Developing a Project Management Tool for Network Migration to Improve Transparency between Enterprises and Network Experts

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Aishwarya Pore

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Technical Project Team Members

Eliza Goggins

Courtney Kennedy

Mackenzie Nguyen

Ashley Rissmeyer

Cecilia Smith

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Gregory Gerling, Department of Systems and Information Engineering

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E. Goggins, C. Kennedy, M. Nguyen, A. Pore, A. Rissmeyer, C. Smith, G.J. Gerling
University of Virginia, eag2fmr, csk6nj, mkn4zxp, aar4mz, cms2ryw, gg7h@virginia.edu

Abstract—**Migrating an enterprise network to a cloud-based platform can help a company realize the benefits of increased automation, security, scalability, and usability. However, completing the migration can be tedious and time-consuming, so as to require an experienced network engineer. Many small and medium-sized enterprises do not internally employ such experts. Moreover, since cloud-based migration is only completed once, companies of all sizes opt to hire a professional network engineer as a consultant. During the migration process, companies often face communication challenges with the hired consultant. The work herein describes the design of a project management tool for cloud network migration to be used as an interface between the enterprise and network engineer. Its design was based upon extensive evaluation of information and functional requirements, and the establishment of the user flow. The design of the user interfaces realizes three important features: a task-based structure that centralizes resources, a graphical map for evaluating the status of dependent tasks, and embedded learning resources for furthering knowledge of networking. In this way, the design of the interface seeks to effectively bridge gaps in communication between enterprises and network engineers.**

I. Introduction

With modern advancements in cloud computing, companies moving toward cloud network management have begun to realize important benefits in automation, security, scalability, and usability. Cloud network management involves virtualizing a computer network or the virtual abstraction of hardware and software resources into a single software-based virtual network [1]. Benefits of cloud network management include the dynamic allocation of resources, which affords network scalability, low-cost data storage, and backup, and ease of network management [2]. However, migrating to a cloud network is no easy task. It involves thoroughly understanding the current network, configuring numerous settings, and troubleshooting unexpected issues upon cutover to the cloud. Moreover, networks can be expansive, and convoluted legacy systems can prove difficult to virtualize. Many companies, especially small and medium enterprises, do not internally employ a network engineer capable of performing migration to the cloud [2]. Furthermore, because migration is completed only once, the time and capital required internally to research and learn the process is prohibitive. Thus, a professional network engineer, acting as a consultant, is often utilized. Indeed, missteps can be detrimental, with a 2022 study showing that 23% of security-related incidents result from the misconfiguration of a company's cloud network [3].

The communication and knowledge transfer between the enterprise client and network engineer consultant is crucial. Many existing tools (e.g., email, instant messaging, cloud storage and file sharing, calendar sharing, video teleconferencing) are often utilized, but result in the dispersion and loss of information. Project management tools attempt to consolidate these disparate tools and make it easier to manage hundreds of interrelated tasks, focusing on the management tasks of planning, scheduling, tracking, and controlling [4]. For example, ClickUp is a widespread application with integrations with Slack, Microsoft Outlook, Google Drive, Zoom to allow enterprise clients to consolidate their tasks [5].

More broadly, companies in other industries, such as construction, prefer project management tools more specialized for their field. For example, products such as Buildertrend, Contractor Foreman, and Jobprogress, address specific needs of the construction industry, including tracking of supplies, coordination of third-party contractors, and adaption of project timelines upon delays [6]. This level of specialization is similarly manifested in the field of cloud network migration, yet no tool is currently available. Indeed, cloud network management may benefit from a user experience that allows enterprise clients and network engineers to work independently on network migration tasks while facilitating transparency and ongoing communication between the parties.

II. Methods

In this work, we describe a project management tool that fits the specific needs of a cloud network migration between enterprise clients and network engineer consultants. This series of enterprise client interfaces consolidate the communication and sharing of information between the two parties involved in migrating a legacy network to a cloud network, with a focus on the client side of the software.

