Migrating
# **Mainframe workloads** to **Azure**

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Summary

Modern day cloud computing offers numerous advantages in terms of compelling economics, support for new age technologies and platforms as well as the much needed agility to adapt information systems quickly and efficiently. This is the major reason for businesses in the world across all market segments to focus on adoption of cloud computing in every sphere of IT.

For several Fortune 100 and 500 customers across various domains such as banking, finance, insurance, retail, manufacturing etc., mainframe systems, which have existed for well over five decades, continue to be the backbone of several mission-critical applications. Due to numerous challenges associated with the mainframe platform, customers are looking to migrate more of their workloads to cloud.

The purpose of this whitepaper is to present Mindtree's approach towards helping its customers in migrating their mainframe workloads to cloud and recommend the preferred option among all cloud service providers. This would include our proprietary assessment framework, technology mapping and reference architecture, part of the legacy modernization roadmap and strategy.
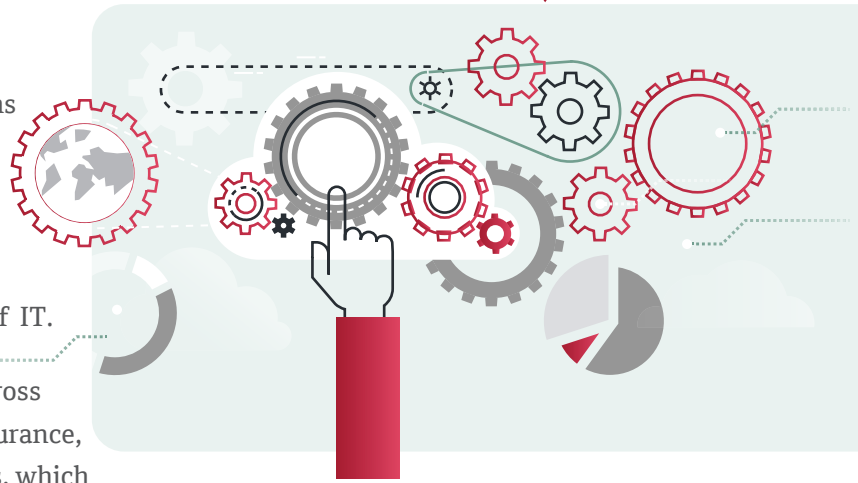
Mainframe Migration to Cloud – Challenges and Benefits

Legacy applications, written decades ago, continue to be the backbone of several mission-critical business applications. Over the course of time, they have become unwieldly to maintain and hence, present numerous bottlenecks in terms of lack of agility, huge incremental maintenance costs, unacceptable time to market, shrinking skillset etc., and hence the need of legacy transformation. Modernization of these systems, which are mission-critical for businesses like banking, insurance, retail, manufacturing etc., will help deliver a unique competitive advantage.
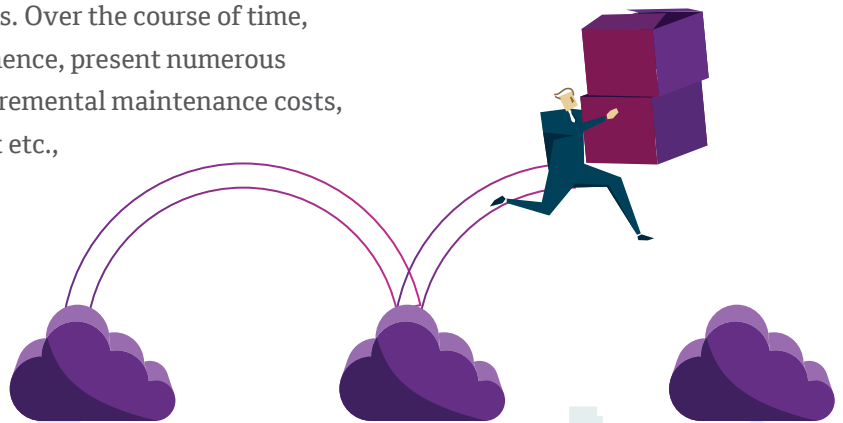
Challenges

The following are the major challenges associated with the migration of mainframe applications to cloud. Mindtree has proven solutions as well as partner products, which adequately address each of these challenges in order to ensure a seamless and smooth migration experience for customers.

