![LTIMindtree]

Whitepaper

AWS Mainframe Migration (Cloud)

Abstract

Organizations across the globe have realized the importance of digital transformation as a key strategic initiative to redefine relationships with their clients, customers, employees, and partners. The digital transformation utilizes modern digital technologies and cloud platforms to meet changing business and market needs. On the contrary, the organizations still possess large legacy mainframe workloads to run their core businesses. Modernizing the mainframe workloads by migrating them to the cloud gives your business enterprise a clear competitive edge with distinct advantages, such as scalability, cost reduction, automation, operational flexibility, rapid development, and faster time-to-market.

This whitepaper will walk you through the challenges and benefits of the mainframe application migration to AWS and provide an insight into the right approach to kickstart your migration journey. A well-planned migration strategy would help carry out a seamless shift without disrupting your organization's workflow. The key to a successful migration is soliciting an expert mainframe migration partner who will employ the appropriate migration approach, which is crucial for the success of your digital transformation engagements.

Introduction

Mainframe computers have been hugely popular over the past few decades, as they can process terabytes of data with high performance and produce valuable output. These large mainframes ran multiple workloads in parallel (such as programs, middleware, data stores, dependencies, and resources) that execute a cohesive set of business functions. Mainframe workloads majorly fall under one of the two categories mentioned below:

Online application

Transaction processing that occurs interactively with the end user is referred to as Online Transaction Processing or OLTP. Mainframe applications that process these OLTP transactions called online applications.

Batch application

With mainframe systems, businesses process data in background and generate reports for review. The applications producing such statements are batch applications.
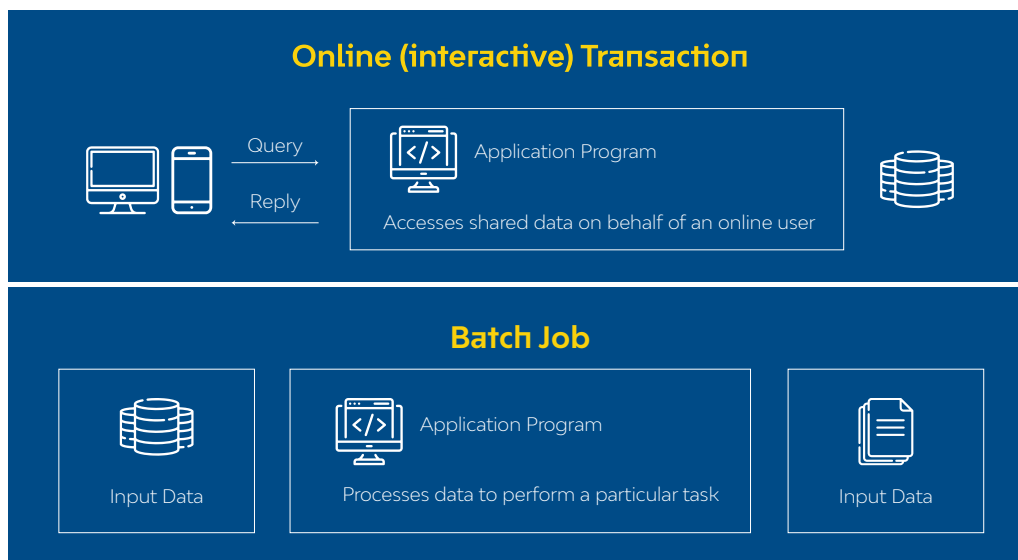
Even after 60 years, the mainframe remains a core and invaluable enterprise technology for large enterprise customers across Finance, Insurance, Manufacturing, Retail, and the public sector industries. The mainframe is still not dead, but with the advancement in technology, has led mainframe to be slowly outpaced by their more modern counterparts. Hence, in this age of rapid digitization and fast-changing business, organizations will have to embrace modernization to reap the benefits of digital transformation.

Challenges with Mainframe Applications

Over the years, mainframe application developed many challenges which are hindering organization growth. The challenges include workload complexity, high operating cost, skill shortage, inflexibility in the system, slow time to market, partial or no omnichannel support, outdated customer experience (UI), etc., to name a few. In following section, let's discuss few of the challenges in detail and how to address the challenges using modern technologies on cloud.

