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Data & Digital Architecture

Gustav Toppenberg
Guest Editor

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CUTTER CONSORTIUM
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Opening Statement

by Gustav Toppenberg, Guest Editor

Digital transformations aren't games of chance, but they do require big and bold commitments in the midst of uncertainty to reinvent the business rather than just improve it incrementally. Digital transformation — as the use of technology to radically improve the performance or reach of an enterprise is called — is an approach that visionary CEOs are pursuing. Three enterprise areas (business models, customer experiences, and operational processes) have become the focus of such transformations, which helps transformation leaders concentrate their skills, expertise, and resources in the best way possible and ensures that the correct leaders are aligned to a specific effort.

The statistics on digital transformation efforts that fail to produce the expected results vary depending on the institution doing the measuring and researching. But it is safe to say that the range is within 60%-85% for large enterprises across the global economy.

To avoid that fate, digital transformation and enterprise architecture (EA) leaders have a choice to make in developing and modernizing their data and digital platforms and architecture to enable and support these transformational efforts. Managed as an iterative balance between building the foundation from a technology perspective and through business use cases, the data and digital architecture platform can be an asset in ensuring that digital transformation efforts are carried out in such a manner that they align to the enterprise and its approach to transformation.

In this issue of *Cutter Business Technology Journal (CBTJ)*, we explore how enabling successful digital transformations through data and digital architectures can facilitate the enablement of the value streams and customer journeys companies build to stay in touch with changing client expectations and user experiences, all while building out the organization's digital backbone.

In This Issue

In our first article, Cutter Consortium Senior Consultants Olivier Pilot, Michael Papadopoulos, and Michael Eiden take a two-part approach to discussing the design of adaptive digital and data architectures. First, they propose a way to design solutions that actively identify and address key uncertainties and concerns so that the right kinds of EA artifacts will emerge to answer key questions about user desirability, technical feasibility, and financial viability for the right people. Second, they share patterns and techniques that can be used to design and build digital and data architectures with a high level of flexibility and adaptability that can better support the changes in priorities that successful digital transformation efforts need to be able to steer.

> *Digital transformation and EA leaders have a choice to make in developing and modernizing their data and digital platforms and architecture to enable and support these transformational efforts.*

Any digital transformation requires significant changes across many dimensions, ranging from operating models to funding models to platform architecture, among others. In our next article, Eric Willeke argues that keeping these changes aligned can be one of the hardest elements of digital transformation, especially when organizations try to sidestep the challenge of evolving their current technology organization to the required level of capability by creating a new, "digital" organization instead. Such attempts fail to address three problem areas that can trip up any digital transformation effort: fragmented value streams,

poor decision governance, and inadequate management of the business capability portfolio. Willeke identifies the symptoms of these ailments and proposes two critical moves organizations can make to correct their value stream and organizational fragmentation. Finally, he discusses specific business capabilities organizations must master in order to enable the robust change management that digital transformation requires.

The digital backbone can be an asset in ensuring that digital transformation efforts are carried out in such a way that they align to the enterprise and its approach to transformation.

In our third article, Thomas Gossler writes about how a digital ecosystem platform demands a solid architecture for data and infrastructure on top of which a network of stakeholders can engage in valuable interactions with each other. The journey from a pipeline business model to an ecosystem platform is no small feat, and Gossler shares the approach he and his colleagues at Siemens Healthineers took and the lessons learned in their seven-year digital transformation. In that time, their initial small cloud-based product has grown to a company-wide program for digital transformation of all of Siemens Healthineers' major business cases. Gossler relates how the company learned to think in platform terms, avoided the "shadow IT" trap, and promoted exponential thinking to unleash the platform's full potential. This case study provides many useful recommendations for others to follow in their own transformation journeys.

Next, Timothy Chiu discusses how data and digital architectures require improved application security and how the new security framework from the US National Institute of Standards and Technology (NIST) endorses this view. As more and more organizations move rapidly to the cloud, he argues, applications and their associated data are increasingly at risk. With supporting data from multiple sources, Chiu frames the risks through examples of data breaches across multiple industries and geographies. Fortunately, he says, NIST is on the case. In its recently revised "Security and Privacy Controls for Information Systems and Organizations," or SP 800-53, NIST adds two application security technologies to its framework, runtime application self-protection (RASP) and interactive application security testing (IAST). Chiu outlines the new NIST requirements and their implementation timeline, as well as explaining what RASP and IAST are and how they can improve and advance application security for organizations.

Finally, Sunny Ray, Joab Meyer, and Karl Johnson share part of a research project that seeks to "demystify digital transformation" through findings from interviews with senior leaders at seven firms undergoing digital transformation in a variety of industries. One of their major initial findings is the degree to which senior leaders' digital mindsets determine the success or failure of these initiatives. Executives who regard — or come to regard — IT as "an investment-worthy enabler of innovation, new business models, and growth" rather than a cost center are more likely to "incorporate digital objectives into their corporate strategies, invest in digital infrastructure with an enterprise-wide view, and grant digital investments longer-term timelines to yield results." The authors highlight the importance of this enterprise-wide view, explaining why a project-by-project approach rarely produces true or lasting digital

Upcoming Topics

Digital Twins
Ron Zahavi

The Role of Agile/DevOps in Digital Transformation
Eric Willeke

Low Code/No Code; Citizen Developer
Michael Papadopoulos

Mobility
Guest Editor, TBD

Data Analytics
Guest Editor, TBD

transformation. Using a case study of a data lake project at General Mills, Ray and her coauthors show how a conscious effort to transform the digital mindsets of executives at the consumer food giant led to a successful digital transformation that is driving improved business outcomes.

Next-Generation Data & Digital Architecture Help Build Your Digital Backbone

Collectively, this group of articles represents a comprehensive view of some of the vital topics all technology leaders must consider when weighing their data and digital architecture design decisions. Critical to this effort is striking the right balance between building the digital capabilities platforms to the scale needed to support an enterprise, which can take a significant amount of time and investment, and delivering incrementally on business use cases that provide real business value. The right balance results in building a digital backbone in the organization alongside the use cases, the two components symbiotically nurturing each other and, as a result, avoiding both spaghetti-type architectures and the gold-plating of platforms.

Digital transformation is commonplace in today's economy. Companies in industries where industry actors and market forces follow a more traditional path and that are undertaking large investment efforts to transform may end up with disjointed, non-sustainable results due to a lack of coordination and the absence of a framework and digital backbone. The digital backbone can be an asset in ensuring that digital transformation efforts are carried out in such a way that they align to the enterprise and its approach to transformation. It is essential that the methodologies, skills and talent, and technology tool chain and infrastructure be created such that they can be easily consumed and adjusted as the company changes.

The existence of a digital backbone in an organization means that anyone aspiring to transform different parts of the enterprise will be able to leverage the digital backbone in a consistent and sustainable way, ensuring that each effort connects to and leverages a common platform. Digital transformation leaders are starting to realize that a powerful digital services backbone to facilitate rapid innovation and responsiveness is key to successfully executing on a digital strategy.

Making sure there is a sustainable foundation in place for the digital transformations an enterprise is considering is critical; this is the core value proposition of the digital backbone. The challenge of establishing such a foundation can be the time it takes to build it and the investment required to nurture it while the company is continually under pressure to perform and innovate.

The articles in this edition of *CBTJ* provide technology executives and architects a great set of perspectives on building out a digital backbone. We hope the insights they offer on next-generation data and digital architectures will act as both a practical guide and inspiration to starting or continuing this journey in your own organization.

Gustav Normark Toppenberg is a Senior Consultant with Cutter Consortium. He is an enterprise transformation executive with 20+ years' experience. Mr. Toppenberg's background includes building and leading transformational efforts for both small and global companies with a focus on business, data, and digital domains. His professional experience includes executive roles in EA, Lean-Agile product delivery, advanced data and analytics, and M&A at Boston Consulting Group (BCG), Catalina Marketing, Aon Plc, and Cisco Systems. Mr. Toppenberg's academic experience teaching and as a publishing practitioner includes roles as an Adjunct Professor at Loyola University Chicago's Quinlan School of Business and University of California, Berkeley, in the areas of advanced analytics/artificial intelligence, emerging technology, design thinking, and Lean-Agile. He is also coauthor of Architecting Growth in the Digital Era: How to Exploit Enterprise Architecture to Enable Corporate Acquisition. *He can be reached at gtoppenberg@cutter.com.*

THE ART OF ARCHITECTURE

Designing Emerging, Adaptive Digital & Data Architectures

by Olivier Pilot, Michael Papadopoulos, and Michael Eiden

Architecture can be summarized as the art of defining a structure that will support and guide the effective and efficient delivery of a solution over time. Whether looking at the best ways to design and launch a new product or service, enable employees to collaborate efficiently and work remotely, or breathe new life into an old offering, good architecture is paramount.

In the olden days, the temptation for architects was to define a solution to a level of detail that was deemed sufficient for engineers to then fully implement it from start to finish. But in digital architectures, this is an anti-pattern that almost always leads to the wrong solution being built, on top of limiting the freedom to adapt to a fast-evolving environment.

In response to this, some have advocated for a "no up-front design" approach. This is a fallacy. Design always happens one way or another, even though some things are just better thought of — or need to be thought of — in a wider perspective than the user stories you will be working on next week.

The key question for architects is therefore double:

1. How can we guide the emergence of architectures that embed the right key decisions at the right point in time?

2. How can we make our digital architectures adaptive and achieve the highest sensible level of flexibility against unknown future changes in direction?

Why Neither Up-Front Design Nor "No Design" Is the Answer

In a classic approach to architecture, we define everything up front across the board, trying to pinpoint all the solution details based on a set of requirements that themselves have been defined up front. There are three major flaws with such an approach:

1. Most of the effort is wasted on detailing parts of a design that were a given or easy to guess (in terms of complexity, not effort).