- Inadequate planning related to time, effort and cost to migrate to cloud
- Incomplete coverage of migration scope
- Inadequate handling of critical interfaces
- Poor assessment of risk due to performance impact
- Lack of proper documentation with knowledge in silos

Benefits

The following are some of the key benefits realized on migrating from mainframes to cloud. Depending on the current IT landscape and degree & maturity of cloud adoption, the degree and extent of these benefits can vary from one organization to another:

Reduced Cost – The economics of the "pay as you go" cloud-computing model is compelling when compared to the high licensing costs of an on premise mainframes server. Cloud TCO calculator is a great way to understand the cost advantages while planning a phase-wise migration of mainframe workloads to the cloud.

Shrinking Skillset – COBOL as well as other legacy platform-related programmers are getting rarer day by day. The cloud leverages new age technology, ensuring the continuous inflow of skilled personnel to develop and maintain such systems.

Agility and Flexibility – Since cloud supports new age languages, technology and platforms with increased productivity, rapid innovation can happen at a tremendous rate. Cloud's high elasticity, scalability and support for DevOps ensures more agility and hence, reduced time to market for implementing new features and products. This ensures business competitiveness in the age of digital transformation.

Mainframe Migration to Cloud – Mindtree's Approach

Identification of the right migration strategy is crucial for the success of modernization engagements and for this, Mindtree uses its industry-proven, scoring-based assessment framework. This scores an application based on parameters like application complexity, business criticality etc. and after due consideration of customer stakeholder inputs, helps zero in on the most appropriate remediation option. The framework is extremely robust and has continuously evolved out of learnings from past and ongoing modernization engagements.

For migration of mainframe workloads to cloud, Mindtree's proprietary assessment framework would help arrive at one of the following solution approaches:

- Re-host – Lift and Shift approach using industry-leading products e.g. Micro Focus Enterprise Server, TMaxSoft Openframe, NTT Data UniKix.
- Automated transformation – Powered by CodeMill (COBOL to Java, Assembler to Java etc.) a Mindtree IP, as well partner tools and products.
- Ground up transformation – Re-architect and rewrite with a reverse engineering approach followed by a forward engineering approach to move Mainframe workloads to a modern technology-based platform.
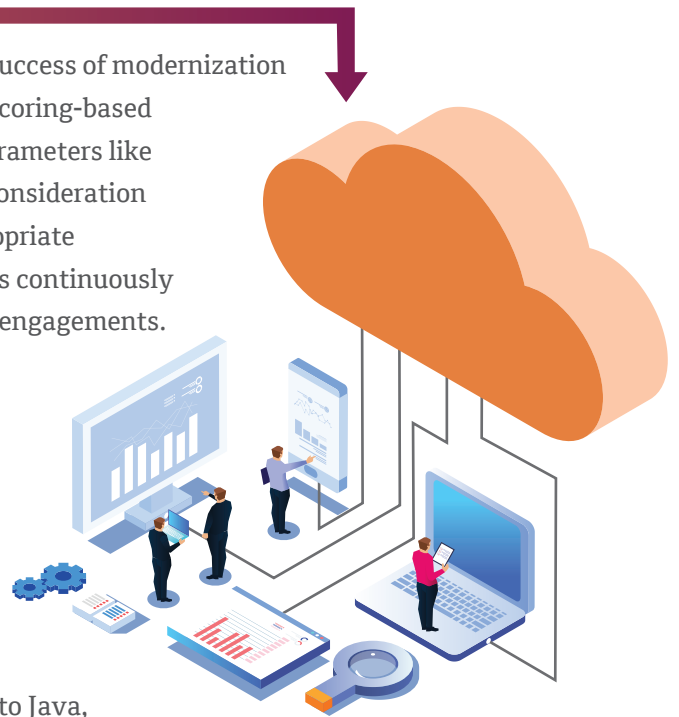
Shown below is Mindtree's proprietary framework, which evaluates the solution options based on the following parameters, to determine the best-fit remediation option.

Legend: Negative, In-between, Positive

Note: "Depending on CASE-to-CASE basis appropriate option is chosen"