Workload Complexity

Developed over years by multiple authors, point of time development, non-configurable business rules, nested loops, unconditional routing, monolithic modules, tightly coupled system, ageing technologies and inefficient old integration patterns are few factors which makes mainframe workloads more complex and inefficient compared to their modern counterparts.

The Cost Factor

The costs of running mainframe systems can get sky high - the higher the transaction volume, the more expensive it gets. Moreover, the costs associated with storage, maintenance, operations, and facilities are also significant factors. In addition to this, proprietary third-party hardware and software's licenses further increase total running cost.

Shortage of Skills

Professionals with the required expertise to maintain and operate mainframe workloads are reaching the edge of retirement and ageing out (average age of COBOL and mainframe experts being 50+ years). In recent years, most universities have stopped training people on mainframe to focus on modern emerging technologies. Organizations are facing mainframe skills shortage, as per recent study 23% of the mainframe workforce has been lost, and 63% have not been replaced.

Time-to-market & Customer Experience

Organizations globally are under immense pressure to create a culture of growth, and turn more competitive, efficient, and responsive to the rapidly changing business scenario. Mainframe applications are monolith in nature and provide old user experience using typical 3270 green screen terminal. Hence, they are a significant barrier in accomplishing the modern business imperatives such as faster time-to-market and better employee & customer experience.

How Modern Technologies on Cloud Addresses these Challenges?

IT teams are looking forward to using an option of modern technologies on the cloud to addresses the above challenges as part of their digital transformation journey. Hence, migrating off mainframes has become imperative for enterprises.

✔ **Reducing workload complexity**

Re-architecting mainframe applications by using modern cloud native technologies brings agility and flexibility into application. In addition, features of the cloud platform such as on-demand access and easy scaling of compute and storage resources, ready-to-use SaaS products, automation of application deployment and provisioning, rapid development, high availability of applications etc., reduce overall workload complexities.

✔ **Adding cost benefits**

Cloud platform provides various options to reduce proprietary hardware and software license fees. Hence, migrating workloads to the cloud reduce overall application runtime cost. Additionally, a cloud's pay-as-you-go model, organization save costs by paying only for the compute time they use instead of providing infrastructure upfront for peak capacity.

✔ **Addressing skills shortage**

Most of the new talents are gravitating towards the newer and more popular cloud technologies. Adopting the popular technologies by migrating applications to cloud mitigates skill shortage problem.

✔ **Time-to-market & better customer experience**

Developing a user-friendly modernized app that can easily adapt to all device size and building modular application improves time-to-market and customer experience. The cloud platform provides tools to build and deploy these modernized applications quickly and organizations can expand their business to new geographical regions by deploying their modernized apps globally in minutes.

Why AWS is the Right Cloud Platform for Migrated Mainframe Applications:

For years, AWS is global market leader in cloud platform provisioning industry and committed to provide uninterruptable, secure, fully scalable and manageable platform to mainframe workloads. AWS offers 175 cloud services, which makes it right choice for migrated mainframe applications.

Following are few areas where AWS provides right products for the migrated mainframe systems.

- AWS offers a pay-as-you-go approach for pricing for over 175 cloud services. With AWS, you pay only for the individual services you need, for as long as you use them, and without requiring long-term contracts or complex licensing.

- AWS provide multiple fully scalable and manageable compute options for migrated mainframe workloads such as on-demand Amazon Elastic Compute Cloud (Amazon EC2) instances, fully managed AWS Lambda, fully managed container services AWS ECS/EKS.

- For migrated mainframe databases AWS provides 15+ multipurpose database options such as AWS RDS, AWS Aurora, AWS Redshift, AWS DynamoDB, AWS MemoryDB, AWS ElasticCache etc. to meet Organization need.

- For migrated files and data archives, AWS provides low-cost high-speed storage options such as AWS S3, AWS EFS, AWS FSx and AWS EBS.

- AWS provides fully managed services for rapid development using Continuous Integration (CI)/Continuous Deployment (CD) pipeline which includes products such as AWS Code Pipeline, AWS CodeCommit, AWS CodeBuild, and AWS CodeDeploy.

