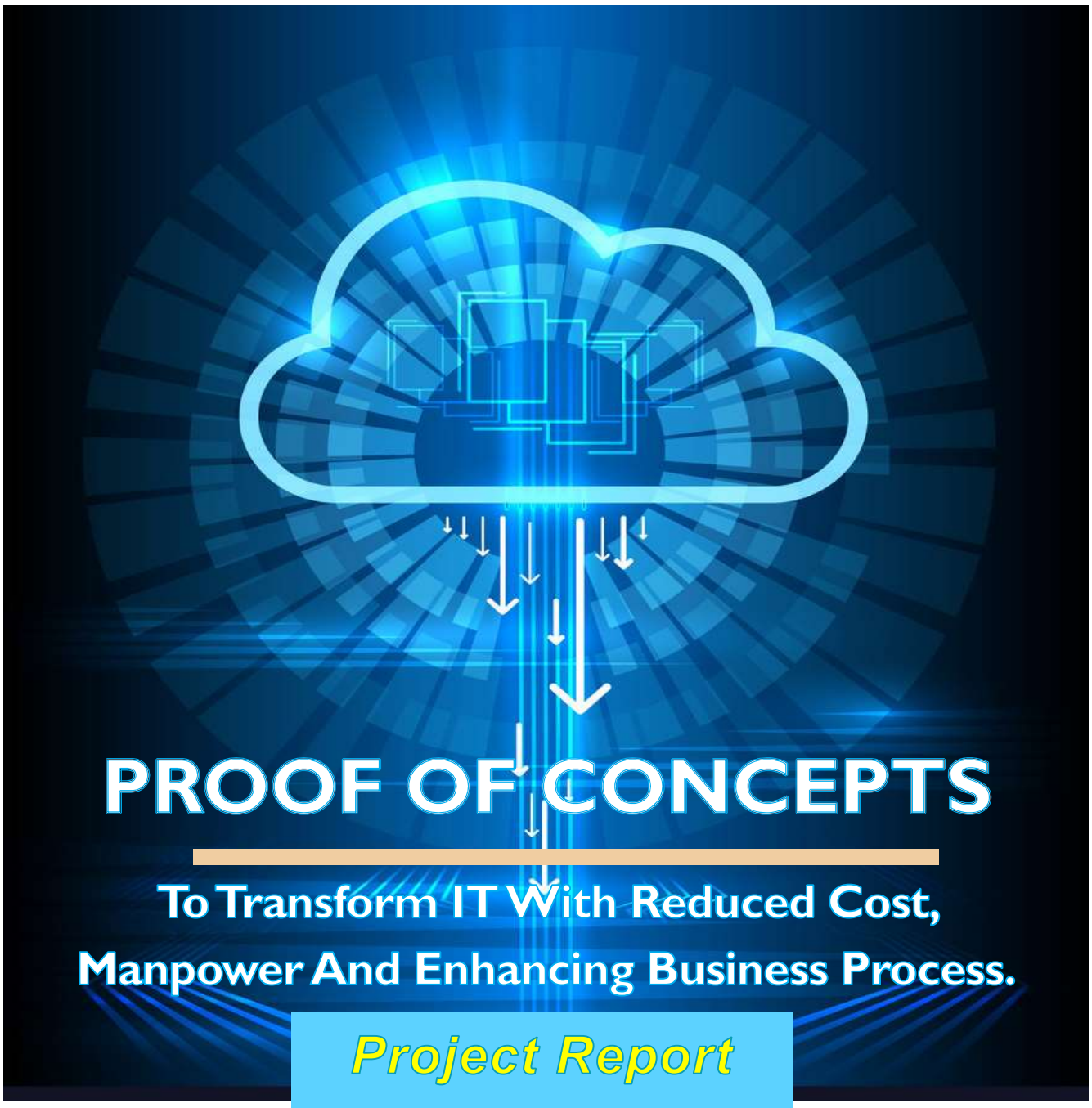

PROOF OF CONCEPTS

To Transform IT With Reduced Cost, Manpower And Enhancing Business Process.

Project Report

Young Leaders 10X – 2019
Batch 2

ACKNOWLEDGEMENT

NTPC as an organization gives ample opportunities to its employees to learn and innovate. Young 10X Leaders program was interesting and gave me opportunity to learn new avenues and to present something useful for the organization through group project and individual project.

I am grateful to the management of BIFPCL for allowing me to do experiment in latest IT technologies for building up IT infrastructure from scratch. I want to thank my small team and vendors who worked to successfully implement low cost cloud ERP solution and digital workplace like G-Suite from Google.

Further on, I want to thank the team PMI for this wonderful 10X program and support.

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Maitree Super Thermal Power Project (2X660 MW)
Bangladesh India Friendship Power Company (P) Ltd [BIFPCL]

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INTRODUCTION

For digital future of NTPC, many concepts have been discussed like Cloud, Big Data, AI, IoT. Various committees were formed in past and recommendations were given. Same has been suggested in few of the projects in 10X module also.

To embrace such new technologies, we need to augment and upgrade the existing IT infrastructure of NTPC as well as approach. With the mindset of keeping everything behind the brick wall and managing everything in-house shall be very difficult in an era when software to platforms are easily available on subscription base model.

We will first go through with existing IT setup of NTPC followed by major roadblocks to adopt the new technologies. Detail proof of concepts are provided which has been actually implemented in Bangladesh India Friendship Power Company Pvt Limited. This has already resulted in cost saving and optimum utilization of IT Manpower. At the end some recommendation has been given to transform the NTPC IT.

1. EXECUTIVE SUMMARY

In NTPC with digital transformation of IT we have to find ways to incorporate new technologies like Cloud, AI, Block chain, IIOT, Big Data, Data Analytics to support our business process effectively. Problem needs to be solved to bring data on to identified platform with proper segregation and secured manner along with integration for analytics. Many IT applications and services may be designed which can be released to end user across geographical locations. We have to relook for our current approach and false sense of security for keeping everything behind the walls. In modern scenario employees are in always connected environment and needs instant access of data to get the work done.

We can't expect to undertake a single IT transformation program – buy some new software, ask our employees what they need – and tick it off the to-do list. We have to keep revisiting. Being flexible enough to respond to this new reality, to embrace and adapt to the new waves of change that will continue to disrupt how we work, is critical.

A digital workplace is a conscious and ongoing commitment. It needs to combine a long-term vision, governing principles, a process of measurement and continual evaluation points. We can't stop this evolution from continuing: but we can steer and choose its direction to our advantage.

Cloud Computing, an emerging new technology for deployment of IT, is the delivery of on-demand computing resources (e.g. servers, storage, network, applications and services) over the internet, with reduced infrastructure costs, agility to scale up/down, faster deployment of applications, ease in integration of applications, better security, pay-only-for-use model. Consistent with GoI policy of 'Cloudby-Default', NTPC may follow Cloud Computing as the default ICT deployment strategy as 'Cloud Power' for IT. We have to segregate the application to host on cloud. We need to ask question such as why Movie or Guest House Booking system needs in-house server & IT manpower, and why it cannot be hosted on a single compute engine of cloud servers? Why exported data of PI servers cannot be used on cloud compute engines for AI and Data Analytics?

Digitalization to support all business process of an organization is very much required in future. We must transform our IT and existing approach to achieve this with reduction in cost and manpower.

2. NTPC IT OVERVIEW

The Information Technology in NTPC is not only a service provider but also being used as a key business driver. Since 2008, NTPC has implemented Enterprise Resource Planning (ERP) application to integrate all its business functions. A new process for procurement budget and automatic PR creation put in place. New CERC tariff norms for 2019-24 implemented.

PI data system has been implemented to capture, display and analyze the plant performance parameters on real time basis which is helping the operation and maintenance of our power plants.

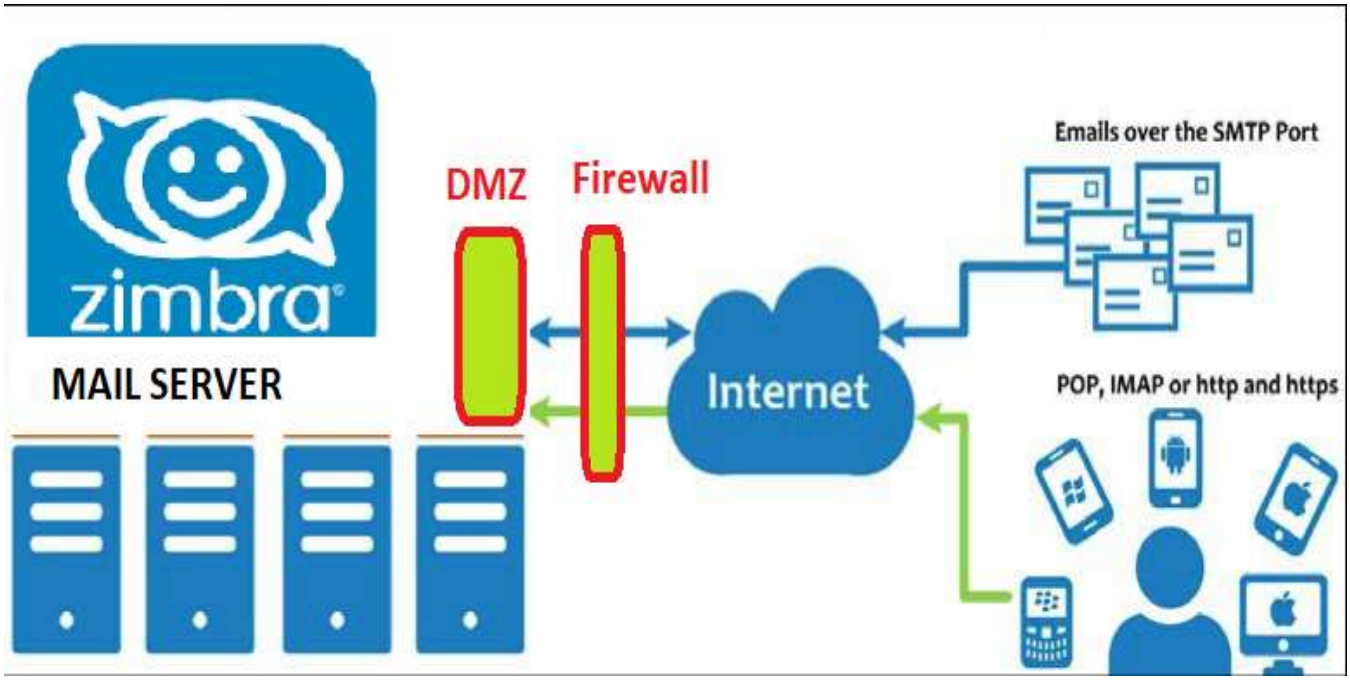
Non-ERP web based applications have been developed in balance areas such as Engineering Drawings approval, Quality Control Management, Hospital Management, Labour Management, Transit Camp Management, RTI, Security Control etc. A number of new web applications and mobile apps such as Coal Monitoring Portal, Ash Management Portal, CPSE Conclave action points monitoring portal etc. have been launched to take care of requirements of various internal departments and Ministry of Power

As a commitment towards environment, NTPC has reengineered and redesigned the business processes to paperless mode. The digitization initiative “Project **PRADIP**” resulted in implementation of e-Office, digitization of documents and paperless processes for different functions. This has not only saved tons of paper but also resulted in faster decision making, transparency and improved efficiency for NTPC.

To further leverage IT in NTPC, an IT Strategy has been finalized. The IT Strategy aims to achieve 100% Paperless Office, Data Analytics for decision making, induction of new technology such as IIOT, AI, Machine learning etc. over next 2 years.

Mail and Messaging Services – NTPC has in-house Zimbra mail system. All users were provided with min. 10GB of mail box size. DR set up for mailing system was commissioned. Existing mail is not integrated with office apps and collaboration tools. There is dedicated team looking after the mail system and password reset. Security team also helps to avert any cyber threats. Email is accessible on mobile, laptop from internet.

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.

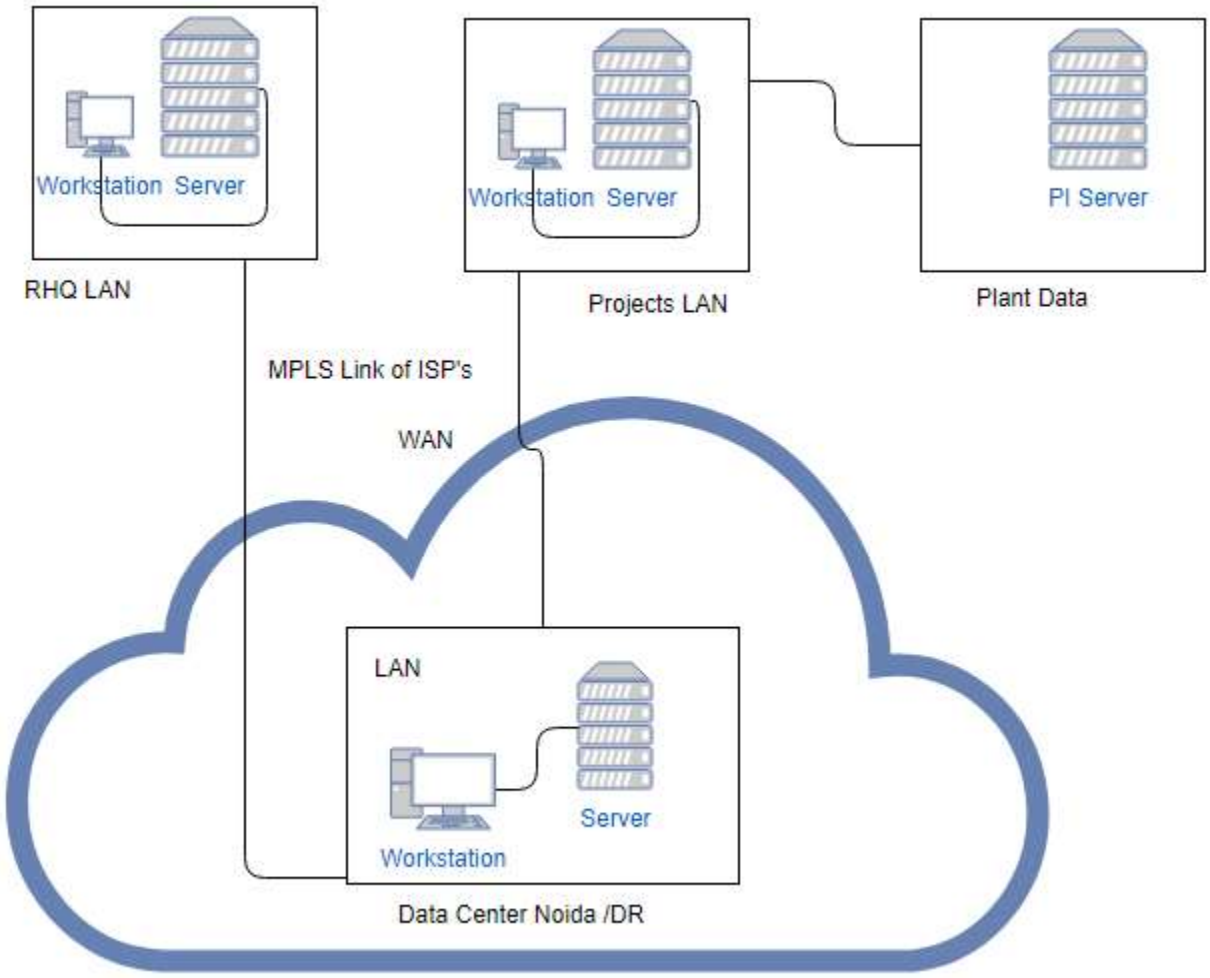


Security Operation Centre(SOC) is in operation where round the clock monitoring of all external and internal data traffic is being done with latest tools through SOC and latest threat management tools are being applied to prevent any cyber-attack or data theft. Timely communication being sent to all users based on threat perception. NTPC's data centers at Noida and Hyderabad are ISO 27001 certified for security compliance.

