SELPRO: An Online Self-Service Telecommunication Provisioning System for SMMEs

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Abstract- The current telecommunication service provisioning methods do not efficiently support small, medium and micro enterprises (SMMEs) in identifying telecommunication services which can improve their business operations. SMMEs are required to follow manual and time intensive procedures in order to receive telecommunication services which meet their business needs. This results in dissatisfied customers and businesses losing money. An online Knowledge-based Recommender System (KBRS) is proposed to overcome this concern. This paper presents SELPRO, a prototype system to support self-provisioning of telecommunication services to SMMEs. It highlights the requirements for an online self-service provisioning (SSP) system and discusses how these requirements are supported by SELPRO. The design and implementation of SELPRO as well as future work to be completed are also discussed.

Index Terms— Internet, E-commerce, Software Design, Processes, Online Self-Service Provisioning and Knowledge-based systems

I. INTRODUCTION

The telecommunication industry is experiencing rapid growth and changes as access to the Internet is becoming an important aspect of social and business advancement [1, 2]. This growth has created an opportunity for more Telecommunication Service Providers (TSPs) to enter the market and increased competition. As a result, some TSPs are reducing costs and providing good quality service to customers through automation of the service provisioning process [3].

The implementation of an online SSP system can provide multiple benefits to TSPs [4]. SSP systems allow customers to purchase services or solve problems without the assistance of a business representative. Online SSP systems provide a TSP the opportunity to obtain a competitive advantage by reducing the amount of human resources required to serve a customer. Online SSP also provides TSPs the ability to serve more customers at a single point in time and allows the TSP to capture customer information, which can be used for future business decisions.

Two types of Intelligent systems namely, Knowledge based systems (commonly known as Expert Systems) and Recommender systems [5] have been used for online SSP systems. Several Knowledge-based Recommender and Expert systems, together with some existing systems implemented by telecommunication companies, were reviewed to identify problems with existing systems and to determine which system best supports SSP. Based on the problems identified, the need for an improved SSP system for telecommunication customers was identified, especially for SMMEs. The reasons why TSPs require SSP systems for SMMEs will be discussed further in Section II.

The proposed solution to address these problems is a constraint-based Knowledge-based Recommender System (KBRS), using a technique called conjunctive queries. A KBRS is a system which uses knowledge about a customer's needs in order to identify products and services which support these needs [6]. Constraint-based KBRSs represent problems as constraint satisfaction problems and solve problems using constraint solvers or conjunctive queries [7]. A conjunctive query is a connected database query, which has a set of selection criteria that is executed in order to determine products and services which meet the customer's needs (specified recommendation rules). Limited research has been conducted to determine whether KBRS can be used for SSP in the telecommunications industry.

The main objective of this paper is to present SELPRO, an online SSP system for the provisioning of telecommunication services for SMMEs. Related work regarding existing online SSP systems and their problems together with KBRSs will be discussed in Section II. Section III will discuss the requirements for an online SSP system for the telecommunications industry. The design and implementation of SELPRO will then be presented in Sections IV and V. Section VI will conclude this paper by presenting the contribution and future work to be completed for this research.

II. RELATED WORK

A. *Online Self-Service Provisioning*

Companies in different industries have implemented online self-service provisioning methods to support customers during service provisioning, decrease costs and improve their business competitiveness [4]. Electronic Commerce utilises online self-service systems, which are systems that allow customers to purchase products and services from anywhere, at any time, in an easier, more intuitive manner [4]. Many telecommunication companies have not yet utilised the potential of online self-service systems [8]. Current online systems (websites) [9, 10, 11] and service provisioning methods used in the telecommunications industry were analysed in order to determine their shortcomings. A field study was also conducted at a major TSP in South Africa [5], which highlighted that the telecommunications industry needs to reduce costs incurred with manual service provisioning methods, as a large amount of human resources is dedicated to service provisioning**.** This study identified that most of these savings could be achieved with respect to provisioning solutions (services) to SMMEs. The solutions that TSPs provide to SMMEs are very similar and comparatively simple. Therefore, this research focused on providing an online SSP system for SMMEs, as the telecommunication solutions provided to SMMEs are not as complex as the solutions provided to large enterprises.