	COST			RISK & GOVERNANCE			TIME-TO-MARKET			FUTURE READY			Architectural Considerations	Recommendation
	Migration	Operational	Other (License, etc)	Org/Process Change	Migration Risk	Complexity	Time to Remediate	Ease of Parallel Systems	Reuse of existing logic	Cloud Services	Capability Expansion	Agility		
Re-host/ Lift and Shift	Positive	In-between	Negative	Positive	Positive	Positive	Positive	Positive	Positive	In-between	In-between	Negative	-Maximum reuse -As-Is Re-platform -Limited future-readiness	Select for time-to-market, low cost, low risk, at the expense of future enhancements.
Automated Migration	In-between	In-between	Positive	Negative	In-between	In-between	In-between	In-between	Positive	Positive	Negative	Negative	-Very limited reuse -Streamlined tech landscape -Data migration and restoration	Select for out-of-box functionality future -readiness, at the expense of cost, process change risk, & time to remediate.
Rewrite	Negative	Positive	Positive	Negative	Negative	Negative	Negative	Positive	In-between	Positive	Positive	Positive	-Future-ready tech -Tech Complexity -Build risk -Data migration	Select for maximum agility and future-readiness, at the expense of cost, risk, and complexity.
Replace	Positive	Positive	Positive	Negative	In-between	Negative	In-between	Negative	In-between	Positive	Positive	Positive	-Map Biz Processess -Re-engg for custom biz rules - Data migration	For industry std. feature set w Product fitment, limited customization & ongoing changes.

Why Azure?

Organizations move to cloud for the ability to scale on demand and being economical, its flexibility, reliable data storage, hybrid capability and high availability. There are multiple service providers available in the market and Microsoft is the leading provider of cloud infrastructure as a service (IaaS) and platform as a service (PaaS) solutions offered under the Azure platform. Azure has the additional advantage of integration with all Microsoft products and their latest releases compared to other cloud platforms.

Compared to other cloud providers, Azure has many advantages:

Ease of Modernization: Azure provides a full-stack, unified set of technologies and support for the modernization roadmap. The mainframe migration process can leverage many components in the migration journey. Azure data migration services can handle large volumes of data from DB2, VSAM and other databases in case of mainframe source systems.

Security: Azure has many compliance certifications and advanced security technology, which attracts financial and insurance clients. To secure the environment, clients can leverage the advanced threat analytics, Azure information protection, multi-factor authorization and the active directory for Mainframe RACF security rules.

Seamless Integration: On-premise interfacing applications with Microsoft's technology stack can be easily migrated without affecting the application's availability with the usage of migration assessment tools, infrastructure migration tools and mature DevOps. Automated source migration from mainframe tools like Endevor, Changeman, SCLM etc. to Git or Team foundation is available on the Azure platform. Also, customers can choose from multiple databases like Azure SQL database, having 99.99%+ availability (as per our experience), or managed database instances as per their requirements.

Platform Stability: Azure has strong hybrid cloud capability and operates in 60+ regions around all parts of the world. From our experience, we know that Azure can offer service level agreements guaranteeing 99.95 percent up time. For the reliability, availability, and serviceability offered by mainframe, only a clustered high availability platform like Azure can support these requirements.
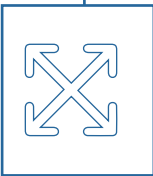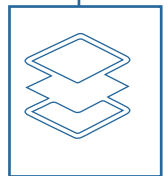
Scaling: Many applications can leverage scaling capabilities within Azure and adjust the processing power with scaling down or up for a batch schedule type of workload or an online heavy transaction. This has direct implications to the cost and billing factors. Since clients can review the billing dashboards and it is transparent compared to the complex calculations of a mainframe billing, customers can fine-tune the applications easily.

For customers having applications over the existing Microsoft infrastructure, Azure perfectly fits in. Azure is the preferred solution for even businesses with non-Microsoft tracks looking to grow and stay ahead of the competition.

