Digital Operations

Digital Enterprise Architecture: Four Elements Critical to Solution Envisioning

Today's digital organization demands an enterprise architecture that is guided by its intended business outcome and which can inform strategy embracing a multidimensional approach covering digitization, data management, analytics, AI and automation. Here's how to get started.

Executive Summary

The digital revolution continues to transform our world. Mobility is rapidly ascending as sensor and actuator capabilities bring intelligence to devices of all varieties via the aptly named Internet of Things (IoT). According to IDC, our digital world is now "doubling in size every two years, and by 2020 the digital universe – the data we create

Cognizant

and copy annually – will reach 44 zettabytes, or 44 trillion gigabytes."[1] As data proliferates exponentially, a new class of applications is emerging, one endowed with the intelligence to redefine the business, operating and technology models in place since the onset of the 21st century.

Companies such as Google, Amazon, Facebook, LinkedIn and Uber are leading the way in monetizing big data and disrupting markets through data-driven strategies. In this regard, McKinsey[2] has emphasized the importance of an integrated approach to data sourcing, model building and organizational transformation.

The pivot to digital depends on a suite of technology developments in the areas of sensors, actuators (for triggering actions), networking/integration and computing (data management, processing, analytics, etc.). This white paper outlines the key architectural elements for undertaking an integrated design approach and thereby accelerating the journey to full-scale digital. The foundational aspects of our approach are guided by TOGAF,[3] the industry-leading enterprise architecture (EA) framework. The proposed architecture elements focus on what we call the four M's – materials, machines, models and mesh.[4]

The overarching perspective of the digital enterprise architecture

The business world is increasingly interconnected via constituent nodes of networked computers. These nodes pervade business, IT systems and applications of varying size, individual devices and even sensors.

The digital architecture of a connected environment forms the foundation of an information ecosystem that provides business services to customers, business partners and employees. Such business services are composed of finer-grained constituent services and data from other nodes – which may be either within or outside the business unit's boundaries. New services are formed by slicing, consolidating and repurposing information contained within the extended enterprise and then,

The digital architecture of a connected environment forms the foundation of an information ecosystem that provides business services to customers, business partners and employees.

Digital vehicular traffic system: Illustrates connected ecosystem multiplying the digital enterprise architecture complexity

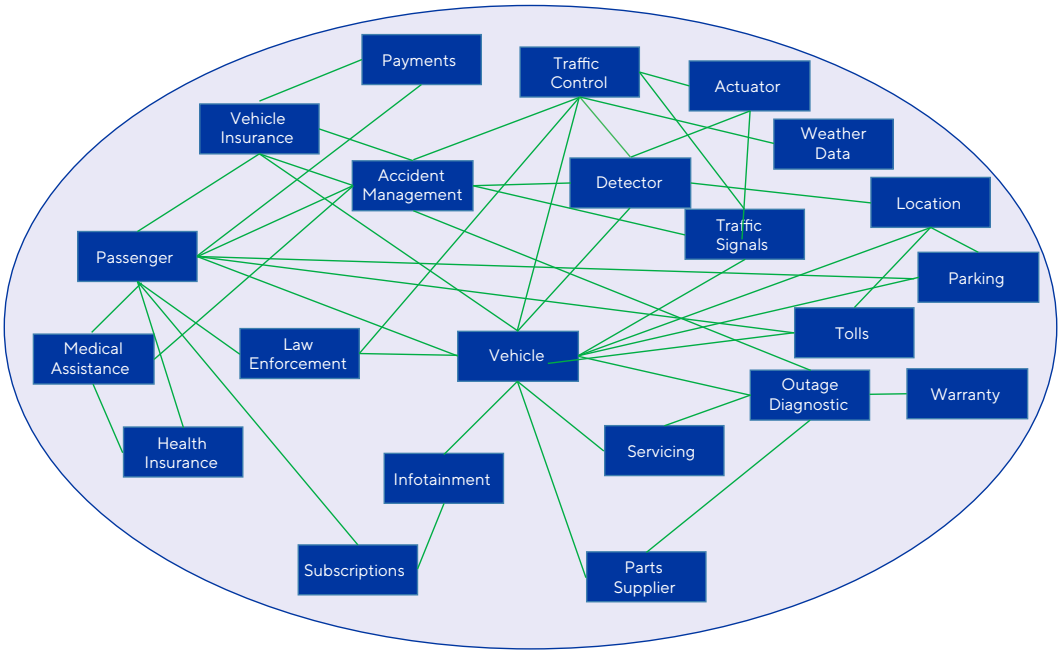


Figure 1

by applying analytical and processing intelligence, generating new services of interest.

