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Hybrid Framework 4.0 for Enterprise Architecture in the Context of Teleworking

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Abstract: Context and justification: The outbreak of the COVID-19 pandemic has triggered a profound change in the business landscape, forcing companies around the world and their information systems to fundamentally rethink their operational models to adapt to an uncertain and complex environment. The digital transformation of businesses and the era of information technology and remote storage are having an impact on business development and the emergence of new business models. Against this backdrop of unprecedented business disruption, companies need to develop robust, flexible, and agile architectures capable of responding rapidly to change, to ensure the continuity and operation of their information systems, and to meet changing customer requirements. With this in mind, this article explores the main elements of two frameworks, namely the six (6) Zachman perspectives and the eight (8) TOGAF phases, taking cloud technology into account to design a new hybrid enterprise architecture framework based on remote working that promotes work continuity without interrupting the organization's primary activities. The results show that defining an enterprise architecture based on a Hybrid Zachman-TOGAF Framework makes it possible to create a flexible, secure, and resilient infrastructure, adapted to the needs of teleworking in the era of Industry 4.0.

Keywords: Enterprise Architecture, COVID-19, Teleworking, Cloud Computing, Framework Zachman and TOGAF

Introduction

Enterprise architecture, traditionally designed to align business strategy with systems and processes, now plays a crucial role in organizational resilience and the ability to adapt to the dynamic challenges imposed by the uncertain business environment. The COVID-19 pandemic, a new unknown factor in the uncertain business environment, has highlighted the need for companies to develop robust, flexible, and agile architectures capable of responding rapidly to changes in the economic, technological, and social context. In the ever-changing world of industry, the era of Industry 4.0 stands out as a radical transformation, propelled by extensive interconnectivity and intelligent integration. At the heart of this revolution is the architecture of the future, a key concept that is shaping the modern industrial landscape and opening exciting new perspectives. Companies are constantly evolving, whether to improve through internal strategic choices (new products, lower costs, etc.) or to respond to multiple external constraints (competition, legislative inflation, etc.). Enterprise architecture in Industry 4.0 must embody a vision in which technology serves as a catalyst for efficiency, collaboration, and informed decision-making for managers and business adaptability in an uncertain environment. However, its implementation requires a thorough understanding of the specific needs of each business, as well as careful planning to ensure a smooth transition. In 2020, faced with the COVID-19 pandemic, some companies have succeeded in reinventing themselves, rethinking their business model, organization, processes, tools, and culture by innovating and strengthening their resilience, while others have struggled to survive or get back on their feet. That's why this article proposes an architectural framework for the enterprise, considering not only the cloud, based on the existing Zachman and TOGAF frameworks but also the post-Covid context, where most organizations are opting to telework. The aim is to strike a balance between stability and reliability on the one hand and agility and flexibility

on the other, to meet changing needs while maintaining a stable business foundation. In this context, we are focusing on the following research questions:

- What is the appropriate framework for systematically supporting this new dematerialized enterprise architecture from a commercial and technical point of view?
- How can a cloud computing system be optimized to support and enhance teleworking-based enterprise architecture?

This problem concerns a few aspects, including efficiency, productivity, collaboration, data security, and resource management, while focusing on optimizing the cloud for teleworking.

This article is organized as follows: In the following, we will immediately address the literature review, focusing on the evolution of Enterprise Architecture Frameworks, their applications and impact on organizations, and their fusion with new Information Technologies for a more efficient organizational system, Then we will define the hypothesis to conceive our organization practicing telework, its architecture then the conception of our hybrid Framework on the basis of the existing, then we will discuss the various stage of our Framework in term of advantage and disadvantage in a context of telework and finally brief conclusions on these principal implications and limits of this article.

Related Work

Developments in Information Technology have led to changes in organizations in terms of organization, software, and work processes; these have had an impact on enterprise architecture by providing several frameworks that architects can implement when approaching the discipline. Enterprise architecture (or urbanization) is a field that aims to provide managers with an overview of the company through its information system. It includes best practices for implementing transition plans to enable the information system to evolve, with an emphasis on the IT side rather than the business side Lankhorst (2013); Bibliographie (2011). The other aspect that enterprise architecture exploits is the reconciliation of information system viewpoints, in particular business viewpoints and the evolution of new IT engineering (industry 4.0). The evolution of information system points of view is a complex problem and a major challenge for the company. It is what enables the company to be both efficient and flexible in changing. The transformation of the information system, the enterprise architecture approach, is a project that requires the mobilization of considerable time and staff, which can result in significant costs.

In this study, we will align models and Information Technology to define a new Framework for a teleworking organization, however taking knowledge from existing related work in the literature will help us to understand the evolution of the status of the enterprise according to the different Frameworks proposed.

Firstly, it is very important to note that at least 80 Enterprise Architecture Frameworks have been identified worldwide Pragmatic (2013) but two radically different approaches emerge from the methods and Frameworks: Those focused on the Enterprise information system and those focused on the Architecture. It can be assumed that the latter could be applied to systems other than the Enterprise system.

A literature search in this Study will focus on the framework Zachman (Gerardus, 2021; Smith, 20118) and TOGAF (Philippe and Gilbert, 2024).