Along with consolidating the tools needed for cloud network migration, the interface is customized to meet the needs of this specialized domain. To do so, the interface introduces three important features: a task-based structure that centralizes resources, a graphical map for evaluating the status of dependent tasks, and embedded learning resources for furthering networking knowledge. First, the task-based structure centralizes resources and eases navigation. When the enterprise client needs to address an assigned task (e.g. providing details on a certain aspect of their network), they

need not leave the task box within the interface. Any potential actions that the user could need to complete the task are in one place, including a task-specific communication thread, file transfer, and learning resources. This also eases the process of referring back to files associated with completed tasks, as any files uploaded to a task remain permanently linked there for future reference. Second, the map-like visualization of tasks and workflow allows the enterprise client to see the phases of work and each phase's associated tasks. Each task is characterized as locked, in-progress, marked for review, or completed and the interdependencies (i.e., one task must be completed before another can be started) are shown. Third, the linked learning resources prompt the enterprise client to learn about networking concepts of the task at hand. These learning resources provide relevant information for each specific task, giving users both context for the work expected of them and domain context to gain a deeper knowledge of network migration. These are especially useful when the task has terms or concepts that are unfamiliar to the enterprise client.

To discern the need for this tool, we used a large, public-domain information technology (IT) company as our source of field knowledge. We utilized their online resources and conducted internal interviews to gather input on important functionalities. Due to our focus on one particular company, our research has been used as a case study which was then generalized to ensure applicability to the field as a whole, as we understand that the issues this IT company faces can be extended to all companies specializing in cloud networking.

III. Methods: Requirements Gathering

Requirements for designing the user interfaces and experience were derived from interviews with relevant stakeholders and subject matter experts. Requirements were iterated upon in response to collected feedback.

A. Information Requirements

Network Device Details: Enterprise clients need to know details for all physical and virtual devices to be included in the virtual network. If not already documented, enterprise clients need to know how to retrieve this information.

Migration Completion Status: Enterprise clients need feedback on completion progress overall and per task. If a bottleneck exists, enterprise clients need to know who is responsible and what actions are needed to resolve the issue.

Task Hierarchy: When tasks are assigned by the network engineer, the enterprise client needs to know task priority. The hierarchy will prioritize tasks acting as a roadblock to future progress and assign less priority to tasks that are optional or without specific endpoints.

Approximate Completion Time: Enterprise clients need to know approximately how long a task will take to complete.

Point of Contact: For cases with multiple network engineers, the enterprise client needs to know whom to contact per task.

Service Level Agreement: The enterprise client and network engineer need to begin the project by drafting a service level agreement that outlines the work to be done, proposed timeline, and pricing structure. This information should be readily referenced.

B. Functional Requirements

Step-by-Step Breakdown of Actions: Actions to be taken by the enterprise client should be broken down into manageable pieces, to clarify task flow and increase system usability.

System Feedback: Throughout migration, enterprise clients need feedback on task completion, such as where corrections are needed.

Flexible Interface and Process: The content of the interface should be able to adapt to a user's needs in the case of a change to the service level agreement.

Task-Breakdown by Enterprise Client: When multiple enterprise clients contribute to migration, each needs to see what their co-workers have completed or are completing.

Multi-Way Communication: As actions are assigned and completed, enterprise clients should be able to ask clarifying questions to the network engineer and vice-versa.

Notification of Needed Actions: If a task or other action requires the enterprise client's attention, they should be notified in a salient manner.

Learning Resources: Enterprise clients with limited knowledge of cloud networking should be able to learn important concepts and terms as they go in an accessible way.

C. Establishing User Flow

Based on the case study, a user workflow diagram was created to illustrate the onboarding and migration process for an enterprise client implementing a cloud-computing network. The user flow diagram was created at a higher level of abstraction, with seven overarching phases (Fig. 1A), and a lower level of abstraction (Fig. 1B) where decision nodes indicate where enterprise clients must make decisions and where steps are dependent. The diagram shows how steps can be completed simultaneously, as not all steps rely on each other. Visualizing the individual steps in each phase contextualizes how each decision affects those subsequent. Grouping steps into more general phases gives a higher-level understanding of the workflow (Fig. 1A). Overall, this diagram provides a visual representation of a complex process, enabling enterprise clients and network engineers to understand the steps in network migration and informing the user flow in designing the migration platform, especially the graphical map view of tasks.