As a result, the functional logic, information used, system and technology involved often cut across applications, application architectures and even enterprise boundaries, which are transparent to the consuming user. Therefore, a digital architecture blueprint is vital for successful implementation of a digital enterprise. However, service-level architectural parameters such as uptimes and response times remain tied to services in a real-time service integration scenario, and need to be factored in when the architecture is defined.

Digital architecture blueprint: Four focus areas

ENTERPRISE DIGITAL ARCHITECTURE			
Business Architecture Focus on business-outcome-driven *models* and process views.	**Information Architecture** Focus on identifying and creating a *mesh* of data and managing the same.	**Application Architecture** Focus on building intelligent *machines*, embodying the logic to work upon the data to do, learn, think.	**Technology Architecture** Focus on the *material* aspect of the intelligent machines covering the hardware and technology choices of implementation (e.g., AI software).

Figure 2

Enterprises need to be adept in digitizing, analyzing data and automating smart actions to attain an edge over rivals and reap enhanced operational efficiencies in the hyper-competitive global economy. This demands new business solutions and approaches.

Building a business architecture

In our digital age, organizations need new models and services to generate greater business value. For this, they need to use the wealth of digital data that surrounds their organizations – from their people, processes, devices and consumer input. We call these Code Halos,[5] unique virtual identities produced by every digital click, swipe, *like*, buy, comment and search. Enterprises need to be adept in digitizing, analyzing data and automating smart actions to attain an edge over rivals and reap enhanced operational efficiencies in the hyper-competitive global economy. This demands new business solutions and approaches.

In our book *What to Do When Machines Do Everything,* the authors from our Center for the Future of Work outline a data-driven approach (see Figure 3) for building intelligent machines needed to thrive in the digital economy.

Intelligent process automation (IPA) applies the machine intelligence (MI) baked into the algorithms that power today's software for creating sophisticated business processes. IPA application can be found in clinical data management for life sciences, claims adjudication for insurers, loan applications in banking, logistics optimization, and traditional technology processes such as infrastructure and information management services. Sites recommending items based on previous purchases are using MI to analyze users' buying patterns and promote other items of likely interest to the customer.

Getting AHEAD with business architecture

Automation
Focus on unleashing the power of the digital workforce comprised of software robots (bots) and virtual personal assistants (VPAs).

Halos
Focus on the true power of personalized services by cultivating information that surrounds people, the organization and devices.

Enhancement
Focus on enhancing end-users' perceptions of system aspects such as utility, ease of use and efficiency.

Abundance
Focus on vast new markets by dropping the price point of existing offers and finding new energy sources with the help of machines.

Discovery
Focus on conceiving new products, new services and new industries by leveraging machine intelligence.

Figure 3

In fact, digital advancement is progressing much faster than what many industry watchers expected. Machines can now read, see, listen, write and actuate. Using these core capabilities, machines can now perform complex tasks and learn new things.

Enterprise digital architecture helps IT organizations to realize diverse business use cases such as the following:

- Enhancing public safety and optimizing utilities through sensor data analysis.
- Assessing patients' health in real time by analyzing patient data from wearable devices and sensors.
- Identifying fraud and money laundering via banking cyber-surveillance.
- Route planning based on crowd-sourced GPS data.
- Discovering new energy sources in the oil and gas industry, and streamlining oil distribution.

With the advancement of smart meters, delivery optimization and algorithmic trading, today's new machines are progressively leading to the next generation of inventions. So the underlying architecture needs to provide an extensible foundation to support such evolution.