2. One effectively settles on one very detailed solution hypothesis and runs with it, whether or not the solution ends up being adequate, feasible, or financially viable.

3. There is little opportunity for the different people involved in designing and building a solution to have a meaningful, ongoing conversation about the different dimensions of a solution (cost, time, quality, feasibility, user expectations, and all the associated tradeoffs). As a result, the ability to readjust the whole solution is limited.

In the best cases, initiatives designed in this way end up being more costly to implement and run or only partially usable (or both). In the worst cases, the solution is unusable or gets abandoned halfway as costs spiral out of control and become unjustifiable when considered in proportion to the value the solution actually realizes for end users. This is even more true in the realm of data architectures, where the next use case for data integration and exploitation is usually not known well in advance.

It's important to note that following an Agile delivery methodology doesn't make you immune to these pitfalls, either. In fact, the opposite mistake of full up-front design is often made in this context. Very little effort is expended up front to come up with the essential elements of a design that will successfully address critical "make or break" uncertainties around the solution. Instead of defining a bad design up front, you incrementally sleepwalk into it.

Such an approach is also something that is simply not realistic in a world where business and IT stakeholders still need to submit budgets in advance and key ideas — including their feasibility and potential costs — need to be discussed before engaging precious resources in the next step of their design and development.

To Let Good Architecture Emerge, Focus on Key Uncertainties

It is a given that architects need to find ways to address the "absolutes" around a solution — the things that we know to be true for sure — in an effective, efficient, and elegant manner. Yet solving problems that truly matter generally involves a high degree of uncertainty. Unfortunately, the more ambitious the objectives, the more unfamiliar the context, and the bigger the unknowns, the greater the likelihood that those uncertainties — when unaddressed — will impede the emergence of a good architecture.

We've seen that trying to handle all of a solution's unknowns at the last minute simply doesn't cut it. So what we need is a way to engage with them that doesn't leave us overwhelmed. Properly identifying and squashing carefully selected uncertainties in a practical way early on will lead to a faster and cheaper design effort as well as fewer bad surprises down the road. Similarly, we've seen that trying to deal with all uncertainties up front is wasteful and leads to inefficient or, worse, ineffective solutions, since resolving them all too early will inevitably rely on assumptions more than evidence. The key to tackling this dual challenge (too little, too late versus too much, too early) is therefore not to try to address all the uncertainties of a solution in one go, but to prioritize them to continuously focus on the next ones that really matter.

Decisively addressing a small number of critical uncertainties early will respond to most of the challenges that could cause a solution to underwhelm or fail down the line. We call those *high-liability uncertainties*; that is, the questions whose answers can make, break, or significantly alter the success of a solution. It is important to be very clear, as early as possible, about what these uncertainties are, prioritize them by potential impact, and systematically find ways to practically reduce them to an acceptable level.

There are two main types of uncertainties that will arise when trying to define or adapt a solution. Some uncertainties arise from the external context, usually market pressures, regulatory rules, and the general environment around the organization or the team. These external uncertainties are more akin to risks and need to be handled as such (including through adaptive architectures). The role of architecture in this context lies within technical scenario planning, where multiple solution options are prepared against likely situations in order to be ready for further execution when appropriate. We will mostly ignore these kinds of uncertainties in the remainder of this article.

Internal uncertainties, on the other hand, relate to areas of darkness about what *we* need to do, when, how, and for how much. These are the uncertainties over which we have some degree of control and that we think we can ultimately address decisively. Architects need to understand these well.

IDEO's "three lenses of innovation" are a good starting point to classify internal uncertainties (see sidebar). A constant dialogue needs to happen between them, and architects have a big role to play in it.

We've seen that trying to handle all of a solution's unknowns at the last minute simply doesn't cut it.

Use Practical Experimentation & Rapid Prototyping to Inform Your Architecture

When a high-liability uncertainty has been correctly identified, it is sometimes too easy to use a set of slides based on many undocumented assumptions as "evidence" to reduce the uncertainty in question. It is very important to be objective. To effectively reduce uncertainties, architects should accept only solid evidence and real feedback, combined with clearly stated assumptions as required. We find the following approaches to be most effective:

- **Prototypes and demonstrators** — mostly for desirability uncertainties, as well as some technical feasibility uncertainties
- **Targeted experimentations and proofs of concept (PoCs)** — for technical feasibility uncertainties
- **Practical experience, one's own or that of others** — when similarities with a situation of reference are high enough

To assess desirability, asking people what they want is *not* an effective way to reduce uncertainty. Asking what people think of a design they can see is a better option, and it requires showing them something that mimics the aspect of the design we want feedback on (i.e., a prototype). This is particularly critical for assessing the link between user desirability and financial viability.

Using IDEO's Three Lenses of Innovation[1] to Categorize Uncertainties

User Desirability

This is what we will need to address for the solution to satisfy a set of real user needs, directly or indirectly. There are two sides to desirability: ensuring that a design is likely to address user needs and also ensuring that those needs are real and important enough. These considerations will also include desirability constraints we need to respect, such as the price a user is willing to pay and for what. Although the identification and management of these uncertainties are not an architect's primary responsibilities, understanding them and their contribution to a solution's success is essential.

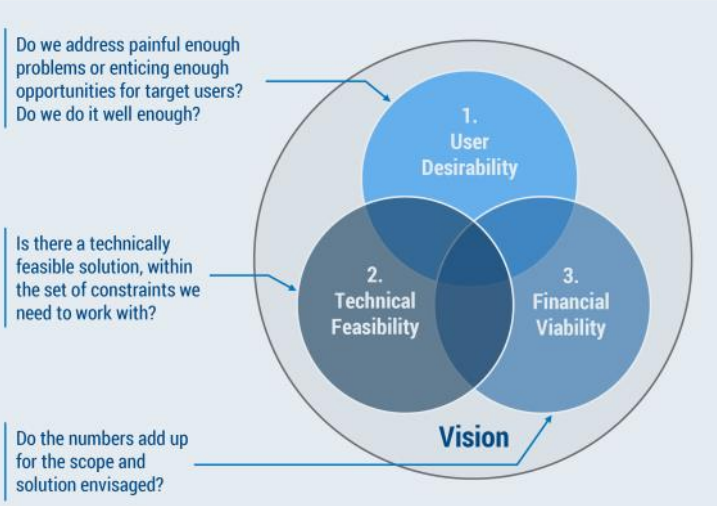

Figure 1 — IDEO's three lenses of innovation. (Adapted from IDEO.)

Technical Feasibility

Feasibility uncertainties are the question marks that exist around our ability to define, implement, run, and evolve a solution that meets the desirability and financial viability parameters required for it to be used and profitable, now and in the future. Addressing these uncertainties might require some tradeoffs in terms of solution adequacy, at least to begin with. Architecture's primary responsibility is to identify the relevant technical challenges and find ways to sustainably handle them.

Financial Viability

Financial viability involves the key unanswered questions that will determine whether the numbers eventually add up. It directly depends on the options drawn up to deal with desirability and feasibility uncertainties. Indeed, different options to address adequacy will lead to different adoption rates, acceptable price points, revenue, and so on. Similarly, different technical options will likely lead to different build and run costs.

[1] "Design Thinking Defined." IDEO, accessed December 2020.

It allows us to gauge more precisely what level of adoption or pricing level we can truly expect from an implemented solution and the technical constraints that the architecture therefore needs to contend with.

Similarly, drawing diagrams on potential technical solutions will usually not suffice to address the most difficult feasibility uncertainties successfully — unless the problem is trivial. Here as well, simple, targeted experimentations and PoCs go a long way to validate, refine, or invalidate technical solution feasibility hypotheses in an environment that more accurately mirrors a specific technical context. Also, in a complex, cloud-centric world, getting financial viability information on the costs of building and running a solution is more easily and accurately done through practical experimentation. Experiments offer the following key advantages:

- Act as a tool to forecast the feasibility of projects.
- Help furnish the use case design and discover new potential use cases.
- Help to obtain timely and valuable feedback from various stakeholders based on a *real* thing.
- Save businesses time and money.

Experience has a role to play, too, especially to reduce technical feasibility uncertainties and financial viability uncertainties regarding solution build and run costs. Uncertainties are sometimes due to a lack of in-house knowledge or experience rather than a true fundamental feasibility challenge. External experience can therefore help when technical similarities with past situations are high enough.

Keep Your Options Open

As architects, our priority should be to get an acceptable degree of confidence on key feasibility uncertainties, using the methods outlined above. We must know whether something that can make or break our solution from a desirability or financial viability perspective is doable, and how. There's no two ways about it.

Yet, as always with architecture, solutions that keep our options as open as possible are better. This is particularly the case for high-liability feasibility uncertainties, provided the associated complexity or optimization tradeoff — there usually is one — is acceptable. The goal is to make hard-to-change decisions as late as possible in the lifecycle, only once they really *must* be made. If feasibility can be solved in two ways with acceptable tradeoffs, choose the most open way.

We should also always try to keep our solutions adaptable to changes in what is desirable. Desirability uncertainties are the easiest to get wrong, even after testing, because they involve human beings. In this case, it is as important for the architect to understand the high-liability desirability uncertainties that *have* been addressed as the ones that remain question marks. These are likely to become the cause of pivots in the future.

While it is impossible to predict the future, the ability to adapt to what we already know is most likely to prompt a solution's future pivot can make the difference between an elegantly evolving architecture and one that must be thrown away. This is especially true for data architectures where there is a strong need to provide a quick turnaround to support exploratory areas and new use cases in areas such as data science and artificial intelligence (AI) research.