Firstly, it is very important to note that at least 80 Enterprise Architecture Frameworks have been identified worldwide Pragmatic (2013) but two radically different approaches emerge from the methods and frameworks: Those focused on the Enterprise information system and those focused on the Architecture. It can be assumed that the latter could be applied to systems other than the Enterprise system. Indeed, the structuring and organization of the various representations involved in describing a company are described using a two-dimensional matrix in the Zachman Framework. The ordinate corresponds to the points of view and the abscissa to the abstractions. Table (1) shows that each cell of the matrix corresponds to the intersection between a stakeholder involved in the architectural design process and an abstraction presented in the form of a question. Each representation is then adapted to the players involved. Zachman thus sees enterprise architecture as a guarantee of quality and maintainability, a representation in matrix form (Fig. 1) with the different points of view and the responsible players on the line, then in the columns the different concepts answering the circumstantial questions: What? What? Where? Who? Who? When? Why? Gerardus (2021).

	What? (Data)	How? (Function)	Where? (Location)	Who? (People)	When? (Time)	Why? (Motivation)
Business Concept Planner	Inventory Identification	Process Identification	Distribution Identification	Responsibility Identification	Timing Identification	Motivation Identification
Business Concept Owner	Inventory Definition	Process Definition	Distribution Definition	Responsibility Definition	Timing Definition	Motivation Definition
Business Logic Designer	Inventory Representation	Process Representation	Distribution Representation	Responsibility Representation	Timing Representation	Motivation Representation
Business Physics Builder	Inventory Specification	Process Specification	Distribution Specification	Responsibility Specification	Timing Specification	Motivation Specification
Business Component Implementer	Inventory Configuration	Process Configuration	Distribution Configuration	Responsibility Configuration	Timing Configuration	Motivation Configuration
User	Inventory Instantiations	Process Instantiations	Distribution Instantiations	Responsibility Instantiations	Timing Instantiations	Motivation Instantiations

Fig. 1: Zachman matrix

Table 1: TOGAF domain alignment and Zachman perspectives

TOGAF (Domains)	Zachman (Perspectives)	Description
Architecture vision	Scope	Identifies the vision and scope of the architecture to support teleworking. Defines strategic objectives and expectations
Architecture business	Business model	Description of the business processes, roles, and responsibilities required for teleworking
Information systems architecture	System model	Modeling of systems required for teleworking, including applications and databases
Technology architecture	Technology model	Identification and description of the technologies, infrastructures, and platforms needed to support teleworking
Opportunities and solutions	Detailed representations	Definition of solutions and opportunities to improve teleworking architecture, with detailed implementation plans
Migration planning	Feasibility	Planning of stages and milestones for migration to a teleworking architecture, including dependencies and risks
Implementation governance	Operations	Implementation of governance to ensure that the teleworking architecture is deployed in accordance with the defined standards and principles
Architecture change management	Functioning enterprise	Managing architectural changes to adapt to technological developments and user needs in a teleworking context

Spurred by the Zachman Framework, enterprise architectures have been designed by some authors either to improve organizational productivity and efficiency in sales Nasution *et al*. (2018), or to assist organizational decision-makers in decision-making to develop strategies for business purposes Rakhmanto *et al*. (2019); Aytekin *et al*. (2020), either to build an information architecture model to integrate information systems that meet the needs of businesses in schools on the one hand and on the other to optimize schools' information system in order to increase the effectiveness and efficiency of admissions process for new students Hidayat and Pamuji (2023). At the advent of Industry 4.0, the Zachman Framework was applied to the development of a data learning management system architecture model, this proved to be a positive solution for the implementation of the learning model which based on the results of user testing concluded that 73.79% of users expressed satisfaction with the service Muslih *et al*. (2020). Enterprise Architecture (EA) has become a necessity for organizations to consider their business, data, infrastructure, and information systems, with this in mind, the Zachman Framework is applied as a planning methodology to an overall governance plan of a state structure to improve the efficiency of electronic service delivery across different business areas and Darmawan *et al*. (2022). finally, The Zachman Framework is used as a measurement tool to review the strategic completeness of the company's architecture of information systems in the company and determine the factors and indicators of knowledge management systems needed by the organization Sardjono *et al*. (2020). However, the Zachman Framework has limitations in that it does not have a meta-model or even a methodology for developing Christophe's (2009) models. In response to the shortcomings of the Zachman Framework, there is the TOGAF framework, which covers a broad vision of enterprise architecture, from the strategic, business, and organizational aspects to concerns relating to the IT system. To address the shortcomings of the Zachman Framework, the TOGAF framework covers a broad vision of enterprise architecture, from the strategic, business, and organizational aspects to concerns relating to the IT system. The framework proposes to describe enterprise architecture in terms of the following main domains, as shown in Fig. (2):

- Business: The company's strategy, management structure, and core business processes
- Data: The logical and physical structure of an organization’s data, including the company's resources for managing it
- Applications: A list of all the information systems and software applications used by the business, with a description of how they participate in the business processes of the business and how they interact with each other and with external services

Technologies: the structure and logic of the software and hardware environments required to run business applications and access data. It includes a description of the entire support infrastructure: networks, servers, processing, etc.

