Flexible Homecare Application Personalization and Integration Using Pattern-based Service Tailoring

Supporting Independent Living of Elderly with IT

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***Abstract*—In most of the industrialized countries, the aging of the population dramatically progress rapidly. This trend demands economically feasible solutions to provide care to elderly, preferably at their home. IT can play an important enabling role in such solutions. Previously, we proposed an approach for personalizing IT-based homecare services by introducing a tailoring process. The tailoring process allows to create personalized services for elderly with various needs. The outcome of a service tailoring process is a so called service plan, which represents a composite service tailored to the specific needs of a specific elderly (the 'care-receiver') as understood by the person responsible for deciding on the care activities (the 'care-giver'). The service plan is created based on a treatment pattern that corresponds to the homecare task for which automated support is needed. In this paper, we elaborate on the idea of pattern-based service tailoring. First, we briefly introduce the architecture of the tailoring platform and identified common homecare tasks via interview with the care-givers. Then, we zoom in on how we established two important aids for creating a service plan, namely the treatment patterns and the abstractions of devices and applications that can be deployed in the automated support. We give examples of both patterns and abstractions, and discuss how these can be used in creating a tailored service plan.**

Keywords: Homecare systems, service oriented computing, user centric, personalization, service tailoring, e-health.

I. Introduction

The increasing percentage of elderly people puts health care services in industrialized countries under great pressure. Providing IT-based care solutions to elderly at their home is one of the means for tackling this problem [1], [2], [3]. These IT-based services should match the individual needs of the elderly, which is possible through a process called service tailoring [4][5].

In [6], a service tailoring process, assisting a person responsible for deciding on the care activities (the 'care-giver') to create a personalized composite service for an elderly (the 'care-receiver'), is presented. The care-giver drives the tailoring by making constrained decisions, based on his professional knowledge, concerning the configuration and composition of predefined basic homecare support actions. The homecare support actions are represented as user-level service descriptions, and referred to as Service Building Blocks (SBBs). Each SBB corresponds to functionality that has been implemented by a device and/or software application, and is available for use by the care-receiver. This approach requires minimal technical knowledge and skills from the care-giver, since the SBBs hide the details of concrete implementations.

Our approach envisions a care-giver who can use his professional knowledge to configure and compose, within a short time period (typically during a home visit), the SBBs to support independent living of a care-receiver. The outcome of the service tailoring process is called a service plan, which represents a composite service tailored to the specific needs of a care-receiver as understood by the care-giver. A service plan contains enough information to allow automated transformation to a complete implementation that can be deployed on a target execution platform.

Designing such a service plan from scratch is a difficult and time consuming task. Our objective is to facilitate the creation of a service plan for a care-giver. The use of patterns is believed to simplify the process of creating a service plan. We make use of treatment patterns as a starting point for the tailoring process, where a treatment pattern is an activity structure for handling a generic homecare task. Thus, the care-giver does not have to create a service plan from scratch, but selects the homecare task to be supported from a menu. The tailoring platform then presents the corresponding treatment pattern as the initial service plan, which should be further refined and completed by the care-giver.

This paper contributes to IT-based homecare support by further detailing the previously proposed service tailoring approach. We identified a list of common homecare tasks and their corresponding treatment patterns by interviewing care-givers at a care institute. We also identified a collection of SBBs by conducting a technology survey. We discuss how these ingredients (treatment patterns and SBBs) are used in the creation of a service plan, tailored to the independent living needs of a care-receiver. We provide several examples to illustrate our approach.

The rest of the paper is structured as follows. In Section II, we present an application scenario to motivate and illustrate the need for our approach. In Section III, we briefly discuss the architecture of the homecare service tailoring platform. In

Section IV, we discuss the common homecare tasks and the corresponding treatment patterns. In Section V, we discuss the concept of SBBs and provide several examples. In Section VI, we explain the creation of a service plan, including the configuration parameters and the definition of decision rules, illustrated with two examples. In Section VII, we discuss related work and compare them with our approach. Finally, in Section VIII, we discuss our findings and present future research directions and in Section IX, we conclude our paper.

II. Application Scenario

We use the following homecare application scenario to motivate the work presented in this paper and to clarify our discussion.