3 Ways to Keep Your Architectural Options Open

In our experience, the following patterns and techniques are useful for keeping our digital and data architectures open to changes:

1. **Use domain-driven design and contracts.** This technique is an evolution of the principle of decoupling in complex systems — and almost as old as software development itself — but it's clearly a pillar of an evolutive architecture. It forces modularization and enables independent evolution and optimization of different parts of a system behind their clear abstractions, with few to no ripple effects. The use of domain-driven design and contracts is a fundamental tenet of digital architectures.

2. **Use expand and contract data schemas.** This technique can be used for database schema design as well as interface design. When defining changes to data structures, it is much more flexible for users of your data or consumers of your contract to deal with a staged expansion and contraction approach. This means that instead of making a change straight away, you first make a nondestructive change — typically by adding and potentially duplicating data rather than renaming or removing structures — and then retiring what needed to be removed at a later point in time.

> *As architects, our priority should be to get an acceptable degree of confidence on key feasibility uncertainties.*

3. **Don't optimize too early.** It's often tempting to build abstraction mechanisms today to optimize hypothetical extension use cases for tomorrow. Always consider the level of certainty for such future extensions as well as the added complexity tradeoff to assess whether it should be done now. Beware of complex abstractions for things that might never happen. Instead, start thinking about high-level plans for what would have to happen if these extensions were indeed needed in the future.

   Similarly, when choosing technologies, always favor the most versatile one that fits your current and upcoming constraints. For example, we have found ourselves favoring modern RDBMS solutions with good JSON document storage and querying capabilities more and more lately, to keep the number of moving parts and technologies down in our solutions. Of course, this might not work for extremely specialized heavy and complex querying scenarios that require more specialized engines (e.g., graph-based AI). If such optimization is not required, though, why make things more complex than they need to be and close down your options?

A General Recipe for Creating Digital Architectures

The general approach outlined below is not a panacea, but we have found it works well for software architecture projects, allowing us to handle uncertainty and deliver such projects successfully:

1. **Establish a set of architectural principles for your solution.** Modern architecture is about patterns. It no longer aims to provide robust, detailed frameworks for mandated solutions and componentry — rather, it should focus on strong general design principles and ensure that it provides guardrails for security, scalability, availability, elasticity, and maintainability. Your principles define the underlying general rules and guidelines to ensure these are respected.

2. **Develop the nonfunctional requirement (NFR) goals of your project and their decomposition.** Through our professional experience, we have found that it is not the functional requirements that kill products. The challenging question is whether you can make them do the things you want them to efficiently, stably, and quickly enough, while also being financially viable and adhering to regulations. A focus on NFR goals allows you to have a meaningful conversation about the adequacy, feasibility, and viability aspects of the functionality.

3. **Develop goal criticalities.** An understanding of what the main goals of the project are allows the architect and team to have an open discussion about feasibility and what can be achieved. It's a good way to apply the Pareto principle on a project — identifying the vital few functionalities that determine 80% of the outcome so you make sure the focus is on those.

4. **Develop architectural alternatives**. Any significant architecture decision — the database engine, how caching works, your security paradigm — will involve tradeoffs. Develop these so that you have options when uncertainty rears its ugly head; they will enable you to quickly adapt.

5. **Develop design tradeoffs and their rationale.** Having architectural alternatives allows you to map out tradeoffs and the rationale behind them so these can be openly discussed, analyzed, and understood by the entire team. Architecture needs to ensure that communication is well understood.

6. **Carry out evaluation and selection.** Not all solutions are the same. With the artifacts from the previous steps, you can begin assessing your architectural choices against your core goals, tradeoffs, and challenges. You can execute swift PoCs and experiments to validate choices, ensuring that you can adhere to the fail-fast but fail-safe principle.

A General Recipe for Creating Data Architectures

When compared with software architecture, data architecture is relatively new. It has come into focus in recent years due to the rise of big data and machine learning. A robust data architecture that allows for change likewise allows for future-proofing, as an initial set of use cases that may be limited to reporting and auditing can then be expanded into predictive analytics, recommendation engines, and assistive AI. This typically requires much richer and wider data to power the algorithms, including access to metadata, transactional data, streaming data, and so on. Such data architectures can evolve to deliver that.

The role of data architects is sometimes vaguely defined and tends to fall on the shoulders of senior business analysts, data scientists, or database and ETL specialists. As with any kind of architecture, designing for uncertainty is a key requirement with data architecture. An organization's data sources and data requirements will always be in flux because organizations will always be undergoing significant changes such as acquisitions, digital transformation programs, or development of new services and products.

Conceptual-Level Data Architecture Design

To start, you will want to build a data blueprint at the enterprise level by designing the data entities and taxonomies that represent each business domain, as well as the data flow underneath the business process. Ensure that you capture:

- Core data entities and data elements about products, clients, and services
- Source data you have, both internal and external, that you can leverage to create outputs
- Output data needed by the organization (and whether it can be created using the source data available)

- Relationships between different data entities (reference integrity, business rules, execution sequence)
- Security policies to be applied to each data entity

Logical-Level Data Architecture Design

This is the data modeling aspect of data architecture, and it should bridge the business requirements to the underlying data management systems (data stores, data pipelines). The goal of architecture here is again not to impose strict rules, but rather to create strong guardrails that allow for efficient use of data and managed change.

Our experience shows that six key areas make or break data projects:

1. **Naming conventions.** Naming conventions are a key — and often misunderstood —element in data modeling efforts. There is power in names. Good, clear, and consistent names enable us humans to more easily understand the complex data. Names should be applied consistently across data.
2. **Data integrity.** Integrity rules need to apply consistently across all of the data. This is of special importance if the same data resides in multiple data sets.
3. **Security and privacy.** These are now key aspects of all database design not only due to the risk and costs of data leaks, but also due to the strong regulatory environment organizations have to operate in (GDPR, CCPA, HIPAA, etc.).
4. **Data pipelines.** Data movement and transformations between applications, systems, and databases should be clearly defined at this level.
5. **Data replication.** With the constant performance gains of storage and its ever-decreasing costs, data replication is used to solve three key challenges: high availability, performance (avoiding network data transfer), and decoupling of downstream workloads that make use of the data. However, too much data replication will lead to poor data quality and inefficiencies. Consider these tradeoffs carefully and make sure to apply your guiding principles.
6. **Data archival and retention policies.** It's important to define these during this stage as well. We have seen numerous projects where archival and retention policies were afterthoughts well into production. This led to the wasting of resources to troubleshoot the "unexpected" problem, inconsistent data across different data stores, and poor performance of queries.

> *The goal of architecture is not to impose strict rules, but rather to create strong guardrails that allow for efficient use of data and managed change.*

Continuous Data Governance

One of the key challenges to data architecture is that it is always subject to change, as data is just a tool to support augmented decision making for your organization by creating insights and knowledge. When your organization changes as a result of a digital transformation, a new product launch, or competitive pressures, your data requirements change as well. This directly implies that data architecture is not static but is a continuous process of managing data, enhancing data, and monitoring constantly. To be able to do this effectively, you need to institute data governance rules early on. Establish data ownership, decision rights, and the controls that ensure security, accountability, and trustworthiness for your data.

The Journey Never Ends

Uncertainties evolve with time. As old key uncertainties are addressed, new ones appear based on new accumulated learning, real-life usage, and new needs. Architecture never ends because improvement and optimization opportunities must be continuously sought, and the natural uncertainties that come with them must be actively managed and addressed.

Letting architectures emerge from evidence against known key uncertainties is critical. At the same time, keeping your architectures as flexible, adaptable, and extensible as possible with tradeoffs that make sense in your context will help make them more resilient against those uncertainties that can't yet be addressed, as well as the ones that haven't appeared yet.

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KNOW YOUR FOCUS

The Missing Step in Digital Transformations:
Defragmenting Your Value Streams

by Eric Willeke

Any meaningful business transformation requires significant changes across many dimensions, including operating models, organizational structures, funding models, data responsibility, and platform architecture. Keeping these changes aligned often proves to be one of the hardest elements of any transformation initiative. This alignment is even more challenging in digital transformations because successful digital change efforts are an overlay across many lines of business (LOBs); they also drive behavior change from early exploration and product strategy all the way through to technology deployment, service design, and ongoing operational behaviors.

These facts lead many organizations to create a new "digital" organization rather than evolve the existing technology organizations to a higher level of capability, thinking this approach will "simplify" the change behaviors. In practice, it often makes the change more challenging and less sustainable due to the decision and authority boundaries with the existing organization and the behavioral and investment negotiation that becomes required at those boundaries. Instead, digital transformations should focus on simplifying the flow of value within the organization as part of creating an incredible experience for customers while accelerating the organization's ability to change.

Pursuing digital transformation involves a deep focus on the nature of the data being used in the organization, the services being exposed around that data, and what business use cases are being improved and reimagined through the use and recomposition of these new services. This article explores the importance of additionally addressing the shape of the organization around those services, the decision authority regarding service directions, and how the company chooses to allocate funding against the service investment. It also examines the negative impact of failing to engage in the challenging organizational change required to realign around the new digital services and away from traditional habits of investing in technology. Inevitably, these changes overlap with other transformations that may be active in the organization, such as a DevOps or Agile transformation, and perhaps also customer care transformations and other more customer-facing change initiatives.

There are three common failure areas that emerge in transformations that don't actively attend to the above concerns. Successfully addressing these areas and creating the ongoing capability for effective and smooth organizational changes will increase the likelihood of a successful digital transformation.

Digital transformations should focus on simplifying the flow of value within the organization as part of creating an incredible experience for customers while accelerating the organization's ability to change.

3 Areas of Potential Failure and Their Symptoms

The first two of these problem areas are fragmentation of value streams and poor distribution of decision rights. Addressing these issues successfully will allow for faster pivoting, better fit-for-purpose implementation of digital capabilities, and improved relationships between technology and business partners. These benefits will allow a company to bring its full technology potential to bear against the most challenging problems its customers face. The third area is poor management of the portfolio of business capabilities. Improvement here seeks to reduce the costs of technology operation and evolution, reduce legacy-system impact to time and budget, reduce technical debt impact to time and quality, and create a more flexible technology infrastructure that can adapt as the company moves into new areas and new businesses.