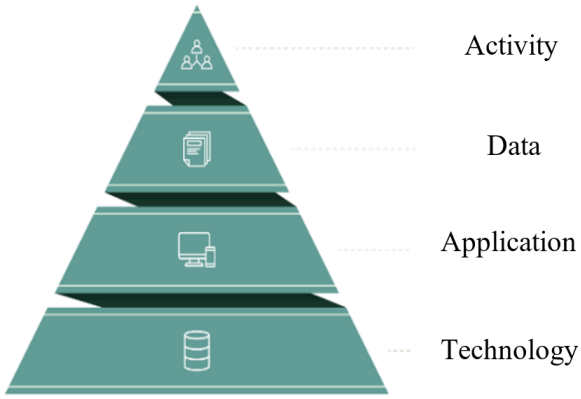

Fig. 2: Enterprise architecture as a function of key domains

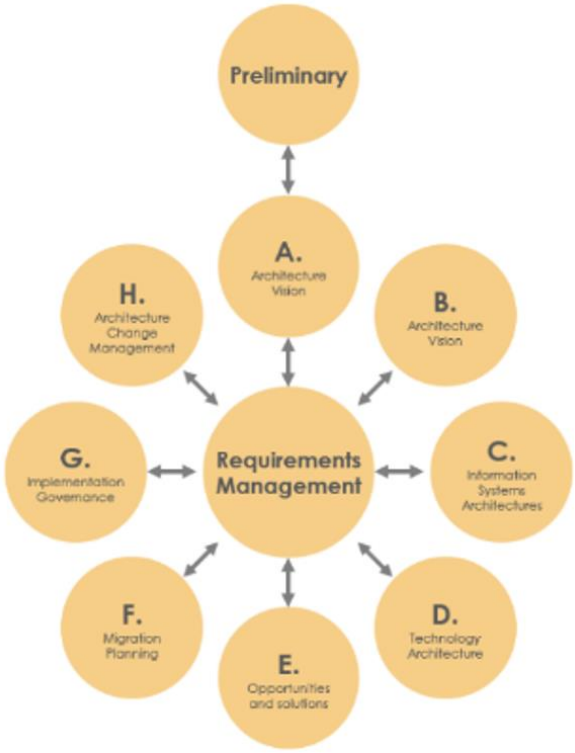

Fig. 3: Architecture Development Method (ADM) (TOGAF®)

TOGAF Framework thus details the collaboration between the different players in enterprise architecture: The management and implementation of the different teams. This collaboration follows the Architecture Development Method (ADM) cycle, which is at the heart of the TOGAF method Philippe and Gilbert (2024) Fig. (3).

Just like the Zachman Framework, TOGAF serves as a basis for the architectural design of an organization, as well as its business processes; in this vein, Sun *et al*. (2022) recommend the various TOGAF phases for ITgovernance of healthcare establishments with a view to improving the quality of patient care, even though SME (Small and Medium-sized Enterprises) are reluctant to adopt this Framework because of their limited resources and their reluctance to use a complex architectural design. However, previous research has highlighted the advantages of an architectural Framework such as TOGAF for SME Wijaya and Gunawan (2023). Indeed, TOGAF helps managers to manage various changes with the aim of transforming the organization into a target operational model along four dimensions for progressive development: Vision, architecture development, planning, and governance integration (Fig. 4). In addition, the COVID-19 pandemic also highlights the need to employ New Information and Communication Technologies (NICT) in the company's TOGAF architectural planning Arman *et al*. (2018). From work styles to employee lifestyles, organizations currently must apply a home-working policy to limit people's mobility, so some organizational processes have evolved to adapt to this post-COVID situation, such as distance educational training Guntara *et al*. (2020), telemedicine Hanifah *et al*. (2023) and online product sales and marketing Prasetyo *et al*. (2020).

This change requires the organization to effectively plan and manage its digital transformation. The results of this research show that using the TOGAF framework, focusing on the "architecture content" component of the framework, as a solution for developing information systems and integrating data can improve the quality of service provided by organizations. Authors such as Utomo *et al*. (2020) argue that the dematerialization of the organization requires a new enterprise architecture model that merges Cloud technology with the two main phases of the TOGAF Framework, namely the technical perspective and the business phase of cloud investment decision-making to promote a holistic cloud investment strategy. Finally, Wahab and Areif (2015) proposed an integrative Framework of COBIT 5 and TOGAF 9.1 to increase the effectiveness of IT applications in local government. This new integrative model minimizes IT-related risks at the operational level while ensuring good governance of the information system.