John and Marie are patients with a minor form of Chronic Obstructive Pulmonary Disease (COPD). Their quality of life is improved when being active and regulating their weight. However, when being active, for example when walking, it is important to monitor their oxygen saturation level for safety reasons. If the saturation level drops too low, exacerbation may occur, leading to hospitalization and more expensive long-term care. Additionally, John has a hearing disorder while Marie has vision impairment. Besides that, both of them suffer from amnesia and need to be reminded for doing their tasks. Nancy, as their professional care-giver, is responsible to create and tailor the homecare services installed in their homes and represented to her as SBBs in the service plans.

Nancy follows the following steps for creating user specific services: 1) She chooses John's name from a list to indicate the care-receiver (for whom a service plan is created). This step is important because the tailoring platform retrieves relevant data of the intended care-receiver, e.g., John's abilities in using the services (such information is used to annotate the service plans with the information required to use the services) and previously created service plans (in case Nancy wants to re-tailor them). 2) Nancy selects the "Monitoring medication taking" task from a list proposed by the tailoring platform. As shown in Figure 1, the tailoring platform proposes a predefined treatment pattern for the "monitoring Medication taking" task. The pattern contains three SBBs, namely Reminder to remind John to take his medicine, Dispenser to help John to take the proper medicine at the right time and correct dosage and Alarm to notify Nancy in case John does not take his medicine at around the expected time. The pattern is annotated with John's special requirements obtained from his profile mentioning that he has a hearing problem and he cannot use any device which uses sound. Exploiting user profile information is helpful, because Nancy does not need to worry about the binding of SBBs to concrete services and this speeds up the tailoring process. It means she does not have to indicate to use a visual reminder device in his service plan. Nevertheless, she can modify these proposed modalities. 3) Nancy configures the pattern by indicating that if John is outside the care home send reminder message 20 minutes before the medicine schedule time and if he is inside the care home send it 10 minutes before the schedule time. She also indicates which message to send and if John does not take the medicine how many times the reminder should be repeated and at what interval before sending an alarm to her.

John and Marie have individual preferences with respect to the delivery of the reminder service. Among others, Marie prefers to get a vibration reminder on her PDA instead of voice, when she has company. Therefore, starting from the same pattern, Nancy tailors Marie's service plan by adding a rule which says that in case Marie has company, sound should not be used as a reminder modality. Nancy visits John and Marie every day and based on their evolving health condition, she can also decide to re-tailor the services, for instance, the need for a particular medicine.

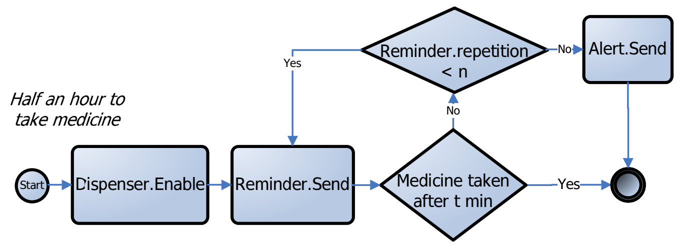

Fig. 1. A simple version of *medication taking* treatment pattern

As described in the example scenario, *John* and *Marie* have individual requirements and preferences, and *Nancy* must create different service plans for them by tailoring existing services. Creating such a service plan requires both domain and IT knowledge. Since the care-givers generally do not have deep IT knowledge, technical details of the service tailoring process should be abstracted as much as possible.

III. Tailoring Platform

The objective of service tailoring is to create a user-specific service plan which can be executed by a provisioning platform at runtime and satisfy the individual needs and preference of a care-receiver. This paper focuses on the tailoring platform and starts with defining its components and the tailoring process. The detailed explanation of how the outcome of the tailoring platform is executed by the provisioning platform is out of the scope of this paper. Interested readers are referred to our earlier work reported in [7]. The tailoring platform is responsible to enhance the creation and tailoring of the service plans by providing Graphical User interface (GUI) for the care-givers. Fig. 2 depicts a simple version of homecare service tailoring platform which is defined based on the Model-View-Controller pattern. In our platform, the *Model* manages the service plan through its various stages of refinement. The *View* presents the plan to the care-giver. Besides a view-presentation of the service plan, there is also additional views to assist the care-giver (e.g., available homecare tasks and their corresponding treatment patterns, where the pattern is the initial stage of a service plan). The *View* queries the model in order to generate the GUI. The care-giver interacts through the GUI to inform the *Controller* about his inputs and *Controller* interprets the input so as to update the *Model*. The *Model* also accesses the (relatively) static information that is relevant for