Designing an application architecture

In fact, digital advancement is progressing much faster than what many industry watchers expected. Machines can now read, see, listen, write and actuate. Using these core capabilities, machines can now perform complex tasks and learn new things. Sooner or later, machines will have the capacity to imitate the other human senses: touch, smell and taste. And with time they will be able to work smarter.

The challenge, therefore, for an enterprise application architect is building intelligent systems that can fulfill business goals which deliver results that exceed competitors' efforts and create additional value for the customer. The architecture must leverage the core capabilities available in some distributed models and enable tighter human-machine collaboration than ever before.

This calls for a focused, methodical approach for identifying how machines can advance automation, productivity and discovery by creating and analyzing Code Halos generated through the abundance of data that permeates business. A retail organization, for example, can leverage four key areas under Code Halos where machines can be a differentiating factor: identification of market segmentation, sentiment analysis, campaign management and recommendation engines. Similarly, there are four areas of enhancement: predictive maintenance, predictive planning, cognitive monitoring and fraud detection. (How to do it is a topic of separate deliberation.)

Designing a modern digital applications architecture

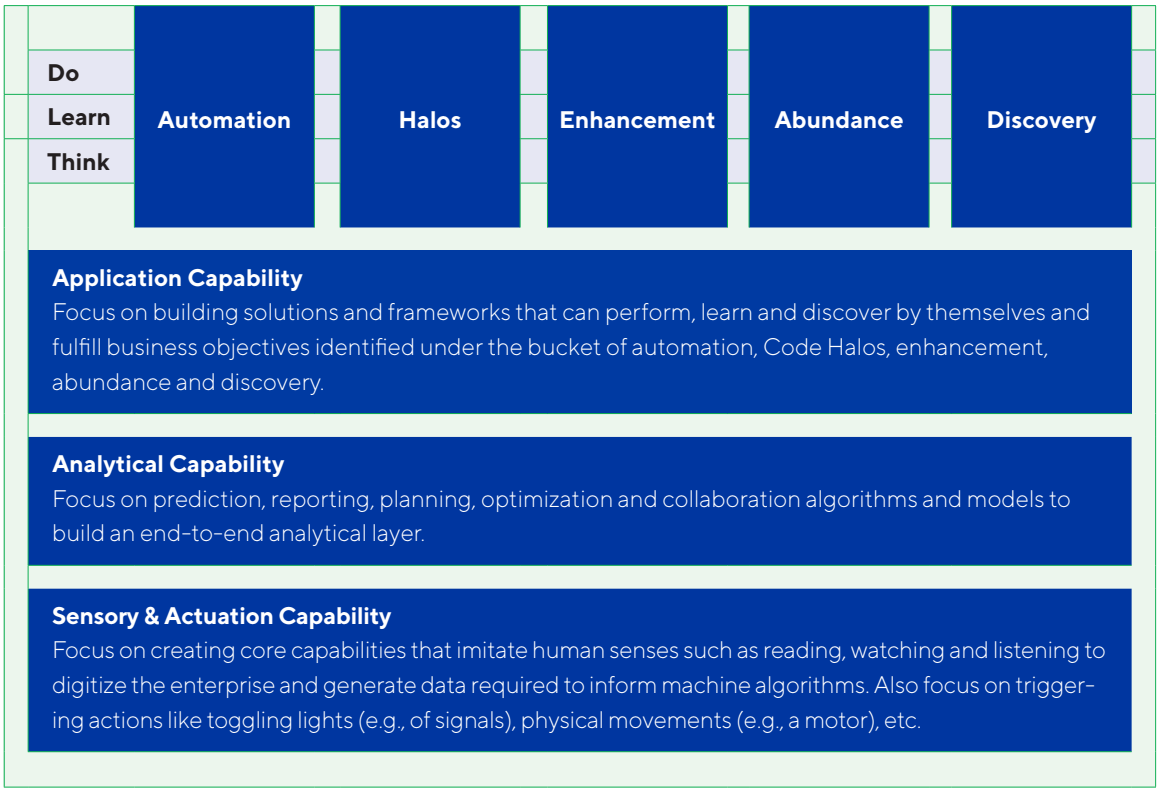


Figure 4

Along with identifying these areas, common analytical practices (such as forecasting, optimizing and planning), are required to build machines in each respective area. Figure 4 illustrates one approach. This design customizes machine learning algorithms and models for common API realization. As organizations shift to digital, forecasting, optimizing and planning activities shift to real-time processes and become part of a continuous cycle rather than the periodic events of yesteryear.