To begin evaluating the efficacy of a digital transformation, it's useful to look for the early indicators of failure that are seen in many attempts at transformation. Many of these have a variety of root causes, some more obvious than others, but they are still symptoms that sponsoring executives should be watching for to ensure they get addressed and mitigated as early as possible.

Keep in mind that most of these symptoms have underlying causes that are quite challenging to address, and therefore the organization will shy away from engaging to correct them. In later sections, we will discuss goal-aligned tools for helping the organization engage, followed by change management capabilities that will facilitate making the hard changes required to address these root causes.

Symptoms of Value Stream Fragmentation

Symptoms in the first category are those that relate to having an overly fragmented value stream. These include:

- Slow or low business impact from digital efforts
- Poor executive visibility into progress and impact of business use cases
- Many people required to update progress on a business use case
- Emergence of many "councils" for decision making around business use cases

The starting condition for almost every transformation is the existence of a component-based, reporting silo–based, or even function-based implementation organization. This is expected, as it is among the primary reasons for undergoing transformation in the first place. However, we should soon see improvement of these symptoms if the transformation is being run effectively. Failure to see improvement in a fairly rapid manner is cause for concern.

Symptoms of Poor Decision Governance

Symptoms in the second category are those that arise from failing to update and evolve the culture of decision making and the way decision rights are granted within the company. These include:

- Turf wars between "traditional" and "digital" implementation organizations
- Leadership hierarchies that emerge reflecting a company's transient bimodal approach
- Ownership transitions of services to "operations" (which may additionally indicate an underlying need to establish DevOps capabilities)
- Misalignment of digital outcomes, company strategy, and LOB strategies
- Lack of a clear digital/customer experience agenda independent of LOB strategies

These symptoms are often more subtle, and it can be difficult to identify their root cause. They show up in some of the more disruptive political patterns that can cripple the long-term culture of a company, putting the success and long-term sustainability of digital transformations at risk.

Symptoms of Poor Business Capability Portfolio Management

Symptoms in the third category are those that transcend any single business-focused value stream but represent a failure of the company to attend to the portfolio management of its business capabilities and the platforms and services that realize those capabilities on behalf of multiple LOBs. These include:

- Steady or increasing dependency count (number of organizations/teams involved) for implementation of individual business use cases
- Increasing duplication and multiple implementations of digital capabilities
- Increasing cost per feature due to legacy systems (and all that that implies)
- Inconsistent or no investment in intentional rationalization of the technology portfolio

These concerns are more easily deferred in smaller organizations with a single LOB, as they do not lead to challenges for quite a while. For large companies with multiple overlapping LOBs, however, attention to business capability management and the business architecture of the organization becomes crucial immediately when commencing digital transformation. The successful management of the business capability portfolio directly influences the platform strategy and the organization structure required to successfully extend and evolve those platforms over time.

2 Critical Moves

All three sets of symptoms described above can be addressed in a relatively straightforward manner by focusing on two areas in quick succession in your transformation.

First, it is absolutely crucial to understand customer journeys and the operational value streams the company uses to deliver against those journeys. A clear and broadly shared visualization of these two elements becomes the basis for many improvement efforts in the organization, establishing a design language for the organization's change strategy. At this point, efforts to describe your customer experience will overlap significantly with the work of business architects in visualizing and describing how the company delivers against its value propositions.

The business capabilities that serve a number of different journeys and value streams become candidates for the initial services (and associated delivery groups) for a digital transformation. This leads to the second move: managing the portfolio of those shared capabilities in a transparent, responsive, and well-respected manner. The platforms that arise to implement those shared capabilities become key assets of the enterprise. Unfortunately, when business partners lose trust in the process for identifying, funding, implementing, and deploying those shared capabilities, they will begin to actively avoid using the services, thus losing out on that value.

Expected Outcomes of the Moves

Both steps above share a set of common goals for the larger silos in the organization: improving the relationships between them, removing friction from interactions, smoothing over the gaps between the silos, and ultimately reducing their overall number. Generally, this approach results in an intentional network of loosely aligned services composed into business-aligned value streams.

Outcome: Connect Feasibility & Desirability

The key goal of design thinking — which is central to any digital transformation effort — is to create products that are desirable, feasible, viable, and sustainable. Unfortunately, the group of people with the skills to know whether something is likely desirable is often organizationally distant from the group of people who know whether something is feasible to build. One of the most important outcomes of effective digital organization approaches is to ensure that the people who have each skill set are close to each other and able to work together routinely, thus allowing the rapid exploration of the art of the possible in the context of a given customer segment and those customers' desires.

Outcome: Increase Pace of Technology Evolution

Rapidly exploring product-market fit requires a technology platform that is capable of being evolved and extended incredibly quickly. Intentional investments into processes and platforms will reduce both the organizational and technical friction associated with developing new capabilities and the overall risk exposure. In turn, these improvements will allow the people closest to the customer to more rapidly experiment and deliver very fit-for-purpose solutions.

When business partners lose trust in the process for identifying, funding, implementing, and deploying shared capabilities, they will begin to actively avoid using the services, thus losing out on that value.

Outcome: Simplify Operating Model Changes

When product-market fit evolves rapidly, it becomes equally important to be able to flex the shape of the organization that delivers those products to the customer. Being able to swiftly change the company's operating model around a product while protecting organizational health allows a company to evolve alongside its customers — and even reinvent itself more effectively. As the disruption of technology adoption decreases and the company culture grows more tolerant of changes, it becomes increasingly possible to support continuous incremental change in business practices in ways that do not seem half-baked from the customer perspective.

Outcome: Improve Steering Capability

The investments into the capability portfolio will allow individual products and environments to evolve very rapidly through local decision making. Despite this speed, a clear definition of value streams and platforms

and a well-aligned governance system will simultaneously improve the overall ability to steer and defend the investments made across all products and services. Not only does this simplify the ability to define and achieve larger cross-cutting strategies as a business, it also allows vastly simplified management of product metrics as well as easier evaluation of platform and architecture investment returns.

Preparing the Ground for Successful Change

None of the goals above will happen without a very intentional organizational change journey focused on achieving them. Perhaps the most important step of navigating this journey is establishing the conditions that allow such changes to become both effective and sustainable, especially given the magnitude of this type of transformation. Going into these changes knowing that a strong value stream alignment is a necessary outcome allows the organization to begin doing foundational work to prepare for that transition. Some of this groundwork aligns with typical change management efforts, while other aspects are specific to the type of change that is necessary when smoothing the flow of value streams is part of the goal.

It is often useful to treat the preconditions for successful change as specific business capabilities. Knowing that an organization will need to rapidly evolve to remain fit for its purpose and deliver the best possible customer outcomes, it is clear that the underlying skills and habits around change management are critical business capabilities themselves. As such, the following activities preparing for value stream alignment are stated as business capabilities in the understanding that they will be repeatable and routine as part of the talent base and governance processes of the organization.

Map, Visualize & Design Business Architecture

Business architecture, especially the aspects around business capabilities and how they are composed into operational and development value streams, becomes a design language for many of the changes that the organization will undertake. There is thus high value in having a broadly distributed set of skills and habits around being able to routinely articulate the current state, define a candidate future state, and use the visuals of the business architecture as communication tools to demonstrate how the organization will evolve to that future state. Facility in consuming these visuals and using them to shape and define local change efforts should be a core management skill.

Define, Capture & Visualize Value Stream Performance

Most organizational governance is not aligned with value stream thinking at this time. Most approaches have governance flow through either leaders or, at best, through product line P&L reporting approaches. However, with new ways of aligning teams, organizations require effective governance techniques that respect this end-to-end thinking and value-centric orientation. These changes are similar to the changes required from cost accounting to throughput accounting in the Lean manufacturing transition, only applied to software and technology investment and business operations instead. Over time, this should become the dominant way of steering investments, managing performance, and reporting results.

Sponsor, Charter, Deploy & Sustain Organizational Change Experiments

Shifting the dominant reorganization approach from a single designed action to one of continuous, safe, small experimental changes becomes a powerful capability when different levels of leadership are driving different degrees of change as part of everyday business evolution. Key aspects of this capability involve forming change leadership teams, understanding the breadth of participation required for successful change, enrolling multiple layers of leadership in every change, and ensuring that decision rights, data authority, and funding responsibilities can be rolled into the change management activities without undue friction.

Define, Deploy & Steer Strategy/Operations for Value Streams and Platforms

As value streams and the business capabilities become the default language and operating structure for the organization, it creates the opportunity to both articulate and deploy strategy along value stream lines. Thus, building habits of bringing entire value streams together to plan both organizational changes and ongoing operational work becomes ever more important. Integrating Lean and Agile change models into this approach provides the decision speed and requisite

breadth of authority to enact significant changes in a relatively short time, all while minimizing the chaos generated from excessive changes. It also provides an easy opportunity to align employee goals to the platforms and value streams in a way that is well integrated with the overall goals of the organization.

Bringing It Back Around

This article has looked at the symptoms of fragmented value streams, the two key moves for correcting the fragmentation, and the critical business capabilities that are necessary to create a value stream–aligned culture and operating organization. To bring this around to the original premise, I strongly recommend that you make building this alignment and developing the associated operational capabilities as specific named goals of your digital and data transformations.

It's easy to look at these goals and say, "That's not part of digital transformation" and point at other active efforts in the company. However, in practice, it is very challenging to disambiguate the various transformations happening in most organizations because each transformation requires benefits that are typically part of a different named transformation. (For more around this perspective, see my previous *Cutter Business Technology Journal* article "Fit-for-Purpose Agility."[1]) I believe this is why it is rare to see a successful digital transformation that does not also include a fairly pervasive Agile presence and extensive DevOps investments.