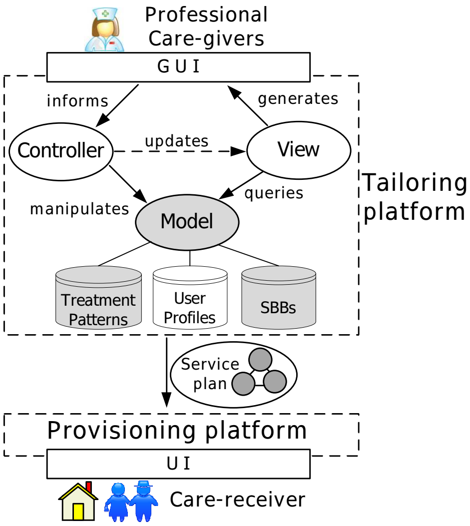

Fig. 2. Homecare Service Tailoring Platform

the tailoring, namely: the set of treatment patterns, the set of service abstractions (SBBs), and the set of user profiles.

The service tailoring process starts with choosing the name of the intended care-receiver by the care-giver. This is helpful, because it allows the tailoring platform exploit the information of that care-receiver stored in the *user profile* and annotate the service plan with user specific information such as the abilities which the care-receiver needs to interact with or use the services. The user profile contains information with respect to the health conditions, disabilities, preferences of the care-receiver. The tailoring process continues by selecting a homecare task by the care-giver from a list of common homecare tasks. Based on the selected task, tailoring platform propose appropriate treatment pattern(s) to the care-giver. The care-giver can easily configure the pattern based on her knowledge and care-receiver's situation. The service tailoring process ends with the generation of the care-receiver specific homecare service specification, i.e., the service plan which constrains the behavior of the homecare services at runtime according to the needs and preferences of the care-receiver. The service plan should foresee all the requirements and preferences of a care-receiver and determine the corresponding desired behavior of the services. The service plan thus created, if confirmed by the care-giver, is deployed to the provisioning platform to be executed. The following steps summarize our proposed service tailoring process:

1) Select the user for whom to create a service plan.
2) Select a task from a given list of homecare tasks.
3) Select a treatment pattern from a given list of alternatives suggested by the tailoring platform.
4) Configure the selected treatment pattern.

IV. Tasks, Treatment Patterns and Roles

There are several tasks which care-givers perform in the homecare domain. Some of these tasks can not be automated such as cleaning the room, washing the care-receivers and changing diaper of a care-receiver with incontinency problem. But there are some other tasks which can be automated such as reminding the care-receiver for doing certain activities and monitoring the health situation of the care-receivers.

Creating a service plan from scratch for each and every care-giver is time consuming, costly and is subject to human errors. We use the concept of patterns to simplify the creation of a service plan. A service plan pattern is a treatment pattern for a specific generic homecare task. Through the use of concept of patterns, the tailoring platform can propose one or several treatment pattern(s) to the care-giver, whenever a task is selected from the given list of common tasks such as *monitoring medication taking*, *monitoring oxygen saturation level*, *monitoring blood pressure* and *reminding a social activity*. Therefore, he does not have to create a service plan from scratch, and instead can configure and modify an already existing plan. The common tasks and their corresponding treatment patterns can be identified by investigating the existing practice in the care centers. For each task, a couple of alternative treatment patterns can be proposed. The purpose of having several treatment patterns for each task is to have different orchestration schemes (composition of services) for the same task. This is helpful, because the care-giver can choose a proper pattern for a specific care-receiver from the existing patterns and there is no need for re-composition of patterns by the care-giver. For example, in the *monitoring medication taking* pattern example, we can have two patterns: in one of them dispenser is enabled before sending the reminder while in the other one reminder is sent before enabling the dispenser.