NTPC Wide Area Network: NTPC's plants and Offices across India, are connected to Corporate Office and main Data-Centre (DC) through 2x34 mbps MPLS links to facilitate seamless communication. The DC and DR (Disaster Recovery) site is connected with 486 mbps MPLS links for data backup.

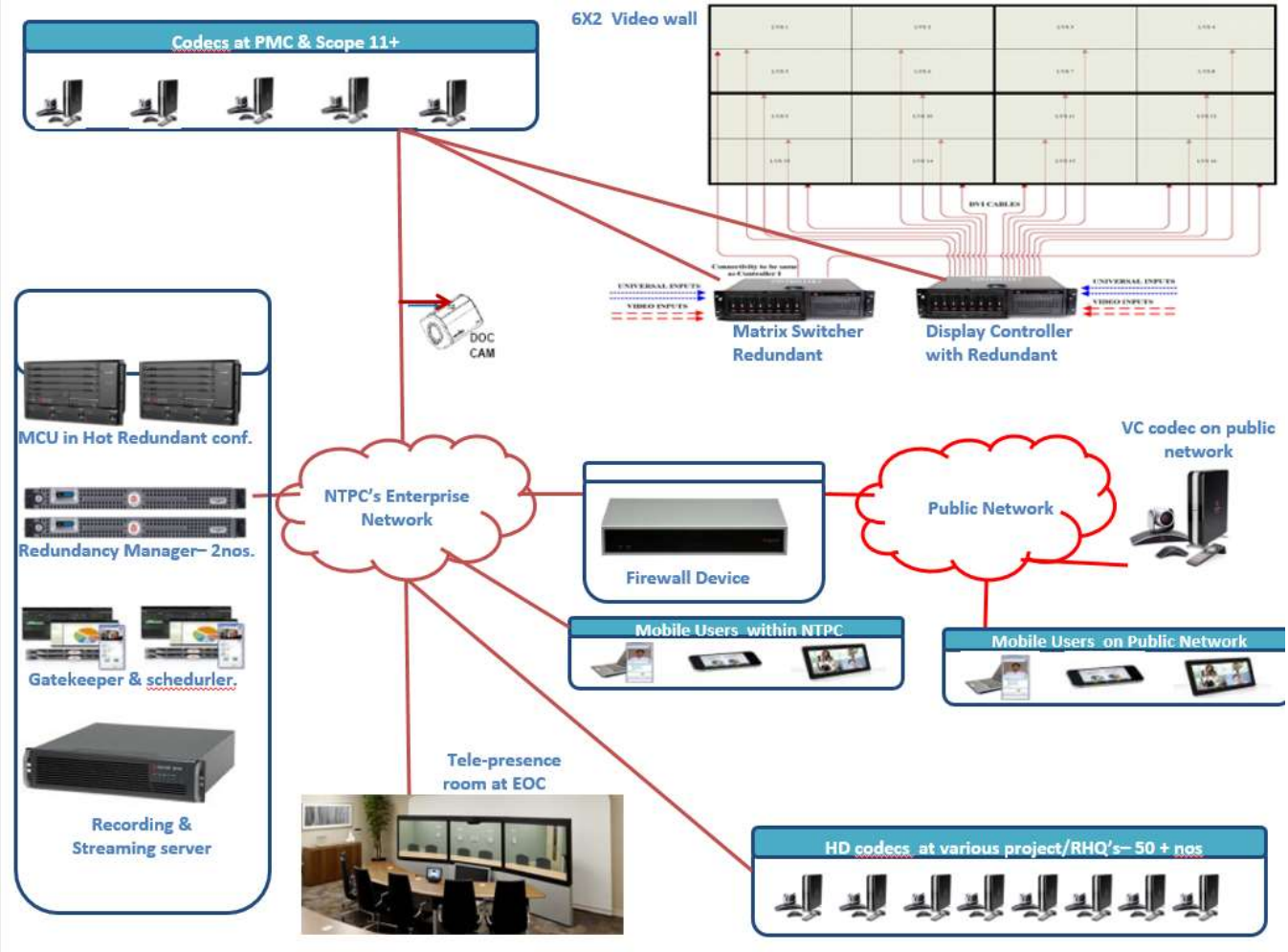
NTPC has dedicated network implemented on MPLS circuit of ISP as shown in below schematic:

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.

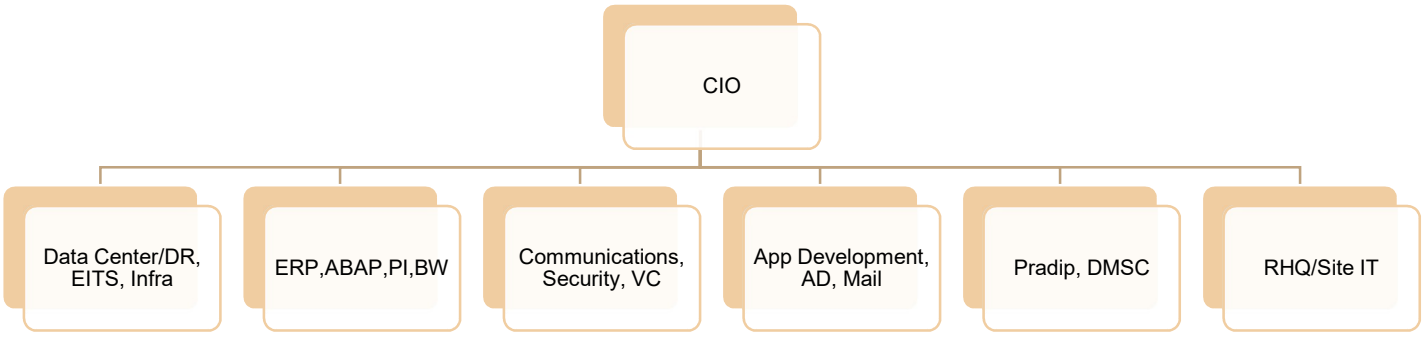


Video Conferencing: The progress of ongoing projects and issues of the running power stations are discussed regularly over high definition Video Conferencing system at Project Monitoring Centre of Corporate Office. Desktop to desktop VC facility also has been provided to senior executives to conduct review meeting from their seat. All NTPC Projects have HD Codec with 55" twin LED Display and document camera. MPLS Bandwidth of project/stations were also upgraded to 12 mbps along with provision of Powergrid MPLS as standby link. Bandwidth of SCOPE has been upgraded up to 155 MBPS. Mobile and desktop clients have also been provided for conducting the VC through laptop or mobile using internet connectivity in case of failure of MPLS link. Tele-Presence (TP) was introduced first time in NTPC. TP is a new technology which has become ubiquitous in the field of high quality VC with look & feel of almost real-presence. TP involves high quality audio and HD video subsystems and room designs with proper lighting and sound considerations in order to achieve the feel of real presence. In fact it will not be out of place to mention that all features of a physical meeting are available in a TP meeting. VC Network schematic is as follows:

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.



NTPC IT Organization Structure: IT Manpower strength is 323 as on Jan'20. Manpower at EOC Noida Data center is 61 and at SRHQ data center is 43. Rest manpower is deputed at RHQ and Projects. Each projects have on average 3-5 manpower. Under the CIO or head of IT all functions have been divided in following groups:



3. AREAS FOR TRANSFORMATION OF IT INFRASTRUCTURE

IT architecture describes company's business operations, including applications and databases. When we choose to ignore the flaws in architecture, we lose precious time and money, not to mention productivity. Managing and strengthening IT architecture will help to focus on long-term goals instead of just short-term needs, enabling to focus wholly on business model and establish a secure and stable architecture. NTPC have to look on following exiting architecture for transformation:

- **Network Architecture**

  Most of the big NTPC Projects has local area network with switches and router which is connected to data center through MPLS. Dedicated network team are maintaining these network. This network is being used for business transaction and physically separated from critical plant operations network.

- **Application Architecture**

  ERP is in place maintained by in-house SAP team. Most of the non-ERP applications are being designed locally as per requirement. Due to duplicity it needs extra effort and manpower.

- **Server Architecture**

  Each project sites have so many servers for Internet proxy, Active directory, Anti-virus, Hosting local applications etc.

- **Security Architecture**

  NTPC has dedicated Network Operation Center in Noida.

- **Procurement: PC & Peripherals**

  PC & Peripherals are procured locally as per requirement and manpower is required for procurement and maintenance.

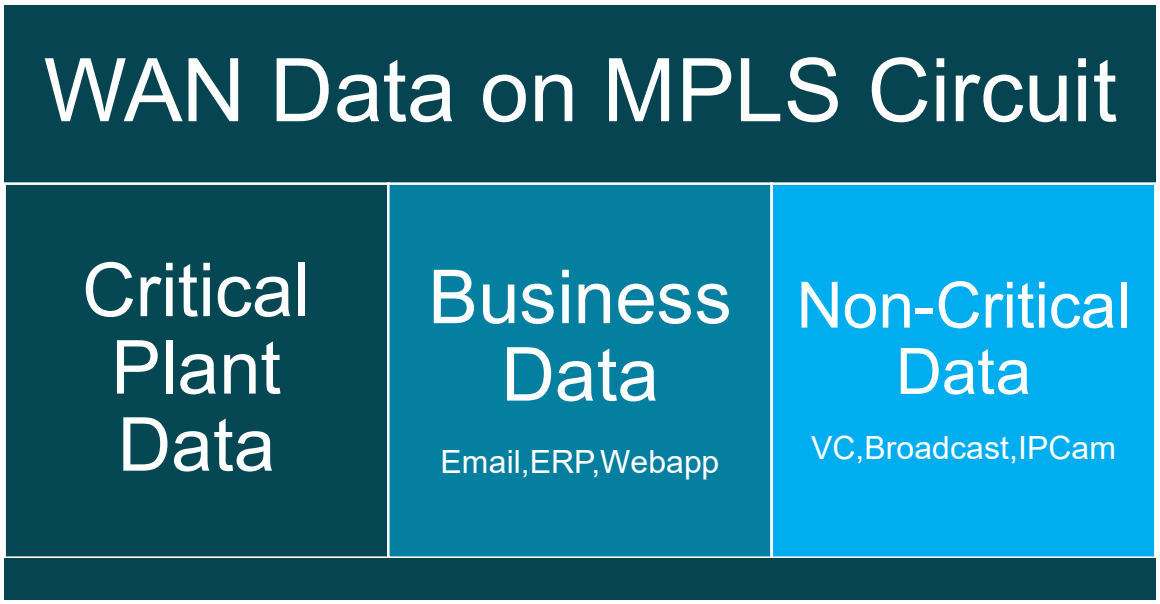
- **IT Manpower & CIO Role**

  All IT services being rendered only by IT executives with minimum outsourcing.

4. ROAD BLOCKS & FALSE SENSE OF SECURITY

Modernization of IT infrastructure is not possible till we get past of false sense of security in existing infrastructure. Most of the new technologies are internet enabled like Cloud, AI, IoT. Same cannot be adopted with a fear of insecurity of data breach from outsiders. Data security firm Code42 has released 2019 Data Exposure Report. The information security leaders surveyed implicated their organizations' own employees in 50 percent of data breaches. Other causes included "external actors" (e.g. cybercriminals via malware) at 28 percent, "software failures" at 27 percent, and "old, unpatched security vulnerabilities." Also study shows over 70% of insider attacks aren't reported externally. There is also a massive trust deficit issue while moving to a Cloud environment. Areas in NTPC where this false sense of security prevailed:

1. **Non Segregation of Data**: Still intranet is not accessible over internet. Employees have to be in office to get the information. Also JV stations do not have any access. This restriction results in employees using adhoc methods to transfer and share data like pen drive, hard drive, email. File sharing websites etc. This put a big question mark on purpose of putting restrictions to not provide data outside the organization premises.



Organization WAN is catering all type of data like critical plant data, business transaction data of ERP and web applications as well as non-critical data like video conferencing, broadcast and IP camera feeds.

2. **Non ERP Application**: The way we work has transformed dramatically in recent decades. The workplace is no longer a physical space, an office, a desk. But even as we continue into this new agile age of work, everyone is moving towards a 'digital workplace'? Nowadays most of the websites are being accessed from mobile devices. The share of laptop and desktop access is reducing drastically. Our workplaces are now built on a complex foundation of different technologies, all designed to help us work faster, smarter, better. The lack of governance, strategy or ownership for new technology has created a messy, fragmented and frustrating experience for organizations and employees alike. We now face escalating numbers of applications, tools and platforms, failing to work intuitively together. Hopping from one platform to the next several times every hour, trying to dig out information trapped or lost in this new tech maze. As the BYOD and BYOA culture continues, that's a sprawl that's only going to get bigger. We can no longer afford to be complacent about this continued evolution and its impact. Our digital experiences in work are failing to keep pace with the consumer market: and its coming at a cost. To deliver the user experience expected by our employees and realize the true potential of the digital workplace, we need to go further. It's time to take hold of the reins, and steer.Major issues with Non-ERP Web and mobile applications are listed below:
    a. Non uniform multiple intranets.
    b. Content management not available to timely update the information.
    c. Search features to easily retrieve data.
    d. Multiple database for each application results in outdated information and outdated links.
    e. Design of application: Mobile friendly UI required. All application must have mobile interface.
    f. Aging web application not being upgraded.
    g. Multiple login for each application which force user to remember or note down complex passwords.
    h. Multiple servers required to run web applications. Sometime single application runs on a single server underutilizing the organization recourses.
    i. Multiple IT manpower required to manage the web applications which increases the IT manpower.
    j. Duplicate Web Applications: Many sites independently develop similar types of web application for local requirement.

