gets processed in the application server and finds its way back to the client-workstation on the reverse path. Different authorization rules like giving access to different information, data, application based on role of user can be defined by the administrator of the centralized system using administrative module of the Portal server. The high availability of the LDAP server/user information is always ensured.
 - vi. The portal administrative console provides an easy-to-use, graphical window to a cell, runs a browser, and connects directly to the Portal server on to a deployment manager node that manages all nodes in a cell. In a Network Deployment Configuration, the Deployment Manager, Node Agent and Application servers all host an administrative service. The service provides the ability to update configuration data for application server and its related components.

vii. RDBMS with high availability clustering feature has been used to hold the transactional as well as other related data. The physical repository of database is maintained in common Storage Area Network i.e. SAN along with the provision of backup server for regular backup and archival process.

viii. **System Software – Technical Specification:**

- g. **Oracle (RDBMS)+RAC 10g** Enterprise edition with CPU based licensing scheme (2 CPU licenses) on AIX Operating System; P-series RISC Server.
- h. **Web sphere Portal** Enable edition with CPU based licensing scheme on AIX Operating System. : P-series RISC Server
- i. **Lotus Domino Enterprise Edition (IBM)** with 150 users an Linux Operating System : X-series Mail Server
- j. **Web sphere Edge Server (IBM) 6.0** with load balancing component on Linux Operating System : X-series Edge Server
- k. **Tivoli Directory (IBM) Server** on Linux Operating System: X-series LAP Server.
- l. **E Trust Antivirus** Enterprise edition with 250 users on Windows 2003 Operating System: X-series Antivirus Server.
- m. **E Trust Antispam** Enterprise edition on Windows 2003 Operating System: X-series Ant spam Server.
- n. **Network System Management (NSM) CA** on Linux Operating System: X-series NSM Server.
- o. **Service Desk (CA)** on Windows Operating System: X-series Help desk Server.
- p. **Tivoli Web sphere Deployment Manager (IBM)** on Linux Operating System : X-series Storage Manager

E. APPLICATIONS ON ROLL:

- i. Three SDT applications viz. **PRIME, AFRES & MMIS**, which were originally developed on client-server architecture using Oracle-D2K platform and already implemented in some of the zonal railways, have now been reengineered by the CRIS software development team to follow the industry standard on N-tier architecture so as to make them web-enabled and functional on a centralized server technology.

- ii. Apart from the fact that the reengineered applications have ‘feel-good’ factors compared to their original version, there has been a lot many quality inputs to the packages as a whole. Some of the value additions are mentioned hereunder:
 - a. Integration is the keyword to the migrated applications, mainly for PRIME & AFRES, wherein separate databases under each of the applications have been clubbed to a single database with no duplication of data/information. This effort on the reengineering front has not only optimized the utilization of disk space, but also enhanced the efficiency of the system by leaps and bounds.
 - b. Unlike the earlier version, the new one has an inbuilt mechanism of managing data integrity, which is regulated by suitable use of constraints at the table level itself, thereby debarring infiltration of unwanted garbage.
 - c. A welcome departure has been made in the sphere of data entry for GIS, PF and DCRG. All the three forms have been amalgamated into a single 3-in-1 nomination. This will help in obviating any omissions in any of the forms.
 - d. Contrary to the practice of making data entry for traveling allowance in the Payroll module of the old system, it has now been made online with entry of basic data that gets updated in the system with back end calculation & validation thereof.
 - e. Online passing of salary bills is a fait accompli in the integrated application i.e. Integrated Payroll Accounting System (IPAS) by CRIS, which was not there in the old version. As an additional feature, a dichotomy representation of various components of salary bill for the current as well as last month is made available to the bill passing/auditing staff who can discern any unusual item or amount.
 - f. Extensive usage of validation checks has been built into the new version of reengineered applications, thereby ruling out plethora of deficiencies as pointed out by Central audit & circulated vide Provisional Para No.99 (2006).
 - g. Small legacy applications such as, Lease Billing, Group Telephone Billing, Books Reconciliation, Fund Certification etc. have either been integrated /under process of lateral integration with the main modules, without disturbing the existing database structure.
- iii. A host of other utilities, which are to be incorporated into the body fabric of the software are listed below:
 - a. Salary, PF and other relevant details including generation of SARAL (for Income Tax purpose) to the individual employee with secured access at user level will be made available through touch screen terminals and Internet domain.