When carrying out homecare tasks, care-givers must follow a specific guidelines and protocols, i.e., medical protocols [8], [9], [10]. The medical protocols guidelines, which are usually in a textual description format, consist of a sequence of connected steps to be followed by care-givers for each specific task. For example, a guideline associated with a care-receiver suffering from COPD, specifies that if the oxygen saturation of the care-receiver drops under a specific level, the care-giver has to, first, give the care-receiver a medicine, then call a doctor and finally, check again the oxygen level after a specific time.

We use the information contained in medical protocol guidelines (and the information collected from interviews) to define treatment patterns in an attempt to assist care-givers carrying out their tasks, e.g., reminding care-receiver for doing different activities and monitoring their health situation, etc., which can benefit from the use of IT-based solutions. As in the case of medical protocols and guidelines, these treatment patterns are generic in nature and can be configured to satisfy the requirements of a specific patterns.

The common tasks and their corresponding treatment patters presented in this paper, are identified by interviewing care-givers working in a care center. Some of the common homecare problems are the following: Incontinence, high blood pressure, dementia, diabetic, CVA, bad hearing and seeing, COPD, sensory problems (hands and legs), arthritis (Rheumatism), psychiatric. We also identified common tasks required to provide care services corresponding to each of these homecare problems. The list of the homecare tasks which can benefit from IT support are the following:

1) Scheduling for different activities such as
   - To measure blood pressure
   - To take the medicine
   - To measure weight
   - To do training
   - To go for a social activity
   - To eat food or to drink
   - To make an appointment with doctor, family member, etc.
2) Monitoring care-receivers' vital signs or activities such as
   - Blood pressure and heart beat pulse
   - Medication taking
   - Oxygen saturation level
   - Sugar level
   - Temperature
   - Training activity

Anyone involved in providing care to the elderly at their home might be considered a care-giver in the homecare domain [11]. We identify different types of care-givers who interact with and help care-receivers in their daily life in the homecare domain. The identified care-givers are as follows: professional nurses, family members, informal care-giver (volunteer non-professional care-givers), occupational therapists, physiotherapist, physicians, pharmacist and psychologist. In this paper, we consider only *professional nurses* as the care-givers, because the care-receivers spend most of their time with processional nurses while receiving care services in comparison to other care-givers.

Due to space restrictions, we exclude the identification process and used only some of these tasks and their corresponding treatment patterns to illustrate our approach.

V. Service Building Blocks

Existing homecare applications and devices are represented as SBBs mainly when these applications and devices have independently useful functionalities. We have conducted a technology survey, constrained in scope by the usability and applicability of the technology for the identified homecare tasks to define required SBBs for homecare domain.

Since a SBB is an abstraction, several alternative implementations may exist that correspond to the same SBB. The tailoring platform is not aware of the alternatives, but configuration parameters of the SBB allow care-givers to indicate selective functionality which may only be provided by one specific implementation. For instance, a SBB for medicine dispenser can have a configuration parameter which enables the care-givers to determine how much time in advance the provisioning platform should send a reminder to the care-receiver. To execute this, the provisioning platform employs a concrete service namely *waiting service* which takes the time it should suspend the process as input and resumes the process after this time has elapsed.

A SBB provides a generic service interface to be used by care-givers in the process of creating a service plan. A SBB also provides a list of configuration parameters to allow a care-giver to specify different aspects of the SBB such as service operations and user interface modalities. In the sequel we present some of these SBBs and their configuration parameters in plain English. We used plain English solely for the purpose of explanation. These SBBs are, however, represented in XML-based languages in their implementation and are represented graphically using BPMN-like notations to the care-givers.