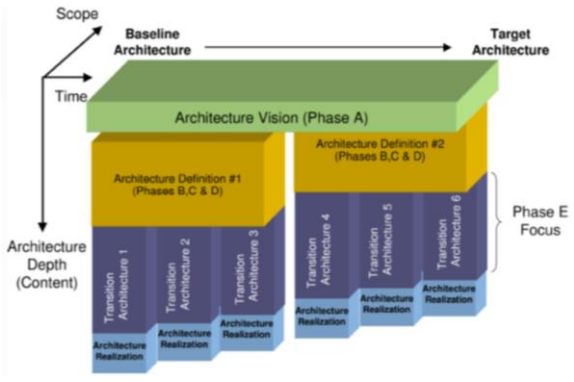

Fig. 4: Progressive development of the TOGAF architecture

Although in its early days, enterprise architecture focused solely on IT artifacts (data, software, etc.) to optimize the use of IT resources, Winter and Fischer (2006). The evolution of IT technology and its increasingly important role at the heart of business processes is becoming a problem that needs to be considered in enterprise architecture. To address this, enterprise architecture has begun to include some business aspects, such as the processes of the players involved Cameron and Mcmillan (2013). By integrating business problems, enterprise architecture is no longer solely a question of the architecture of the company's IT system, but rather of the architecture of the Information System as a whole. Organizations can use enterprise architecture to complement their data, business, application, and technology architecture by creating business models, business strategies, and business processes that are aligned with the organization's IT infrastructure Bhattacherjee (2012). Some authors, such as Bernard, even argue that it would be interesting to include the company's strategy within the scope of an Enterprise Architecture Framework, to provide a global view of all the company's resources. For him, the term "company" implies a high-level view of the entire organization Bernard (2012). So, with the term "architecture", we have the establishment of a structured and coherent framework for the analysis, planning, and exploitation of all the resources available to the company to achieve its objectives. According to James Lapalme, a company operating in a competitive environment reacts to events external to its operations. For some authors, the architecture to be put in place must include its relationship with its environment to measure its impact and facilitate the adaptation and innovation processes Lapalme (2012).

Analysis of Works Presented in Literature

In the research work identified in the literature, we find several definitions of Enterprise Architecture from different angles according to proposed Frameworks the first version of this framework was introduced by Zachman (1987). This study, which focused on defining the Framework, did not consider new parameters such as industry 4.0 technologies, the current working environment within companies: Remote working, the competitive factor, and the evolution of the company linked to globalization and technological progress. In this article, we propose a hybrid enterprise architecture Framework based on the Zachman and TOGAF frameworks for a teleworking enterprise, because the transformation of remote working requires more than simply setting up videoconferencing tools. This requires an integrated approach that encompasses strategy, processes, technology, security, and change management.

Materials and Methods

The design of the new hybrid framework is based on the Zachman Framework, version 3.0 post-2004 Gerardus (2021) and TOGAF Kotusev (2018). Thus, this article focuses on the six perspectives of the Zachman Framework by integrating them into the different TOGAF phases from phase A to phase H to meet specific needs and challenges of teleworking. This involves considering technological aspects, business processes, and human interactions that are essential to support a distributed organization.

Materials

The different materials used to design our framework are:

- Simulation software and platform
  - Software: Enterprise Architect Modeling Tool 16.1 (x64)
  - Architecture Development Method Toolbox*)*
  - Zachman Framework Toolbox
  - Jet 4.0 Database Engine Using WineHQ
  - Simulation platform: HP Core i7, 32 GB of RAM
  - Operating System: Linux Ubuntu 20.04 (64bits)
- Framework
  - The Zachman Framework version 3 with its six perspectives, Gerardus (2021)
  - The TOGAF Framework, Philippe and Gilbert (2024), Kotusev (2018)
- Modeling method: UML, Pascal (2009)
  - Class diagram
  - Sequence diagram

Methods

To do this, we would need to integrate these two frameworks and then map Zachman's questions to TOGAF's components so that the new hybrid framework is adapted to telework.

Component Entity of Organization

- Organizational entity comprising:

Strategic Management

Role: To define the company's vision, mission, and strategic objectives.

Responsibilities: Formulate policies and guidelines for remote working.

Human Resources Department

Role: To manage staff and teleworking policies.

Responsibilities: Establish teleworking policies, manage benefits, and ensure compliance with employment regulations.

Operations Department

Role:To supervise day-to-day operations and ensure business continuity.

Responsibilities: Coordinate operational activities, manage resources, and ensure process efficiency:

- Technology, Safety, and Risk Management unit, comprising

IT Infrastructure

Role: To provide and manage the technological infrastructure required for remote working.

Responsibilities: Deploying and maintaining networks, servers, storage systems, and communications equipment.

Technical Development Team

Role: To design and develop the applications and systems required for remote working and to support and maintain the systems.

Responsibilities: Create secure applications adapted to the needs of remote employees, resolve technical problems, aid end users and keep systems updated.

It Security Team

Role: To protect the company's systems and data against security threats, to manage user identities and control access to company resources, and to identify, assess, and manage the risks associated with remote working.

Responsibilities: Implementing security measures, monitoring threats, ensuring user authentication and authorization, managing access privileges, responding to security incidents, implementing risk management strategies, and ensuring the resilience of operations:

- Users Entities

Employees (Local or Remote)

Role: Use the company's systems and applications to carry out their work remotely and within the company.

Responsibilities: Comply with security policies, use the tools provided, and report technical or security problems.

Online Supervisors

Role: Supervise remote employees and ensure productivity and compliance.

Responsibilities: Manage performance, provide guidance, and ensure effective communication with remote employees.

