

# **Analytical Techniques for Decision Making in Agriculture**

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# **Analytical Techniques for Decision Making in Agriculture**

— *Editors* —

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# Preface

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The book titled “Analytical Techniques for Decision Making in Agriculture” provides a summary of analytical techniques used by the professionals for Decision Making in Agriculture. The book is divided in 25 chapters. Each chapter has been developed based on the presentations by the respective authors in training programme to the faculty working in the areas of agricultural research. However, the analytical techniques covered are useful for the scholars working in other domains also.

The book is different from other books on analytical techniques in many aspects. Some books cover analytical techniques in theoretical sense. Some other books cover practical aspects of a single issue without the emphasis on quantitative analysis. However, the application of analytical techniques presented in the book is based on actual research, several years of experience of the authors and the actual datasets rather than hypothetical ones. Hence, the chapters offer real problems and the solutions while using the specified analytical technique. Further, the book provides a comprehensive overview of bioinformatics, ICT, GIS etc., in modern research.

We take this opportunity to gratefully acknowledge the contribution made by the authors of various chapters in the preparation of this book. We warmly acknowledge the various sources and publications from which valuable materials for this book has been drawn.

We sincerely acknowledge the help received from Dr P S Birthal, Acting Director, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi who encouraged and provided institutional facilities in preparation of the book. We acknowledge the financial assistance received from Education Division, ICAR in organizing the Summer School on “Analytical Techniques for Decision Making in Agriculture”.

We also take this opportunity to express our sincere thanks and gratitude to all who have made valuable suggestions to enhance the utility of the book and also wish to acknowledge and express our sincere thanks and gratitude to Astral International (P) Ltd, New Delhi for providing the necessary encouragement to publish this book.

*S.S. Raju*

*Rajni Jain*

*Usha Ahuja*

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# **Chapter 24**

# **Data Center and its Services in ICAR**

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## **Introduction**

There was a time when our information needs were simpler. But since the dawn of the Internet, high-bandwidth broadband, smartphones and other new technologies, are constantly online and constantly demanding that data be delivered to the computers, gaming systems, TVs and phones. Electronic exchange of data is required for just about every type of business transaction, and is becoming the norm for many of our personal interactions. With this massive demand for near-instantaneous delivery of digital information came the need for concentrations of computer and networking equipment that can handle the requests and serve up the goods. Thus, the modern data center was born.

A data center is a facility that centralizes an organization's IT operations and equipment, and where it stores, manages, and disseminates its data. Data centers house a network's most critical systems and are vital to the continuity of daily operations. Consequentially, the security and reliability of data centers and their information is a top priority for organizations. It consists of servers and storage

equipment that run application software, process, store data and content. The data center environment is controlled in terms of temperature and humidity, both to ensure the performance and the operational integrity of the systems within. Facilities will generally include power supplies, backup power, chillers, cabling, fire and water detection systems, security controls etc.

The main purpose of a data center is running the IT systems applications that handle the core business and operational data of the organization. It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls and various security devices. Communications in data centers today are most often based on networks running the IP protocol suite. Data centers contain a set of routers and switches that transport traffic between the servers and to the outside world. Some of the servers at the data center are used for running the basic Internet and intranet services needed by internal users in the organization, *e.g.*, e-mail servers, proxy servers, and DNS servers. Network security elements such as firewalls, VPN gateways, intrusion detection systems are also usually deployed.

## **Data Center Goals**

The benefits provided by a Data Center include traditional business-oriented goals such as the support for business operations around the clock, lowering the total cost of operation and the maintenance needed to sustain the business functions, the rapid deployment of applications and consolidation of computing resources (Mauricio and Maurizio, 2004).