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.

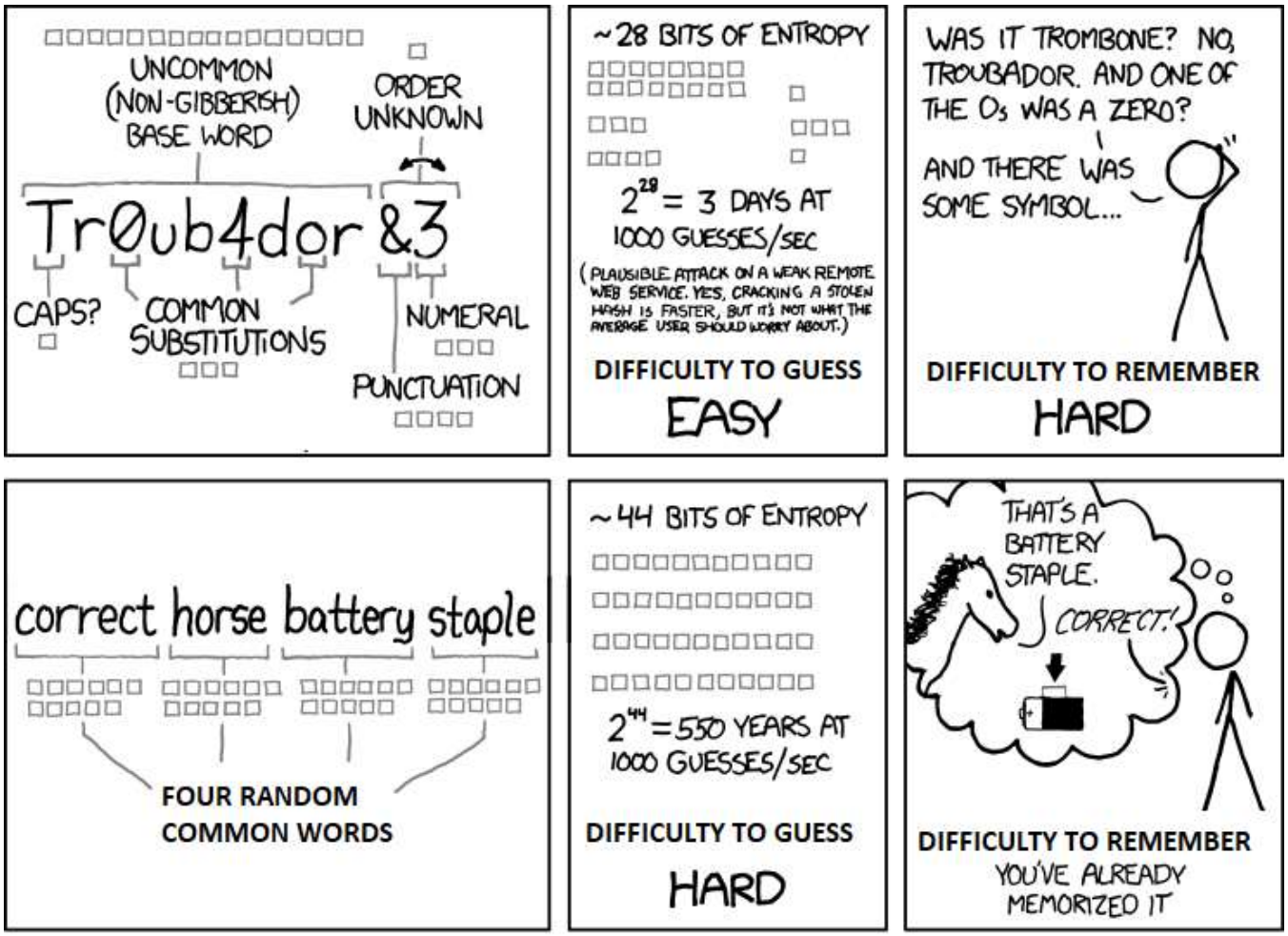
S.No.	Name of application	S.No.	Name of application	S.No.	Name of application
Corporate Centre		**NRHQ**		**NRHQ**	
1	Document Tracking System	**NRHQ-Lucknow**		**Rihand**	
2	Paryavaran Monitoring System	1	Root Certificate Installer	1	Android App For Telephone Directory
3	RTI Application	2	Online Directory	2	NTPC Bus Service - TicketBooking System
4	Retiree Portal	3	Online Conference/ Meeting room booking system	3	Club Cinema - Seat Booking SYStem
5	Parliamant Question & Answer Application	4	SMS Check my System utility	**WR-II**	
6	Ambient Air Quality Management System	5	Online IT Assets & Complaint Management System	**Sipat**	
7	Legal cases Monitoring System	6	Online Survey application	1	e-Services
8	Conference Hall Booking System	7	Regional generation data display	2	Document Track System (DTS)
9	Gate Pass System	8	Employee birthday portal	3	Document Mgmt System (DMS)
10	PI Alerts	9	Daily thought updater	4	HR-Quarter Mgmt system
11	PI Tag Health Monitor	10	Employee Entitlement System	5	E-suggestion
12	Hindi Register	11	SMS portal	6	e-entitlement
13	OH Prism	12	IP Manager	7	C&I Shift
14	GPRS based Rake Monotoring System	**Singrauli**		8	Gas Cylinder Track system
15	Material and Service codification	1	Complaint Management System (PC & Peripherals)	9	BUH Dash Board
16	Hospital Management System	2	Online Telephone & Mail Directory	10	AWARE Boiler thickness (OEM)
17	Tender Website	3	Online Suggestion Scheme	**Korba**	
18	On-line Complaint Management System	4	Team Singrauli	1	Online Suggestion system
19	Property Return Application	5	Online SMS System	2	Tax Invoice Calculation And Printing for Ash/Brick/Cinosphere
NCR-HQ			a. SMS Gateway (Web interface)	3	Online Tube Thickness
Faridabad			b. SMS sending module	4	Online Club Movie
1	Labour Gate pass System		c. PI Data monitoring module for unit trip and synchronizaton module	5	Online Password Reset Request
2	Material Gate pass system		d. Query Based reply module	6	Online Training system
3	IVRS		e. Scheduler module	7	Online Estate Office System
4	SMS Alerts: Employees punch SMS, communication messages, query based information	6	IP Manager	8	Online Inventory Mgmt system
5	Mobile Apps: Employees directory, Faridabad information app	7	Document Tracking System	**ER-II**	
Dadri		8	Singrauli Sign On	**Talcher Kaniha**	
1	Form38 mgmt system	9	Hindi Quarterly Progress Report System	1	E-Time Office System
2	BE-PIP(s) MGMT SYSTEM	10	Labour Gate Pass System	2	E-File Tracking System
3	HR help desk	11	Movie Ticket Booking System	3	E-Suggestion System
4	Finance help desk	12	Web Updation Portal	4	E-Bus Booking System
5	Telephone comp. Mgmt system	13	Medicon	5	Quarter Management System
6	Material gate pass system	14	Online No Dues System	**SRHQ**	
7	Township comp mgmt system	15	Lube Oil Management System	**Ramagundam**	
8	Annual medical health checkup	16	Online ISO System	1	Document Tracking System
9	Finance diary system	**Unchahar**		2	Gate Pass System
10	Visitors gate pass system	1	Android App For Telephone Directory	3	Material Gate Pass System
11	Ash management system	2	Material Exit gate pass system (Returnable / non-returnable)	4	Visitor Gate Pass System
12	IT asset management system	3	Quarter Allotment system	5	Online Functional Hall Booking
13	PC/peripherals comp. Mgmt sys	4	Electricity billing system for commercial consumers.	6	Online 5S system
14	Library mgmt system	5	Coal rake monitoring system	7	Online Estate Application
15	Petrol mgmt system	6	Suggestion system for BE dept.	8	Online Quarter Application
WR - I		**Vindhyachal**		9	Suggestion Box
Mouda		1	Club Movie Booking System	10	Red Tag Application
1	Drawing management system	2	Job Monitoring System	11	Complaint Management System (IT,Telephone,Civil,Electrical)
2	HR Estate Management System	3	e-Tad Complaint System	12	Shift Exchange
3	Asset Management System	4	Cartridge Management System	13	SMS System
4	Online Registration system for Project Meet	5	Drawing Management System	14	IT Asset Management System
5	Project Alert System	6	FQA QP/QC Issue system	15	MGR GPS Tracking System
Kawas		7	Lube Oil System	16	Minutes of Meeting
1	DOCTRACK	8	Mill BRS Life Chart System	17	SRLDC Revision Monitoring
2	Material Exit Gate Pass System	9	HR Manpower System		
3	e-SMS System				

Above is the In-house Application running at various locations. Few Major applications are listed below:

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.

- PP&M Website
- PRIMS
- WebMiles
- OS Website
- HR GM & Workmen Appraisal System
- Guest House Booking System
- CLIMS
- MANAS
- Property Return Application
- NRE Portal
- NETRA Online Services
- Idea Portal
- JV OS Portal
- NTPC Micro Learning
- NTPC Vigilance
- Tele Medicine Doctor's Appointment Booking (PARAMARSH)
- Employee Directory (SAMPARK)
- NTPC Plant Live
- NTPC Ex-Employees
- Holiday Calendar
- Empanelled Hospitals
- NTPC Rajbhasha
- Ash Utilisation
- Vendor Invoice Status
- NTPC Safety
- Online Safety Pledge
- NTPC Tender
- NTPC Tree Plantation
- NTPC Safety Manual
- Business Excellence
- NTPC GETS
- NTPC CEMS
- NTPC Pratibha
- PMI Feedback
- Fuel Transport

3. **Enterprise Single Sign On and Multiple complex passwords for Various applications**:
   Still use of password complexity and secret questions. User lockout on 3-5 password attempts. While world standard is moving towards two factor and multi factor authentication with self-password reset. It's a fact that Most of our IT manpower is engaged in resolving password issues.



The National Institute of Standards and Technology (NIST) is a non-regulatory federal agency within the U.S. Department of Commerce. NIST only regulates federal agencies, corporate security teams are taking advantage of their guidelines.NIST has drafted new rules and recommendations for protecting digital identities.NIST advises agencies to jettison outdated password complexity rules in favor of user-friendliness. Here are new recommendations:

1. NIST recommends removing all password complexity rules, they just create a false sense of security.Length matters a lot more, which is why the new guidelines call for a strict 8-character minimum and even suggested moving character maximums to at least 64. Blank space allowed.
2. No Periodic Password Resets: Frequent mandatory password resets can even make security worse, they tend to make them weaker from the start.
3. Enable "Show Password While Typing": during typing, User have a much better shot at putting lengthy passwords in correctly on the first try.
4. Allow Paste in Password Fields: “Paste” functionality is now advantageous due to the widespread use of password managers.
5. Forbid Commonly Used Passwords like dictionary words.
6. Don't Use Password Hints or Secret Questions.
7. Limit the Number of Password Attempts: There is a wide spread between the number of guesses a typo-prone user needs and the number of guesses an attacker needs
8. Password Storage: Many security attacks have nothing to do with weak passwords and everything to do with the authenticator's storage of passwords. NIST guidelines require that passwords be salted with at least 32 bits of data and hashed with a one-way key derivation function such as Password-Based Key Derivation Function 2 (PBKDF2) or Balloon.
9. Multifactor Authentication: The NIST requires multifactor authentication, commonly referred to as 2FA (2-Factor Authentication): A verification that requires users to demonstrate at least two of “something you know” (like a password or sms otp), “something you have” (like a phone), and “something you are” (like a fingerprint) drastically decreases the probability of a successful attack.

The new NIST guidelines reveal an important moral: easier, more convenient security will make more people take proper precautions, so make your system intelligent. The extraneous password rules are just making things worse. Recent studies have shown that the conventional wisdom on passwords is wrong, so organization need to rethink password strategies to stop wasting time on password complexity and focus on security and effective preventative measures like extra salting and 2FA.

Ref: https://pages.nist.gov/800-63-3/sp800-63b.html

4. **Less Involvement with Functions & Importance of Role of Shadow IT:** IT must be intertwined with functions. The best use of IT cannot be delivered by a disconnected or siloed IT Department looking after specific task of PC, Peripheral, Network and Security for users. IT Leadership has to enable and build cross-functional teams to design their digital and cloud roadmap and deliver the same.

   Shadow IT is a term used in NTPC for the IT personnel reporting in a function and fulfilling the requirements. This helped the NTPC a lot to brought new technologies. Project

monitoring center with state of the art video conferencing and monitoring tool is such example. Some of monitoring tools were extended to ministries for rural electrification monitoring and clean India Mission. Even Artificial Intelligence has been used first time in NTPC for safety issues through IP camera in PP&M Department. Similarly, C&I Engg came up with virtual reality training module for PMI.
Samvad APP from corporate communication group is also a professional standard mobile app.

5. **Security on Cloud**: The abundance of technology investments gives firms a false sense of confidence in their security posture. Security team currently employ a variety of tools and technologies to identify risks and test the effectiveness of their security controls. As a result, they are left with point-in-time assessments that require them to cobble together data from disparate systems to truly understand the organization's security posture. This approach is reactive, labor-intensive, and insufficient in scale. A fundamental aspect of cyber-security is the visibility of assets owned by an organization. Continuous asset profiling and vulnerability management is key to detecting such simple errors, It doesn't matter how good your technology is, in the end it will be let down by poor operational practices.
   Security has two parts; one is technology and other is the user. If users are not fully trained the security cannot be implemented properly. So in addition to technology, users should be made aware of the impact of security and its importance.
   However, cloud solutions come with best security solution and security practices. It also has best security team monitoring the infrastructure.
6. **Issues with Data Redundancy:** Similar to redundant applications, data redundancy occurs when the same set of data is stored in multiple locations, sometimes for backup and recovery purposes. When businesses transfer data from physical centers to the cloud, they don't always check for redundancies, which can lead to greater long-term costs, lower performance, and compromised security.