1) Reminder: To notify a care-receiver to do something.
   Operation: Send Message()
   Configuration parameters: *string* Message: message to send to the care-receivers, *time* Timeout: waiting time between each reminder, *integer* Repetition: Number of reminder message repetition, *list* Location: where to send the reminder message, *list* Modality: in which device/modality to show the message.
   Some possible values for configuration parameters: Modality: audio, video, text and vibration; Location: name of the rooms and outside the home.
2) Alarm: To inform a care-giver if there is a hazard situation.
   Operation: Send Alarm()
   Configuration parameters: *string* Message: message to send to the care-givers, *list* Interface: in which interface to show the alert, *person* care-giver(s): to whom send the alert.
   Some possible values for configuration parameters: Interface: call, SMS, email.
3) Medicine dispenser: To help a care-receiver to take the correct dosage of the medicines.
   Operation: Enable(); to enable (disable) dispenser, care-receiver can (not) take medicine.
   Configuration parameters: *list* Modality: the type of interaction between care-receiver and dispenser to take the medicine from it, *list* Location: location of the care-receiver.
   Some possible values for configuration parameters: Modality: pushing a button, automatic.
4) Oxygen saturation meter: To measure the level of oxygen saturation on the body of a care-receiver.
   Operations: Set Saturation Level Threshold (); to set a threshold for sending notification.
   Notify Saturation Level (); to notify the care-givers if the oxygen saturation level drops blow a predefined level.
   Get Saturation Level (); to measure the current oxygen saturation level.
   Configuration parameters: *integer* Threshold: under this value, an alert message should be send to the care-givers, *time* Timeout: waiting time after expected time for measuring oxygen saturation level.
   Some possible values for configuration parameters: Threshold: 90.
5) Blood pressure meter: To measure the blood pressure of a care-receiver.

Operations: Set Blood Pressure Threshold (); to set a threshold for sending notification.
Notify Blood Pressure Level (); to notify the care-givers if the blood pressure is above/under predefined level.
Get Saturation Level (); to measure the current blood pressure level.
Configuration parameters: *integer* Diastolic1, Diastolic2: to set the threshold for diastolic level, *integer* Systolic1, Systolic2: to set the threshold for the systolic level, *time* Timeout: waiting time after expected time for measuring blood pressure.
Some possible values for configuration parameters: Diastolic1: 55, Diastolic2: 100, Systolic1: 80, Systolic2: 200.

6) Weight meter: To measure the weight of a care-receiver.
Operations: Get Weight amount ()
Configuration parameters: *time* Timeout: waiting time after expected time for measuring weight.
7) Step counter: To measure the steps a care-receiver takes during a day.
Operations: Get Steps Amount()
Configuration parameters: *integer* Steps: to set the threshold for steps which a care-receiver should take during a day.
8) Agenda: To set/notify schedules of a care-receiver for various tasks (e.g., medicine intake, appointments).
Operations: Set Event(); to set an event in the agenda.
Notify Event(); to notify the care-receivers or/and provisioning platform (to trigger a process) based on the scheduling time.
Configuration parameters: *person* Care-receiver: for whom to set the schedule, *list* Event Type: for which task/event to schedule the agenda, *date* Date: for which date to schedule, *time* Time: for which time to schedule, *list* Repeat: how often this schedule will be occurred, *time* Reminder Time: how long before the schedule send a notification, *list* Location: where the event location is (this parameter is needed for some tasks, e.g., to notify a care-receiver about a social activity in a specific place).
Some possible values for configuration parameters: Event Type: taking medicine, measuring blood pressure, participate in a social activity, Repeat: every day, once a week or once a month, Reminder Time: half an hour or one hour.
9) Call: To call other service plans within a service plan.
Operations: Call Process()

The configuration parameters receive the configuration values from three different sources: care-givers, provisioning platform (e.g., context values) and user profile (care-receiver profile). For example, in the *reminder* SBB, the *modality* parameter acquire the value from the user profile, the *location* parameter acquire the value from the provisioning platform at runtime and *message, timeout and repetition* parameters' value set by the care-giver.

In order to make the SBBs reusable and context-independent, different and sometimes conflicting aspects need to be balanced. One of this aspect is the proper level of SBB granularity [12]. Defining more or less operations and configuration parameters makes a SBB more or less generic. Having more generic SBBs make them more reusable, however making a composition of these SBBs becomes complicated.

VI. Service Plan

We call the treatment pattern configured to satisfy the requirements of a specific care-receiver a service plan. A service plan consists of two parts: internal and external representations. The external representation of a service plan is defined to be understood and configured by the care-givers. The internal representation of the service plan is defined to be understood and executed by the provisioning platform.