The main shortcomings identified with existing online systems (websites) [9, 10, 11] in the telecommunication industry, are presented below:

- Customers experience information overload, as current systems still provide long textual lists of products and services (Figure 1 contains an example of what some telecommunication companies provide on their websites);
- Customers are not supported throughout the service provisioning process, as the systems do not capture a customer's needs or recommend products and services which satisfy the customer's needs;
- Customers are required to have product and service knowledge as non-functional properties of products and services are not effectively presented to customers;
- Customers cannot purchase basic telecommunication services which meet their business needs without interacting with a TSP sales representative, as current online systems only provide the ability to purchase a selected range of products and services.

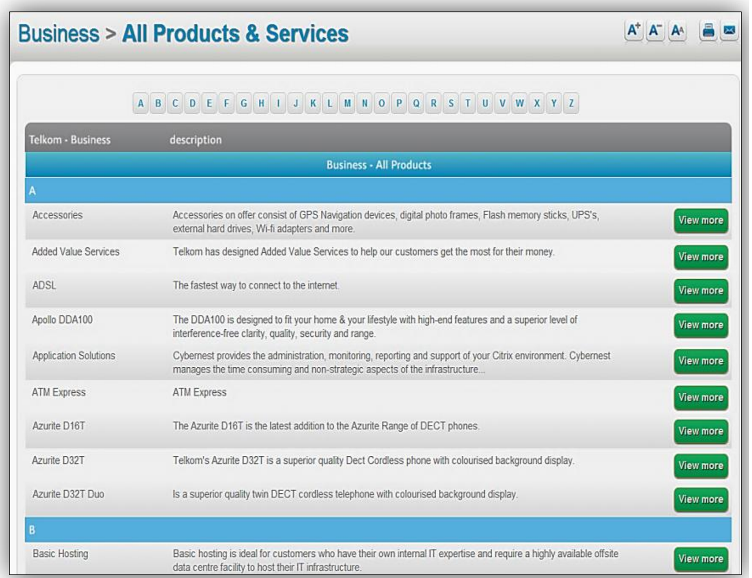

Figure 1: An example of a long textual list of products and services used by many other TSPs [9]

B. Knowledge-based Recommender Systems

An online KBRS can be used to support TSP customers with the purchase decision making process. The decision to use a KBRS was made after comparing the Knowledge-based systems against the requirements gathered in Section III. An Expert System was deemed less suitable as it did not meet some functional and design requirements, such as providing up-to-date information to customers. KBRSs consist of two types of systems used to recommend product and service types which change with time. The two common types of KBRS are constraint-based and case-based systems [7]. The review of the South African TSP websites assisted in identifying that the product and service types frequently change as new and updated products and services constantly enter the market [2].

A KBRS was identified as an appropriate system to recommend these types of products and services [7]. A KBRS guides a customer in a personalised way by recommending products and services which meet the customer's needs, by selecting from many product and service options. The two types of KBRS were compared in order to determine the KBRS more suitable for provisioning telecommunication products and services.

Constraint-based and case-based KBRSs are similar in the way they complete the recommendation process but differ in the way in which they use the knowledge provided to the system. Constraint-based systems only use the knowledge received from the customer explicitly and then define recommendation rules to retrieve products and services which satisfy the customer's needs. Case-based systems use similarity measures to identify products and services which are similar to the customer's needs. These products and services are then recommended for purchase.

It was identified that the sales representatives of TSPs use a presales questionnaire template to determine the customer's telecommunication needs and their current business and computing infrastructure [5]. The sales representatives review the customer's answers and use their expert knowledge to recommend products and services which meet the customer's needs. These findings motivated the selection of the constraint-based approach. The constraint-based approach allows the answers provided by the customer to be expressed in explicit recommendation rules, which can be used to identify products and services which satisfy the customer's needs [7].

III. Requirements for Online Self-Service Systems in the Telecommunication Industry

In order to support customers in the service provisioning process effectively and efficiently, the approach used needs to meet a formal set of requirements. The approach also needs to decrease the amount of human resources required to provide telecommunication products and services to customers, as allocating too many human resources for service provisioning is a problem currently being experienced by TSPs, as highlighted in Section II. The requirements for online SSP in the telecommunication industry were identified through a field study that was conducted with six ICT specialists from a well-known TSP in South Africa, see [5] and literature sources[12, 13]. The requirements gathering process also assisted in identifying the problems with current online service provisioning systems, presented earlier in Section II. The requirements that were gathered were categorised into functional, design and information, and performance requirements.