   Conduct regular checks to identify and eliminate redundant and unused data. Make sure your network isn't harboring data replicators, which continue to copy data, even after its duplicates have been deleted. You should also implement master data management (MDM), a process of centralizing data that will allow you to streamline data sharing and gain a comprehensive view of data. If you are looking to safeguard your system in case of a malfunction, backup is a great option for protecting data, without the added risks of redundancy. Backups also protect against a wider variety of problems than redundancy.

7. **Concerns for Single Points of Failure:** Another concern if for cloud architecture is the presence of single points of failure (SPOF), a flaw in which a single malfunction can jeopardize the operation of an entire system. For example, a faulty application with no backup can lead to system failure, creating multiple security issues and unnecessary downtime.

   With less focus on training, People can also become a single point of failure, such as placing a single person in charge of multiple systems. SPOF can be prevented by having backup systems in place and training multiple people to learn how to use them. To detect and mitigate SPOFs, perform an SPOF audit, making sure to document every component of your IT infrastructure. Then, identify any SPOFs, and make sure you have the necessary backups in place to minimize risk.

8. **Fear of Data Breach:** Cloud service provider are not thought as normal vendors just because their infrastructure is running on internet. Reality is that you are going to sign a proper agreement with them like a vendor to legally bind them for your business data. This fear originates because people use cloud services for free in daily life and they give consent that their personal data can be used by service provider for advertisement and other things. But in case of agreement same cannot be done. They are bound to provide security to data as per agreement.

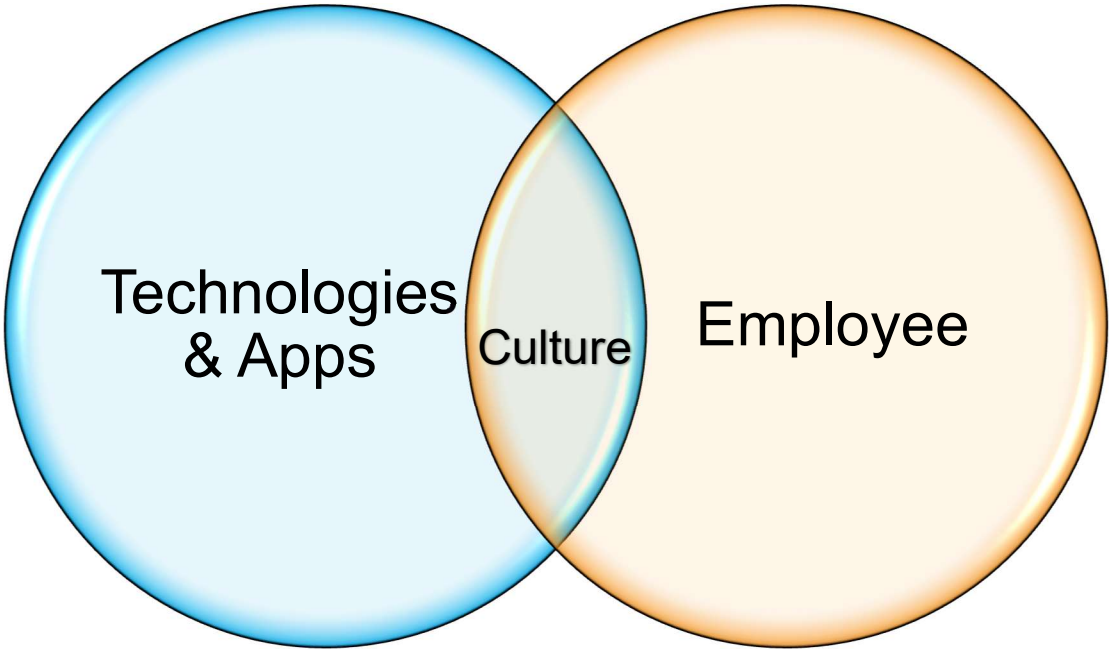
5. PROOF OF CONCEPTS IMPLEMENTED IN BIFPCL

Bangladesh India Friendship Power Company (Pvt) Ltd (BIFPCL) is 50:50 JV between NTPC & Bangladesh Power Development Board (BPDB) with Head Office in Dhaka and Maitree Super Thermal Power Project (2×660 MW) at Rampal, Khulna. In July 2018, IT department has captured the requirement and expectation of users in BIFPCL and prepared an IT roadmap for digitalization of BIFPCL considering the optimum utilization of IT manpower with reduction in cost. IT roadmap was prepared with identification of activities in which some activities has to be implemented and developed in-house and some activities has to be implemented through off the shelf software solutions. With full support of management for latest technologies, Major IT activities implemented:

5.1 Digital Workplace Solution: G-Suite by Google Cloud

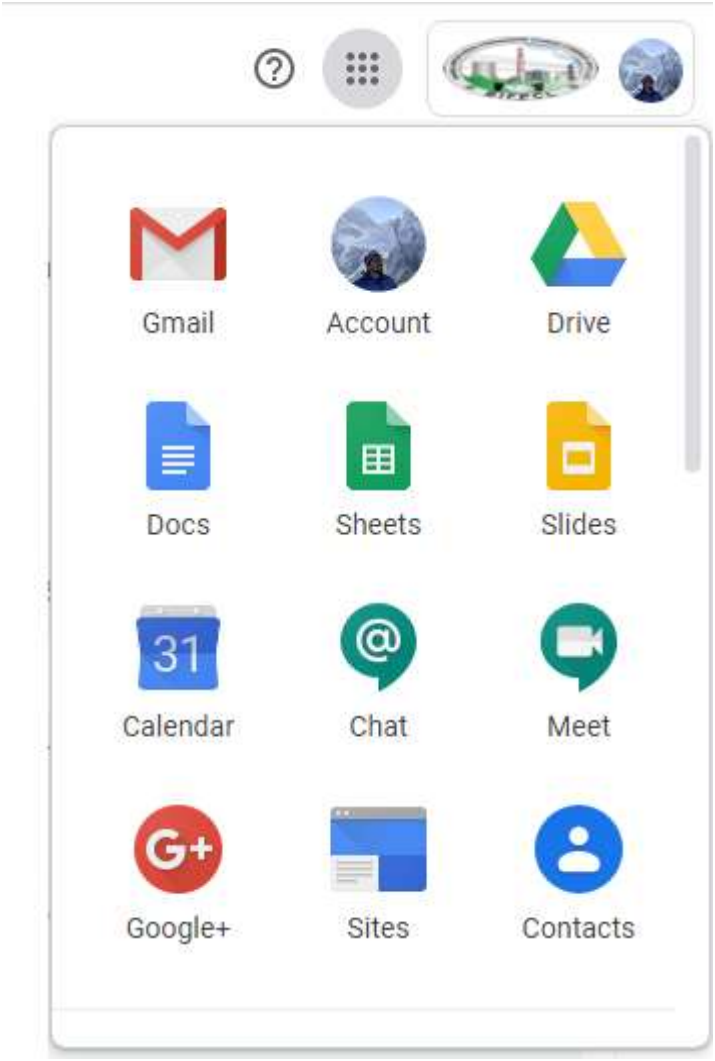
Technology Description

The digital workplace strategically unifies an organization's employees and the technologies they use in an ecosystem that strives to facilitate agile ways of working, improve employee engagement and deliver an exceptional experience for its users.



When the technology shapes the employee experience in strategic and considered way with aligning of business vision, values and becomes foundation of organizational culture which drives employee engagement.

G Suite is a collection of business, productivity, collaboration, and education software developed and powered by Google. The primary G Suite tools include Gmail, Drive, Docs, Sheets, Slides, Forms, Calendar, Google+, Sites, Hangouts, and Keep.
The G Suite Products



Google offers a wide variety of products for both personal and enterprise use. Most are accessible with a Google account (by tapping the menu in the top right corner), though some need to be installed as Google Chrome extensions to gain full functionality.

- **Gmail** is the G Suite email software. It was released in 2004 and now has over 1 billion users worldwide. With a G Suite plan, businesses enjoy 30GB of storage space, custom company email addresses (user@bifpcl.com), unlimited Google Group email addresses,

24/7 phone and email support, and compatible add-ons available through the G Suite Marketplace.

- **Google Drive** is the G Suite cloud storage platform and was launched in 2012. Drive manages all of your company's content and supports collaboration across your entire organization. It also allows you to view various file formats so you don't have to download additional software to your devices. Depending on the G Suite plan, businesses enjoy 30GB, 1TB, or unlimited storage per user and audit and reporting insights for Drive content.

- **Office Suit:** Google Docs, Google Sheets, and Google Slides are the G Suite word processor, spreadsheet, and presentation programs, respectively. They were added to the platform in 2006. These programs allow real-time collaboration, save changes automatically, and track revision history. Users can insert comments, suggest edits, communicate through a built-in chat, and create templates for future use. With a G Suite plan, businesses enjoy unlimited revision history among other perks.

- **Google Forms** is the G Suite web form and survey tool. Also launched in 2006, Forms shares many of the same features as Docs, Sheets, and Slides, such as automatic saving, real-time collaboration, and template creation. To collect data through Forms, users can personalize surveys or quizzes, send respondents the URL, and review the data (that's automatically collected in Sheets).

- **Google Calendar** is the G Suite online calendar. It was launched in 2006 and integrates with Gmail to manage schedules, appointments, meetings, and tasks (via Google Tasks). With a G Suite plan, businesses enjoy smart scheduling (where employees can see open windows of time on coworkers' calendars), calendars for Google Groups, calendars for meeting rooms and shared resources, public calendars so customers can view company events, and easy migration from external calendars (e.g. iCal, Outlook, or Exchange).

- **Google Hangouts** is the G Suite communication and messaging tool. Originally launched in 2006 as Google Talk, Hangouts supports text, voice and video conversations (for up to 25 participants) and can be used between desktop and mobile devices. It's also a common alternative to Slack. With a G Suite plan, businesses enjoy a seamless integration with Calendar, screen sharing for participants, auto focus and intelligent muting features, public livestreams automatically saved in YouTube, and custom administrative controls.

- **Google Keep** is the G Suite note-taking tool. The newest addition to the G Suite platform, Keep can be used to create, organize, and share memos, lists, images and voice notes across multiple devices. It's available as a Chrome download and mobile application. With

a G Suite plan, businesses enjoy a seamless integration with Google Docs among other perks.

- **Technology Benefit**

BIFPCL has successfully migrated in Aug'18 from traditional old email system to cloud based agile email service from Google to make BIFPCL a digital workplace with following benefits:

- 30 GB Space to each user with enhanced mobility to access mail service
- No IT manpower for Email Server Maintenance. Zero email related complaints or password reset requests.
- Self-reset password with 2 factor authentication
- Industry standard Google cloud security
- Google drive for storage of documents
- Collaboration and Video Call feature
- Enhanced productivity for executives
- Cost Effective: 4000 BDT per user per year
- Availability of servers are quite impressive

Services	DEC 2019	NOV 2019	OCT 2019	SEP 2019
G Suite	99.994%	99.991%	99.994%	99.993%
Google Calendar	99.998%	99.986%	99.998%	99.997%
Google Docs	99.973%	99.977%	99.982%	99.987%
Google Drive	99.985%	99.987%	99.979%	99.978%
Google Forms	99.998%	99.998%	99.997%	99.998%
Gmail	99.996%	99.995%	99.995%	99.994%
Google Groups	99.993%	99.982%	99.995%	99.994%
Google Hangouts Chat	99.999%	99.924%	99.989%	99.989%
Classic Google Hangouts	99.999%	99.997%	99.999%	99.999%
Google Hangouts Meet	99.997%	99.963%	99.997%	99.997%
Google Slides	99.973%	99.977%	99.978%	99.978%
Google Sites	99.999%	99.999%	99.999%	99.999%
Google Sheets	99.980%	99.982%	99.984%	99.983%

5.2 Cloud based SAP Implementation: SAP Business One on Amazon Web Services

- **Technology Description**

Cloud services are growing at a rapid rate because of the benefits that they bring. Nonetheless, there are compelling. Cloud computing is emerging as a viable alternative to the traditional approach of standing up and hosting applications within an organization. It's a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Traditionally, organizations have purchased and deployed infrastructure (networks, hardware, software, etc.) and dedicated the IT resources to specific applications. There are several characteristics of cloud computing that differentiate the capability from more traditional IT implementation. This includes the following:

- On-Demand – Ability to provision IT services immediately without needing to necessarily purchase hardware and software. Deployment of IT resources typically occurs almost immediately or within hours.
- Internet/Intranet Access – Applications or services can typically operate over the Internet or Intranet. This allows multiple types of devices such as mobile laptops, phones, tablets, etc. to access resources.
- Resource pooling – Hardware, software, network, storage, and other IT resources can be pooled so that multiple user groups can share the same underlying infrastructure while maintaining their own security boundaries.
- Scalability – Applications and computing resources can be expanded and contracted based on need. This provides for rapid scalability based on demand.
- Measured Service – IT services can be measured and charged based on utilization. This characteristic has also provided the ability to use computing as a utility. Much like electricity or water is charged, computing can be charged based on utilization. Resource utilization can be monitored and reported to provide transparency to the consumer of the services. However, this presents a different cost model than many organizations are accustomed to. There are several service models for cloud computing. A service model describes the capability that the cloud service provides. The three service models include:

1. Software as a Service (SaaS) –This capability provides software to users that is typically accessed through a web-browser. This includes applications such as email, database applications (e.g., contact management), customer relations management (CRM), etc. Customers do not manage the software, operating systems, network, servers, storage, etc. under a SaaS service model.

2. Platform as a Service (PaaS) – This capability allows consumers to deploy their own custom applications in a cloud environment. Consumers are responsible for managing their own applications but do not need to manage the underlying operating systems, network, servers, storage, etc.

3. Infrastructure as a Service (IaaS) – This capability provides consumers with the most flexibility but requires consumers to be more involved with the management of their environment than any of the other service models.

- There are various defined deployment models of cloud services. A deployment model describes where the physical infrastructure is deployed and who manages it:

1. Private Cloud – IT infrastructure is deployed for a single organization but may be used by multiple business units. For example, a single government agency may deploy a private cloud within its datacenter that would only support business units within the agency. IT infrastructure is purchased, owned, and managed by the agency. Each business unit would share the common IT resource and be billed based on what it consumes.

2. Community Cloud – IT infrastructure is deployed for exclusive use by a specific community of consumers with the same mission, security requirements, policy, etc. For example, Amazon Web Services (AWS) provide a cloud service that can only be used by government and organizations responsible for managing government systems. In this case AWS is a third party responsible for the community cloud. However, a community cloud may also be deployed and managed by multiple organizations that share use of the community cloud resources. The infrastructure may be deployed on or off-premises.