IV. Methods: Prototype Design

Utilizing the knowledge gained from the user flow diagram, along with feedback from stakeholders and an initial set of heuristic evaluators, we created wireframes of the user interface. The design incorporates five features that were found essential to the migration process. These include a

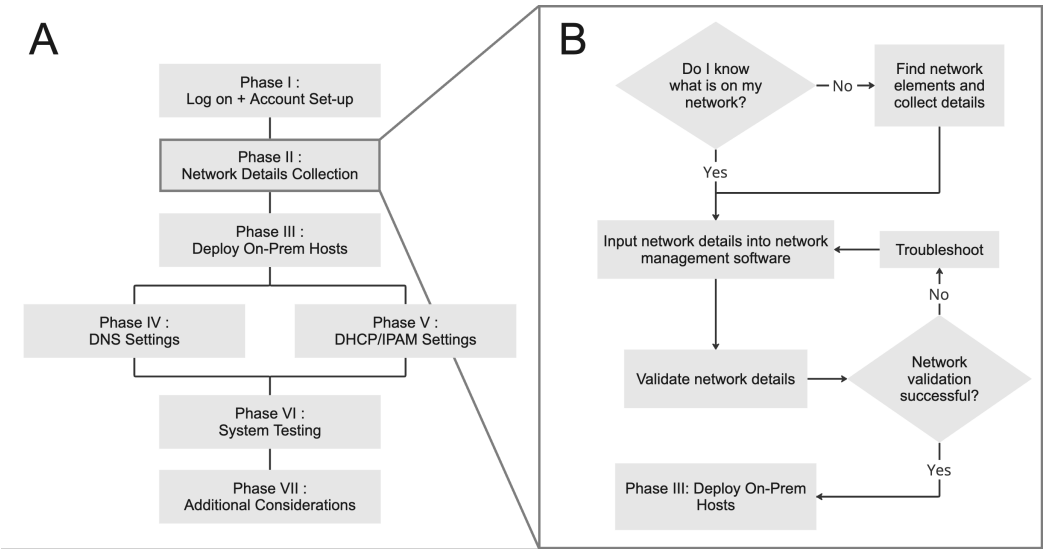

Fig. 1. User flow diagram. **(A)** Higher level of abstraction **(B)** Example of decisions made within specific phase

dashboard with overall migration status and links to other interface features (Fig. 3), two ways of visualizing tasks, a file drop, and a learning resources page. Three important features of the interface are the task-based structure, a graphical map, and embedded learning resources.

Task-based Structure: Tasks are at the center of this interface and within the task, the user can do more than simply "mark as complete." Each task has an accordion that allows the enterprise client to complete actions, including communication, file transfer, and learning, without leaving the page (Fig. 4A). As a result, action history and documentation exist within the specific task. The network engineer adds the description of the task, which increases the transparency of task requirements for the enterprise client. The enterprise client can upload files associated with the task, providing record-keeping and file organization needed for the network engineer. When a file is uploaded, it is auto-organized into an associated folder on the file drop page, thus eliminating the need for external tracking of files. There are also learning resources embedded within the task, which give the enterprise client the freedom to explore the subject matter of the task in more detail. Finally, the comment activity section of the task allows for open communication about the task between the enterprise client and network engineer. When an enterprise client is tagged in a comment, they are notified on their dashboard (Fig. 3) and in the notification center (bell icon). A task-specific comment section ensures conversations and decisions are not lost in multiple communication channels like email and video calls. Instead, all communication is centralized in the comments of the task. This tool brings together the typical project management functionality of tracking task completion and ownership with the functionality of tools used to communicate, learn, and complete the task, not just record completion.

Graphical task map: The graphical task map (Fig. 4B) allows for the typical spreadsheet-style view of tasks to be viewed in a reimagined way. The task map provides a means for enterprise clients to see the zoomed-out overall progress of their network migration. The task map includes larger circles for each phase, with phase completion shown by the percent value and the progress ring around the phase circle. Surrounding each phase are the tasks associated with the phase. There are three types of task circles, each represented by a different icon, and three levels of interdependencies between tasks, shown with the different lines connecting tasks (Fig. 2). This provides benefit to the enterprise client to see what they need to accomplish in order to move forward with the migration process, specifically visualizing which tasks will unlock others. When a phase circle is selected, the page