Uml Class Diagram for Functional Entities

Below is the textual syntax of the class diagram between the different functional entities of our organization:

```
@startuml
    class Strategic management {
    +Define Vision ()
    +Formulate policies ()
    }
    class Human Ressource {
    +Manage Staff ()
    +Establish teleworking policies ()
    }
    class Operations {
    +Supervisor Operations ()
    +Managing Resource's ()
    }
    class IT Infrastructure {
    +Deploy Infrastructure ()
    + Systems maintenance ()
    }
    class development {
    +Create Applications ()
    +Ensuring application security ()
    }
    class Technical Security Support {
    +Provide Assistance ()
    +Problem Solving ()
    +Implementing safety ()
    +Watch Threats ()
    +Managing identities ()
    +Control Access ()
    +Identify Risks ()
    +Implementing strategies ()
    }
    class Employees {
    +Uers system ()
    +Respecting safety policies ()
    }
    class Supervisor Online {
    +Supervisor Employees ()
    +Gérer Performances ()
    }
    Strategic management --> human resources
    Strategic management --> Operations
    human resources --> Employees
    Operations --> IT Infrastructure
    Operations --> technical support
    IT Infrastructure --> development
    IT Infrastructure --> Support Technique
    development --> IT Security
    technical support --> Employees
    IT Security --> Identity and access management
    risk management --> Strategic management
    Employees --> Online Supervisor
@enduml
```

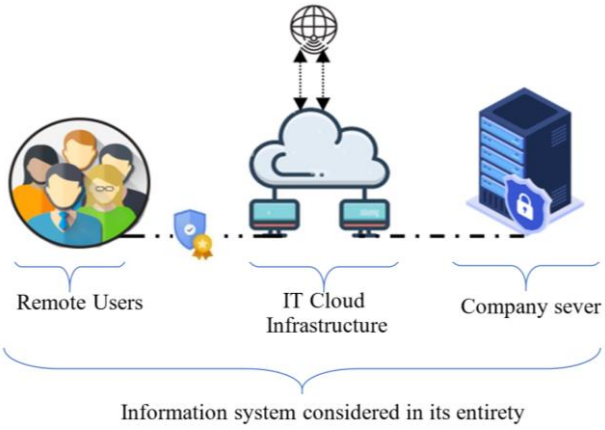

Fig. 5: Organization's system

Diagram of the Information System Under Consideration

In our Information System, we consider three main types of entities, as shown in Fig. (5):

- Employees or remote users
- IT cloud infrastructure
- company server entity

- The employee Entity is made up of all the employees in our remote information system
- IT Cloud Infrastructure is the platform and infrastructure that facilitate remote access, collaboration, and management of IT resources in a flexible and scalable way

The company's server entity is where the decision-making system and part of the operational system are located, except for those who work remotely.

Organizational System Entities Sequence Diagram

Actors: The various players are:

- Remote employee
- Cloud infrastructure
- Company server
- Authentication management system
- Enterprise application

Sequences

Figure (6) describes the sequence for connecting employees to company resources remotely:

1. Remote employee connection: The remote employee initiates a connection request via a secure access application
2. Cloud connection request: The secure access application sends a connection request to the cloud
3. Authentication verification (Cloud): The cloud redirects the request to the authentication management system (IAM) to verify the employee's credentials
4. Authentication Validation (IAM) The IAM system checks the identification information and sends the result back to the cloud
5. Success Authentication: If authentication is successful, the cloud generates an access token and sends it to the employee's secure access application
6. Requesting access to the enterprise application: The employee, now authenticated, sends a request for access to the enterprise application via the cloud, using the access token
7. Transmission of the request to the enterprise server: The cloud transmits the request, along with the access token, to the enterprise server where the application is hosted
8. Validation of the request by the enterprise server: The enterprise server checks the access token. If valid, it grants access to the enterprise application
9. Access to the enterprise application: The enterprise server transmits access to the enterprise application via the cloud, providing the necessary data and services to the employee's secure access application
10. Data processing: The employee interacts with the enterprise application to perform tasks. Data requests and results pass through the cloud to the enterprise server and vice versa
11. Data update (if necessary): Data changes made by the employee are sent to the company server via the cloud to be updated in the company database
12. Employee disconnection: When the employee ends their session, they initiate a disconnection. The cloud invalidates the access token and ends the session

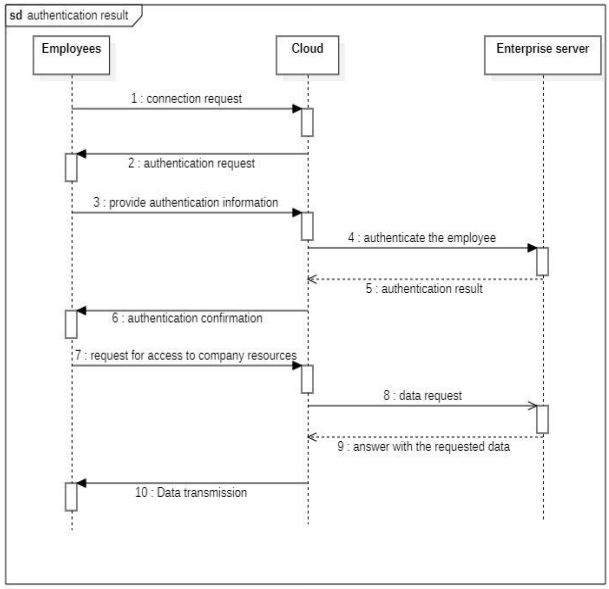

Fig. 6: Sequence diagram: 'Remote authentication' of employees to company resources

UML textual syntax for the main entities of the information system:

@**startuml**
actor Remote employee
actor Cloud
actor Company server
Remote employee -> Secure Access Application: Initiate connection
Secure Access Application -> Cloud: Connection request
Cloud -> IAM system: Authentication verification
IAM system -> Cloud: Authentication result
Cloud -> Secure Access Application: Access Token
Remote employee -> Secure Access Application: Enterprise application access request
Secure access application -> Cloud: Request transmission with token
Cloud -> Enterprise server: Request for access to the application with the token
Enterprise server -> Cloud: Request validation
Cloud -> Secure access application: Access to enterprise application
Remote employee -> Enterprise application: Interaction and data processing
Enterprise application -> Cloud -> Enterprise server: Transmission of data changes (if necessary)
Remote employee -> Secure access application: Logout
Secure access application -> Cloud: Invalidate access token
@**enduml**

Graphical representation of textual syntax is

Steps for Integration between the Zachman and Togaf Frameworks

This stage involves aligning TOGAF domains with Zachman's perspectives.

Mapping Zachman Queries to TOGAF Components, Adapted for Teleworking

In this section, we map the Zachman matrix queries on the x-axis to the TOGAF components to ensure complete coverage of the different dimensions of enterprise architecture considering the particularities of telework. The challenge at this level is to provide a coherent and structured framework for integrating the two Frameworks to respond specifically to the needs and challenges of telework. Zachman's questions (What, How, Where, Who, When, Why) ensure that all the essential dimensions of the architecture are considered, while TOGAF provides detailed components for each architecture domain (Business, Data, Application, Technology), enabling in-depth coverage and integrated management. This correspondence is presented in the Table (2).

Table 2: Correspondence between Zachman queries and TOGAF components

Query (Zachman)	Components (TOGAF)
What (data)	Data architecture artifacts
How (functions)	Business processes and application architecture
Where (network)	Technological infrastructure and geographical distribution
Who (people)	Roles, responsibilities, and stakeholders
When (times)	Timetables and phases of development and deployment
Why (motivation)	Business requirements, aims, and objectives

Objectives of this correspondence will be to:

- Ensuring full coverage of the Enterprise Architecture Dimensions
- Adapt the Components to the Specificities of Teleworking
- Facilitate Planning and Implementation
- Promote Communication and Collaboration

This correspondence between the Zachman and TOGAF frameworks will enable us to define a hybrid Zachman-TOGAF framework for a teleworking company. In the rest of this study, we present the Zachman and TOGAF Hybrid correspondence table, then in detail the different phases of our Hybrid Framework by highlighting the different TOGAF components from A to F in the six Zachman perspectives.

Results

Different Phases of the Hybrid Zachman-TOGAF Framework to Build an Enterprise Architecture Adapted to Telework

The various phases of our Hybrid Zachman-TOGAF Framework are divided into eight (8) stages. This means that two new perspectives will be added to the six (6) existing Zachman perspectives since version 3 of the Zachman Framework, post-2004, comply with the eight TOGAF components. To do this, we are targeting specific aspects of governance and change management that are not sufficiently covered by the current Zachman perspectives. These two new perspectives will be specific to implement governance and architectural change management to cover the G and H phases of TOGAF. Thus, we define:

- The corporate governance perspective *is* derived from the combination of the 6 Zachman perspectives (functioning enterprise). Who? Question: Who is involved in governance? Roles? And stakeholders?
  The objective is to guarantee effective governance during the implementation of architecture, ensuring compliance, quality, and alignment with strategic objectives

This perspective will define those responsible for governance, auditors, and stakeholders. Table (3): Line 6, column 4 [Teleworkers, real people])

- Enterprise architecture management perspective resulting from the combination of the 6 Zachman perspective (Functioning Enterprise) and the Why question (Motivation): Why are change management activities necessary?
  The aim is to manage architectural changes in a systematic and controlled way to meet new requirements and minimize risks. This perspective must be consistent with the organization's objectives of adaptability, continuous improvement, and risk management (Table 3: Line 6, column 6 [Objectives achieved])

Preliminary Phase

- Objectives:
  - Preparing the organization for the adoption of the Hybrid Framework
  - Define the scope and establish the architectural principles
- Activities:
  - Define the company's vision and objectives
  - Identify stakeholders and expectations
  - Assess current capabilities and future needs

Table 3: Hybrid Zachman-TOGAF framework for a teleworking organization

Steps	Zachman (1-8)	TOGAF phases (A-H)
1	*Visionnaire (Scope)* and why (motivation), and what (data)	Phase A: Architectural Vision Objectives: Develop a clear vision for a teleworking company Activities: - Identify strategic objectives (flexibility, reduced costs) - Define use cases and requirements - Prepare a case study and a high-level roadmap
2	Business model and how (functions), and who (people)	Phase B: Business Architecture Objectives: Define the business architecture in terms of products, services, business processes and capabilities Activities: - Modeling the business processes and services essential to teleworking - Define the organizational structure for a distributed team by identifying the roles and responsibilities of teleworkers - Analyze the impact on the organization and business processes
3	(System model) and what (data) how (functions)	Phase C: Information Systems Architectures This phase is divided into two parts: Data architecture: C1 and application architecture: C2 C1: Data Architecture Objectives: Define the data structure and data requirements for teleworking Activities: - Modeling data requirements (security, access) for teleworking - Define data management and security policies C2: Application Architecture Objectives: Define the architecture of the applications needed to support teleworking Activities: - Identifying and modeling collaboration and project management applications - Define integrations and data flows between applications
4	(Technology model) Et where (network)	Phase D: Technology Architecture Objectives: Defining the technological architecture needed to support the business architecture and information systems for teleworking Activities: - Modeling the network infrastructure, including VPN, Cloud, and other teleworking technologies - Define network security and remote access policies - Ensure security and connectivity (VPN, firewall)