3. Public Cloud – IT infrastructure is deployed for use by the general public. The infrastructure is owned and managed by a commercial business or government organization. The infrastructure is located at the public cloud service provider's location but may be used by organizations outside of the cloud provider's location 4. Hybrid Cloud – IT infrastructure is a mix of two or more cloud deployment models (i.e., Private, Community, and/or Public). For example, an organization may deploy a private cloud to support their internal line-of-business applications, and use a public cloud service provider to host applications that support the general public.

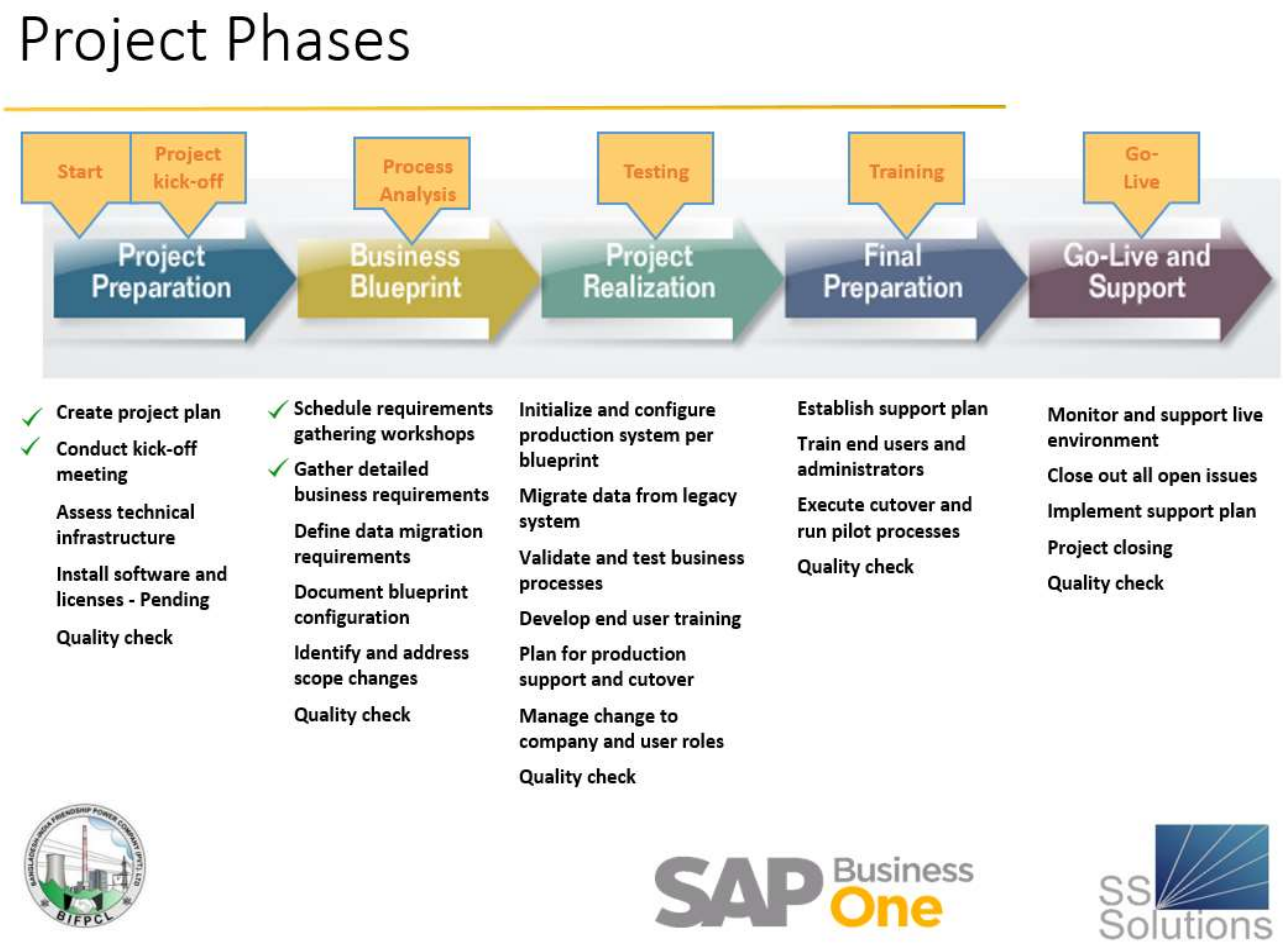
Technology Benefit

BIFPCL has awarded the SAP implementation in Apr'19 which is a world Class Integrated Business Solution to integrate the business process of HR, Finance, and C&M. This helped BIFPCL to fully automate its entire business processes with adoption of international best practices in Information Technology systems and manage operation of size and scale to monitor the financials, inventory, human resource, C&M vital for a sustainable growth. The system shall be adequate to handle the complex and flexible business and MIS needs and provide centralized control for the top management by eliminating the possibility of critical gaps in the management control and the associated decision making criteria in a structured manner. Key benefits are

- Provide insight for better decision making – Dashboards/MIS/Analytics
- Ensure consistency in reporting
- Maintain single version of truth
- Minimize human effort with reduction in manpower and increase productivity in long term.

Cloud based implementation has been preferred for better return on investment. Only subscription fee for hardware configuration needs to be paid on the basis of number of users. Similarly, subscription fee for software licenses also needs to be paid on the basis of number of users. Server maintenance, Power backup, Disaster recovery, networking, security, etc are taken care of by expert IT team of cloud service provider. Hardware refresh is also in scope of provider. Scalability of application according to the growing needs of organization becomes easy as more number of cloud based licenses can be purchased as and when required. Additionally, one in-premises data storage facility has been set up at Dhaka head office to get regular backup of data. BIFPCL implemented SAP in following Phases:

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.



Project was started in May'2019 and completed in Aug'2019. Total cost of implementation is 90 Lakh BDT for 3 years which is one third of in premises implementation excluding cost of IT manpower. BIFPCL Business Process mapped:

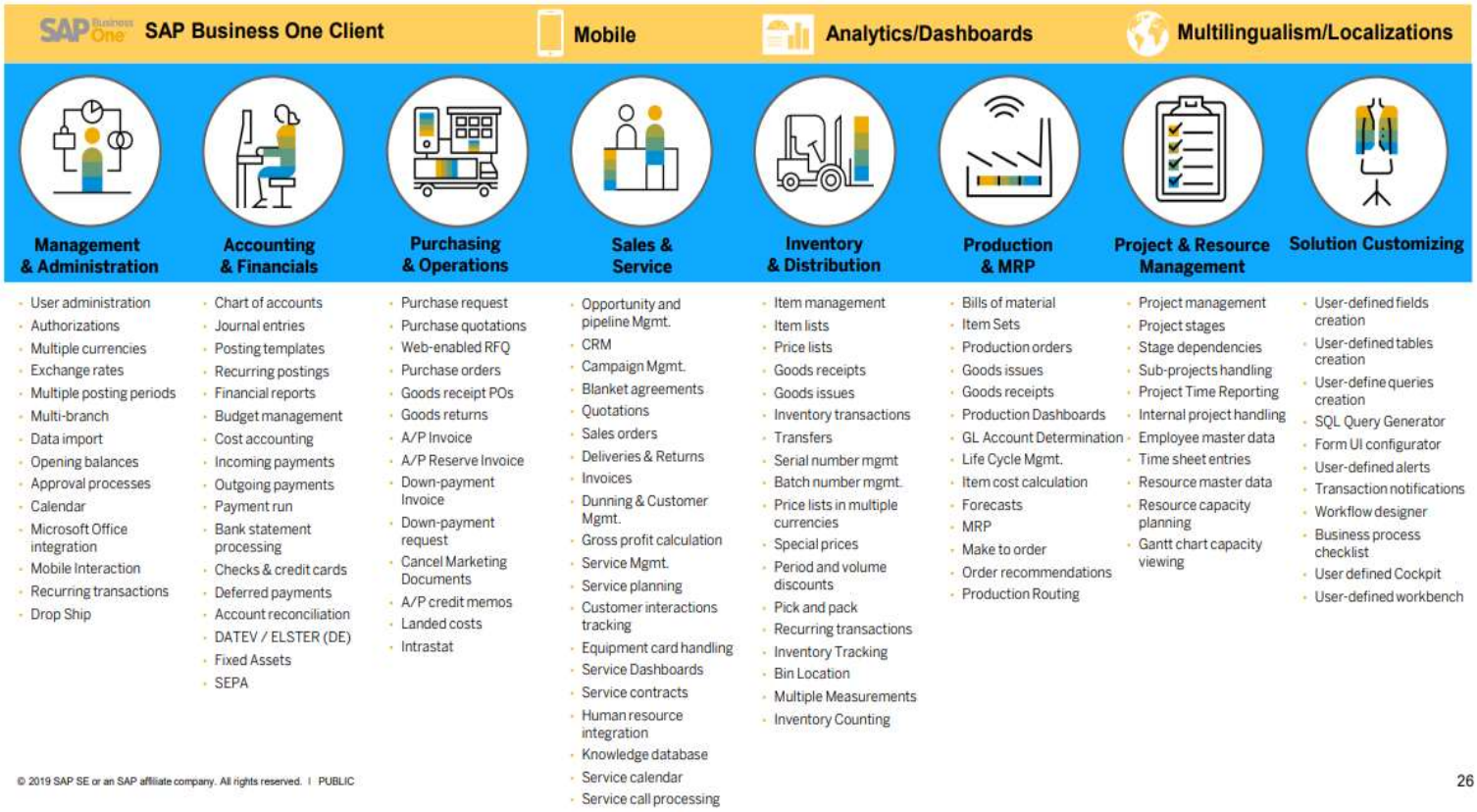
- Purchase Request(PR)
- Purchase Quotation (PQ)
- Purchase Order (PO)
- Goods Receipt PO (GRPO)
- Item code creation
- Stock Management
- Asset accounting
- Party Payment
- Payment Voucher
- Balance Sheet

BIFPCL.ONLINE

Implementation Partner : M/S SS Solution, Dhaka

Cloud services are growing at a rapid rate because of the benefits that they bring. Nonetheless, there are compelling reasons for both private and public sectors to consider deploying systems using cloud technologies. Most organizations in public and private sectors are already in the process of deploying private cloud solutions since they present the least amount of risk while still attaining gain. The main reason for this is that private clouds are completely under control of the organization where security risks can be contained and where SLAs can be more easily adapted to reflect cloud operations. Most organizations are seeing benefits of private cloud solutions when deploying IaaS and PaaS service models. Because the first step to developing a private cloud requires deployment of virtualization technologies, companies quickly realize benefits as they move to a private cloud solution. Following is the functionality for SAP implementation:

SAP Business One Key Functionality

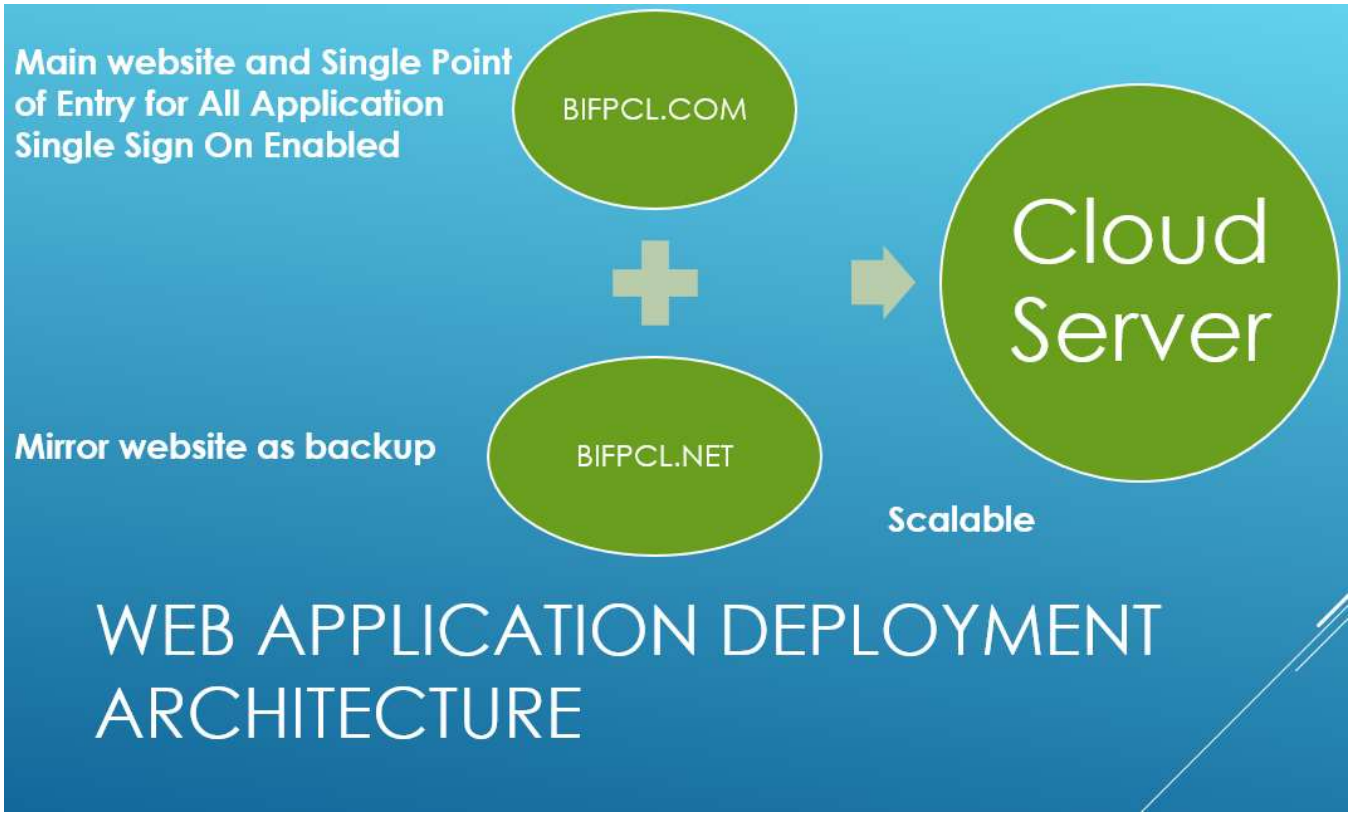


5.3 Cloud Servers for Application: Step towards server less organization

BIFPCL is not using in-house IT infrastructure and relying on Cloud servers thus saving cost on Servers, Data Center, UPS, IT manpower etc. with following benefits:

- No LAN/WAN server. No Intranet concept.
- Intranet over internet with Single Sign On for all web application. No multiple passwords.
- Server resources scalable as per requirement.
- Office premises wi-fi with all application available on internet.
- No manpower for server
- No hardware liability

Proof of Concepts: To transform IT with reduced cost, manpower and enhancing business process.