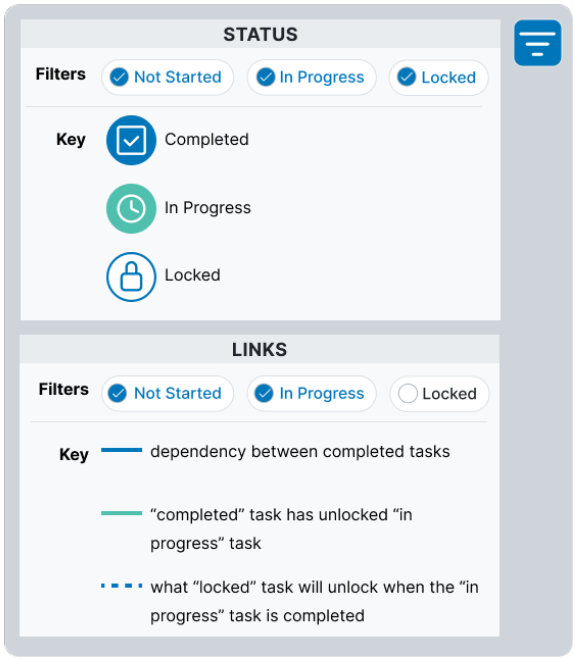

Fig. 2. Key to graphical task map symbols and colors

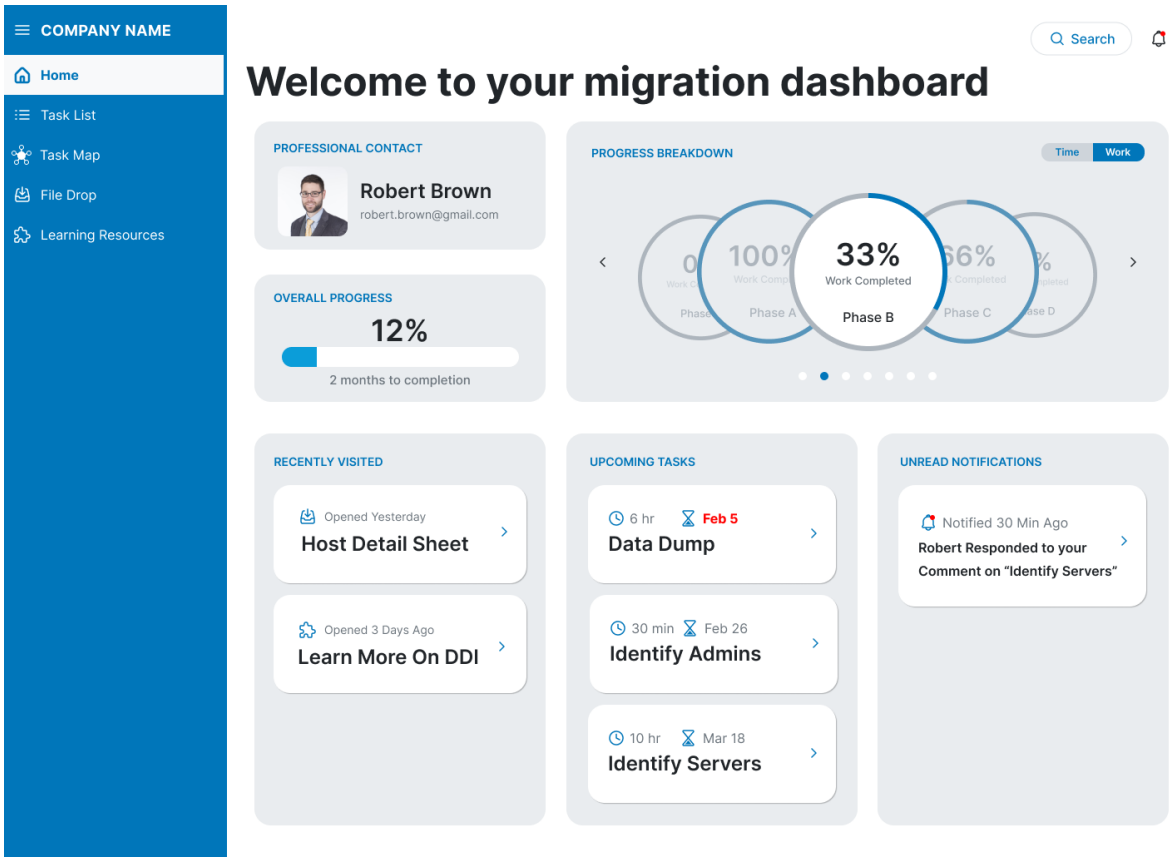

Fig. 3. Interface landing page and migration dashboard.

zooms in to show a more detailed view of the phase progress and the tasks within the selected phase (Fig. 4B). When a specific task is selected, it is highlighted in the map view and the task details expand, similarly to the list view. This provides consistency with other interface components and allows enterprise clients to visualize and interact with their tasks in different ways.