Fundamentally, it is valuable to focus early in digital transformation on defragmenting value streams because successful digital capabilities require iteration, iteration requires speed, and speed requires simple, malleable technology platforms with minimal dependencies. Meanwhile, effective iteration also requires feedback on fit for purpose, which requires access to customers, which requires services to be closely connected to the businesses they serve. These fast connections aren't possible in a siloed organization that inflicts a time tax on every decision.

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LAYING THE FOUNDATION

Building a Digital Ecosystem Platform from the Bottom Up

by Thomas Gossler

Technology advancements often enable new market entrants to disrupt existing pipeline business models and thus change the dynamics of entire industries. New market entrants do that by building their businesses around a platform model using scalable technology like the cloud that allows them to grow exponentially with very low marginal costs.

To counter this threat and to leverage such business models, large companies typically decide to start company-wide digital transformation initiatives with the goals of modernizing their ways of working and eventually establishing platforms of their own. Usually, the starting point is to build value-added services around their existing products with the help of a partner network and deliver them scalably to drive higher usage and adoption. Digital ecosystem platforms are all about interactions and value creation. Ensuring that the ecosystem partners benefit from the ecosystem helps in defending the existing product portfolio against new market entrants and preparing for disruptive changes in their industry.

A digital ecosystem platform enables interactions around core value units between users (producers and consumers) and is often composed of three logical layers: data, technology infrastructure, and network/marketplace/community.[1] Not all companies are building their own platforms; many are hooking into one or more existing platforms and thus just contribute to one or more of these layers. Either way, the quality of data and the reliability, performance, and ease of use of the infrastructure is key for the user experience (UX) and for the ecosystem to flourish. It takes time to build such a mature foundation along the people, process, and product dimensions.

Approaches & Lessons Learned

Seven years ago, the company I work for, Siemens Healthineers, began exploring a new platform business model. We started by developing a small, cloud-based product that focused on key foundational aspects. Over time, this product has grown — bottom up — into a company-wide program for digital transformation of major business cases. This article describes the approaches we took and the lessons learned.

Start Small, Explore Opportunities Thoughtfully

There are many challenges ahead for a company that wishes to build its own platform. Digital transformation is different for every organization, which is why it is risky to just copy others. Before launching a costly change initiative for the whole company, it is vital to have a clear understanding of the "why" behind the effort. Embarking on the transition without a clear goal will only lead to exponential change instead of exponential growth.

When contemplating transformation, you should test your assumptions in a pilot project before betting the farm on them. Such a project should be chosen to have minimal impact on the company in case of failure, should be realistic to build with a small team, and should have high potential for growth.

When Siemens Healthineers launched its platform initiative, we started with a small project in a protected environment within the company that enabled us to explore possibilities and test our assumptions about predicted future changes in the business model. We identified and selected our potential business case carefully. The plan was to build a cloud-based product, from scratch, for existing customers around the globe. It would give them new, differentiating capabilities; offer the ability to leverage the latest technological innovations; and be offered under a freemium subscription model.

The objective was to discover what it takes to build, offer, and sell such a software-as-a-service (SaaS) solution with a fast time to market and a low total cost of ownership in a safe environment, where it would not compete with existing products. This approach — start

small, learn fast, and focus on building a foundation with a small offering on top as a proof of concept — turned out to be a winning strategy.

Expect — and Allow Time for — One Learning Curve After Another

Although we chose the right strategy, the learning curve(s) turned out to be steeper and the planned learning phase much longer than expected — multiple years instead of one year in the end. And this was only for the initially small and isolated team of 25 people (which grew to about 60 over this period). For a bigger team, the learning phase would likely be even longer.

In the beginning, the challenges we faced involved tools and technologies. This led to a decision to keep the level of governance low and give the project team freedom to experiment and learn fast. For example, the team didn't have to get up-front approval for all newly allocated cloud resources but was instead allowed to just create them and proceed quickly instead of having to wait for clearing of budget, naming conventions, documentation requests, and so on.

Soon the focus shifted to earning the necessary trust of customers in the company's security and data privacy practices, which required not only technical changes, but also contractual and even procedural adaptations to comply with internal and external regulatory requirements and regional law. The longer-than-anticipated time to market led to heavy discussions about strategic investments because the initial business plan had called for an early breakeven.

Later, the low level of governance turned into another challenge because the costs for cloud resource consumption had outgrown the yearly budget earlier than expected, and we had to initiate a lengthy process of cleaning up the cloud environment and eliminating waste. Then, with a growing number of users and amount of feedback, the spotlight turned to operations after we realized how different the approaches are for delivering managed scalable services in contrast to products installed at scale. In addition, we had to revise our approach to storing and processing a growing amount of data to better support the use case scenarios and legal requirements.

Finally, we had to contend with cultural and political consequences once marketing and communications started to position the all-new offering prominently beside the existing product portfolio and probed the resonance on the customer side. People in the existing lines of business grew concerned when they began to see their customers express interest in the new platform offering, fearing they might lose sales of the products they were responsible for.

For all these reasons, we would have been well advised to plan more time for the initial learning phase.

> *To prevent the accidental emergence of a permanent second central IT group, it is important to ensure regular informational exchange between both sides.*

Avoid Emergence of a Permanent Second Central IT Group

Although it makes a lot of sense to start a digital transformation initiative with a small, focused project in an environment of freedom with a lower level of governance and a strong business orientation, there are certain aspects on which you shouldn't compromise. For example, it can be helpful to initially allow a kind of "shadow IT" for the pilot project to protect it from established governance entities that would fight the required changes in line with their responsibilities. But to prevent the accidental emergence of a permanent second central IT group, it is important to ensure regular informational exchange between both sides.

One goal of this exchange is to avoid unnecessary changes and possibly stay aligned with existing patterns and practices. Another goal is to trigger the timely buildup of necessary competencies in the existing central IT group. That way, it can support the new tools and technologies once the anticipated success of the digital transformation project leads to increasing demand throughout the organization. It is generally also a concern to define a company-wide cloud strategy early before separate groups start their own cloud initiatives independently and across different cloud platforms.

Furthermore, it is best to avoid a separation between company-internal IT use cases and external, customer-oriented use cases. There is no sharp division between these two in a platform business — it is a dynamic continuum. Establishing an enterprise architecture that considers both sides independently poses a risk. These aspects will be costly to change later and might cause

unwanted redundancies, increase operational costs, and even impede the exploitation of new business models.

Enable the Needed Culture Shift

During digital transformation, an organization is typically trying to achieve faster time to market with frequent releases but without compromising on quality. A widely recognized way to achieve this is by adopting an Agile development approach and continuous delivery practices, including so-called DevSecOps. This abbreviation refers to an organizational setup that removes "walls" and fosters close cooperation of R&D, cybersecurity (including data protection), and operations across all phases of the iterative development process.

Continuous delivery denotes a high degree of automation in software build, test, integration, and deployment and is key for being fast while keeping the quality up. It is important to understand that such an approach requires active support from top management and entails a change process of its own, consisting of changes in company culture that, of course, take time themselves.

> *More valuable transactions between users of the platform keep them engaged and attract new users.*

After observing the pilot team struggle for a while, Siemens Healthineers decided to engage well-respected continuous delivery consultants over a longer period in all disciplines, covering even training for top management and pair programming with developers. This had a sustained positive impact on the way of working in the small team and later also in the broader organization when other groups followed the team's example and started to adopt DevOps and continuous delivery practices.

Engage in Exponential Thinking

Migrating an existing classic application into the cloud without modification (lift and shift), for example, is often misinterpreted as an act of digital transformation. It might be an initial step on the way to a SaaS offering, but it is not even close to the actual idea and characteristics of such an offering. The "as-a-service" paradigm implies characteristics like permanent availability, pay-per-use, and low cost by leveraging economies of scale. None of these can be achieved by a simple lift-and-shift approach. This explains another necessary change of mindset from (only) traditional product pipeline thinking[2] to (also) platform thinking.

A pipeline product is shipped to a customer and is used by one or more users independently from other such products shipped to other customers. A platform, in contrast, is a central service and is the basis for an ecosystem. Pipeline products can get connected through a platform, which may add value for the users of each individual instance of the product as well as for the users of the platform services. Such an ecosystem platform typically optimizes a few transactions between users instead of focusing on a set of features like pipeline products do. In combination, this enables new business models.

To leverage the full potential of this approach, it is advisable to teach all of the organization's product owners about exponential thinking. Then encourage them to apply it in their daily work to identify scenarios in which connectivity to the platform or a new transaction on the platform can add value for the users (producers and/or consumers). More valuable transactions between users of the platform keep them engaged and attract new users. Such self-reinforcing effects can be accelerated by enabling and incentivizing activities that pull new users into the ecosystem. This can lead to exponential growth of users, transactions, created value, and revenue for producers and the provider of the platform.

Invest in Training & Maintenance to Prevent Innovation Overload

Digital transformation for most companies also means focusing more on their actual business by utilizing external services and components from other vendors or open source projects for non-differentiating things like standard IT. These other vendors are in the same situation, wanting to deliver value faster and more frequently and adapt to customer needs quickly. This results in an overwhelming amount of innovation over time and requires a systematic approach for continuous modernization.

Considering this constant investment into training and maintenance as a productivity loss and a drag on time-to-market goals is risky. This short-sighted mindset can lead to falling behind competitors, especially when they are better at leveraging the latest technology to offer

their services at lower cost with higher flexibility. These rivals also become more attractive as employers because of their state-of-the-art technology and practices. To remain competitive, you'll need to make the investments required to keep up with — and not be swamped by — continuous innovation.