- b. Vendors/contractors/suppliers can also avail customized access to the status of their bills/payments with ECoR.
- c. Enhanced security at application and database level will be ensured through rational software and audit trail respectively.

iv. **Current Status:**

- a. **PRIME** (Pay Roll & Interrelated Modules)
 - Payroll module (Bio-data, change data, Process Reports, DA arrears) fully implemented in Hqrs (since Sept '06) & under parallel run at other units.
 - Leave, Income Tax, Bonus modules already implemented at Hqrs, and under implementation at other units.
 - TA, Seniority, Quarter, Supplementary Bills modules already developed and under test bed implementation at Hqrs.
 - Career, Cadre, Loans & Advances, Pass & Settlement still under development and likely to be put into test bed implementation.
- b. **AFRES** (Advance Finance Railway Earning & Expenditure System)
 - Internal check module already implemented in Hqrs. (since Aug '07) and under implementation at other units.
 - Books & PF modules already developed and under test run at Hqrs.
 - Cash and Pay, Pension, Suspense, Budget, Traffic Accounts, Finance & Inspection modules still under development by CRIS team at Hqrs.
- c. **MMIS** (Material Management Information System)
 - Purchase, Security & Depot modules already developed under parallel run at Hqrs & Mancheswar Depot.
 - Finance module under development; Sales and Uniform modules to be taken up for development.

All the modules have been targeted for final implementation by 31st March '08.

ACCRUED BENEFITS:

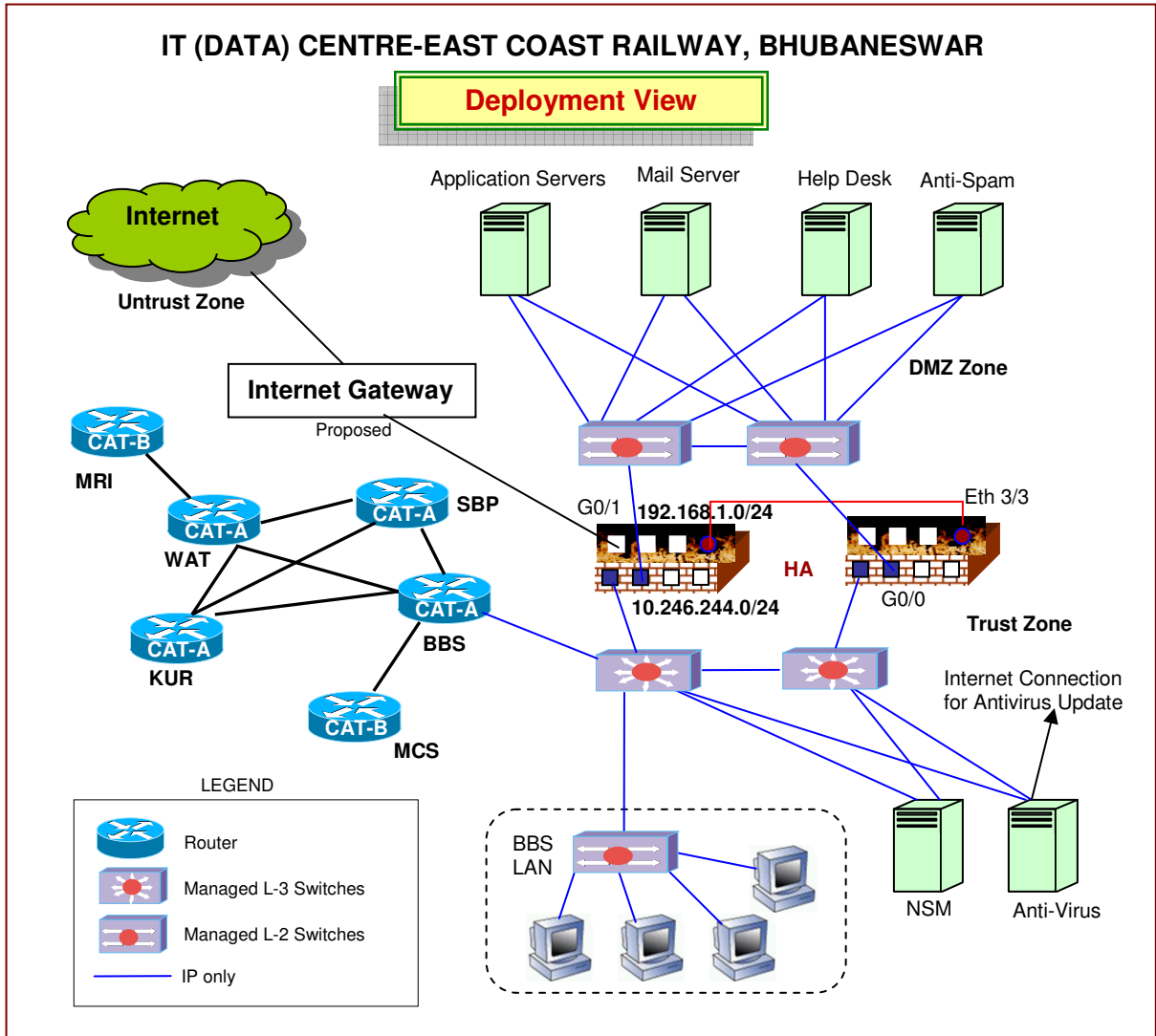
- i. The necessity of deploying a large array of highly paid personnel has been eradicated in Divisions/Units. The recurring cost of erstwhile EDP establishment as well as hardware and software (procurement and maintenance) against the Division/Unit has been kept at nil.

- ii. The rare prospects of getting the consolidated information at one go under this system have been made a reality through seamless transfer of data from one location to the other because of centralized database.
- iii. Full-proof security of database as well as application on Production server is ensured by user authentication achieved through LDAP server. Further, simultaneous updating of antivirus software is being done at each of the client end PC terminals directly from the centrally located antivirus server.
- iv. Change management control and HW/SW maintenance through Service Desk software will ensure that everything is properly documented from the user end and does not stimulate a chaotic environment.
- v. Periodical backup using LTO and provision of keeping DATs at different locations to meet any exigencies has been devised to ensure integrity of data in case of any disaster/natural calamity.

FUTURE PROSPECTS:

1. More no. of SDT applications viz. Personnel Management Information System (PMIS), Operating Statistics System (OSS), Passenger Accounting System (PAS) & Freight Accounting System (FAS) will be reengineered and implemented in phases.
2. Management Information Systems (MISs) for various departments which are under development at the level of Railway Board level through CRIS will be customized & deployed as and when made available to the zonal railways.
3. All the applications are planned to be linked to the Decision Support System at different levels of hierarchy both at Hqrs. and unit level so that managers at all level can get online access to processed data/information.
4. Scope for integrating with other communications systems, such as internet, mobile phone, hand held terminals, Universal Product Code readers can be explored to make information available to the railway employees and customers at any remote location.

Disclaimer: *The opinion, belief and viewpoints expressed by the author in this article do not necessarily reflect the opinion, belief and viewpoints of East Coast Railway.*



ECoR IT (Data) Centre



Server Room



P-series Servers 42 U Rack
X-series Servers 42U Rack
Networking components 45U Rack



Development Cell



IT Activity Hall