Architects need to identify the sources from which they can acquire the relevant data to model the enterprise as realistically as possible. Along with identifying the sources, they must identify or build interfaces that can capture an information object with its attributes.

Intuiting information architecture

Information is digital's key substrate, the base upon which application capabilities and analytical capabilities thrive.

The challenge to enhanced digitization of the physical business world starts with generating a model that properly simulates the business. Many organizations have begun to do this with their IoT deployments and related digital initiatives. Architects need to identify the sources from which they can acquire the relevant data to model the enterprise as realistically as possible. Along with identifying the sources, they must identify or build interfaces that can capture an information object with its attributes. Thus far, organizations have been focusing primarily on objects and their attributes, as success for a digital solution lies in the ability to capture the holistic behavior of an object. Moreover, with the proliferation of data, the challenge becomes one of petadata management – how to acquire, store and organize vast quantities of quality data. When there is availability of data aplenty, categorizing the information is key to better management.

Finally, siloed data cannot reveal the full story. The dots need to be connected to complete the narrative. Hence, an integrated view of information must be built by correlating the objects and building a comprehensive enterprise information model and associated interfaces. (A detailed approach to achieve this is a discussion topic for the future.)

Eyeing the right information architecture

Integrated view
Focus on connecting information to build a real-world model that makes the information livelier so that it all tells a better story.

Data type
Focus on classifying data, whether it is structured, unstructured, audio, image, video, document or sensor data coming from RDBMS, No-SQL, HDFS, CMS, etc., so that it can be better managed when acquiring, storing, organizing and analyzing high volumes of data.

Interface
Focus on data from a diverse set of interfaces (e.g., sensors, telemetry, wearables, audio, video, chat, e-mail) that not only capture attributes of a specific object but also its associated functionalities.

Source
Focus on sourcing data from enterprise systems, social media, mobile platforms, sensor networks, print media, etc. so that anything and everything associated with the organization can be digitized.

Figure 5

Envisioning the technology architecture

Companies need to keep digging for digital fuel (i.e., mining data of all types and formats) to continually grow their business intelligence. Special technologies and materials are required to discover, acquire, organize and analyze big data. Traditional technologies, such as CPU-based computing and relational databases, fall short in managing the volume, velocity and variety of data.

At the same time, technologies that power MI are proliferating. A disciplined approach to finding and applying the most appropriate tools is critical. In this regard, an effective technology architecture can ensure that this critical element is in place at the right time in tandem with addressing the key human and organizational issues involved in a cultural change. Figure 6 summarizes key technical areas and their characteristics.

IoT devices and platforms are crucial for data acquisition and real-time ingestion of different types of data. Once acquired, various data storage technologies (i.e., RDBMS, No-SQL, CMS, HDFS), along with data warehouse tools, help to organize the data through transformation, normalization, encoding, generating training sets, etc. The processed data is fed to analysis tools with built-in algorithms such as clustering, learning, etc., and models such as predictive, optimization, planning, etc. Finally, an enterprise should appropriately experiment with emerging industry-specific business solutions[6] or MI platforms.

Focusing on technology architecture

Figure 6

Looking forward

The digital world has brought tremendous opportunities and new challenges. The key is to prioritize and convert the opportunities in a systematic and holistic enterprise-focused approach to create a digital solution. The solution needs to be functionally effective, practical, supportive for a plug-and-play architecture and, importantly, scalable in part and as a whole. The solution design would typically focus on modernization and hardening of legacy and core IT supporting multimodal architecture models. A digital-ready, scalable architecture would prioritize specific aspects of architecture like cloud adoption and security improvements focusing on the four M's of digital engineering discussed before. It's essential to avoid looking at it as a narrow data, automation, integration, IoT or analytics problem.