Technology Mapping

Code Mapping

Depending on the chosen migration strategy, whether re-host (lift & shift) or re-write, there may be a need for low/medium/high code modification/configuration while moving workloads from mainframes to cloud. Mindtree's uniquely-tailored solution accelerators (CodeMill) as well as partner and re-hosting products, accelerate mainframe code conversion to modern languages, hosted on a new age architecture platform on cloud. Mindtree adopts a hybrid approach in code conversion wherein the tool-generated results are manually verified and refactored, matching the coding standards of the target platform. Mindtree's business rule extraction process combines the technical rules generated by the zBRE tool with the BA/SME functional rules to form an exhaustive list of rules, re-written in a modern language, on Azure cloud.
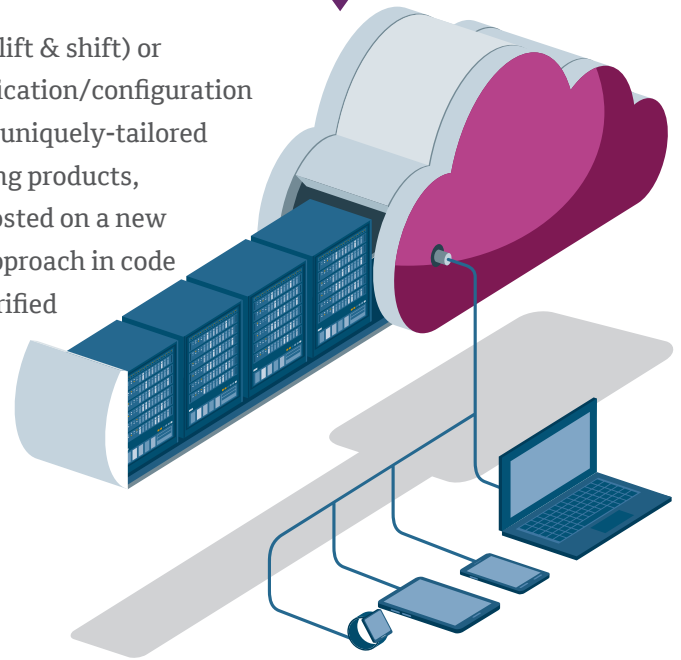
Although each Mainframe migration has its own unique flavor, from our prior experience with similar engagements, we have observed some very common source-to-target mappings while moving from mainframes to Azure - *(Highlighted in the below table).*

Source on Mainframe Platform	Target on Azure Platform	Migration Strategy	
z/OS, MVS, VSE	Azure(Windows, Linux or UNIX)	Re-host	Re-write
CICS	Micro Focus CICS	Re-host	-
CICS	HTML, Angular JS screens	-	Re-write
IMS DC	Micro Focus IMS DC	Re-host	-
IMS DC	HTML, Angular JS screens	-	Re-write
JCL	Micro Focus JCL	Re-host	-
JCL	Shell Scripts, PowerShell scripts	-	Re-write
REXX	Micro Focus REXX	Re-host	-
REXX	Shell scripts, PowerShell scripts	-	Re-write
COBOL, PL/1	Micro Focus COBOL, PL/1	Re-host	-
COBOL, PL/1	C#, Java, .Net	-	Re-write
Assembler, NATURAL **	C#, Java, .Net	-	Re-write
FORTRAN **	C#, Java, .Net, FORTRAN	-	Re-write

*** Needs to be re-written*

Technology Mapping

Like code conversion/migration, data conversion/migration is equally important while migrating mainframe workloads to cloud. As part of an elaborate data migration plan, thorough analysis should be done for various kinds of databases existing in mainframes, be it hierarchical like IMS DB, relational like DB2 or files (VSAM, flat files).This process should be iterative in nature and identify all potential conversion and migration-related issues upfront. Thorough review and signoffs by SMEs should validate the conversion/migration strategy.

Once the file structures are created and validated, the actual data is migrated from the on-premise mainframe to the Azure cloud environment. A thorough parallel run is needed before a cut over to the target Azure cloud platform.
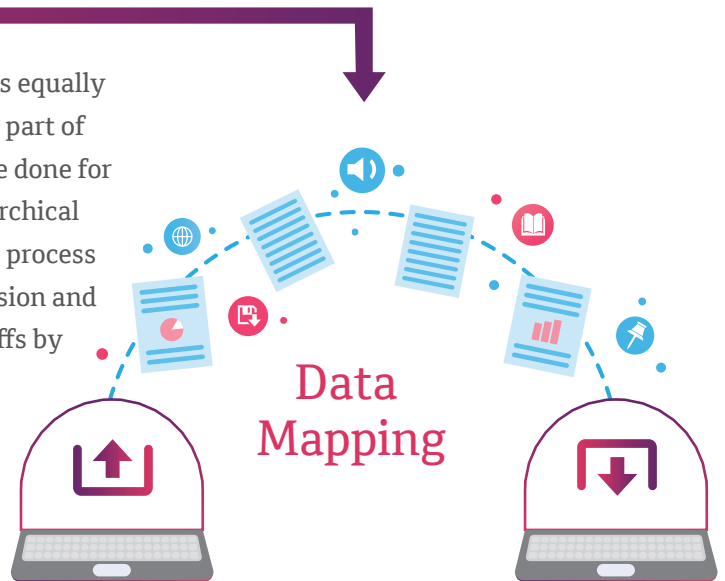
From our prior experience on similar engagements, we have seen that hierarchical databases (IMS DB) and indexed (VSAM)/flat files end up getting converted to relational databases for ease of migration. Based on our experience, we have provided a mapping of database from source to target.