Single Sign On: All mobile and web application use Single login ID and Password Which helps user to not keep multiple passwords. It has two factor authentication and self-password reset facility using OTP.

Comprehensive Daily Progress Monitoring System

- At MSTPPP Project activities are in full swing therefore Online Daily Progress Monitoring System is developed in the form of quantitative measures as well as visual Progress dashboard based on Contractors' work and review of works highlighting critical hold ups so that set targets are realized without any difficulty and helps TS Dept for effective project monitoring. It also helps to resolve interface problems between various department.
- The system is daily updated by punching the daily work progress in various area through mobile app. Later on TS Dept is using the comprehensive report for monitoring and daily review meeting purpose. Few summary reports are also available for top management and can be accessed on Mobile.
- The system makes proper day-wise progress log of various activities which can also be utilized in future. It also has facility to monitor the critical issues of project as well as monitoring of Milestones.
- IP Camera have also been installed for getting live feed for progress monitoring.

QR based Online Gate Pass System

- At MSTPPP Project a large number of workforce is engaged in construction work through EPC contractor BHEL and sub agencies. Initially there was difficulty in maintaining the record of all the workers. Therefore, one QR based online gate pass system has been developed in-house. This is the centralized intelligent component which streamlines the management of information of workers, agencies and insurance details. The system can be used for keeping track of every workers pass validity, insurance, safety and security issues by keeping and monitoring all relevant data centrally. It also alleviates the sufferings of BIFPCL manpower from maintaining the duplicate data on excel files.
- Now gate passes are being issued through the system where agency enters all the personal details of worker in to the system which later on goes to online approval of EPC contractor BHEL and BIFPCL. Approval is given after checking proper insurance, medical and other safety records. Comprehensive reports available to all stakeholders on real-time basis for executing the task.

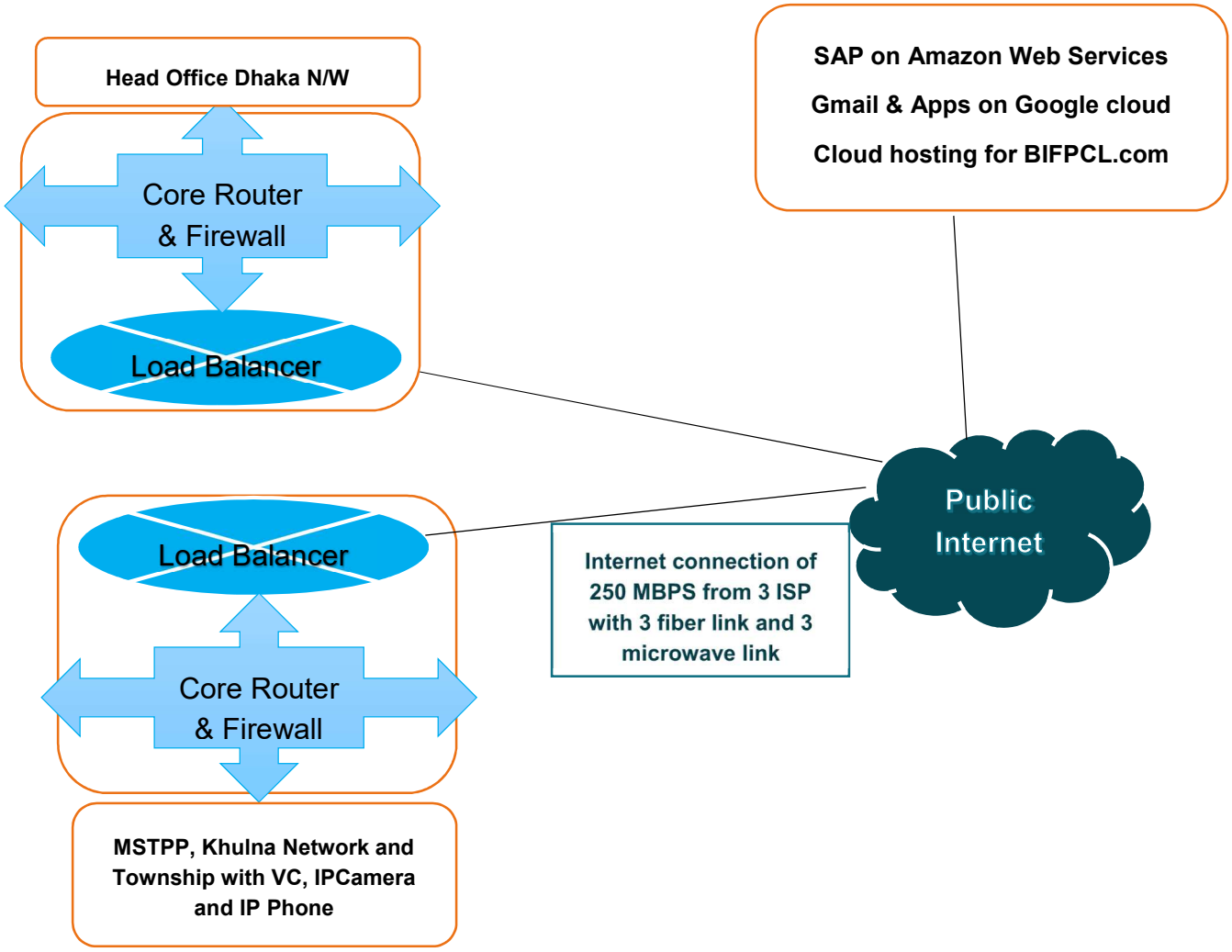
Other IT Initiatives

- Upgradation of official website: Latest web technology and responsive design for corporate website.
- HR Leave Management: An in-house application integrated with biometric machine to manage the leave records of all BIFPCL employees. Leave & attendance report being generated and available on mobile.

- HR Recruitment App: In-house developed to help in recruitment drive. Candidates can apply online with personal and educational qualification and submit the application.
- Online publication of Tender: In-house developed to publish the tender documents on website with vendor registration facility.
- DocStore: Integrated content management solution developed in-house. It is a document repository
- Safety App: In-house developed to upload safety clearance and safety incident reporting.
- E-learning Module: In-house developed repository for providing online content on various aspect of power plant for learning of executives.

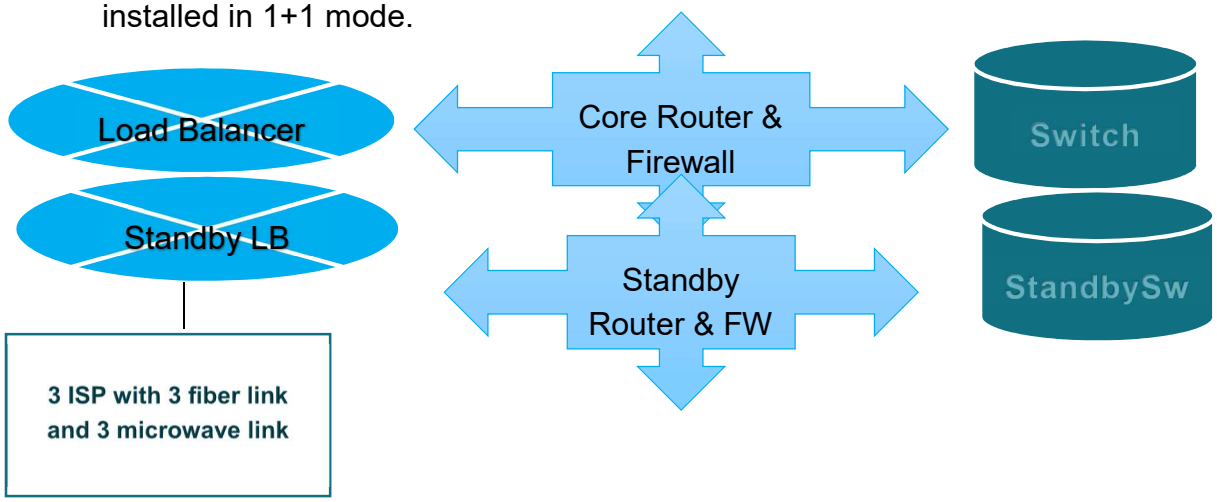
5.4 BIFPCL Network without MPLS: Only ISP

BIFPCL has head office situated at Dhaka and Project office is located at Maitree Super Thermal Power Project Khulna. Head office is completely Wi-Fi and no LAN connections.



There are multiple ISP available providing internet connection to make redundancy and have uninterrupted internet connection 24 X 7. Load balancer is being used to manage internet traffic. All data for ERP from cloud servers, email services from google cloud and various web application from BIFPCL.com being accessed through internet. IP camera feed through mobile app for project monitoring is available through internet anywhere in the world. IP telephony being used for landline connection with ISD facility.

Redundancy: Proper Network redundancy is maintained. All IT Network equipment's are installed in 1+1 mode.



5.5 BIFPCL IT Procurement:

In BIFPCL no desktop PC procurement is being done. Procurement of Laptops has been preferred for following reasons:

- Less maintenance requirement compared to desktop.
- Safety during power surge.
- No dependency on External UPS power with inbuilt battery.
- Easy connectivity through Wi-Fi.
- Portability facility to carry from one place to another for day to day work.

Laptop have 3 years' warranty and must be buyback after 3 years and replacement is being done.

Similarly, No Server procurement being done. All the servers compute engine is being hired from cloud. For example, bifpcl.com with single sign on and various non ERP App runs with only 256 MB of server RAM and merely cost BDT 15000 per year.

No individual printers are provided. All printers are centralize network printer with print, scan and copy facility.

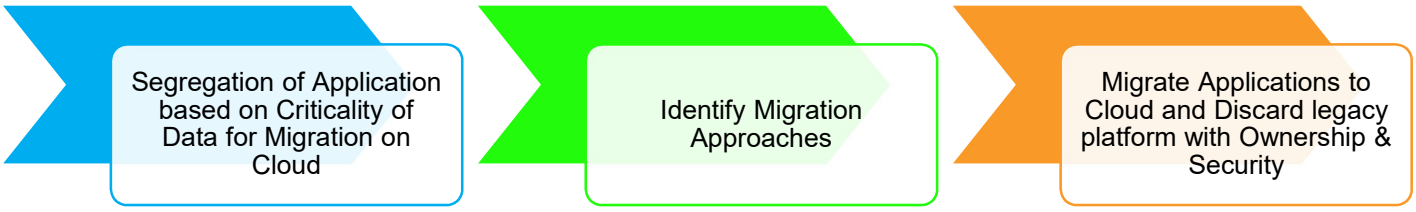
6. RECOMMENDATIONS FOR TRANSFORMING NTPC IT

6.1 Upgradation of the legacy application portfolio: NTPC

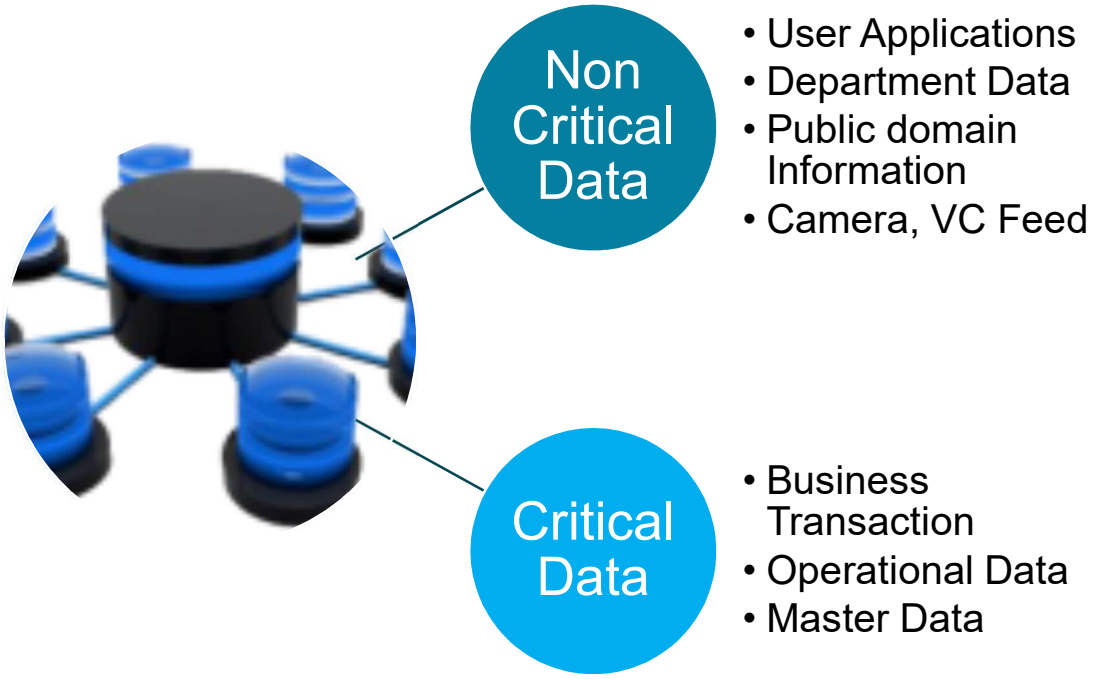
has currently many in-house developed applications accessible within organization and maintained by IT resources. Major applications are:

1. PP&M Website and Monitoring tools.
2. O&M Portal and related apps.
3. CLIMS
4. Various Intranets of corporate, regions and projects.
5. HR Portal and application.
6. DREAMS and Engineering Application
7. Contracts Websites, Tendering, Party Payment Portal
8. Other Departmental Portals like Safety, BE, Commercial, FT, NETRA, PMI etc.
9. Medical Application
10. Samvad , Sampark and various Mobile Apps

In present day it's sheer wastage of resources to purchase high configuration servers and install single or small applications with underutilizing the server's resources. We must identify duplicate application and plan for migration to cloud. The cloud system architecture should support horizontal scaling when required, thus allowing to make incremental capital investments when required. The system should support lights out scenarios by allowing nonintrusive monitoring of solution components for better manageability and proactive maintenance. Whenever options are available, open source frameworks/components shall be used instead of proprietary frameworks/components to avoid vendor lock-in and high operation and maintenance costs. Following steps are required to transform the in-house application portfolio:



1. **Segregation of Application based on Criticality of Data for Migration on Cloud**: All in-house applications needs to be listed out as given at 4.2 and needs to be segregated on basis of criticality of data. This will also help in removal of duplicate application running at various locations.