The solution designer needs to examine individual aspects of data procurement, gain business insight and then convert this knowledge into services that add business value. Each of these aspects requires deep dives and elaboration into architectural building blocks – starting with technical capability. Dimensions such as security, architectural governance and data stewardship will then need to be addressed. Special attention is required to manage the sensitivities related to automation's impact on people. Each issue could be a topic for a separate in-depth deliberation.

Endnotes

1 "Data Growth, Business Opportunities, and the IT Imperatives," IDC, April 2014, https://www.emc.com/leadership/digital-universe/2014iview/executive-summary.htm.

2 "Three keys to building a data-driven strategy," McKinsey, March 2013, http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/three-keys-to-building-a-data-driven-strategy.

3 TOGAF, http://www.opengroup.org/subjectareas/enterprise/togaf.

4 Malcolm Frank, Paul Roehrig and Ben Pring, *What to Do When Machines Do Everything*, John Wiley & Sons, February 2017, https://www.wiley.com/en-us/.

5 To+Do+When+Machines+Do+Everything%3A+How+to+Get+Ahead+in+a+World+of+AI%2C+Algorithms%2C+Bots%2C+and+Big+Data-p-9781119278665.

6 Malcolm Frank, Paul Roehrig and Ben Pring, *Code Halos: How the Digital Lives of People, Things, and Organizations Are Changing the Rules of Business*, John Wiley & Sons, April 2014, https://www.wiley.com/en-us/Code+Halos%3A+How+the+Digital+Lives+of+People%2C+Things%2C+and+Organizations+are+Changing+the+Rules+of+Business-p-9781118862070.

About the authors

Abhik Sengupta

IT and Digital Enterprise Architecture Consultant, Cognizant Consulting

Abhik Sengupta is an IT and Digital Enterprise Architecture Consultant within Cognizant Consulting. With nearly three decades of industry experience, Abhik leads a team of enterprise architects and legacy transformation specialists guiding and supporting major enterprises across the world in their IT and enterprise architecture strategy and organization transformation initiatives. He has authored papers published in IEEE and other publications. Abhik can be reached at Abhik.Sengupta@cognizant.com.

Kamales Mandal

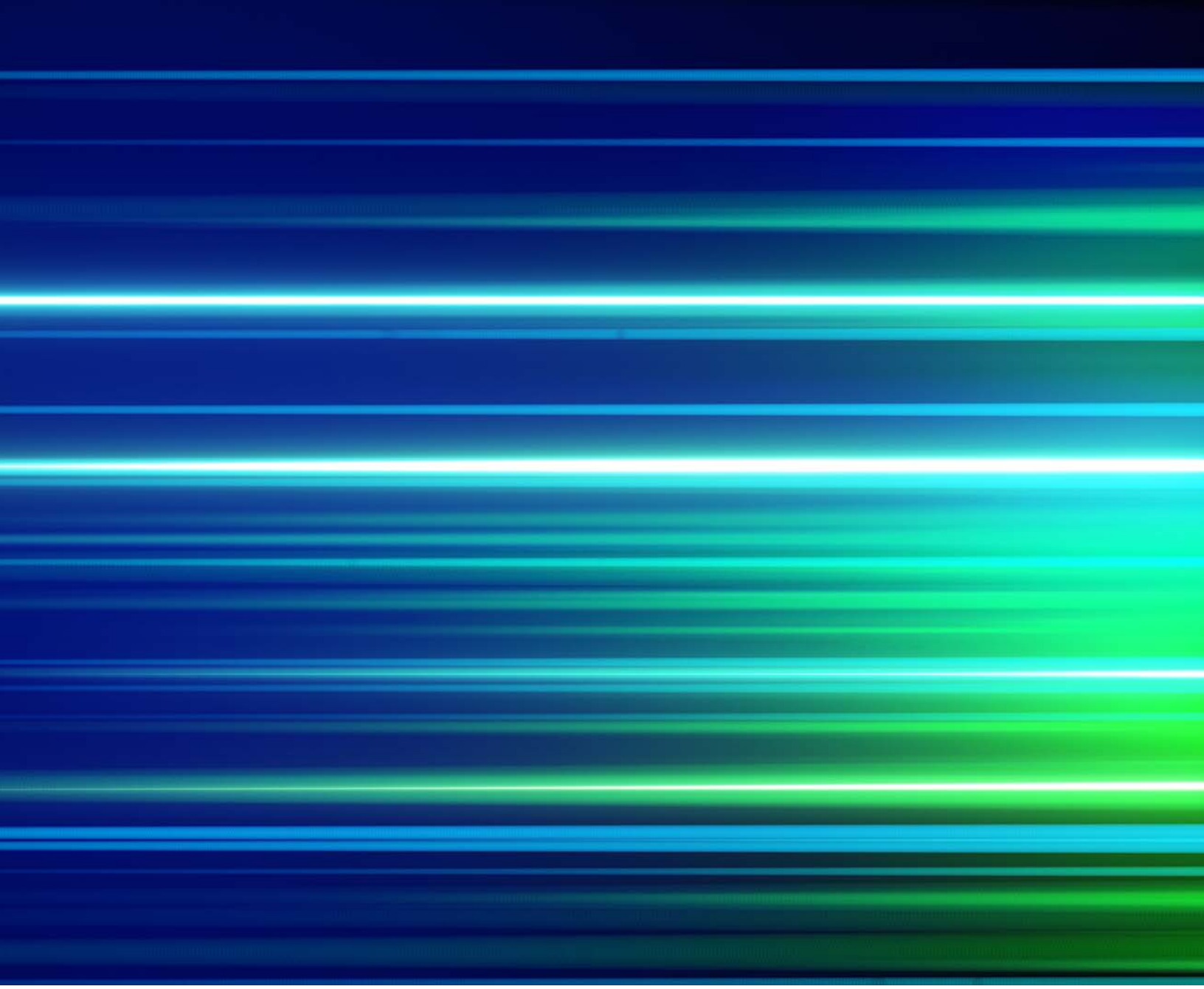
Enterprise Architect, Cognizant Consulting