- ***Functional Requirements***
  - Automate the process of identifying a customer's (SMME) needs and providing a solution (products and services)
  - Search and provide solutions to customers based on the customer's needs as different customers have different needs.
  - Provide the customer with expert assistance during the service provisioning process.
  - Select a solution based on more than one criterion (requirements).

- ***Design and Information Requirements***
  - Categorise products and services for easier interpretation and understanding for customers so that they have a high level overview of the product and services functionalities.
  - Display up-to-date and relevant information about products and services.
  - Present properties of services important for customers to be able to make rational decisions, such as non-functional properties and the role of the telecommunication services.
  - Do not use long textual lists of products as it is confusing and time consuming for customers to use when viewing product and service information.

- ***Performance Requirements***
  - Provide customer solutions efficiently.
  - Ensure robust performance.
  - Be able to recommend a solution, choosing from various possibilities.

These requirements need to be addressed for the development of an online SSP system in the telecommunication industry.

IV. DESIGN

SELPRO was developed to support telecommunication customers (SMMEs) during the service provisioning process by identifying a customer's needs and recommending products and services which address these needs. The functionalities presented in SELPRO were based on the requirements which were gathered and presented in Section III. Figure 2 presents a schematic view of the components and actors found in a typical Knowledge-based system [14]. Figure 2 shows all the components used in the design of SELPRO. The numbers above the components highlight the order in which the components of SELPRO were designed and implemented. The figure also shows the actors involved in SELPRO and the components they will use to interact with SELPRO. The user will interact with SELPRO through the user interface component, while expert knowledge will be captured through the knowledge acquisition facility.

Identifying a customer's telecommunication needs and recommending products and services which address this need is the current problem scenario which SELPRO addresses. SELPRO, being a constraint-based KBRS, represent its problems as constraint satisfaction problems (CSP). The component which contains the CSP is represented in Figure 2 as the Context component [15]. The Inference Mechanism (IM) and Explanation facility (EF) uses the Knowledge base data to solve the current problem scenario in the Context component. Only the user interface, knowledge base and IM components will be discussed in this section. These components are essential for the functionality of SELPRO.

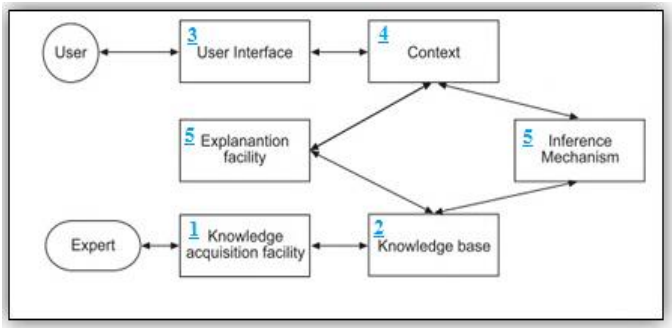

Figure 2: Knowledge-based system components [14]

A. *Knowledge base component and knowledge acquisition methods*

The knowledge base component contains information about the customer's business and computing infrastructure and telecommunication products and services and their attributes. This component highlighted the product and service data currently present in SELPRO and the customer data required by SELPRO. Together with this information in the knowledge base, SELPRO requires additional expert knowledge. The expert knowledge is captured and formulated into rules which are used by the IM to solve problems. The information contained in SELPRO is captured from various sources using different knowledge acquisition techniques. The information required about the customer (e.g. Name, Surname, Address, Number of workstations, Media transfer types) was determined after reviewing pre-sales questionnaires and order forms on the websites of several telecommunication companies [9, 10, 11].

Four main service types were identified that most SMMEs require in order to address their businesses telecommunication needs, namely Email, Internet, Domain Name and Hosting services. These services types were identified after reviewing telecommunication service packages offered to SMMEs by TSPs [10,16] and through the field study that was conducted with the TSP and Information and Communications Technology (ICT) specialists at Nelson Mandela Metropolitan University (NMMU). The information and attributes of these services (e.g. Service name, Price, Storage capacities, Number of e-mail accounts, Modem) were captured after reviewing the services and the solution packages that telecommunication companies offer to SMMEs [9, 10]. The expert's tacit knowledge was captured using semi-structured interviews [17] for the field study with the ICT specialists at NMMU and reviewing capacity planning documents. Capacity planning documents are used by businesses to help them manage resources, e.g. identifying a sufficient amount of email storage capacity for an employee. The three ICT specialists at NMMU had job roles that ranged from Service Provider Managers to Senior System Engineers. One of the ICT specialists has a great of amount of experience and knowledge in provisioning telecommunication services to businesses as he has been working for a TSP for many years. The ICT specialists also provide the four identified telecommunication services to staff and students at NMMU and therefore their job description and knowledge was deemed similar to a service provider working for a TSP.