We specify the external representation of the service plan by using workflow-based techniques. The reason behind this decision is that the medical protocols resemble closely to the concept of workflow, i.e., both of them provide a depiction of a sequence of operations that need to be performed to perform a task. Moreover, the workflow-based techniques are developed to support communication between technical and non-technical users. More specifically, we use BPMN [13] like notations for representing the service plans. Such a service plan consists of several activities referring to the use of SBBs and their configuration parameters (annotated as data item to each activity). Beside activities, a service plan contains some decision points to specify the behaviour of the service plan at runtime. A care-giver can easily configure the plans by specifying/modifying the configuration parameters' values. By composing and configuring the SBBs in a service plan, we will be able to provide required homecare services to the care-receivers.

A. Decision Rules

Decision rules are used to specify how the system should behave while providing services. We used rules to support care-givers to specify the constraints or values while defining the service plan. We provide rules to the care-givers who can chose to use in the service plan they are creating, i.e., a care-giver can choose from a list of available rules for each service plan. This is required because for a care-giver, it is either a difficult task or cannot always describe and write decision rules. However, a care-giver can easily read, use and assign values to the rules. We identify four types of decision rules in homecare domain which are as follow:

1) *Trigger Rules*: This type of rules are needed to specify when a process (i.e., service plan) should be started. We model this type of rules as Event Condition Action (ECA) rules [14] of the from *on* event *if* predefined condition is true *do* start the process. We identify three type of events which can trigger a service plan process: a. Time event based on predefined schedule, b. Context event based on the change in the context of a care-receiver and c. Chain event based on calling from other processes (the condition part of this event is always true).

TABLE I
EXAMPLES OF TRIGGER RULES

Rules	Event	Condition	Action	Homecare Task
R1	Agenda.Medicine	Medicine.notTaken	After *t* min start the process	Monitoring Medication taking
R2	CareReceiver.NotEnoughWalked	Care-receiver.Activity.Sitting	start the process	Monitoring Doing Training
R3	BloodPressureProcess.Called	Always true	start the process	Monitoring Doing Training

Three examples of trigger rules, used in two different service plans, are illustrated in Table I.

2) *Configuration Rules*: In each service plan process, decision points are used to specify the control flow of the process to decide what to do based on the run-time data. The necessary values comes form the configuration parameters of SBBs. The following rule is an example of configuration rules, in the *monitoring medication taking* task.
   - *If* Reminder.repetition $> n$ *Then* Alarm.send
3) *Mapping Rules*: This type of rules is used for mapping each SBB to available concrete services. The following rule is an example of mapping rules, in the *monitoring medication taking* task for Marie's service plan.
   - *If* Care-receiver.hasVisualImpairments *Then* Reminder.Modality= Voice
4) *Safety Rules*: These types of rules are used to specify safety constraints and requirements because the homecare services are classified as safety-critical systems [15]. Any system malfunctioning could lead to the loss of a life. The following rules are examples of safety rules, in the *monitoring medication taking* and *monitoring training activity* tasks.
   - *If* MedicationTaking.Process.Fails *Then* Call
   - *If* TrainingActivity.Process.Fails *Then* SendSMS

B. Example Service Plans

We illustrate our discussion of service plans with two homecare tasks and their corresponding treatment patterns. Fig. 3 shows the treatment pattern for *monitoring blood pressure* task which is selected by *Nancy* to be configured for *John*. Some of the default values of the configuration parameters, shown in this example, are identified via interview such as *30 minutes* interval between each reminder message, and some others can be obtained from the John's user profile such as *visual modality* for reminder message. Fig. 4 shows the treatment pattern for *monitoring training activity* task which is selected by *Nancy* to be configured for *Marie*.

VII. Related Work

There are several approaches advocating the use of service plan with the goal of realizing application services with ease [16], [17], [18], [19], [20]. The approaches are defined based on the concept of graphs, workflows, rules or the combination of these concepts. The scope of these approaches are also different, i.e., they are defined for resolving specific problems in different application domains. In the following, we discuss some of the relevant approaches to identify their strengths and weaknesses in comparison to the work presented in this paper.