Kamales Mandal is an Enterprise Architect within Cognizant Consulting. He has over 17 years of experience in diverse walks of enterprise application development, enterprise integration and IT consulting, and has worked with major enterprises across North America, Australia, UK and Latin America in the retail, government, healthcare and financial domains. Kamales has authored multiple papers and is the key architect of an emerging semantic technology-based, model-driven consulting platform: ACE (analyze. consult. execute). He can be reached at Kamales.Mandal@cognizant.com.

Tapodhan Sen

Architect, Cognizant's Global Technology Office

Tapodhan Sen is an Architect in Cognizant's Global Technology Office. He has over 20 years of experience architecting complex adaptive systems, focusing on interoperability and automation. Tapodhan is an experienced enterprise architect with wide-ranging experience at established blue chip companies and broad exposure to various industry sectors including government, finance, telecommunications, publishing and information media. He can be reached at Tapodhan.Sen@cognizant.com.



About Cognizant

Cognizant (Nasdaq-100: CTSH) is one of the world's leading professional services companies, transforming clients' business, operating and technology models for the digital era. Our unique industry-based, consultative approach helps clients envision, build and run more innovative and efficient businesses. Headquartered in the U.S., Cognizant is ranked 193 on the Fortune 500 and is consistently listed among the most admired companies in the world. Learn how Cognizant helps clients lead with digital at www.cognizant.com or follow us @Cognizant.

Cognizant

World Headquarters
500 Frank W. Burr Blvd.
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Fax: +1 201 801 0243
Toll Free: +1 888 937 3277

European Headquarters
1 Kingdom Street
Paddington Central
London W2 6BD England
Phone: +44 (0) 20 7297 7600
Fax: +44 (0) 20 7121 0102

India Operations Headquarters
#5/535 Old Mahabalipuram Road
Okkiyam Pettai, Thoraipakkam
Chennai, 600 096 India
Phone: +91 (0) 44 4209 6000
Fax: +91 (0) 44 4209 6060

APAC Headquarters
1 Changi Business Park Crescent,
Plaza 8@CBP # 07-04/05/06,
Tower A, Singapore 486025
Phone: + 65 6812 4051
Fax: + 65 6324 4051

Codex 3245.02