These business goals generate a number of information technology initiatives, including the following:

- ★ Business continuance
- ★ Increased security in the Data Center
- ★ Application, server, and Data Center consolidation
- ★ Integration of applications whether client/server and multitier (*n-tier*), or web services-related applications
- ★ Storage consolidation

## **Data Center Advantages**

- ★ Data centers are secure. It will typically be manned 24 hours a day 7 days a week and be physically very difficult to break in to.
- ★ Server is going to be kept in a secure environment that is prepared for the eventuality of power cuts. A data center will have huge banks of batteries and generators that will keep the electricity flowing indefinitely whilst the power outage is fixed.
- ★ The data center will have multiple high bandwidth and geographically diverse fiber connections to the internet.
- ★ Servers doesn't overheat and the data on servers can be safely and easily backed up (Davis, 2012).

## Data Center Requirements

An effective data center operation is achieved through a balanced investment in the facility and equipment housed. The elements of a data center are usable space, IT equipment which includes servers, storage hardware, cables, racks, firewalls. Also it requires support infrastructure such as uninterruptible power resources, room air conditioners, heating and exhaust systems. The operational staff is required to monitor operations and maintain IT and infrastructural equipment around the clock (Hwaiyu, 2015).

## Data Center Vs Cloud Computing

The main difference between a data center and a cloud is that a cloud is an off-premise form of computing that stores data on the Internet, whereas a data center refers to on premise hardware that stores data within an organization's local network. While cloud services are outsourced to third-party cloud providers who perform all updates and ongoing maintenance, data centers are typically run by an in-house IT department.

Although both types of computing systems can store data, as a physical unit, only a data center can store servers and other equipment. As such, cloud service providers use data centers to house cloud services and cloud-based resources. For cloud-hosting purposes, vendors also often own multiple data centers in several geographic locations to safeguard data availability during outages and other data center failures (Angeles, 2013).

## ICAR – Data Center and its Services

The state of art Data Center (Figure 24.1) has been created by Indian Council of Agricultural Research (ICAR) at Indian Agricultural Statistics Research Institute

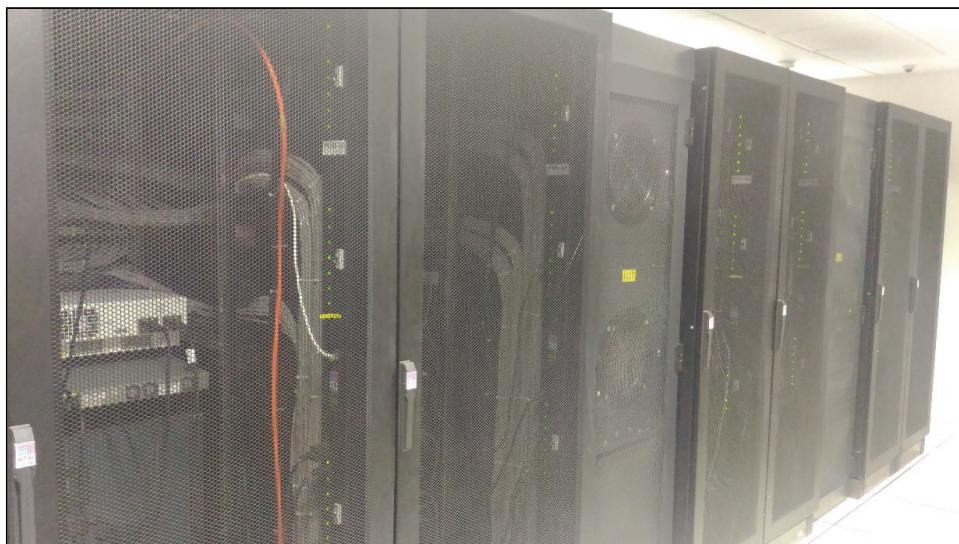


Figure 24.1: ICAR – Data Center at IASRI, New Delhi.

(ICAR-IASRI), New Delhi with the objective of providing the efficient collaboration among ICAR personnel through Unified messaging and dissemination of scientific/research/technological/educational/extension information through hosting of web sites and applications.