Table 3: Continue

5	Detailed representation and when (temps)	Phase E: Opportunities and solutions Objectives: Identify possible solutions, evaluate options, and prepare projects to implement the architecture Activities: - Assessing the technologies and solutions available for teleworking - Identifying migration risks and strategies - Develop a detailed implementation plan - Planning the implementation stages and managing risks
6	Functioning enterprise and when (times)	Phase F: Migration planning Objective: Ensuring effective implementation Activities: - Identify opportunities to improve processes - Implement the migration plan - Monitor and adjust as necessary
7	Corporate governance and who (people)	Phase G: Implementation Governance Objective: Ensure governance of the effective implementation of the architecture Activities: - Implement the migration plan - Supervise the implementation of solutions - Monitor and adjust as required - Ensure compliance with architectural principles and standards
8	Enterprise architecture management and why (motivation)	Phase H: Architecture change management Objective: Managing changes to the architecture in response to business needs and technological developments Activities: - Establish change management processes - Monitor effectiveness and adapt architecture as necessary - Evaluate the changes required and their impact - Update the architecture accordingly

Framework begins with a preliminary phase, followed by the definition of eight hybrid stages combining the various Zachman perspectives with the TOGAF phases. For each stage, the objectives are clearly specified, as are the activities to be carried out (Table 3).

The adoption of a hybrid Zachman-TOGAF Framework using the cloud offers a comprehensive approach to managing the architecture of a teleworking organization. Combining the strengths of the two frameworks with the advantages of cloud solutions, this new framework makes it possible to build a flexible, secure, and resilient infrastructure, while aligning strategic and technological objectives for optimum, sustainable performance tailored to the needs of teleworking. This framework offers significant advantages in terms of:

 Strategic alignment:

- Coherence between IT and Business: The Hybrid Framework ensures close alignment between the company's strategic objectives and its IT initiatives, making it easier to achieve business objectives
- Holistic vision: Provides a complete view of the organization, integrating strategic, business, system, and technological perspectives

 Flexibility and agility:

- Adaptability: Enables rapid adaptation to change in the working environment, new technologies, and the changing needs of employees and customers
- Modularity: The framework's modular structure makes it easy to integrate new technological solutions without disrupting the entire system

 Enhanced security:

- Data protection: Integration of robust security features (firewall, VPN, multi-factor authentication, etc.) to protect the sensitive data of employees working remotely
- Compliance: Helps maintain compliance with current regulations and security standards

 Operational efficiency:

- Resource optimization: Optimize the use of IT and human resources, reducing operational costs and improving efficiency
- Automation: Facilitates the automation of business and IT processes, reducing manual tasks and associated errors

 Improved collaboration and communication:

- Collaboration tools: Integration of modern collaboration tools (Microsoft Teams, Slack, Zoom) to facilitate communication between employees, regardless of their location
- Knowledge Sharing: Promotes knowledge sharing and innovation through collaboration and project management platforms

 Resilience and business continuity:

- Disaster recovery planning: Integration of disaster recovery and business continuity plans to ensure that the business can operate uninterrupted in the event of a crisis
- Monitoring and incident management: Continuous monitoring systems to detect and respond rapidly to security incidents and breakdowns

 Improving the employee experience :

- Comfort and productivity: Provides employees with the tools and resources they need to work effectively from anywhere, improving their comfort and productivity
- Well-being support: Incorporates human resources policies focused on the well-being of employees working remotely

 Informed decision:

- Analysis and Reporting: Facilitates data analysis and reporting for informed decision-making
- Transparency: Improves the transparency of processes and operations within the organization

 Innovation and competitiveness:

- Adoption of new technologies: Enables the rapid and effective adoption of new technologies, giving the company a competitive edge
- Innovation Culture: Fosters a culture of innovation by integrating agile and collaborative practices

Comparison and Discussion

Comparison

Utomo *et al*. (2020) at the International Conference on Information Management and Technology (ICIMTech) 2020 at Auckland University of Technology in New Zealand presented a research paper on Tailoring the TOGAF Architectural Development Method to Cloud Adoption Strategy, a set of criteria for comparing TOGAF-based enterprise architecture frameworks from authors Zardari and Bahsoon (2011), Khajeh-Hosseini *et al*. (2012) Isom and Holley (2012):

- The right balance between business and technology strategy. The framework accentuates impacts from both financial and technical aspects resulting from changes in the enterprise architecture.
- A lifecycle method. The framework allows continuous monitoring with feedback to dynamically refine the processes
- Replicable. The framework can generate comparable outcomes in various circumstances by different users.
- Precise. The concepts or theories presented in the framework should be measurable and comprehensible.
- Falsifiable. The concepts can be applied and refutable or testable
- Parsimonious. The concepts are reasonably described with the most possible straightforward explanation.