Embedded Learning Resources: A primary goal of the system was to transfer knowledge from the network engineer to the enterprise client so that the enterprise client would feel comfortable monitoring the network at the completion of the migration process. This is accomplished by incorporating these suggested learning resources within each task, providing relevant information to either learn more about the topic or gather more detailed information on how to complete the task. This differentiates the interface by offering potential resources as they are needed because the enterprise client may not realize they do not understand background and/or contextual material until it is shown to them, rather than forcing them to perfect their search criteria attempting to find relevant material on a separate page.

V. Methods: Heuristic Evaluation

A. Heuristic Evaluators

A heuristic evaluation was conducted to assess the usability and functionality of the interface. The two evaluators included a graduate student with little domain experience and a user experience researcher from a cloud networking platform.

B. Evaluation Metrics

Intuitive Task Flow: The order of steps to complete the migration process is obvious to the user. The user requires no external explanations or guidance for where to go next.

Understanding of System Progress: The user has a clear understanding of what has been completed and what still needs to be completed before completing migration. The user is able to decipher their stage in the migration process.

Intelligible Migration Tasks: The required steps for migration are clearly explained and understandable by a user, whether they have prior experience or not. The user should be able to input the correct information without external explanation or guidance.

Customizable with Relevant Information: The migration process is customizable to the user's needs. The user should be able to view steps relevant to their company and the scope of their migration and should not have to deal with irrelevant steps or information.

Positive User Experience: Users enjoy using the product, finding it helpful and informative rather than confusing and stressful. The user should want to continue using the product rather than using alternatives.