It meets the international standard of Data Center Tier III specifications with adherence to ISO 27001, ITIL and TIA 942 standards. The solution is based on Structured, Scalable and Resilient Network Architecture. The data center contains servers which are connected to high performance LAN Switches, for processing millions of packets per second, depending on users and application and its contents. The computing environment consists of 448 core computing with 150TB storage space which will enable the high speed of computing/processing of data. Virtualization aids in segmentation of computing for resource allocation and making available the need based storage for different applications. In the software component Microsoft Exchange Mail server, Windows and Linux operating systems along various databases (MSAccess, MySQL, and SQL Server etc.) are available in the Data Center. The Unified messaging solution is based on Microsoft Exchange Server. The unified communication feature of the solution will help ICAR personnel to stay connected with each other via instant messaging, email, audio/video calls, persistent chat rooms, online meeting and presentations for scientific/research/technological/educational/extension information exchange. This helps in creating Uniform Email ID of ICAR and its institutes/departments under single ICAR domain for effective communication at individual desktop (Choubey *et al.*, 2014).

## **Technical Architecture**

This facility has IT and Non-IT parts, wherein IT part deals with hardware/software and its integration. Installation of hardware, policy formulation, domain name registration and its configuration in the system and then loading and configuration of software as per policy requirements has been done. In the Non-IT part, Data Center environment has been created in Fire safe mode. Setup has been done for supply of water chiller based cooling and power supply. ICT infrastructure has been designed in such a way so as to provide redundancy for Power supplies, Controllers, CPUs to support 100 per cent uptime experience. The ICAR – Data center architecture is shown in Figure 24.2.

The data center has servers which are connected to high performance LAN Switches, for processing millions of packets per second, depending on users and application and its contents.

## **Computing Environment**

The computing environment enables the high speed of computing/processing of data. Core layer switches 1G/10G/40G enabled module provides easy scalability. The following are the some major computing environment in ICAR- Data center.