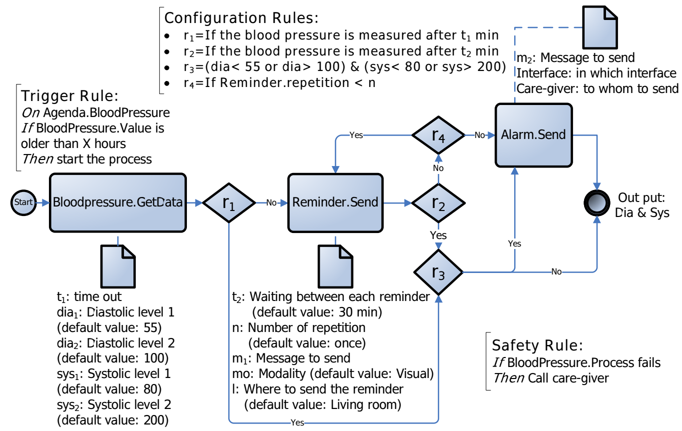

Fig. 3. *Blood pressure* treatment pattern selected for John

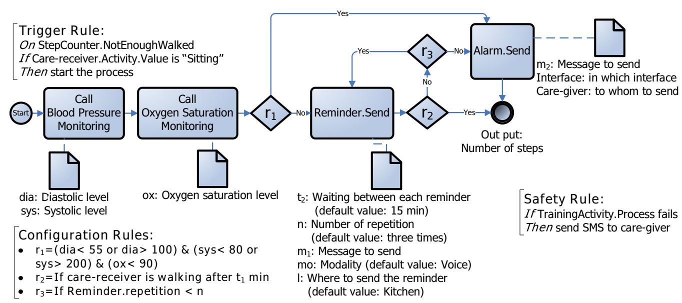

Fig. 4. *Doing training* treatment pattern selected for Marie

In other domains, enriching business processes by business rules to achieve better flexibility has been investigated [16], [17]. The main idea behind these approaches is to extract the highly dynamic decision rules from the process and manipulate them without affecting the processes themselves. This extraction seems interesting because with respect to current service provisioning technologies changing the business rules are simpler than changing the business processes [21]. However, the existing approaches cannot be used as is because in the homecare domain the decision rules and configuration parameters should be configured by a non-technical care-giver. Moreover, the homecare-specific rules such as *safety rules* may not be fully supported by the existing approaches.

In other works, several approaches are proposed to support computer-based modeling of medical protocols [22]. Rule-based medical protocols like Arden Syntax for Medical Logic Modules (MLM), which is part of Health Level Seven (HL7) standard [23], has been employed to facilitate knowledge sharing among care-givers for instance for COPD treatment [24]. Workflow-based medical protocols (e.g., care-flow [25], [26]) are proposed to define which task needs to be executed at which order while providing care to a care-receiver. Unlike in our approaches, these works neither consider the use of workflow patterns nor the personalization aspects. The use of workflow patterns would allow non-technical care-providers create and personalize the service plan for a specific care-receiver.

The service plan as proposed in the Match project [27] is based on directed graph. This plan specifies how the interaction between different services can be mapped, and hence allows to specify multiple alternative compositions that can be used for satisfying a specific needs. These alternative compositions are prioritized in the order of care-receiver's preferences. However, creating such a service plan is beyond the capacity of non-technical users like care-givers. The work presented in [28] proposes to use an UML as a means to define service plan. This approach is similar to ours, however they do not support explicitly decision rules besides their UML plans, thus, tailoring an existing service plan for an individual needs and preferences of a care-receiver with their approach, is quite time consuming task.

VIII. Discussion

At present we target professional care-givers as target end-users of the tailoring platform. In particular, we would like licensed nurses to be able to use the platform for creating and personalizing the care services to the individual care-receivers' needs. This is because licensed nurses have professional skills and knowledge (in contract to most volunteer care-givers) as well as frequent interaction with the care-receiver in providing day-to-day care (as opposed to general practitioners or specialists). The user interface of the tailoring platform should therefore be developed taking account of the professional skills and knowledge and the (limited) IT knowledge that can be expected from licensed nurses. Later on we will consider other end-user types, including the care-receiver him/herself, and investigate whether and, if so, how the platform can be useful with variations on the user interface but minimal changes to the platform's internal architecture.