B. User Interface component

The User Interface (UI) was then designed to obtain the customer data required by SELPRO. The users of SELPRO interact with the system through the UI component, where customers are allowed to view their solutions and enter or update customer information. The design of the UI is based on various standards and guidelines from literature sources and current online systems of telecommunication companies [9, 18]. These guidelines were followed to create an easy–to-use UI for SELPRO. A task list was compiled from the requirements that were presented in Section III. This task list was used to guide the UI design of SELPRO to ensure that all the user tasks were supported.

The main tasks which SELPRO supports are:

- Entering a need for a service by choosing from the four service categories highlighted in Section IV, namely, email, Internet, hosting and domain name;
- Viewing a recommended solution (service package/products and services) for the need;
- Buying the solution in an efficient manner which promotes user satisfaction.

KBRSs are known as conversational recommenders and can comprise of different styles such as the wizard-style and interactive dialogue. The wizard-style was chosen for the UI design of SELPRO as it is preferred for online system design [7]. The users of SELPRO can complete the three main tasks by following a wizard-style approach. Figure 3 presents the wizard-style approach, currently being used by a major telecommunication company.

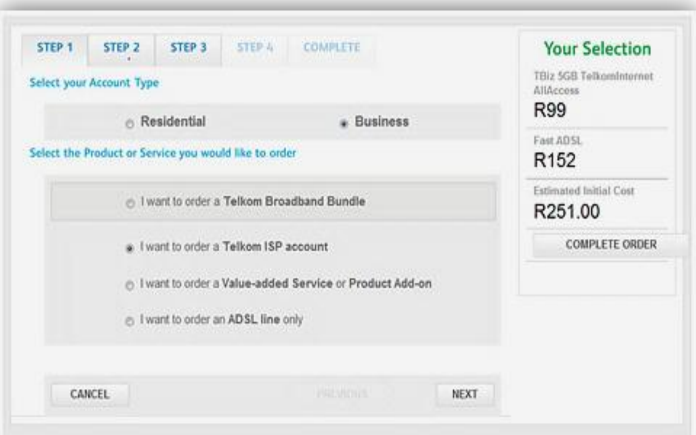

Figure 3: Wizard-style approach[9]

C. Inference Mechanism component

The logic contained within SELPRO is controlled by the IM. The IM firstly generates a filter condition (customer need) from answers that the customer provides about the customer's needs and computing infrastructure [7]. The IM applies the rules created from the expert knowledge to the customer's needs and product and service information, in order to obtain a solution. The IM can solve the CSP in the context component using one of two techniques: Conjunctive Queries (CQ) or Constraint Solvers (CS) [7]. CQ was the technique chosen for SELPRO as it was sufficient to solve the current problem, as CS are mostly used to solve more complex problems in business [7]. A CQ corresponds to "select-project-join" and "select-from-where" SQL queries joined by the "and" operator [19]. The IM then uses the rules created from the expert's knowledge and the customer's needs to formulate a CQ. The CQ is then executed against the product and service information stored in the knowledge base in order to determine the solution for the customer. Section V, which discusses the implementation of the IM, will explain how the information used by the IM (rules and CQs) are formed and used in more detail.

V. IMPLEMENTATION

SELPRO was implemented using Java Server Faces 2.0 (JSF 2.0) and PrimeFaces. The implementation of SELPRO will be described based on the three main user tasks SELPRO supports; as described in Section IV. SELPRO was also required to be an online KBRS. JSF 2.0 together with PrimeFaces provides a rich web framework that can be used to easily create online applications. PrimeFaces also provide an easy-to-use light-weight library and flexibility which other UI component libraries do not provide [20].