2. **Identify the Migration Approaches**: Carefully select the migration approaches based on application. Migration of data and applications to the cloud will enhance the availability, agility and functionality of the application and improve the interoperability with other applications. The existing applications are to be migrated to the cloud progressively. For this, application-centric approach shall be made by proper mapping of the existing application and its associated server hardware with due consideration to financial aspects and technical parameters and thereafter roadmap shall be made to migrate. There seven five well established approaches to migrate traditional applications to the cloud, these include:

   - **REHOST** on Infrastructure as a Service (IaaS). Redeploy an application component to another physical, virtual or cloud infrastructure without recompiling, altering the application code, or modifying features and functions.

   - **REPLACE** with Software as a Service (SaaS)**.** Eliminate the former application component altogether and replace it, taking new requirements and needs into account.

- **Encapsulate**. To leverage and extend an application's features and value, encapsulate data and functions in the application and make them available as services via an application programming interface (API). Implementation specifics and knowledge are hidden behind the interface.

- **Replatform**. Migrate an application component to a new runtime platform. Make minimal changes to code to adapt to the new platform, but don't change the code structure or the features and functions it provides.

- **REFACTOR** for Platform as a Service (PaaS). Restructure and optimize existing code without changing its external behavior to remove technical debt and to improve the component's features and structure.

- **Rearchitect**. Materially alter the application code so you can shift it to a new application architecture and fully exploit new and better capabilities of the application platform.

- **REBUILD** on PaaS. Rebuild or rewrite the application component from scratch while preserving its scope and specifications.

The key is to understand if problem is caused by technology, architecture or functionality of the application, and how each modernization approach improves those aspects. After conducting a thorough assessment, the best choice for the organization facing the skills shortage problem above is between rearchitect and rebuild or replace. Rearchitecting has a moderate cost and risk, but will yield moderate results. Rebuilding or replacing provides the best results, but with higher costs and higher risk.

3. **Migrate Applications to Cloud and Discard legacy platform with Ownerships & Security**: Application ownership after hosting on Cloud, shall remain with the original Application owning department. The application owner agency shall have right on access, retrieval, modification and deletion of the data and shall define the policies and processes of data access. Secured access to be given to Admin of the Application for maintenance and upgradation. Parallel after successful deployment and testing on cloud, old application and hardware platform shall be discarded. The Info-Security will be the shared responsibility of Cloud administrator so that the Applications uploaded /run are secure on the Cloud, and the Application

Developer for making the application secure and resilient, to Run on the Cloud, by implementing necessary security Controls, Role-Based Authentication and suitable encryption of Data as per the latest standards.

[Final Outcome]

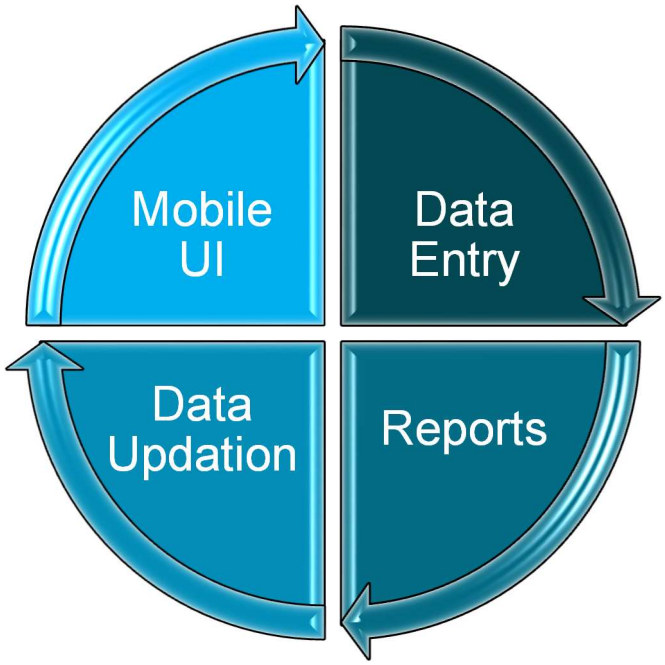
After Migration to cloud NTPC will have following benefits:

1. Reduction in IT Hardware and Server: For example, Intranet shall be available over Internet. Similarly, duplicate application shall be avoided.
2. Less IT Manpower required. No IT Manpower needed at Site for Application development and server management.
3. All applications will be running on cloud engines and easily sharing the data with each other which will help to implement AI and Data Analytics.

6.2 Upgradation of non ERP application Delivery:

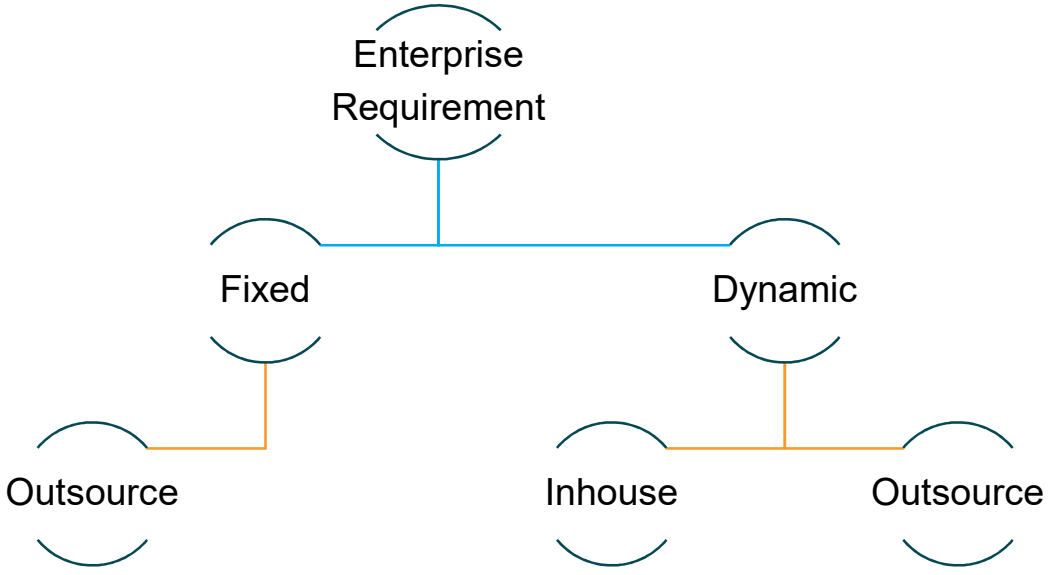
NTPC has currently many applications designed on many platforms. Many times sites are developing application for own requirement. For migrating to cloud and effectively use IT developers following is suggested:

1. **Centralize Application Development:** All application requirement needs to be fulfilled from centralized application delivery. This will remove the manpower requirement for application development at Project sites. NTPC should have scalable cloud application deployment model. This will help in rapidly deploy applications which can be accessed at any project location through internet.
   Developers, often code applications on local system and then, when reach a work milestone, move the code to the production environment. With PaaS available, all developers should begin to develop and deploy their code in the cloud. Most integrated development environments (IDE) provide plugins to streamline the process and make it feel as close to developing locally as possible.
2. **Database Design**: For Major application choose a database that is scalable and located on a separate server or container from your application code. Then you can scale the database independently. For small application small in memory database like SQLite can be used. Avoid too many database platforms.
   Strictly control the database access mapping with various application. Provide read only view of Data to other application for sharing which will help in Data Analytics.
3. **Rapid Application Development**: To maintain the reusable codes and API for Data Entry, Data Updation and Report which helps in quickly delivering the data to day small requirement. Mobile UI code should be available for quick deployment.



Reusable Code & API

4. **Outsource Application Development:** In cases where requirements are fixed, application development needs to be outsourced. Cases where requirements keep changing may be developed by in-house team or through outsourcing contract for long duration.



5. **Scalability:** In general, there are two kinds of scalability:
   Horizontal scalability, which means the ability of a web application to accommodate more requests. In other words, an app must be able to work if the number of users grows dramatically.
   Vertical scalability, which means the ability to add new components to a web application without damaging its performance.

6. **Avoid vendor lock-in:** While many cloud providers provide great-looking proprietary APIs that reduce the amount of code or work may be avoided if possible. This is nothing more than a simple ploy to get you locked into their ecosystem while making it extremely hard to move application to another provider in future. To avoid these custom APIs, stick with tried-and-true technology stacks across application, including the database tier, storage tier, and any micro service endpoints.

[Final Outcome]

NTPC May have following benefits:

1. No IT Manpower needed at Site for Application development and server management.
2. Application will be developed and maintained for Pan-NTPC usage with DR provision.
3. Central database source for consumption to all application for data analytics.
4. Standard application development practices will result in better UI, Security, Testing, upgradation, Mobile ready application interface.
5. Resource scalability shall be available.
6. All non-ERP Application can have Single Sign On and remove multiple passwords.
7. Central repository of application help manual shall be available.
8. Same application can be readily available to be deployed at other JV's or other clients through consultancy.

6.3 Upgradation of ERP Applications:

SAP and Paperless Project Pradip are big ERP Applications NTPC is using. Both require Big Data Center at Noida along with Disaster Recovery at Hyderabad. Dedicated Server, Network and Security team are looking after the infrastructure along with application and functional team.

SAP R/3 is the oldest version of ERP. The name R/3 comes from the three-level architecture of the software. The first level from the user's point of view is the presentation level on which

the user interface is located. Below this is the application level, which represents the business logic. The third and last level is the database level. The successor version **SAP ECC** also follows this architecture. ECC stands for ERP Central Component. With this version, SAP has moved away from the idea of "everything in one software" to software with certain basic functionalities. In both systems, the data is stored in a relational database and the processes in the systems are transaction-based. **SAP S/4 HANA**, on the contrary, exists as an on-premises or a cloud solution. It also has a database based on columns. It's an imagined platform that combines data processing, database, and in-memory processing, provides libraries for planning, text processing, predictive, spatial and business analytics

SAP has already provided many cloud solutions which can be implemented in NTPC with further refinement in existing business process and migration of Data. SAP – HANA is already a best candidate for same. The migration to SAP S/4HANA is not a one-off project such as an upgrade or database migration. At the outset, doing an SAP S/4HANA cloud data migration requires understanding a few differences between S/4HANA Cloud and S/4HANA on-premises. SAP provides a number of tools to expedite the SAP S/4HANA cloud data migration process. A detail assessment in context of NTPC needs to be carried out to identify the upgradation of existing SAP system:

New implementation or re-implementation—In this strategy, standardize and simplify existing landscape by implementing it anew in S/4HANA. Once finished, retire legacy SAP system.

System conversion—Here, convert the entire SAP ERP system for a business to S/4HANA.

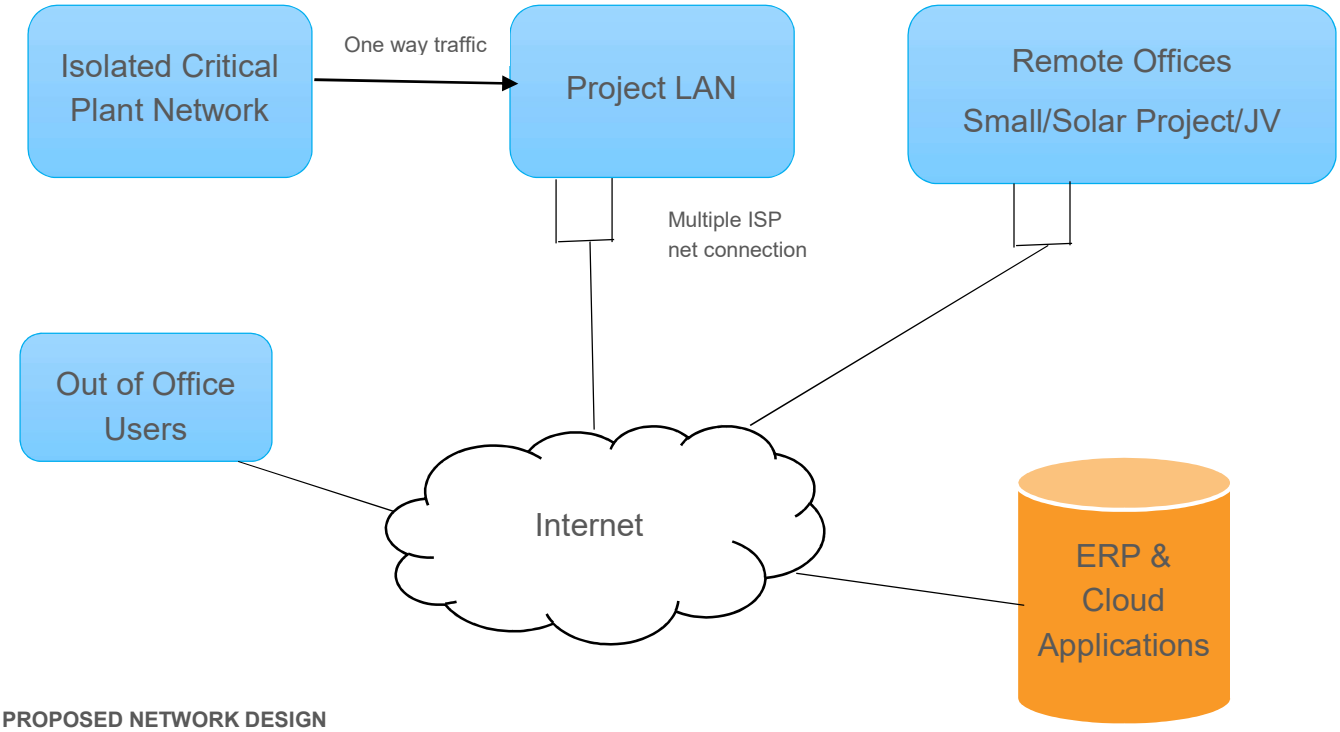
6.4 Transformation of MPLS WAN

MPLS is a layer 2 communication switching protocol that relies on compact switching labels to relay payload to the next hop, as opposed to the layer 3 IP addressing used in common IP-routing protocol. Essentially, MPLS allows a router to place a 'label' on packets of internet traffic, each label explaining where the information needs to go next. A decade or so ago, this meant a reduction in processing time at each router – a speed augmentation that was welcomed by big business.