- AWS provides elasticity using AWS Auto Scaling across availability zones and data centers for applications. Horizontal scalability is facilitated by replicas or Amazon Aurora Multi-Master for databases.

- Infrastructure automation on AWS achieved using AWS Command Line Interface (CLI), AWS Software Development Kits (SDKs), AWS Cloud Development Kit (AWS CDK), and AWS CloudFormation templates.

- AWS not only prioritizes security, but it also enables the organizations to inherit the best practices of policies, architecture, and operational processes that satisfy the demands of security-sensitive environments. AWS provides 20+ security related services in areas such as identify & access management, threat detection, infrastructure protection, data protection, incident response and compliance.

Benefits that AWS offers are usually outside the range of legacy applications running on mainframe systems, including greater agility, scalability, and cost-effectiveness. Modernizing the mainframe architecture would allow organizations to leverage the cloud and take advantage of these benefits.

Mainframe Migration Options

With the modernization of the existing mainframe environment by migrating to the AWS, enterprises can reap this new system's benefits and capabilities that ensure increased business agility, operational flexibility, and cost-efficiency. A migration approach that's well-planned is a must, and the ideal method should be aligned with the organization's risk tolerance and overall cloud strategy.

Here is an overview of the three most effective and commonly used migration options:

**Re-hosting**
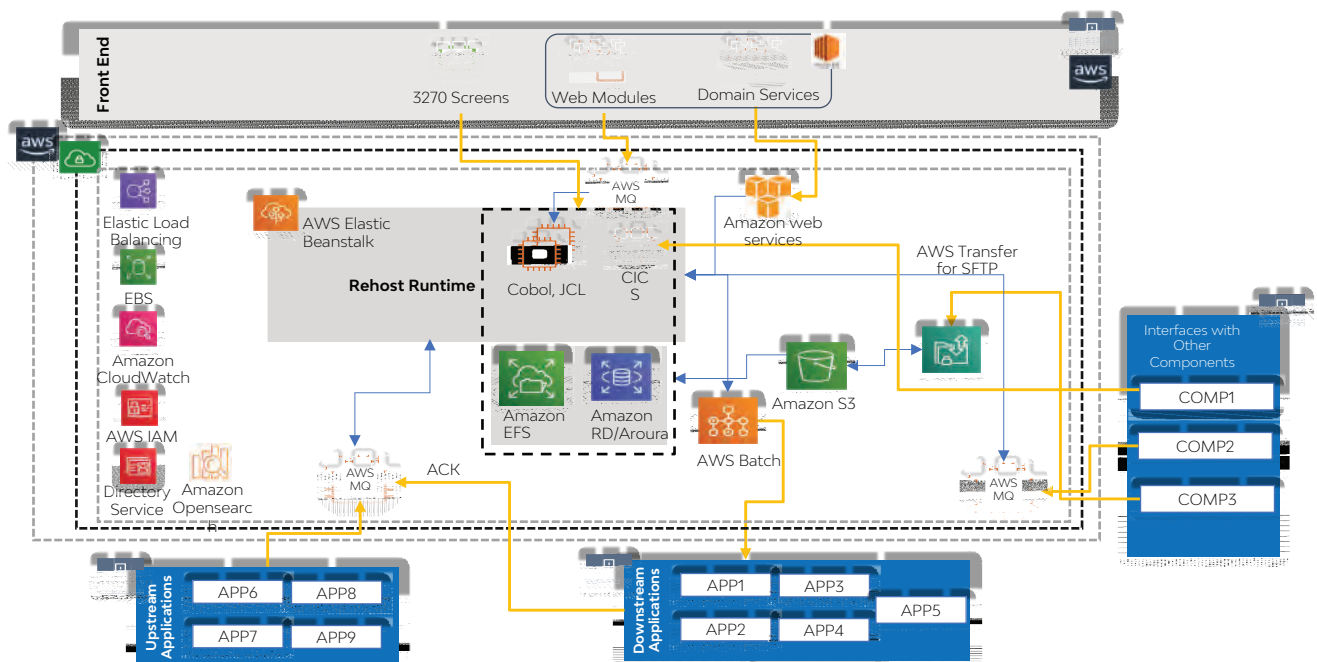
Re-factoring

The refactoring approach allows to "re-architect" existing applications to leverage the features and services offered by AWS environments. This approach involves restructuring existing code or programming language to a modern one to reduce the risk of technical debt and several skill-related risks. There is a total refurbishment of an application to adapt it to AWS, and this option is preferred when the company has a strong business need for cloud features (such as improved development agility, scalability, or performance).
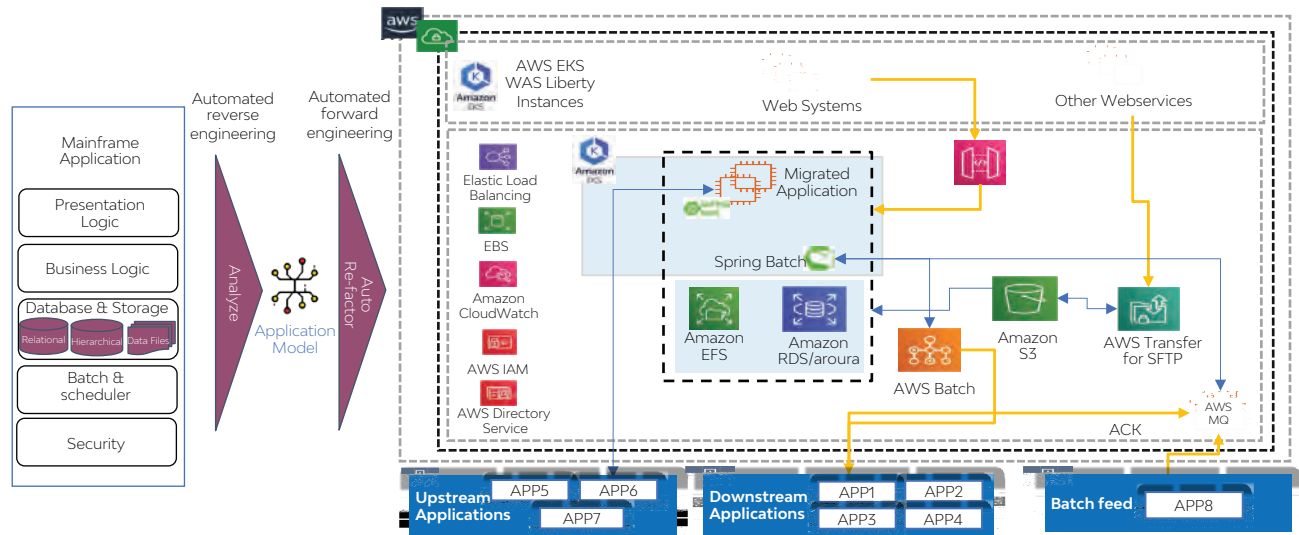
Automated Refactoring tools analyse and transform the complete legacy stack (such as COBOL-based), resulting in the automatic creation of a coherent and functionally equivalent target stack (such as Java-based or .Net based). Typically, the resulting application follows the best practices similar to cloud-native applications, which are service-oriented, service-enabled, and have packaged optimizations for AWS services. The Automated Refactoring tools' value and differentiators rely mainly on their automated forward-engineering capabilities. In this transformation, there is optimum automation for efficiency & quality but no manual re-write of code