A. Implementation tools

JSF 2.0 is a Java based standard for easily building server-side user interfaces and PrimeFaces is an open source component suite for JSF [20, 21]. PrimeFaces contains over one hundred Ajax powered components which can easily be used in JSF applications. PrimeFaces was used to construct the UI components implemented in SELPRO, including a wizard-style purchasing component similar to the one presented in Figure 3. The alignment of the components presented on the UI of SELPRO was done using the 960 grid system, which is a set of Cascading Style Sheet (CSS) files coded with dimensions commonly used in online applications [22]. The knowledge base component is a MySQL database. The CQs formulated by the IM are standard SQL queries which are used to access the data in the MySQL database. These open source implementation tools were determined as sufficient for proof-of-concept purposes.

B. User and Component interaction

This section firstly presents a screenshot (Figure 4) from the email service screen of SELPRO and the components in Figure 2. These figures form the base of the discussion presented in this section. This discussion is presented in order to highlight how a user interacts with SELPRO and how SELPRO operates.

A user firstly logs in using his or her credentials. The user then enters the home screen and starts entering a need by answering the first question ("What service do you need?") by selecting a service category from the UI component (A in Figure 4). The user is then presented with a specific set of questions (B in Figure 4) for the particular service category selected by the user. The user then completes the questions, which formulate the user's needs (filtering criteria) used by the IM to recommend a solution/s which meets the user's needs. The user can then view the recommended solution/s (C in Figure 4). The user can then select the solution and continue to the checkout process presented in Figure 5.

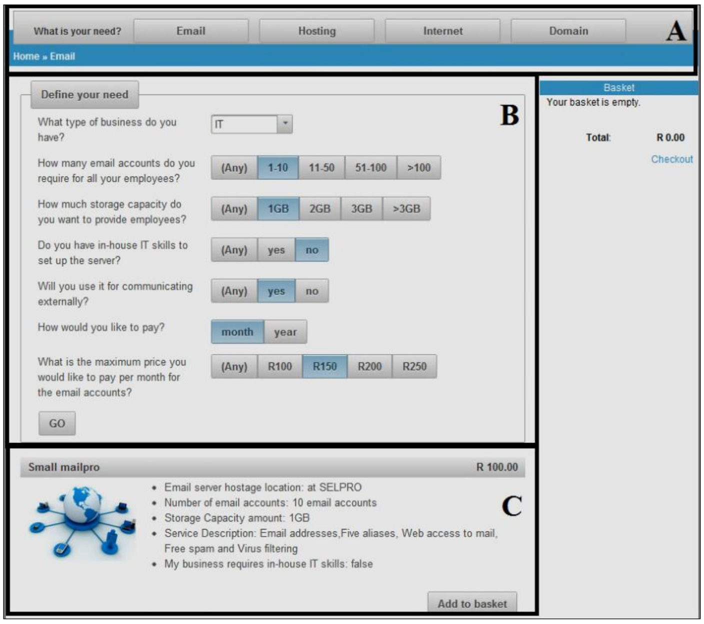

Figure 4: Need specification for an email service in SELPRO

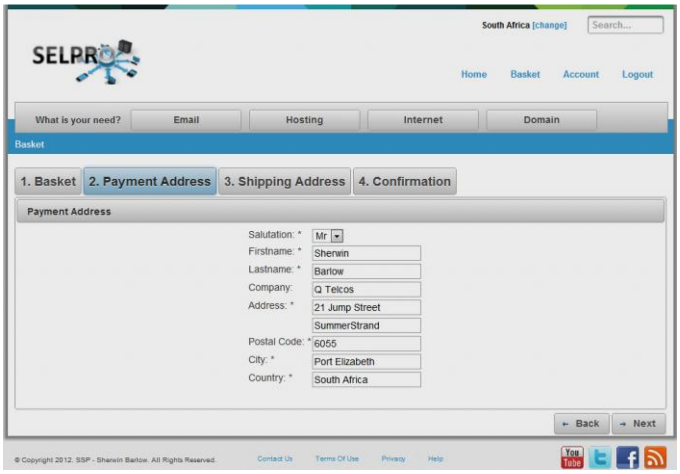

Figure 5: Confirmation process in SELPRO

C. User Interface component

The UI component firstly displays the four service categories (A in Figure 4), thus reducing the information overload for a user. This also supports the first task discussed Section IV, of allowing the user to select from service categories. These service categories displayed are obtained from the data stored in the knowledge base. The data stored in the knowledge base was captured using a *DataLoader* class that is executed when needed.