In addition to these six criteria, we have added two more in Table (4):

- Governance and Change Management: The set of processes, structures, and mechanisms used to manage and control the enterprise architecture to ensure that the organization's strategic objectives are achieved
- Scalability and resilience: Essential characteristics that enable organizations to respond effectively to changes and to the specific needs of their environment

Table 4: Comparative analysis of cloud adoption frameworks where G: Governance, S: Scalability, R: Resilience

Framework Criteria		Enterprise architecture			
		TOGAF framework			Hybrid ramework (Zachman-TOGAF)
		Zardari (2016)	Khajeh *et al.* (2012)	Isom and Holley (2012)	
Balanced business and technical aspect		Moderate	Moderate	√	√
A life cycle approach		√	X	√	√
Replicable		√	√	√	√
Precise		Moderate	√	√	√
Falsifiable		√	√	√	√
Parsimonious		√	√	√	√
Governance and Change Management	G	√	√	√	√
Scalability and resilience	R	X	Moderate	X	
	S	√	√	√	√
	R	Moderate	Moderate	Moderate	

The TOGAF-based enterprise architecture frameworks of Zardari and Bahsoon (2011); Khajeh-Hosseini *et al*. (2012); and Isom and Holley (2012) each have their distinct advantages. Indeed, all based on TOGAF, these Frameworks can be ideal for a sequential implementation of an enterprise architecture, however, TOGAF puts a strong emphasis on governance, which can introduce cumbersome bureaucratic processes. This can slow down decision-making and the ability to respond quickly to changing business needs. Also, the TOGAF methodology requires exhaustive documentation, which can be perceived as an additional administrative burden, diverting resources from productive work. Finally, cloud environments evolve rapidly and TOGAF may not be agile enough to adapt to rapid changes in cloud technologies and business models. However, implementing a hybrid Zachman-TOGAF Framework combines the comprehensive structure and systematic classification of the Zachman Framework with the detailed methodology and robust governance processes of TOGAF. Leveraging the strength of both the Zachman and TOGAF Frameworks, this hybrid Framework enables the creation of a complete enterprise architecture that provides an integrated, adaptable, and resilient multi-dimensional view, capable of responding to modern challenges such as teleworking and emerging technologies such as cloud computing, artificial intelligence, the Internet of Things (IoT) and blockchain, while ensuring robust governance and effective change management.

However, making a choice between the two Frameworks will depend on the specific needs of the organization, its structure, and its ability to manage the complexity and adaptation required to integrate these enterprise architecture models.

Discussion

The COVID-19 pandemic has significantly transformed the way businesses operate, accelerating the adoption of teleworking on an unprecedented scale. In this post-COVID era, businesses are looking to sustain and optimize these new working practices using Industry 4.0 technologies. To respond to this trend, it is essential to have an enterprise architecture framework that can not only manage the complexity of hybrid environments but also maximize the efficiency, security, and satisfaction of employees working remotely. By integrating two Frameworks that offer a methodical and comprehensive approach to meeting the growing needs of teleworking in a structured and efficient way. We need to adapt to the new challenges in terms of infrastructure and technology, as well as enhanced security, strategic alignment, and optimized collaboration. This integrated approach takes advantage of Zachman's granular structure and TOGAF's detailed methodology, resulting in greater flexibility and adaptability. By combining the strengths of the two frameworks, organizations can better manage the rapid changes and new challenges associated with teleworking, such as data security, access management, and real-time collaboration. Data security challenges: The framework gives businesses the ability to define robust security policies (details in Zachman's 'What' column) and implement secure technology architectures (TOGAF). The modeling of roles and responsibilities (Zachman's ‘Who’ column) and the definition of application and network architectures ensure secure and controlled access to company resources (TOGAF). Finally, the design of business processes (Zachman's ‘How’ column) and application architectures (TOGAF) integrate collaboration and real-time communication tools.

Conclusion

By integrating the TOGAF methodology into the Zachman matrix, we can ensure a comprehensive, flexible, and structured approach to addressing the specific challenges of teleworking. By integrating specific perspectives for implementation governance and change management, the challenges and opportunities associated with teleworking can be managed, enabling organizations to improve their operational efficiency, as well as strengthening their resilience and capacity for innovation in a post-COVID world. However, the definition of each organization's own security policy can also be a weakness, so from an immediate perspective, we intend to define a robust security policy and rigorous governance processes that can ensure compliance and risk management, essential in a distributed working environment based on Industry 4.0 technologies, in this case, the Cloud.

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Author’s Contributions

Kouassi Thomas and Brou Pacôme: Contributed to the conceptualization, the modeling of the information system, the formal analysis, the study of the Zachman and TOGAF Frameworks, establishing the correspondence for the definition of the new Zachman-TOGAF Hybrid Framework as well as its stages.

Koffi Kanga: Contributed to the conceptualization and modeling of the information system and to the textual syntax of the various UML diagrams.

Olivier Asseu and Yvon Kermarrec: Contributed to the conceptualization, supervision, review, editing, and administration of the project.

Ethics

The study accurately and thoroughly represents the authors' research and analysis. The work acknowledges the valuable contributions of coauthors and co-researchers. The findings are properly put into research history. The text cites all references and related works.

Conflict of Interest

The authors hereby declare their complete independence from any organization or entity that may have a financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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