Re-engineering

This approach involves ground up development of the application, that is, "rebuild" using all the cloud services and features and discarding any legacy components. This approach requires complete knowledge of the existing application processes and functionality and a good grasp of AWS services. The rebuilding approach results in a completely new application with an improved feature set and capabilities.
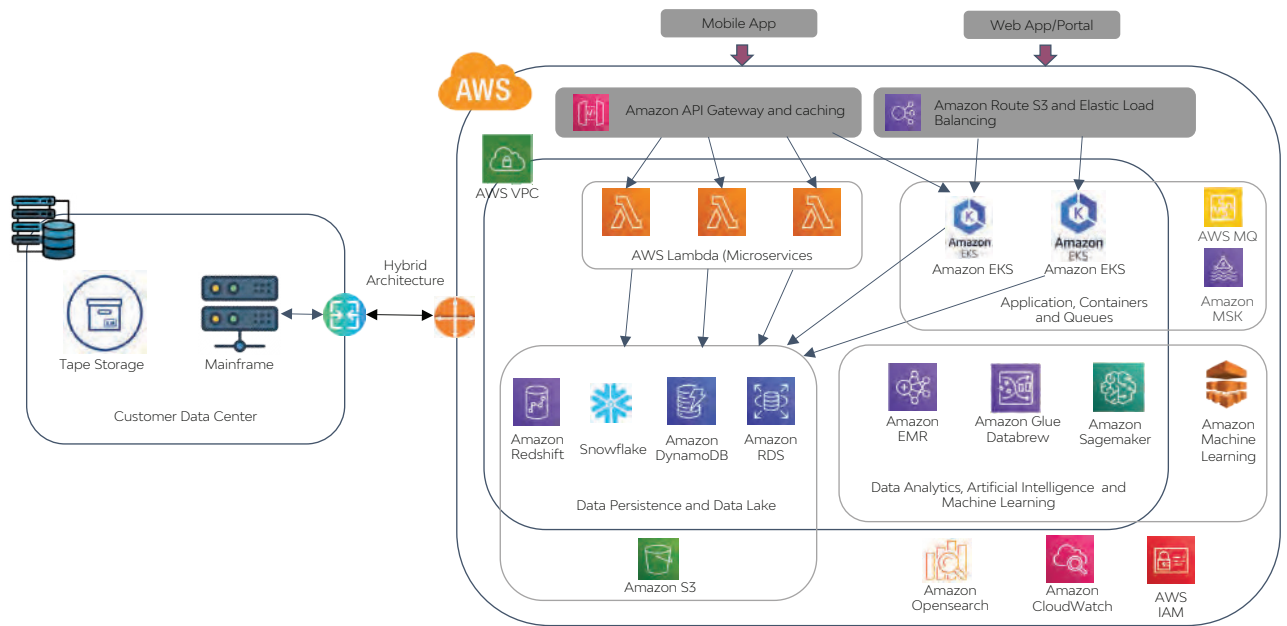
This approach is recommended when the existing mainframe application can no longer meet future-state business requirements or agile target architecture. While rebuilding, the organization can leverage a microservice-based architecture by using cloud-native techniques, leveraging micro-services, containers & decoupling, data analytics, artificial intelligence, and machine learning.
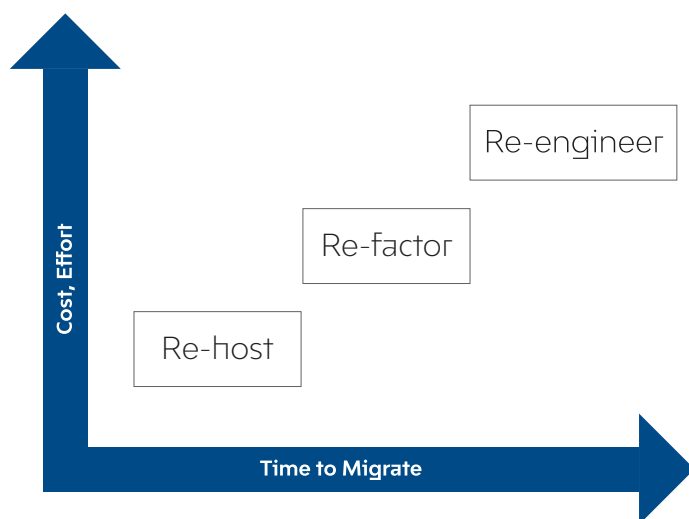
Suitable Migration Options

As each method or approach has its pros and cons, an assessment by migration partners like LTIMindtree is recommended to decide most suitable migration option based on organization's need and build business case for budget approvals.

Rehost: Re-host, emulator based "lift & shift" approach, is most time and cost-effective solution to migrate mainframe applications to AWS and save runtime cost. However, as there is minimal change in application functionality and technology, the application is not transformed enough to address all mainframe challenges such as skill shortage, workload complexity, time-to-market, consumer experience, etc.

Refactoring: Re-factor applications using auto code conversion approach is a relatively expensive option but can offer the best possible benefits of the modern technology. This option does address few mainframe challenges such as cost, skill shortage, scalability, etc. However, as there is no change in application functionalities, the option doesn't address challenges such as workload complexity, time to market, consumer experience and so on.