MPLS was originally designed to offer a stable, dependable connection – and it did, for a time. Yet the fact remains that MPLS no longer meets all the requirements of today's enterprises working to an unprecedented global scale. In the 20 years MPLS has existed, a raft of progress has very much changed the online landscape. In the 90s, mission-critical applications were not in the cloud, and users were not accessing corporate applications from mobile devices. MPLS was an adequate workaround for yesterday's challenges but not

today's. Earlier application needed low latency connections but today applications are designed to be hosted on cloud and can be accessible from internet.

Today, when large businesses look to connect branch offices with company headquarters, there are a number of things they should consider about MPLS before continuing to rely entirely on this connectivity solution. Remote international sites may find MPLS is not available, or prohibitively expensive. With NTPC operating numerous branch locations across the globe and expanding into new territories through mergers and acquisitions, MPLS can be unacceptable in today's digital landscape. Currently major thermal plants are connected through MPLS. MPLS requires the same service provider across the network It's a shocking truth, but it is mandatory that the same MPLS service provider operates across all locations in your network. And, as we're all well aware, switching provider is no easy task. **For NTPC many JV, International offices and solar plants needs to be connected through multiple ISP internet lines which are readily available locally**. Enterprises need network flexibility and need connectivity to cloud services since the internet is the cheapest and simplest connectivity option into the cloud. . A broadband provider can usually light up a site within two or three business days. An MPLS provider will take weeks or months to connect the same site. The cost per bit for broadband is much lower than MPLS in most geographies, and high-bandwidth options for MPLS are sometimes hard to find even if you don't have the budget for it.



PROPOSED NETWORK DESIGN

The WAN is being revolutionized by enterprise's growing adoption of cloud and SaaS services, which are largely public internet based. This is where using MPLS can put you at a disadvantage. Knowledge-based, cloud-fueled, global, and mobile enterprises demand a high performance, agile, application-agnostic, quick to deploy, affordable to own, and managed network solution.

In traffic over the MPLS network to the data centers, network security screen both inbound and outbound internet traffic. With internet as a primary network connection, we need to architect their security. Remote sites will need local next-generation firewalls, intrusion protect appliances, and other security services.

SD-WAN (Software-Defined Wide Area Network) can also be explored which presents a new, flexible and exciting option for those looking for an alternative to MPLS-based networking, or a hybrid network configuration. This differs by providing multiple high-bandwidth connections simultaneously, or by utilising a combination of MPLS and internet. These are cost-effective, and can be aggregated to allow for faster connections. This aggregation can include WAN connections to a single site, and, by bonding different types of connection together, performance is optimised.Improved SLAs, increased network visibility, end-to-end encryption across the network (including the internet)
SD-WAN gives the ability to intelligently control the traffic from one location to another and load-balance to the highest-performing available link, offering application surety. SD-WAN can also deploy quickly when requirements change in order to bring bandwidth in line with an application's needs.

[Final Outcome]

NTPC May have following benefits:

1. Only one or two outsourced expert Network Engineer shall be required at Project location to manage the internet connectivity.
2. Modern application design is suitable for internet connectivity and does not require low latency.
3. Various small projects, offices, JV's can be brought into NTPC network.
4. **Critical Plant operation system shall be kept completely isolated to avert any cyber security threat. Only one-way data for analytics needs to be retrieved through firewall and proper security.**

6.5 Digital Workplace: Email, VC, Office Tools

For a digital workplace NTPC has to provide data and application to employees anywhere, anytime and on any device in a secure way. 6.1 to 6.4 helps in achieving this goal. Still mailing, office suite and video conferencing system needs to be upgraded. In current scenario isolated mail system like Zimbra is not so much productive. In market cloud email solutions with integration of office tool and collaboration tools are already available. Two major candidates for such solutions are GSuite and Office 365. Both has subscription model available and there is no need to manage own infrastructure.

GSuite has online office tools available which are compatible with MS Office. To avoid change management issue in case of GSuite adoption dedicated MS Office may be purchased for selected functional users like finance.

GSuite & Office365 provide excellent video conferencing capability which may reduce the cost of in-house hardware based VC. Both have email services which are by default integrated with various tools and storage. Both have world class security team monitoring the data centers round the clock.

[Final Outcome]

NTPC May have following benefits:

1. Only one or two executives shall be required to manage the Enterprise mail system.

2. No password reset support shall be required.
3. Cost of In-house VC infrastructure and Manpower will come down.
4. Increase in efficiency of employees.

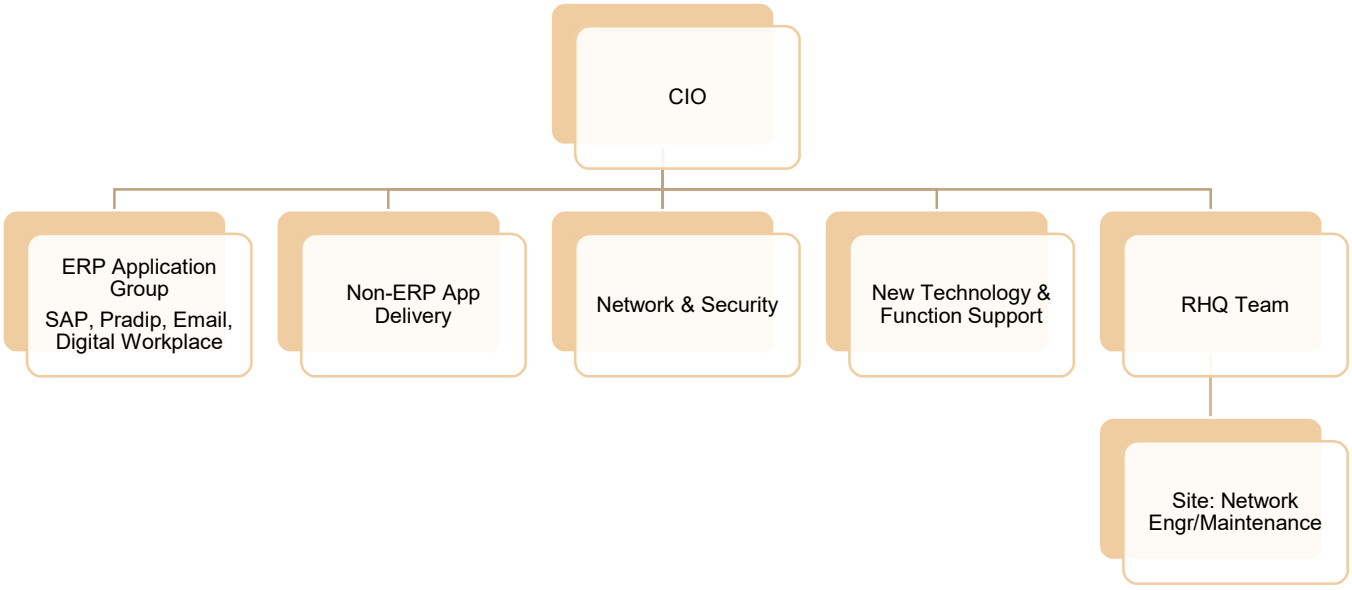
6.6 IT Procurement

Moving Enterprise application to cloud shall reduce the IT hardware liability and save cost. Desktop PC & Server procurement needs to be stopped. It needs to be done only for specific needs. Laptop procurement can also be switched to employees with help of HR. In today's world purchase of Laptop or PC by individual is not a big deal and IT support is not required for purchase. It will drastically help to reduce the manpower required for procurement. Employees can purchase the laptop with online approval of configuration from IT and directly claim it. Laptop should have 3 years' comprehensive warranty and insurance.

For Operating Stations & Green Field projects basic IT network infrastructure requirement should be immediately taken care by procurement team at RHQ. With move towards paperless, requirement of printers shall also be less.

6.6 IT Organization Structure & CIO Role

Digital transformation of Business requires IT role to be changed from Service provider to Key Process enabler. IT Involvement is required from planning stage of all business activities. CIO should be involved at highest level Management decision making to enable the digital business transformation and keep IT in sync with dynamic needs of the company. IT to be re-organized as following:



ERP application group may look after the SAP, e-Office, Digital workplace implementation with cloud infrastructure.

Non-ERP App delivery group to full-fill application requirement of functions and projects by outsourcing or in-house developing the applications and deploying on cloud. Same can be extended to JV's and external agencies requirement. Proper centralizing capturing and monitoring mechanism of requirement till delivery of solution.

Network & Security group to manage enterprise network and security. Penetration testing and proper security audits to be done for cloud and internal infrastructure.

New Technology & Function Support group to explore the new technologies with cross functional teams of various business functions. Deputation of IT executive up to E5 to be ensured in various domain like PP&M, cooml, OS, HR, Fin etc for 1-2 years to better understand the business requirement.

RHQ Team: Team of 1 or 2 executives Cater the need of procurement of sites. Manage network and maintenance contract for manpower engagement. 1 to 2 Contractual maintenance engineer with fixed monthly salary basis to be engaged for deputation at site and RHQs. Also 2 to 3 Contractual network engineer with fixed monthly salary basis to be engaged for deputation at site and RHQs. Manpower engaged under comprehensive AMC or under maintenance contract have wage issues and impact on quality of service.

[Final Outcome]

NTPC May have following benefits:

1. This will help to reduce number of IT manpower required for doing similar kind of job like application development, server maintenance, procurement, networking.
2. At site only contractual manpower shall be required for managing network and infra maintenance.
3. Procurement needs can be easily catered from RHQ with good vendor base.
4. This will improve the coordination between groups and business functions.
5. Roles and responsibility can be easily defined. It will eliminate grey area for IT service delivery.
6. It will help to identify the competency and skill development.
7. Training needs to be identified and professional certification can be encouraged.

6.7 Corporate funding for Innovation & Intellectual Property in new technologies

For Advances in automation, the digitization of information, readily solution in market is difficult to find. For getting solution in IIOT, AI, Analytics for NTPC following can be done:

Encouraging collaboration with University: In today's competitive environment, we must also develop new partnerships with leading universities, IITs, foundations, and other research-intensive institutions. These partnerships are not just about transferring knowledge from lab to practice. With provision of critical funding for talented faculty and students to pursue foundational research will help enhance the business process of company. This will also help to keep intellectual property right on the solution.

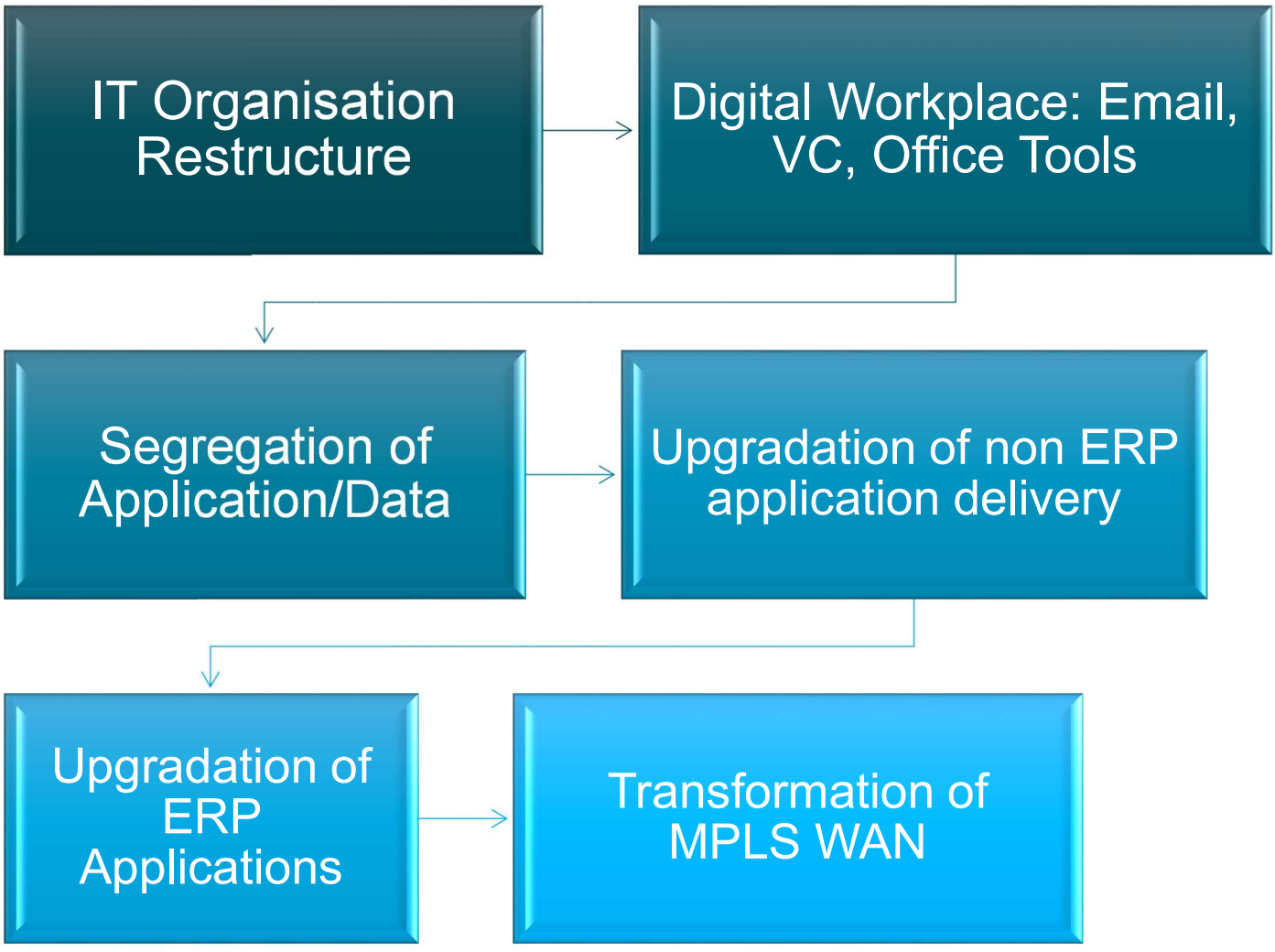
Fostering entrepreneurship: We need to explore possibility for allowing startup to solve our business problem. We have to recognize the high-value, high-return solution offered by these collaborations.

[Final Outcome]

NTPC May have following benefits:

1. This will help to find custom solutions for new technologies.
2. New solutions developed can be extended to JVs and other external agencies.

7. ROADMAP


IT Organisation Restructure
Digital Workplace: Email, VC, Office Tools
Segregation of Application/Data
Upgradation of non ERP application delivery
Upgradation of ERP Applications
Transformation of MPLS WAN

Thank You