- ★ 448 Core Computing
- ★ 150 TB storage
- ★ Microsoft OS

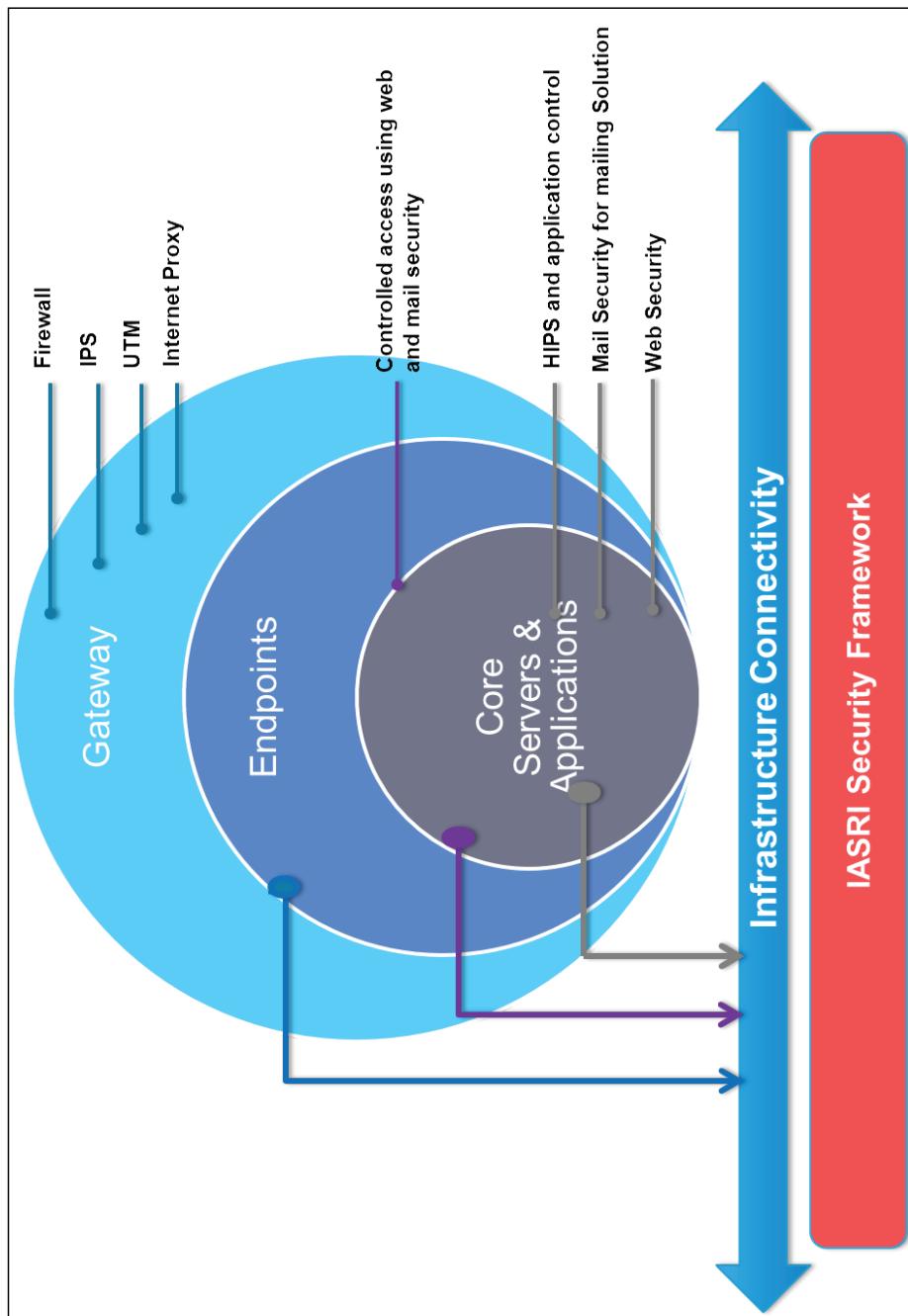


Figure 24.2: ICAR – Data Center Architecture.

- ★ Linux OS
- ★ Microsoft SQL DBMS
- ★ MySQL
- ★ Active Directory
- ★ Microsoft Exchange 2013
- ★ Microsoft Lync 2013
- ★ Virtualization
- ★ Switches

## **Services Offered**

The following are the services offered by the ICAR – Data center.

- ★ Virtual Machine and Data Storage
- ★ Web hosting
- ★ Unified Communication:
  - ★ Messaging (Webmail and POP)
  - ★ Phonebook
  - ★ Calendar
  - ★ Schedule meetings
  - ★ Chat
  - ★ Presence
  - ★ Web Conferencing
  - ★ Video Conferencing
  - ★ Content Sharing

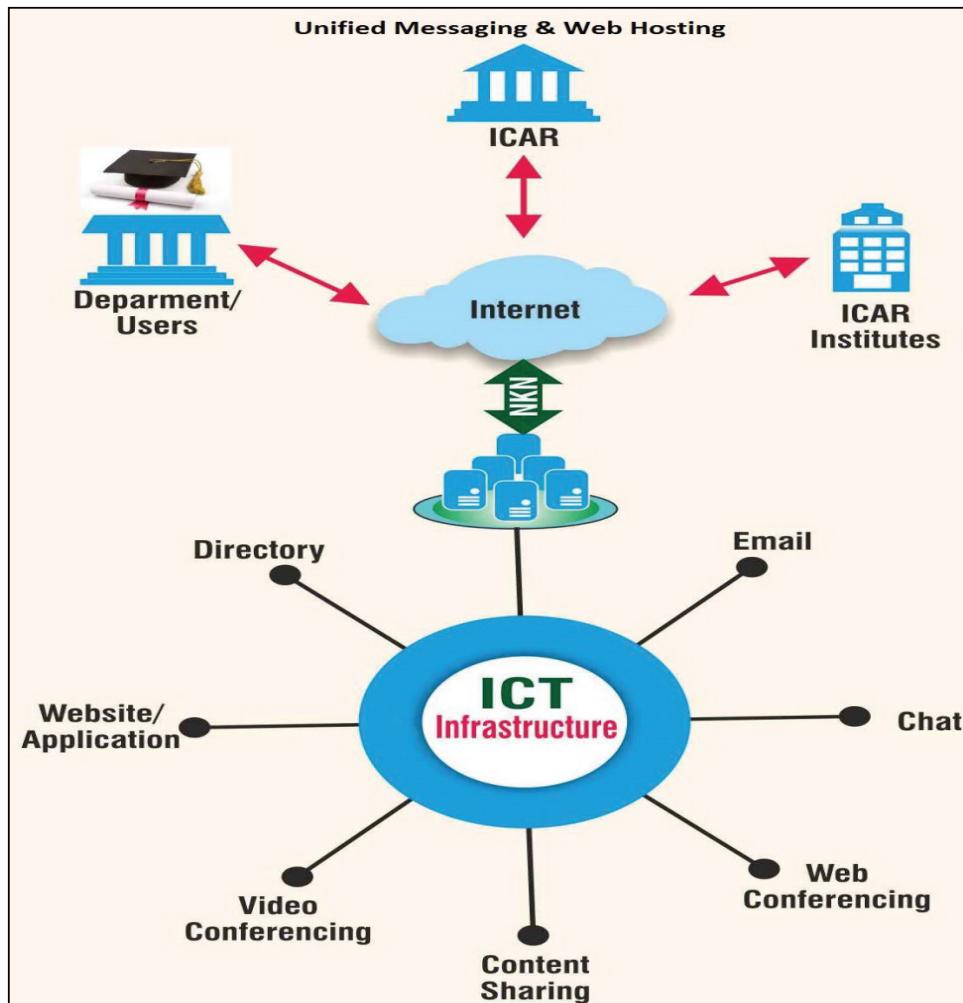
The concept diagram to access the unified messaging solution in ICAR is shown in Figure 24.3.