We are currently implementing the service plan patterns using WebSphere Lombardi Edition[1] and we plan to use WebSphere ILOG JRules[2] to model our decision rules. The latter enables us to define rules in plain natural text which is easy to understand for non-technical care-givers. Unlike other domains, users in the homecare domain, i.e. elderly people or care-receivers in our terminology, are subject to various impairments. This characteristic of elderly people is determinant in service usage. Hence, services should be selected not only based on user preferences, but also based on their health related situation. We are investigating suitable user profiles for the homecare domain to consider the user's abilities in using the services and the user's preferences. The information in the user profile is used to annotate the service plan, which in turn guides the provisioning platform to select proper concrete services for various care-receivers.

To validate and improve the current proposed solution, we aim first at applying our approach in a real life case and then consider some possible extensions based on the results of this application. One of the extensions can be to provide additional SBBs and their configuration parameters. The other one would be to provide alternative service plans representation styles to the care-giver. For example, currently we are thinking of a wizard based application, which requires the care-giver to configure one activity (SBB) of the service plan at a time (while showing the complete service plan at the bottom of the configuration window). Another possible alternative can be presenting all the configuration parameters and decision rules together in a table-like structure so that the care-giver can configure them at once. Moreover, we plan to extend our current approach to allow selection of multiple related care tasks at the same time and thus combining two or more related treatment patterns as starting point for the creation of a personalized service plan.

During the validation, we plan to evaluate the usability of our approach and improve it based on the evaluation results. To measure the usability of the proposed approach, we follow the usability standard - ISO 9241. In particular, we are interested to investigate the *effectiveness*, *efficiency* and *satisfaction* aspects of the proposed approach. Through an effectiveness analysis we plan to investigate the accuracy (compliance with medical protocols) and completeness (contain enough information) of the service plans. An efficiency analysis will allow us to see how long does it takes for a care-giver to tailor a service plan in relation to the accuracy and completeness of the service plan. A satisfaction analysis will allow us to know the care-givers' perception about the ease-of-use and benefits of the tailoring platform.

Tailoring in the service tailoring process can be done in various ways and with respect to various elements in the service plan. For example, treatment patterns can be tailored by adding or removing activities or decision rules; SBBs can be tailored by setting their configuration parameters. If we consider different types of end-users of the tailoring platform, we should also distinguish between different roles with different capabilities/rights in the service tailoring process. Nurses follow the medical protocols in providing specific care services and these protocols are embodied in the treatment patterns. Nurses can therefore not change the patterns. However, a physician together with the managing department of a care institute may sit together once a year and decide to change some of their local medical protocols, which then may affect the predefined treatment patterns in the tailoring platform. So there is a need for providing a management interface which allows for changing or replacement of the treatment patterns. Providing such a facility is useful, however it should fit within the policy of an organization.

IX. Conclusion

In this paper, we discuss an approach with which a professional care-giver can create personalized plans for automated care support to elderly who want to live independently in their own private home. The personalized plan, called service plan,

[1] http://www-01.ibm.com/software/integration/lombardi-edition/

[2] http://publib.boulder.ibm.com/infocenter/brjrules/v7r1/index.jsp

is created through a GUI provided by a service tailoring platform. The creation is facilitated by using treatment patterns, corresponding to common homecare tasks, as starting point for the service plan. Since the needs of individual elderly are slowly changing with time, care-givers should also be able to re-tailor previously created services quickly and easily.

We define service tailoring as a process which consists of activities that a care-giver needs to perform for personalizing the services at design time, i.e. prior to the provisioning of homecare services. The service plan constrains the behavior of the homecare services at runtime. A complete service plan allows the generation of software that can be deployed on a provisioning platform to orchestrate available services. The service plan is a composition of existing service building blocks (SBBs) for a specific common homecare task which is configured by the care-giver to provide appropriate homecare applications to the individual care-receivers. Creating such a service plan could be a difficult and time consuming task for a care-giver. The use of service plan patterns, i.e. treatment patterns, is believed to simplify the creation of a service plan. A care-giver does not have to create a service plan from scratch, but instead can configure and modify an existing pattern proposed by the tailoring platform. Because of the high similarity of the care services at an abstract level, we interviewed care-givers to identify homecare common tasks and their corresponding treatment patterns. In this paper, we further investigate the ingredients of each treatment pattern and describe the required SBBs, and their configuration parameters and decision rules for the homecare domain. We can make a rich collection of homecare services by composing and configuring the SBBs.

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