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# Alternative Process Notations for Mobile Information Systems

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**Abstract.** Model-based requirements specifications may be performed using a wide variety of notations, emphasizing different standards and information needs. Most of these notations have been developed with more traditional information systems development in mind, not specifically for mobile information systems. While many of the same modelling approaches will be relevant for mobile information systems, too, there are reasons to believe that the modelling needs in that domain might be somewhat different. In particular, the location and context of an information processing activity will be less fixed than for a desktop-based system, and this may also cause a bigger need for modeling this location and context. This paper explores some alternative notation variants for UML activity diagrams to address these needs. Some notations are proposed and compared, using a case study from the home care domain.

**Keywords:** Requirements specifications, model-based, UML, use case diagrams, BPMN

## 1. Introduction

A large number of diagrammatic modeling techniques have been used in information systems analysis and requirements engineering, such as goal modeling [1] conceptual modeling [10], and process modeling [4] including UML, use cases [11] and BPMN. For requirements specification [5] [6], there exist different diagrammatic modeling languages typically to address a lot of different aspects [7], such as

- WHAT (information is supposed to be handled by the system, e.g., in terms of classes and relationships)
- HOW (is the system going to solve its tasks, e.g., in terms of process models)
- WHEN (are tasks going to be performed, e.g., shown in more precise process models including timing)

- WHY – in terms of goals or business rules
- WHO – in terms of agents / roles. Some languages typically combine WHY and WHO, such as i\* or Kaos [3]

For mobile information systems another question emerges, namely WHERE? Most naively this can be considered in a purely geographical sense – where is a certain activity supposed to be performed or a certain service supposed to be offered? However, it can also be considered from a multi-channel [12] point of view – through which kind of equipment is the functionality going to be offered? [13] [14] Or from the point of view of the working context: In what situation is the user when needing the functionality, e.g., is it going to be used in a car, and is the car standing still or driving, and in the latter case: is it the person driving the car who actually needs to use the system at the same time? All this may have important bearings on the requirements and later design of the system, and would therefore be relevant to capture in early stage system models. This paper is organised with related works in section 1.2, proposed diagram notation in section 1.3 followed by evaluation in section 1.4, conclusion and with possible future work in section 1.5.

## 2. Related Works

The Volere specification approach [8] provides a general template for all kind of requirements, but as mentioned earlier mobile requirements specification is unique and could not specify the “where” aspect. RE techniques mostly uses diagrams for requirements and visual notations play important role in all engineering disciplines. The works carried out in MPOWER project [17] uses UML notations in their home care system extensively and concludes UML profiles can be used as a mechanism for toolchains based on OMG’s Model Driven Architecture(MDA) and UML standards[16]. Larsson [7] proposes the three building blocks for knowing the processes list How, What and Why, adds Who for use oriented design approach and omitted the ‘Where’ concept. Veijalainen [15] mobile ontologies development identifies the ‘where’ aspect, but excludes the ‘what’ aspect.

## 3. Proposed Diagram Notation

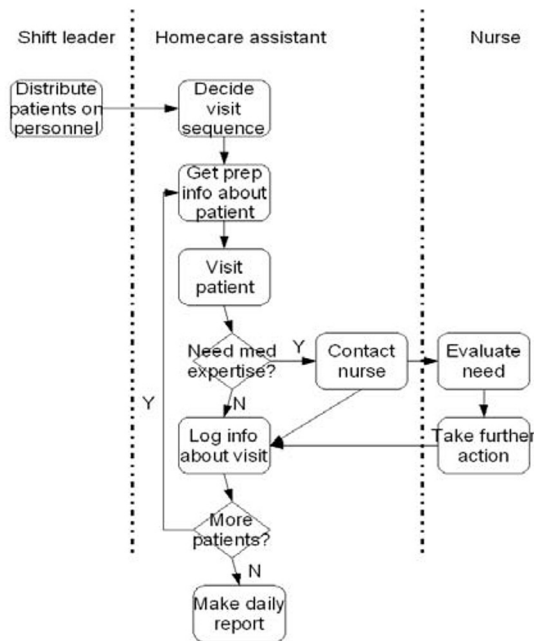
With the background of Home care system [9] case study, consider the simple UML [2] activity diagram in Fig. 1. A brief summary of home care system is given below: *The shift leader is responsible for the work at the zone, answering to Trondheim municipality. Nurses typically have more somatic knowledge than the home care assistants, and are to support social needs. The home care assistants typically work more broadly work with personal care before lunch, and then with home care (i.e. practical tasks in the home).*

The diagram in Fig. 1 typically focuses on HOW the process is performed (the activity boxes and decision diamonds) and by WHOM (swimlanes, typically roles in the organization). WHAT could be included by rectangles representing information objects manipulated by the activities (not done here for the sake of

simplicity). WHY is not so much included in this type of diagram, but could be addressed in another type of diagram, for instance a goal hierarchy.