The unified communication in ICAR has been hosted and available at <https://mail.icar.gov.in> (Figure 24.4)

## **Features of the Solution**

The solution has the following features:

- ★ Scalability
- ★ 24 x 7 availability
- ★ Interoperability
- ★ Security
- ★ Manageability
- ★ Integration
- ★ Reliability
- ★ Adherence to ISO 27001, ITIL, TIA 942 standards

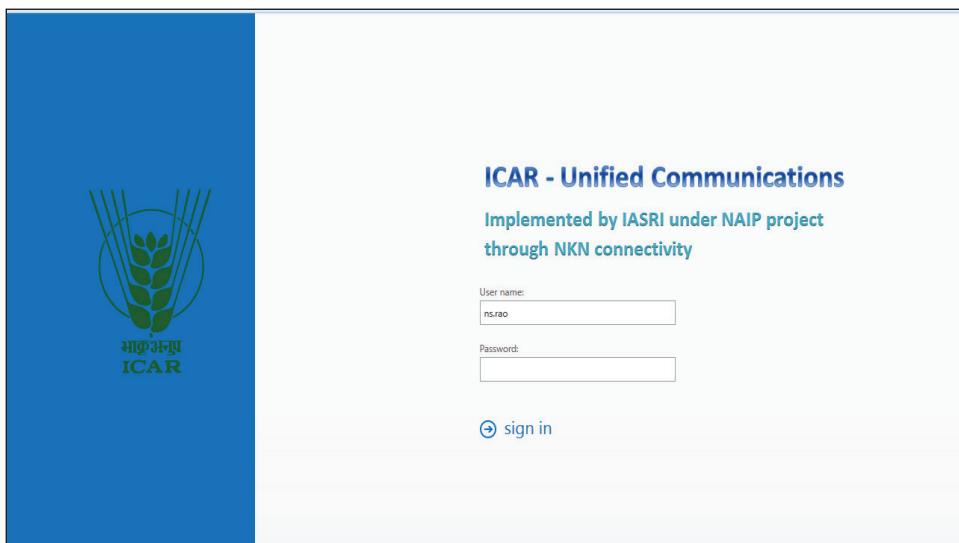


**Figure 24.3: Context Diagram of Unified Messaging Solution.**

Other features of the solution includes end-to-end security option with granular traffic control and monitoring smooth integration, migration, easy and centralized network management and fire protection.

## Infrastructure

The following infrastructure has been established under ICAR-Data Center to provide unified mail messaging and web hosting solution in ICAR.