The questions presented for each service category (B in Figure 4) were obtained from capacity planning documents, pre-sales questionnaires and the field study. These questions form part of the service category data stored in the knowledge base. These questions also support the first task discussed in Section IV.

The solutions are displayed below the questions as seen in C in Figure 4. The non-functional properties of the solution are then displayed to the user addressing the design requirement of presenting important information to the customer, which helps with the purchase decision making (properties such as price, storage capacity and number of accounts provided). This data is stored in the knowledge base and was obtained from the review of telecommunication companies solutions as mentioned in Section IV. This data is also captured through the *DataLoader* class. This component (C in Figure 4) also supports the second task discussed in Section IV.

The process the user follows in SELPRO is presented in a conversational manner with the help of the wizard-style approach discussed in Figure 5. This process firstly displays the customer basket and then captures customer and business data. The customer data in the knowledge base is explicitly captured from the fields the user is required to complete during the service provisioning process. Only relevant information about customers is captured before confirming the solution (such as Name, Last Name and Address). This information is used to identify the person conducting the purchase on behalf of the business. The shipping address of the business is then required; this can be similar to the customer address. SELPRO provides an option that populates the shipping address information, if this is needed. All of this is done to ensure that customers are allowed to purchase their solution quickly. This approach will hopefully contribute to user satisfaction and allow users to conduct a purchase in an intuitive manner. This approach also supports the third task that was discussed in Section IV.

D. Inference Mechanism component

The main task of the IM is to provide a service recommendation/s to the user's needs from the services represented in the knowledge base (as shown in Table 1 as VPROD). The user can generate needs from possible customer properties (VC) from the options to the questions presented in the UI component (B in Figure 4). The user's requirements received from the UI component are interpreted as shown in Table 1 as CR.

<table>
<tr><th>Symbol</th><th>Expressions and Interpretations generated</th></tr>
<tr><td>VPROD</td><td>{ price (0...1000), num_of_accounts (0...unlimited), hosting_location (internal, external), storage_cap(1GB,3GB,10GB) }
<table>
<tr><th>Id</th><th>price (R)</th><th>n_o_a</th><th>h_l</th><th>storage_cap</th></tr>
<tr><td>P1</td><td>200</td><td>50</td><td>internal</td><td>1GB</td></tr>
<tr><td>P2</td><td>500</td><td>200</td><td>external</td><td>3GB</td></tr>
</table></td></tr>
<tr><td>VC</td><td>{ max_price (0,200,500), num_accounts_needed(50,200,500), business_type(law,bank,manfact,IT), media_transfd(images,video,sound) }</td></tr>
<tr><td>CR</td><td>{ max_price=200, business_type=bank, media_transfd=images }</td></tr>
<tr><td>CF</td><td>{ business_type =IT >>hosting_location=external, media_transf=images>>storage_cap=1GB }
e.g.business_type is customer property selected from questions asked in Figure 4B and this is mapped to product property hosting_location</td></tr>
<tr><td>CQ</td><td>e.g. of CQ {Q[price<= 200, hosting_location=external, storage_cap=1GB]Services table(VPROD) }</td></tr>
</table>

Table 1: Inference Mechanism interpretations

The IM uses the CR, VPROD and expert knowledge acquired from the field study to generate filtering conditions (CF) using an *Interpret* method. This method defines relationships between the VC and VPROD (shown in Table 1 as CF). The CFS are then returned to the IM and used to create the CQ.

The IM then uses a *Search* method that executes the CQ against VPROD in order to receive the recommended service/s displayed on the UI component (C in Figure 4).

VI. CONCLUSION AND FUTURE WORK

Current service provisioning methods for TSPs have several shortcomings, as they are manual and resource intensive. The envisaged contribution of this research is to determine the extent to which the online KBRS can be used to support customers (SMMEs) with self-service provisioning of telecommunication services. This paper proposes an online SSP prototype as a solution to the shortcomings of current service provisioning methods. Requirements for online self-service system were identified in this paper and a prototype (SELPRO) online KBRS using CQs was developed to enable SMMEs to purchase telecommunication services without the assistance of a TSP sales representative.

A usability study will be conducted to determine if any usability problems exist with SELPRO. The evaluation will also determine if SELPRO supports customers effectively and efficiently during the SSP process.

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