| Source DB on Mainframes	Target DB on Azure Platform	Migration Strategy	
DB2	Micro Focus, other market products Azure Sql, DB2 LUW, Oracle, Sql Server	Re-host	Re-write
IMS DB	Micro Focus, other market products Azure Sql, DB2 LUW, Oracle, Sql Server	Re-host	Re-write
VSAM, other flat files	Micro Focus, other market products Azure Sql, DB2 LUW, Oracle, Sql Server	Re-host	Re-write
GDGs	GDGs	Re-host	Re-write

Reference Architecture
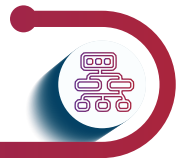
For most customers with a legacy-heavy landscape, a big bang one time deployment and cut over of all its mainframe applications to Azure is never the most preferred migration strategy.

Most organizations undertake a cautious approach of following a phase-wise migration path for their mainframe applications to cloud. Slowly embracing Azure as the target platform for their less critical mainframe applications sets the tone for eventually migrating the strategic and mission-critical mainframe applications towards the end of the modernization journey. The phase-wise migration results in incremental cost savings, by gradually moving out of mainframe workloads to cloud.

A rigorous as well as thorough migration plan makes it possible to undertake a phase-wise roll out to Azure cloud, and yet be able to maintain ongoing communication and integration with the on premise mainframe workloads. *The following image shows the reference architecture.*
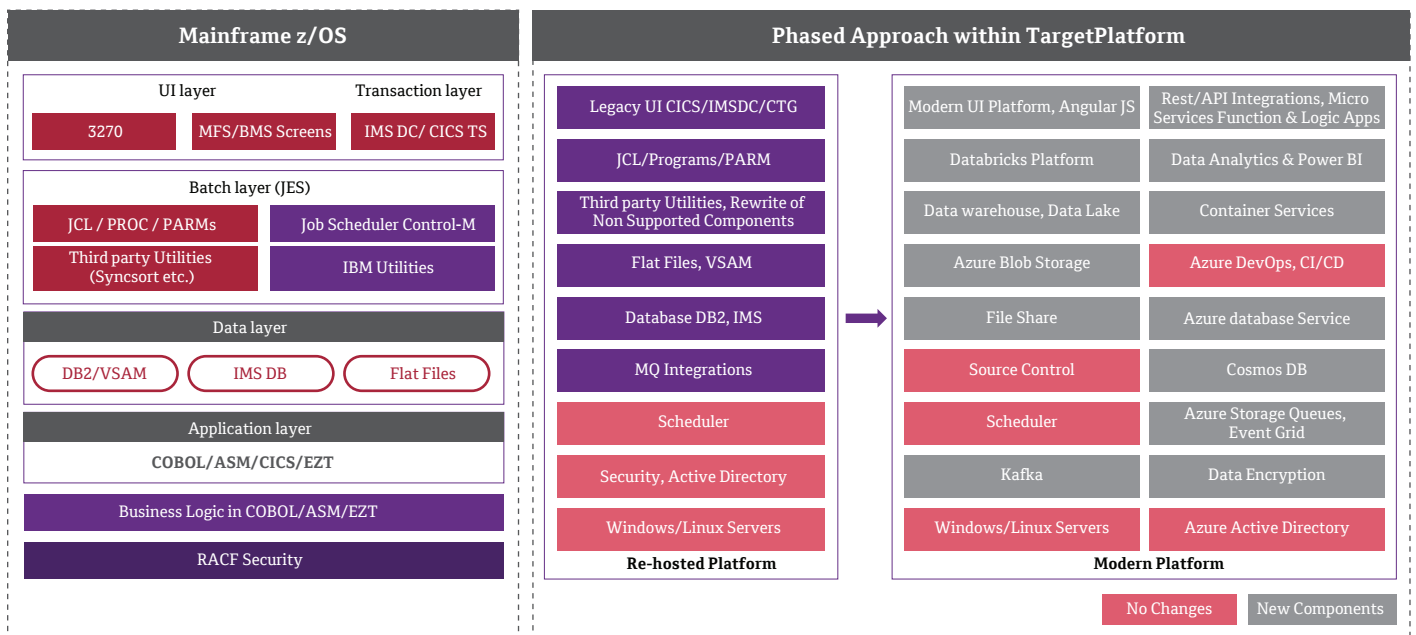
The Azure cloud platform can support the re-hosted mainframe workload without much change. Complete transformation of the applications can happen from the re-hosted platform and can leverage some of the latest products in the Big Data and microservices architecture. Azure provides support for all necessary components in both a re-hosted and modern platform. While in the re-hosted platform, components can almost work the same way as in mainframe on a virtual machine or container, the modern platform can leverage some of the features like distributed computing, data analytics and reporting, modular non monolithic microservices architecture, reactive frameworks, real-time data updates and high availability databases. Some of the salient features in this approach are:

- Seamlessly integrate with internal and external systems for data exchange
- Automate integration and harmonization of data from multiple source systems spanning variety of data
- DevOps, centralized version control integrated with CI/CD
- Meets all security standards and handles all monitoring requirements
- Massively parallel processing architecture to handle the current and future workload by leveraging containers
- Flexible design to allow data loads to distributed across clusters by the load balancers

Solution Highlights

Mindtree's execution approach of migrating mainframe workloads to cloud have the following highlights –

- **Automation First** approach to expedite the migration process
- **Exploration-led implementation** involving the following steps –
  - Conceptualize and brainstorm the proof of Concept (PoC)
  - Integrate the results of the PoC with the factory model framework
  - Build and deploy
- **Factory model approach** - with a pre-designed approach, having multiple tracks running in parallel
  - **Reverse engineering team** – Engaged with the analysis of the existing mainframe portfolio and unearthing business rules
  - **Data migration team** – Understand the existing data model and architect a target platform data model with a plan for data migration
  - **Forward engineering team** – Understand the rules unearthed by the reverse engineering teams and carve the best suited approach for the identified target platform
  - **Modernization lab** - This is the lean team responsible for finding all possible automation candidates during various phases of project execution
- **Partnerships and Alliances** – Mindtree-established modernization solutions, partnerships with industry leaders in 'mainframe to cloud' migration vendors such as Astadia and Micro Focus, makes Mindtree very well-positioned to address all the challenges faced during migration and modernization.
- **Prior experience out of such modernization engagements**
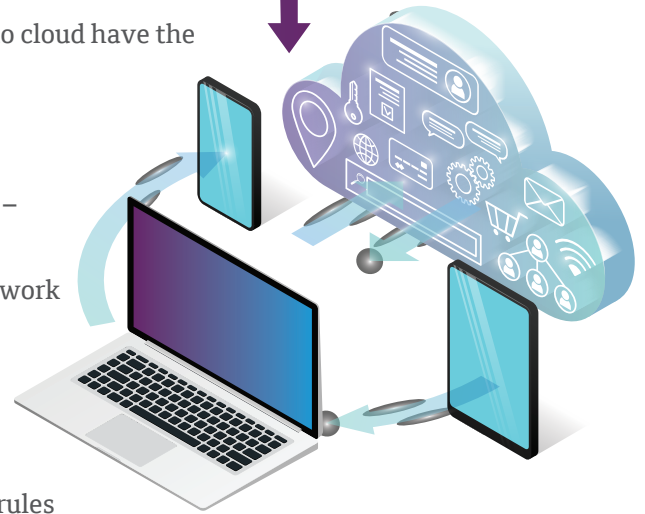
Conclusion

Once the mainframe workloads are migrated and deployed to Microsoft Azure, all the benefits of cloud computing namely: ease of integration, elasticity, scalability, agility will be realized. This would make the target platform future-ready in terms of meeting the digital transformation needs of an enterprise. Mindtree would be happy to hear from you about your 'Legacy Migration' related needs and how we can help you leverage Azure.

About the Author
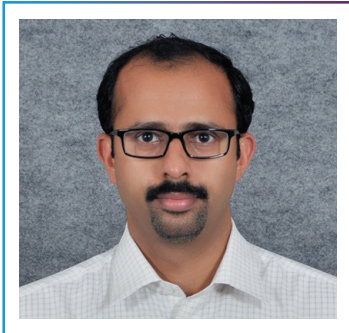
Ajo Paul
Enterprise Architect

Ajo Paul has 23+ years of experience and is currently working as an Enterprise Architect for portfolio modernization. He has extensive experience in migration and automation across the project life cycle including portfolio assessment, code generation, data migration and testing.

Dipyaman Paul
Senior Consultant

With 16+ years of overall IT experience across portfolio assessment, reverse engineering and target roadmap definition, Dipyaman Paul currently works as a Presales and Consulting Lead as part of Mindtree's legacy modernization practice.

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