Think in Platform Terms

A platform is different from a pipeline product. Organizations with a pipeline business model organize everything along a chain of product activities, including sourcing, sales, and service. Platforms facilitate interactions between users. This requires a different way of thinking and a different organization. It implies a clear user-centric design for keeping users engaged, while also attracting new users. Especially in the early days, users are almost as valuable for the feedback they provide as for the money earned from their subscriptions.

The best platforms are not born as platforms but as compelling products that eventually evolve into platforms over time. Sometimes it is necessary to integrate or even consolidate multiple products into a new service. However, many platform initiatives face the challenge of having to start out "empty," which means without users and without previously created value. Even though this challenge can be overcome, it does mean that it potentially takes more time to make a platform successful than a product.

Achieving success with a platform may require a long-term strategy instead of a business plan that demands a short-term breakeven. The latter will cause recurring discussions about whether the platform endeavor should be stopped and puts the initiative under pressure, introducing additional risks like a lack of focus or reduced quality of the foundation. Low quality could be the result of lacking expected capabilities or growing technical debt that cannot be paid back.

Do Not Forget Operations

As mentioned above, users expect certain characteristics from a digital platform, such as permanent availability, responsiveness, and reliable interactions. Although these qualities are usually easier to achieve in a cloud environment, thanks to continuous delivery practices, it requires real-time monitoring and quick reaction to incidents. Furthermore, the continuous evolution of the software requires ongoing planning and adaptation of existing operational procedures or development of new ones.

In a pipeline-oriented business, operations are typically not a distinct discipline. In a platform business, they are. Recognizing that difference from the beginning (and acting accordingly) is an important part of digital transformation and will prevent negative surprises in the late phases of the service lifecycle. Depending on the reach of the offering, the target audience, and the use cases, a platform may require 24/7 support around the globe. Organizational structures need to be established to allow scalable handling of customer requests.

> *Platforms facilitate interactions between users. This requires a different way of thinking and a different organization.*

Siemens Healthineers has worked with its existing global support group to be able to provide first- and second-level support during typical customer working hours in all major world regions. New use cases in the platform may require extended support. It is advisable to introduce a cloud operating model with a service management orientation that defines a structured approach to defining, releasing, operating, and supporting digital services.

Ensure Data Protection by Design & Default

All sorts of software must adhere to the EU's General Data Protection Regulation (GDPR) and the proper collection and storage of personally identifiable information (PII). That's especially the case when it comes to platforms, which often want to enable the legal secondary use of customer or user data. This is where it gets challenging. The goal is to give every person control over which of his or her PII — if any — a system uses and to enable that individual to review and/or delete any or all of it.

GDPR specifically requires companies to protect the user's PII through a "data protection by design and default" approach. This means that the software must be designed such that all settings and configurations are set by default so that no user information is collected without an explicit opt-in.

This mandate can come into conflict with the goal of enabling fast, easy interactions on a platform. We strive to handle these strict requirements in the software in a way that is compliant but not cumbersome for the user. At Siemens Healthineers, there is a central UX group that works together with all product groups to foster user-centric design and ensure a consistent UX across all products.

Establish a Comprehensive Data Framework

Besides complying with a comprehensive legal framework comprising regulatory requirements and regional law, it is also necessary to stay in control of where data is stored and how access to it is granted to whom, for which purpose, and for how long. The more data is distributed across many places, the more challenging this can be.

As part of its digital transformation, Siemens Healthineers is consolidating all systems and technologies containing business, customer, or even clinical data into one highly available and scalable data lake. It features a comprehensive and similarly scalable access control mechanism on top as part of an overall data framework that augments the underlying data lake with additional services like data processing and analytics mechanisms and a data catalog. The latter enables simple data discovery across the enterprise.

Overall, the goal is a single and consistent approach to finding, exploring, accessing, and managing any kind of data, over its entire lifecycle, according to regulatory and legal constraints. Such a centralized approach to handling data is possible today with the help of cloud technologies, and it enables the buildup and later evolution of the platform.

Master Change Management

Establishing a platform in a large enterprise alongside an existing product portfolio implies significant change management. If this challenge is tackled by starting a platform initiative small and growing into it slowly, the probability is high that initial problems will also be smaller and that lessons learned can be applied along the way. This approach helps avoid large detours and ensures that the effort's direction can be adjusted frequently based on feedback.

This method also helps defuse defensive reactions. Smaller projects are easier to accept and support in the company even if they have disruptive potential. A partial goal of a digital transformation should be the convergence or even consolidation of redundant products and services.

Key Takeaways

I hope that sharing how our company built our digital ecosystem and the experiences we had and the lessons we learned along the way will provide helpful guidance to readers from other domains. Here is summary of the key takeaways:

- Before starting an initiative, understand the why and place end users at the center.
- Beware of big design up front. Start small and explore business opportunities carefully.
- Do not underestimate the time it takes to lay the foundation.
- After an initial success, start developing competencies across the company right away.
- Foster exponential thinking to unlock the initiative's full potential.

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ANOTHER DAY BRINGS ...

Take It from NIST: Data & Digital Architecture Requires Application Security

by Timothy Chiu

With organizations rapidly moving to the cloud, applications and their associated data are at greater risk than ever. Each day brings a new security report showing increasing numbers of attacks on Web applications and zero-day exploits on application vulnerabilities that are still making it to production. With each successful attack, we also hear of a new data breach, each one as appalling as the next. According to Verizon's "2020 Data Breach Investigations Report,"[1] attacks on Web applications accounted for 43% of all breaches in 2019 — more than double the previous year's total.

It is clear that the security solutions in use today are not working. Even the US National Institute of Standards and Technology (NIST) has recognized the need to do more to secure applications running in the cloud. Recently, NIST updated its security and privacy framework, "Security and Privacy Controls for Information Systems and Organizations," or SP 800-53.[2] The final version released on 23 September 2020 includes new requirements for runtime application self-protection (RASP) and interactive application security testing (IAST). This article covers the new NIST mandates and when federal government agencies and enterprises working with the government will need to comply with these new requirements. It also explains what RASP and IAST are and how these technologies can improve and advance application security for organizations.

Tackling Today's Security Concerns

2020 brought with it the COVID-19 pandemic and the newly widespread phenomenon of working from home, which has stepped up the data and digital architecture transformation in many organizations. One of the key features of this digital transformation has been cloud adoption and an accelerated move of data and applications to the cloud. Having more data and applications in the cloud translates to a larger attack surface for cybercriminals, who are increasingly targeting Web applications and their associated data repositories. With nearly 80% of organizations claiming to have had a cloud data breach in the last 18 months,[3] there is no such thing as a safe organization. Everyone is a target.

This year's "Mandiant Security Effectiveness Report"[4] found that only 26% of attacks are detected, meaning that 74% of cyberattacks were successful in bypassing organizations' security measures. In other words, today's existing security solutions are failing to protect Web applications and data in the cloud. It was partly in recognition of this failure of widely used security technologies to secure existing data and applications that NIST updated and released Revision 5 of the SP 800-53 security and privacy framework.

> *With each successful attack, we also hear of a new data breach, each one as appalling as the next.*

Until this most recent release, SP 800-53 had not had an update since NIST finalized Revision 4 in April 2013. Revision 5 focuses on updating and revising privacy and security controls. While much of the news regarding the revision has focused on the updates to the privacy framework, there are two important new requirements in the area of application security, which are the focus of this article. Specifically, these updates are found in the following sections:

1. **RASP** — "SI-7 Software, Firmware, and Information Integrity – Section 17: Runtime Application Self-Protection"
2. **IAST** — "SA-11 Developer Testing and Evaluation – Section 9: Interactive Application Security Testing"

The addition of these two application security technologies, RASP and IAST, to the framework highlights the importance of application security as part of enterprise

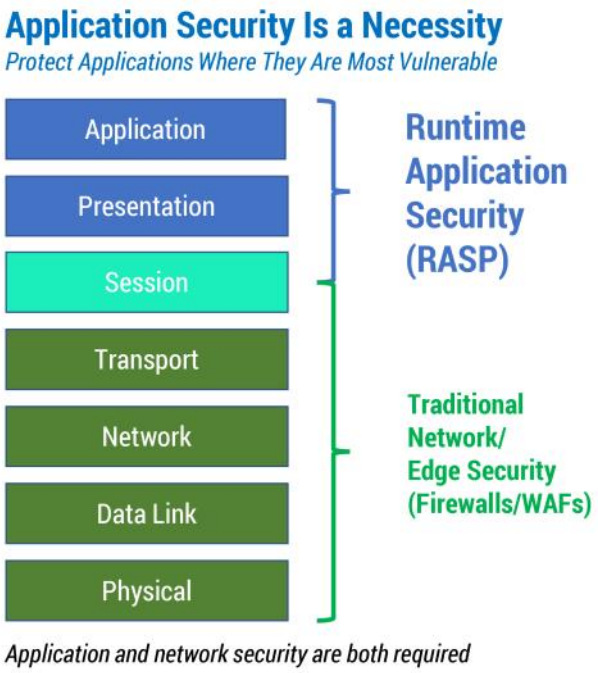

Figure 1 — Network and application security cover different layers of the system.

security. The inclusion of IAST adds advanced security testing that is used during the software development phase, helping developers catch security flaws and vulnerabilities before an application is launched to production. Similarly, the addition of RASP will provide further protection and advanced security for applications and data during runtime.

These are important steps forward. While the NIST framework is primarily used by agencies within the federal government as a plan and structure for their technology deployments, an estimated 30%-50% of enterprises[5] also use this framework for their security architecture.

When Do Government Agencies Need to Comply with SP 800-53 Revision 5?

Now that NIST has released the final version of SP 800-53 Revision 5, agencies in the federal government and those working with the federal government may be wondering when they must comply with the new security framework requirements.