**Figure 24.4:** <https://mail.icar.gov.in> – Home Page.

## Hardware

Server Devices:	CISCO UCS and CISCO Rack Servers
Storage:	EMC Networker
Network Devices:	Switches-CISCO L3 and CISCO L2 Switches, Array 2600
Security:	IPS, Firewall, IronPort, FortiGate, WebGateway
Backup and Restoration:	EMC Networker
Database:	SQL Server 2012, 2008 R2 and MY SQL
Alert Monitoring:	HPSM
Call Logging Tool:	HPSM
BMS PART:	State of the Art UPS and Air-Conditioning System, Fire Detection Control systems and Network cabling

## Software

OS:	Linux 7.0, Windows Server Data center 2012 and 2008.
Application:	MS Exchange 2013, Windows AD, Lync 2013, Web Hosting, SQL

## Purpose of the Infrastructure Setup

### Servers

A server is a program that awaits and fulfills requests from client programs in the same or other computers. A given application in a computer may function

as a client with requests for services from other programs and also as a server of requests from other programs.

**Exchange Servers:** Storing and accessing emails

**Lync Servers:** IM, Presence, audio, video chatting etc.

**SQL Servers:** storing application data and accessing application

## **Firewall**

A firewall is a part of a computer system or network that is designed to block unauthorized access while permitting outward communication. It is a device or set of devices configured to permit, deny, encrypt, decrypt, or proxy all computer traffic between different security domains based upon a set of rules and other criteria.

Firewalls can be implemented in both hardware and software, or a combination of both. Firewalls are frequently used to prevent unauthorized Internet users from accessing private networks connected to the Internet, especially intranets. All messages entering or leaving the intranet pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria

## **IronPort**

The Cisco IronPort is an appliance that is deployed into an existing mail infrastructure. All emails are sent to the IronPort and the IronPort is either the last point out (most common configuration) or it can process email and then send it back to the mail server where it is sent out.

## **Storage**

Product called **EMC VNX 5600** is used to store entire data. Total storage capacity of this data center infra comes up to approx. 140TB.

## **Backup**

Product called **EMC Networker** is used. Data are backed up in tapes in tape library. Each tape capacity 2.5TB.

## **Conclusion**

The information technology has revolutionized the way of living and conducting business. Organizations are experiencing a brutally competitive business environment and in order to survive, businesses have to embrace technology. It is the accelerating pace of business and the corresponding quickening of the pace of change itself that led to conceiving the idea of development of ICT infrastructure such as Data Center for ICAR. The Data Center provides the basis towards the implementation of standardized IT policy in ICAR. It also provides much secured, highly reliable, quickly scalable, efficient management and optimized utilization of resources in ICAR to deliver the Unified communications and Web Hosting services to ICAR and its institutions. It is envisioned to provide services for hosting websites and applications relating to information in the areas of education, research and extension projects of the institutes. This enables Scientist to focus on designing

system for delivery of information and services and need not to spent efforts on data management and hosting of applications.

## **References**

- Angeles, S. (2013). *Cloud vs Data Center: What's the difference?* Retrieved from <http://www.businessnewsdaily.com/4982-cloud-vs-data-center.html>
- Choubey A.K., Arora Alka, Marwaha Sudeep, Bhardwaj Anshu, Dahiya Shashi, Islam S.N., Kumar Mukesh, Rao N.S., Singh Pal and Ahuja Sangeeta (2014). “Final Project Report on Implementation of Management Information System (MIS) including Financial Management System (FMS) in ICAR”. IASRI, New Delhi.
- Davis, T. (2012). *The advantages of using a data center.* Retrieved from <http://www.timico.co.uk/blog/2012/06/21/the-advantages-of-using-a-data-centre>
- Hwaiyu Geng, P.E. (2015). *Data Center Handbook.* John Wiley and Sons Inc., New Jersey
- Mauricio Arregoces and Maurizio Portolani (2004). *Data Center Fundamentals.* Cisco Press, Indianapolis, USA.