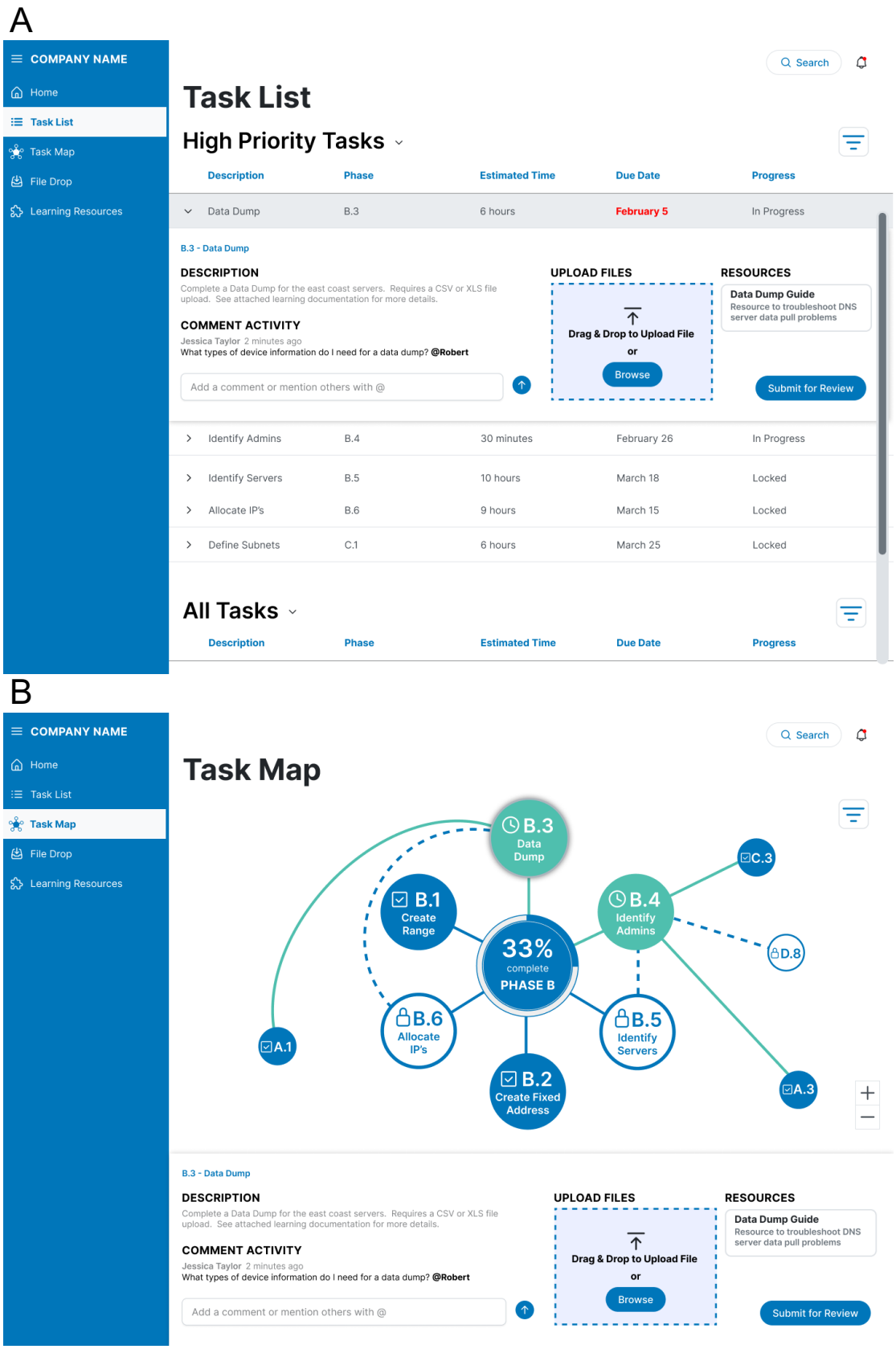

Fig. 4. Task views showing when a task is selected, details for the task become available. **(A)** List view **(B)** Graphical map view

C. Procedures

The evaluators were instructed to review the initial interface (not pictured here) and rank each component against the five usability principles defined above, where 1 indicates the metric is not met at all and 5 indicates the metric meets expectations. First, the evaluators were informed of the use case that the interface was built upon, along with the usability principles. The evaluators were then virtually walked through all the interface screens. After and throughout the walk-through, evaluators were asked to provide feedback on how the designs met the usability principles and general critiques.

VI. Results

During the heuristic evaluation, evaluators were first presented a use case. This allowed them to understand the overall system and how the screens fit together. Throughout the process, verbal qualitative sentiments were noted and after completion, the evaluators ranked the five usability principles on a scale from 1 to 5. Overall, both evaluators' scores were positive and the design scored an average of 4.25.

Intuitive Task Flow (Average Score: 4.5): Both evaluators thought the interface and progression of steps from the dashboard were clear. The left-side navigation bar informed the enterprise client where they were in the interface task flow. Using consistent iconography and visual hierarchy throughout the interface also helped in this aspect.

Understanding of System Progress (Average Score: 3.75): Both evaluators felt that there could be better clarity as to what the progress was on the home dashboard, primarily due to the unclear connection between overall migration progress and individual phase progress. Both evaluators thought using the task map to show the overall task progress was useful.

Intelligible Migration Tasks (Average Score: 4.5): The interface aims to show that migration tasks are non-linear and multifaceted. Both evaluators thought that the interface depicted these aspects through the accordion-style task list and the dynamic nature of the task map.

Customizable with Relevant Information (Average Score: 4): One of the evaluators thought that the interface is clearly only built for the enterprise client and has all the information that is relevant to them, so the design scores high in this category. The other evaluator felt that the interface lacks any customization to the enterprise client because the professional network engineer assigns all the information and tasks.

Positive User Experience (Average Score: 4.5): Both evaluators felt the design was clean and mostly intuitive, with minor pain points. One of the evaluators really enjoyed the automatic population feature of the file drop and felt that it was a key aspect of the interface.

After the evaluations were completed, minor changes were made to make the design more cohesive and intuitive to the enterprise client. Changes included rewording, removing extra buttons and unclear features, and changing color to improve contrast and salience.

VII. Discussion

This enterprise client experience, created from a cloud networking industry case study, provides a specialized project management tool with five distinct features: the dashboard, list view of tasks, map view of tasks, file drop, and learning page. The interface was prototyped and iterated based on ongoing design reviews and a thorough heuristic evaluation. With the help of these stakeholders, the project received the necessary tweaks and developed into a beneficial tool for network migration.

This tool provides three novel components, separating the interface from its competitors. The first is the task-based structure. With the tight integration of the task overview and the means to complete the task, the enterprise client can finish a step of the migration process in less than three clicks. The second is the graphical task map. This map provides a holistic overview of the network migration process, displaying architecture-specific interdependencies and a visualization of an enterprise client's system state. The third is the learning resources. These suggested resources appear on numerous pages throughout the interface, guiding the enterprise client to educate themselves on the complex subject material throughout the migration process and thus feel comfortable with the steps beyond migration. These features, combined with the overarching benefit of several industry-specific features consolidated in one place, provide a unique, customized instrument for the cloud networking industry.

The primary limitation of this project was the lack of contacts with cloud network experience. Due to the high specialization required for network migration, only a few individuals could consult on a project of this nature. With more time and resources, further testing could be performed to evaluate the functionality and effectiveness of the prototype.

Acknowledgment

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