The answer is found in a publication from the US Office of Management and Budget (OMB), "Circular No. A-130":

> For legacy information systems, agencies are expected to meet the requirements of, and be in compliance with, NIST standards and guidelines within one year of their respective publication dates unless otherwise directed by OMB. The one-year compliance date for revisions to NIST publications applies only to new or updated material in the publications. For information systems under development or for legacy systems undergoing significant changes, agencies are expected to meet the requirements of, and be in compliance with, NIST standards and guidelines immediately upon deployment of the systems.[6]

This means that any systems currently in development will need to be in compliance when they are released for deployment. All remaining legacy systems must be in compliance by 23 September 2021. The only other option for federal agencies is to request a waiver from the standard.

What Is RASP?

Runtime application self-protection was first introduced in 2012 as a security category, but it did not gain significant attention until 2014. As a product category, RASP describes security products that run directly on an application server and provide security and protection for the applications running on that server. RASP is a subcategory of the broader category known as application security (see Figure 1).

By running directly on the same server as the application it is protecting, a RASP solution has visibility into, and an understanding of, the operation and functioning of the protected application that other types of security solutions lack. RASP provides continuous security for the application during runtime, and RASP solutions often have the ability to protect any existing vulnerabilities in the application from being exploited by attacks.

On the application server, a RASP solution can analyze the application while it is executing in real time, validate that it is functioning correctly, and understand the context of the application's interactions. RASP solutions benefit from being able to monitor and evaluate the application, often with code-level visibility. Typical edge network security solutions don't provide this level of visibility. System/host- and operating system–level security solutions likewise lack this level of interaction and visibility into applications that are running on a server.

Some of the latest RASP solutions implement security technologies that are extremely efficient, have minimal impact on running applications, and are effective at zero-day attack detection and protection. Modern RASP solutions typically include several protection features, including:

- Protection for the OWASP "Top 10 Web Application Security Risks"[7]
- Memory-based attack protection
- Zero-day attack protection
- Real-time attack blocking/virtual patching
- Broad support for application infrastructure

Introduced in 2003 and updated every few years, the OWASP Top 10 Web Application Security Risks list enumerates the risks that should be of primary concern to application security professionals. Many of the risks on the current list, released in 2017, have been featured through all of the list's revisions. For example, two vulnerabilities — cross-site scripting (XSS) and SQL injection (SQLi) — have been featured on the OWASP Top 10 since its inception and remain the top two most widely targeted vulnerabilities in Web application attacks today.[8]

In addition to protecting applications from the risks on the OWASP Top 10 list, RASP solutions can provide memory-based attack protection. Memory-based attacks, also known as malware-free attacks, have been growing over time to become a significant concern. The number of malware-free attacks has increased to the point that, as of the beginning of 2020, they now exceed the number of malware-based attacks.[9]

Zero-day attacks have similarly been increasing over time and remain one of the more difficult attacks to detect, resulting in the many breaches we continue to see in the news. Some security solutions have a tough time with zero-day attacks because they are truly novel and different from prior known attacks. Traditional security technologies are based on matching and detecting variations on known prior attacks. Technologies like machine learning, artificial intelligence, heuristics, and fuzzy logic all start with prior attack knowledge and train or learn from these prior attacks to detect new ones. Instead of relying on past attacks to protect against a zero-day attack, a RASP solution has the ability to look at security from the point of view of the application. Some RASP solutions can actually validate the execution of the code in memory to protect the application from these truly new zero-day attacks.

By residing on the server, RASPs serve as a last line of defense after network and system security solutions. Network and system security solutions remain important, however, providing other types of necessary security. Implementing RASP does not eliminate the need for network and system security.

Zero-day attacks have been increasing over time and remain one of the more difficult attacks to detect, resulting in the many breaches we continue to see in the news.

Because RASP solutions protect Web applications running in production that are typically hosted in the cloud, they must support many different cloud infrastructures and platforms, including Amazon Web Services (AWS), Google Cloud, and Microsoft Azure. RASP solutions also have to work with bare metal deployments, virtual machine deployments, containers (like Docker), and frameworks like Kubernetes that have become popular in recent years.

Adding RASP to the Existing Application Security Layer

For many organizations, application security began with the use of Web application firewalls (WAFs), which started gaining traction in the late 1990s. After the introduction of the OWASP Top 10 list in 2003, WAFs were primarily marketed as the way to protect applications against those itemized risks.

While WAFs predate the introduction of the OWASP Top 10, they have not changed much in their coverage and capabilities since then. WAFs continue to function as a network perimeter security solution. Over the same period, Web threats have continued to evolve. While WAFs can help with certain types of attacks, including network-based attacks, they lack the visibility to protect applications against the new, more sophisticated attacks that target and trigger vulnerabilities found in Web applications.

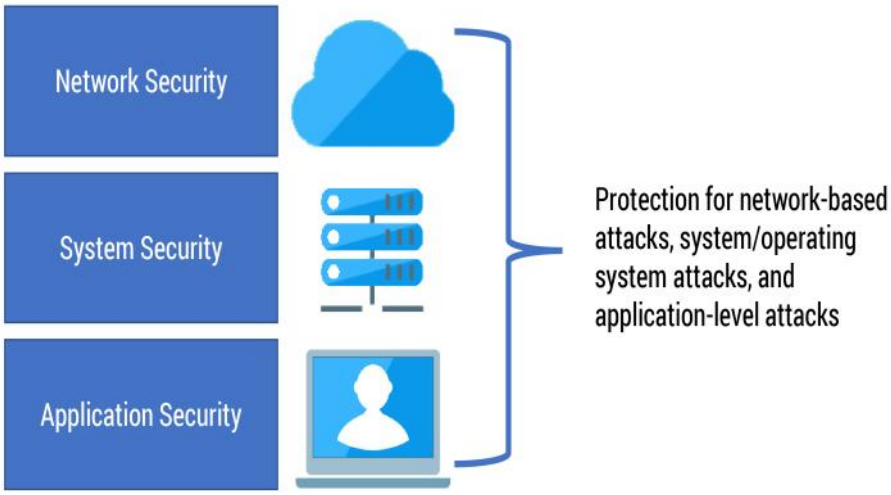

Figure 2 — Today's security requires multilayered defense-in-depth.

Many organizations also consider typical system security measures like anti-malware/antivirus solutions and newer methods like endpoint detection and response (EDR) as providing security for their applications. These solutions safeguard the underlying system and operating system that the applications depend on, but they do not provide application-level protection for the Web applications or the vulnerabilities that can be targeted within those applications, such as SQLi, XSS, and the other OWASP Top 10 risks. System-level security also fails to address the security needs of applications running in containers and container frameworks. Without application-level protections, data and applications are left open to sophisticated attacks and data breaches.

The only way to successfully secure today's applications is through the use of a multilayered security model, which includes a network security layer, operating system–level security layer, and an application security layer (see Figure 2). The new requirements for RASP and IAST in the NIST security and privacy framework recognize the necessity for this further level of application security.

RASP solutions can detect attacks where WAFs and system security lack visibility and control. Unlike WAFs, which only have visibility into the traffic coming to and from the server, a RASP can see what is happening inside the application to determine whether there is inappropriate use of the application itself.

As the last line of defense in the security framework, it is also important for RASP solutions to be able to block an attack as it happens in real time. By blocking the attack, the RASP offers virtual patching, enabling it to protect existing vulnerabilities from being exploited. RASP is the first security category to offer self-protection for the application.

What Is IAST?

While IAST is one of the latest buzzwords in security testing for applications during development, the technology category also arose around 2013 and just began gaining traction over the last three years. Interactive application security testing differs from traditional testing methodologies, including static application security testing (SAST) and dynamic application security testing (DAST), in that IAST uses a software agent running directly on the application server to observe the application as it is being tested. This is similar to the way RASP functions to protect applications during production. IAST solutions have the visibility to report further details on the vulnerabilities that are discovered during testing and detect additional vulnerabilities not seen by black-box testing tools.

SAST and DAST, as traditional application-testing technologies, have limitations in terms of visibility and the ability to detect vulnerabilities in the application being tested. SAST is used earlier in the development process. It examines the code as it is being developed, looking for problems. DAST is a black-box testing methodology that sends attacks to the application and bases its results on the responses the application returns. Besides the lack of visibility these technologies have compared with IAST, another common complaint about both SAST and DAST is the prevalence of false positives. IAST solutions tend to have fewer false positives, as they are able to validate the vulnerability directly in the application itself.

Today, there are two categories of IAST solutions: active and passive. The NIST requirement does not specify which should be implemented, so it is up to practitioners to decide which makes sense for their development environment. Active IAST is similar to DAST running with a RASP solution in that it also uses an active attack component along with the IAST agent running on the application server. In many cases, running a RASP solution with existing DAST testing can provide IAST-level results. Passive IAST, on the other hand, uses an agent to scan and detect vulnerabilities during normal QA testing without the need to employ an active attack.

RASP and IAST Are Necessary Additions to Security in the Age of Digital Transformation

With their inclusion in the recently finalized SP 800-53 Revision 5, RASP and IAST are attracting newfound attention. In SP 800-53, NIST has recognized the need for better application security, and organizations would do well to follow its lead. By implementing IAST, organizations will get better results from their security testing thanks to the increased visibility IAST solutions offer. Adding RASP will provide an additional layer of security for applications in production, enable much-needed visibility, and offer self-protection for applications that have vulnerabilities in production.

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IT'S ALL ABOUT THE JOURNEY

Demystifying Digital Transformation:
Start with the Digital Mindsets of Leaders

by Sunny Ray, Joab Meyer, and Karl Johnson

As change management specialists, we have seen many transformations suffer due to poor alignment between a company's strategic aspirations and the mindsets of those charged with carrying out the change. We find this dynamic especially prevalent within non–digital native incumbent firms embarking upon digital transformation. With this misalignment in mind, we have set out to "demystify digital transformation" through interviews with a cross-section of senior leaders at seven firms in a variety of industries, including consumer packaged goods, agribusiness, manufacturing, and finance. As we conduct our research, a comprehensive view of how mindsets must evolve to enable this transformation within firms is emerging. One of our most prominent initial observations centers on the digital mindsets of leaders; this mindset determines whether an organization's digital transformation gains traction or flounders.