Re-engineering: Re-engineering or Re-building transforms application to core and reap all benefits of modern technologies and platform. The approach addresses most of mainframe application challenges including workload complexity, time-to-market and consumer experience. However, Re-engineering is costliest and time-consuming migration approach.

Rehosting and Refactoring migration are not truly mainframe applications transformation options, they are pit stops in journey of complete modernization. One needs to optimize and evolve these migrated applications to make them cloud native and gain advantage of cloud computing technology.

Regardless of the options adopted, organizations should consider the mainframe workloads in their cloud migration strategy, resulting in significant cost savings, increased agility, and a future-proofed architecture.
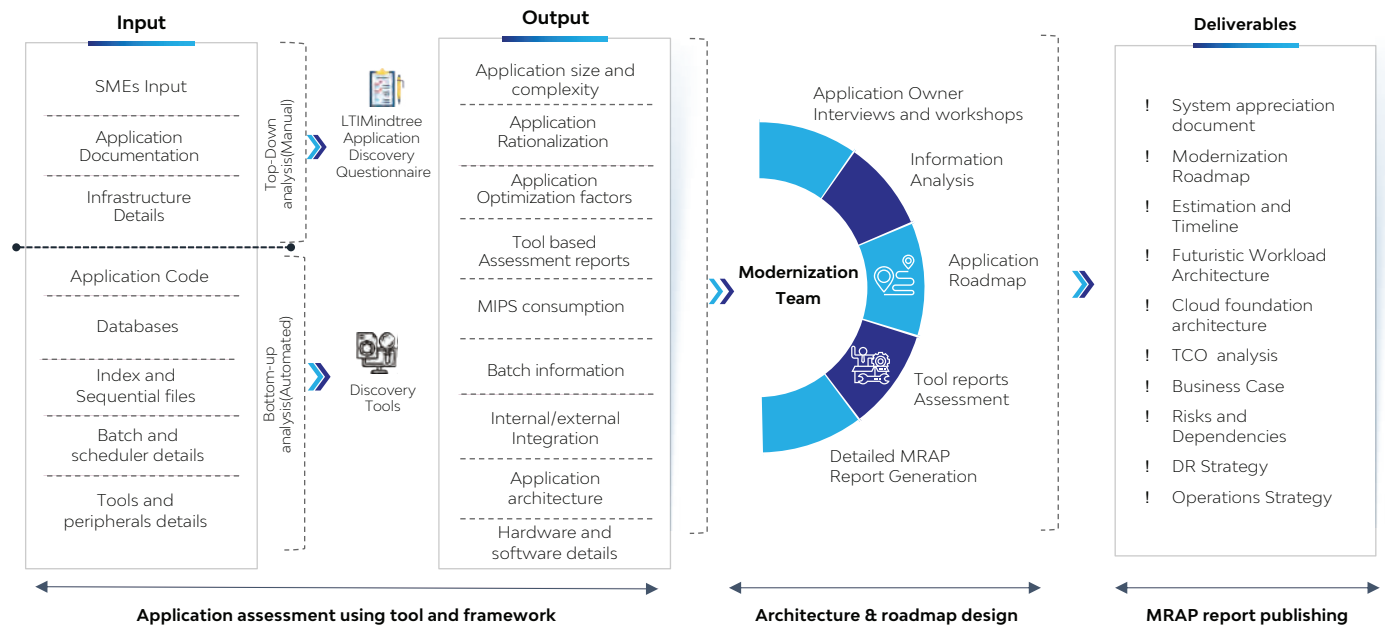
LTIMindtree's Mainframe migration approach

LTIMindtree's mainframe migration approach is an all-inclusive suite of contemporary tools and processes that offer application-readiness assessment, architecture design and blueprint, besides tool-led migration, testing, and operations management. The approach brings together several key constructs across the migration lifecycle to accelerate digital transformation.