Our interviews with business leaders indicate that companies can execute inefficient and fatiguing cycles of well-intentioned projects that never result in true or lasting digital transformation.

As we explore and describe the necessary shifts in leaders' digital mindsets, we will provide illustrative snapshots of the ongoing digital transformation at General Mills, a global food company with 35,000 employees generating US $17 billion in net sales last fiscal year. General Mills' journey to establish a centralized data lake to complement its successful 150-year history of producing branded consumer packaged foods is an example of the path many companies are on today. These transformation journeys typically begin with the realization that external competitive forces require the organization to change significantly to remain competitive.

The consumer food industry was experiencing unprecedented change when General Mills initiated its data lake program in 2015. Private equity firms were acquiring veteran industry players while, simultaneously, channel customers and consumers were demanding greater levels of customization and personalization. These forces, as well as digital native companies seeking to expand into traditional manufacturing or brick-and-mortar retail industries, are common catalysts for incumbents to pursue digital transformation.

Why the Project-by-Project Approach Generally Fails

There are numerous ways in which organizations may elect to respond to these situations. Our interviews with business leaders indicate that companies can execute inefficient and fatiguing cycles of well-intentioned projects that never result in true or lasting digital transformation. For example, customer-facing business groups striving to be responsive to their clients may fund and execute digital projects on a customer-by-customer basis with little attention to opportunities for integration or optimizing expensive digital infrastructure. IT functions may take a similarly siloed approach when creating business cases for the use of new digital capabilities. To make matters worse, they may embark on selling these capabilities simultaneously into different parts of the organization to secure funding, often lacking an overarching strategy for adopting the new ways of working embedded in these business cases.

The dispersed funding and project-by-project deployment inherent in this approach to "digital transformation" present several additional downsides. Foremost, organizations lose the opportunity to thoughtfully prioritize investment based on criteria that drive the greatest impact across the entire enterprise. Many of the firms across the industries we interviewed understand that building digital capabilities may enable

the blending of new and existing business models, but these opportunities are difficult to discern within a fragmented portfolio of projects.

Secondly, without a centrally coordinated funding source, each project is at risk of losing funding and support when an internal client faces pressures to meet quarterly goals, an internal champion moves to a new role, or some other unforeseen variance occurs. One of the consequences of establishing processes that drive responsive IT support to the business is that these processes often perpetuate the project-by-project approach to digital. Intentionally evolving from these established practices to an enterprise approach to digital transformation requires a shift in the digital mindsets of leaders — often at the highest levels of the organization.

From Cost to Investment

Several of the organizations we interviewed described shifting mindsets about the value of digital innovation among their executive leaders and boards. This fostered an enterprise versus project-by-project approach to digital transformation. As these leaders' mindsets evolved, they began to perceive IT less as a cost center and more as an investment-worthy enabler of innovation, new business models, and growth. Subsequently, these senior leaders began to incorporate digital objectives into their corporate strategies, invest in digital infrastructure with an enterprise-wide view, and grant digital investments longer-term timelines to yield results.

The organizations we interviewed described unique paths in how their senior leaders experienced mindset shifts related to digital. General Mills provides an example of how good activism and engagement at a senior executive level can set the stage for success. There, the VP for IT (IT VP) crafted and deployed a strategy to begin shifting the digital mindsets of, first, the CFO and, eventually, the rest of the executive team. This work ultimately led to the development and adoption of an enterprise-wide approach to digital transformation.

One of the first strategic challenges the data lake program at General Mills faced was in gaining executive buy-in. A critical concern related to the project's perceived rate of return was raised with a common refrain of, "If you can't show a rate of return, I don't want to invest." The IT VP addressed this concern by taking a "Ladder Up to a Strategy" approach, which was his way of getting the CFO to share ownership of the data lake at a point when the details of this investment were still unclear. This Ladder Up to a Strategy began by including the data lake in investment opportunities shared with the CFO. It also set the stage for generating agreement among the executive team to support the creation of a centralized data lake at General Mills. Designating data as a corporate asset is another of the themes related to shifting the digital mindset of leaders, which we will discuss later.

The IT VP was, in these ways, able to enlist the CFO as a co-owner of this strategy and develop a fellow advocate when engaging the entire executive leadership team. In tandem, the two were able to allay concerns that the data lake investment might not yield high enough "rate of return" results relative to other potential investments. This first step in the Ladder Up to a Strategy approach gave the IT VP the opportunity to then engage the executive team in further discussion of how digital investments might present opportunities to innovate, create new business models, and grow the business at General Mills.

Another critical means for shifting the digital mindsets of the company's senior executives from IT as a cost center to digital as an investment was the way the data lake investment was integrated into a broader strategy orchestrated by the IT VP entitled "Leading Digital Transformation." At General Mills and other firms we interviewed, leveraging such integrated strategies to secure commitment at the senior level often helps accelerate and sustain digital transformation. These firms find it critical to include and integrate their digital transformation strategy with other three- to five-year strategies to which the entire enterprise is already committed. At General Mills, the integration of the digital transformation strategy with other enterprise strategies was so successful that when the data lake eventually rolled out, a solutions development director directly involved noted, "We don't have a separate digital transformation strategy; at the end of the day, we are here to drive business results."

Local Ownership to Democratization of Data

One of the priorities of General Mills' Leading Digital Transformation strategy was to "Drive Action Through Connected Data." Leaders we've interviewed at other organizations have described a critical digital mindset shift exemplified by moving away from local harvesting, access, analysis, and ownership of data. At General Mills, the connected data priority provided the foundation on which to build understanding and acceptance of

a new digital mindset that treats data as an enterprise-wide asset. In many organizations, this shift from local to enterprise stewardship of data has been described as the "democratization of data." When data and data stewardship are centralized, it enables all parts of the organization to access and analyze the organization's entire set of data to make more informed decisions at a local level.

While the rationale for data democratization may seem evident, it can be very disruptive to the long-established approaches that leaders have used to acquire, manage, and analyze data. Thus, organizations need to be intentional in how they advocate and adopt the democratization of data. This focus on advocacy and adoption differentiates the organizations that have been able to accelerate and sustain digital transformation from those that have not. As we continue the General Mills story, we will see the purposeful creation of communities of practice (CoPs) as one example of how organizations can build advocacy and adoption to help shift the prevailing digital mindsets of leaders.

While the rationale for data democratization may seem evident, it can be very disruptive to the long-established approaches that leaders have used to acquire, manage, and analyze data.

Shifting Mindsets Fosters Adoption

At General Mills, the data lake program consolidated most key business data in one place with a granular level of detail and reliability. As a result, users from across the organization could trust the data, find relevant details within it, and connect it to their business challenges. This data could then be used across the enterprise to drive action. While there were many technical hurdles, one of the main challenges was the people aspect of this change. Specifically, key leaders and teams, both within and outside IT, needed to understand that adoption of the data lake would address their business challenges.

On a tactical level, a clear and consistent structure was needed to ensure stakeholders were included and able to buy in to the opportunities presented by a data lake. IT identified key users and leaders across the organization and brought together several CoPs. These CoPs discussed with directors and solution managers such day-to-day topics as the biggest pain points, use cases, and what data was needed. These discussions informed the roadmap for data lake use cases.

At a strategic level, a "Connected Data" CoP was formed to educate key business leaders on the benefits of an enterprise approach to digital transformation, including adoption of the data lake. For example, this CoP identified several key overlapping data sets that helped the team prioritize the order in which the data should be brought into the data lake. Bringing these key resources together to address challenges such as the overlapping data sets helped shift leaders' digital mindsets toward appreciation of an enterprise investment approach to digital transformation and the benefits of data democratization.

One of the first business leaders to recognize the value of the data lake was the newly hired VP of Strategic Revenue Management (SRM VP). Soon after coming on board, he met with the IT VP. After learning about the data lake, he exclaimed, "Why didn't they tell me about the data lake in the interview! I can't deliver our SRM strategy without it."

While the SRM VP was thankful for the strategic alignment the IT team had done to build out the data lake foundation, he knew the operating units (OUs) his team supported would be laser-focused on the business outcome of revenue generation. At the same time, he knew their reporting capabilities were siloed and saw that the OUs lacked an enterprise-grade system to enable consistent and scalable reporting. According to the director for IT strategy, the SRM VP saw the data lake as "an opportunity to be a true capability partner who can create recommendations and insights the OUs could use to make better promotional investments through consistent and scalable reporting."

Overall, it took 12 to 18 months to implement the data lake at General Mills and develop the surrounding operational and governance practices needed to sustain it. In the three years after implementation, the data lake went from a concept to over 600 terabytes of data with over 500 users. While the program execution experienced challenges that come with any new rollout, the shift in leaders' digital mindsets was a key element of this successful digital transformation. In fact, shifting the digital mindsets of leaders from cost to investment and from local ownership to democratization of data accelerated adoption by directing attention away from technical challenges and the data lake itself toward conversations of how to deliver better business outcomes.

Our research indicates that leaders, key stakeholders, and potential advocates for digital transformation undergo shifts in their digital mindsets that help accelerate and sustain organizational digital transformation. At this point, we can recommend that organizations pursuing digital transformation consider how they will actively promote the evolution of digital mindsets in leaders. These mindsets are instrumental in building a strong foundation for digital transformation. Transitioning from a disparate project-by-project approach to an enterprise approach can be a rough road that is frustrating to navigate. Finding opportunities to build understanding and advocacy with your leaders smooths the digital transformation path ahead.

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