Application Assessment	Design and Templatization	Migration	Testing & Go Live	Operations
• Shortlisted applications • Automated tool-based discovery • Focused group interviews • Application decomposition analysis • Compatibility analysis • Internal and external interfaces • Cloud Total Cost of Ownership (TCO) • Migration scope • Risk and dependencies	• Architectural blueprint • Database design • Security design • Network design • Templatization • Service catalog	• Tool based migration • Rehost, Refactor, and, Re-engineer • Database migration • File migration • Other component migration • Non supported component remediation	• Functional testing • Integration testing • Performance testing • User acceptance testing • Validation • Cut over and go-live	• Deployment automation • Golden images • Patch management • Monitoring and logging • Security and backup • Well architect framework and governance
• Assessment questionnaire • Cast and Partner's tools • Infinity Platform	• Terraform • Infinity Platform	• Cloud Endure • AWS DMS • Infinity Platform	• Selenium • Jmeter • Postman • Curl Scripts • Jenkins/Canvas DevOps	• Cloud Ensure • Jenkins • Canvas DevOps • Cloud Image Builder • Powermon • DataDog

✔ LTIMindtree's MRAP Framework for Application Assessment

Assessment lays foundation to overall migration program. Migration Readiness Assessment & Planning (MRAP) framework is a 3-step process that helps to assess existing mainframe workloads and provide most suitable solution to migrate application to cloud, as explained in the below illustration

Input	Output
SMEs Input	Application size and complexity
Application Documentation	Application Rationalization
Infrastructure Details	Application Optimization factors
Application Code	Tool based Assessment reports
Databases	MIPS consumption
Index and Sequential files	Batch information
Batch and scheduler details	Internal/external Integration
Tools and peripherals details	Application architecture
	Hardware and software details

Top-Down analysis(Manual) — LTIMindtree Application Discovery Questionnaire

Bottom-up analysis(Automated) — Discovery Tools

Modernization Team

- Application Owner Interviews and workshops
- Information Analysis
- Application Roadmap
- Tool reports Assessment
- Detailed MRAP Report Generation

Deliverables

- ! System appreciation document
- ! Modernization Roadmap
- ! Estimation and Timeline
- ! Futuristic Workload Architecture
- ! Cloud foundation architecture
- ! TCO analysis
- ! Business Case
- ! Risks and Dependencies
- ! DR Strategy
- ! Operations Strategy

Application assessment using tool and framework   **Architecture & roadmap design**   **MRAP report publishing**

*MRAP: Migration readiness assessment & planning

✔ LTIMindtree's Migration Partners

We are partnered with modernization tool vendors to bring automation in order to accelerate the implementation of modernization solutions. The tools and software bring automation in each migration step including inventory baselining, application analysis, rule mining, code-conversion, rehosting, and data migration.

conclusion

Modernizing helps business houses attain a more agile and straight forward architectural framework to cope with the ever-changing customer expectations. The benefits of migrating to AWS are not only limited to bringing down the operational costs and cutting down on the capital, but it also increases business flexibility and responsiveness to changing business requirements.

Organizations now have multiple options to migrate their mainframe workloads to AWS to reap above mentioned benefits. However, when it comes to choose suitable mainframe migration option, there is no magical approach or a one-size-fits-all strategy. A well-thought-out and thorough approach to modernize the legacy mainframe applications is required, as each business case is unique.

The time to modernize mainframe systems is NOW. However, there is a need to plan well and understand the risks involved.

Next Steps

We would be happy to assist with multiple aspects of your mainframe modernization initiatives. Ensure accelerated migration to AWS with our robust frameworks and solutions. To learn more about our mainframe migration capabilities, please get in touch with us and review our value propositions.

Digitally Transform Your Business by Migrating to the AWS

Contact Us

Authors
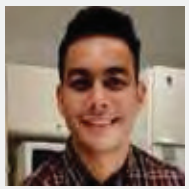
Keshar Jain

Keshar Jain is a Enterprise Architect - Migration and Modernization at LTIMindtree. He has more than 14 years of experience in modernization and cloud migration with key expertise in AS/400 and mainframe technologies. In his role he consult clients to build and strategize their Cloud migration journey.

Sushil Ajgaonkar

Sushil Ajgaonkar is part of Enterprise Architecture team at LTIMindtree and currently leads the Mainframe Modernization COE. In this role he is responsible for developing solutioning & delivery capabilities and partnering with best-of-breed solution providers for modernization of mainframe applications.

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