The WHERE dimension is typically not included in this type of diagram. Since the process is about home care and the loop indicates that the home care assistant is visiting multiple patients during the day, one could make the guess that the assistant might need to drive a car or use some other kind of transportation to get around to the various clients, but this is not explicit in the model. However, this could be interesting both for understanding the process and for discussing potential improvements. For instance, when it comes to understanding:

- Is the activity “Get preparatory information about patient” performed while in office (i.e., before going to see the patient), during transportation, or at the patient’s home?
- Similarly, is “Log info about visit” performed at the patient’s, upon returning to the car, or when returning to the office?



**Fig. 1.** Example UML activity diagram for a home care process

And, when it comes to possible improvement:

- Assuming the assistant currently returns to the office after each patient, which increases the drive time and makes for a less efficient process –

how to distinguish this diagrammatically from the other alternative of only returning to the office after visiting all patients?

- Assuming that the assistant currently makes temporary logs on paper, which then have to be transcribed electronically after the visiting round – how to distinguish this from the practice of logging electronically while at the patient’s or in the car, using mobile equipment?
- Assuming that the shift leader wants more flexibility, e.g., dynamically re-allocating patients between different assistants, either based on assistant capacity (for instance, one assistant might end up using extra time with one patient due to some complications, thus not having time for all patients on her list, while another assistant might have available capacity) or based on patient availability (e.g., one patient is not available for home care for a certain period of the day because she needs to go to the dentist or whatever, and therefore wants to be rescheduled). This could be achieved by communicating interactively with the assistants while they are on their rounds, but this would require the use of mobile equipment and necessary documentation about patients being available through that equipment, rather than assistants having received the needed documentation on paper prior to their rounds.

For both these main purposes (process comprehension and process improvement) it could be worthwhile to look into notations which explicitly show WHERE a task is performed, in what context, and with what equipment. Here we will explore various ways to do this:

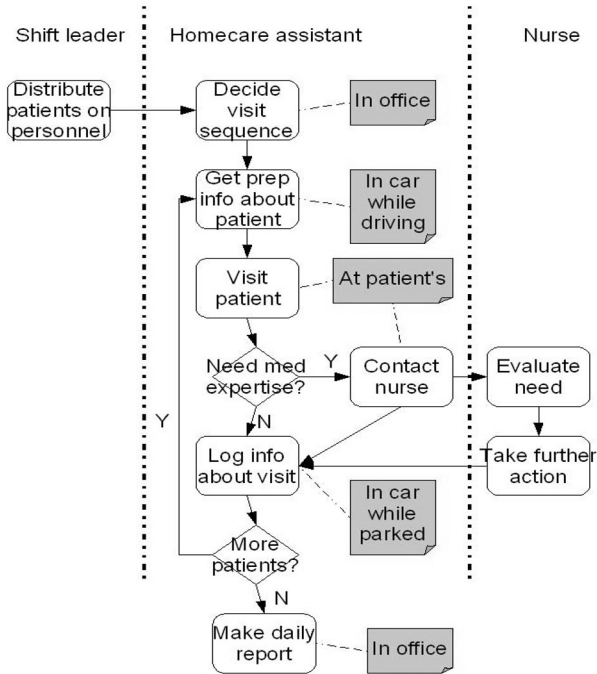
- attempt A: using existing notation as-is, just adding some explanatory annotation
- attempt B: redefine the usage of swimlanes
- attempt C: using color or other notation to indicate WHERE-aspects

In Fig. 2 the first approach is illustrated. The diagram is largely the same as we just showed, only that some annotational boxes have been added where appropriate. Also, it is clearly shown where the activities of the home care assistant are performed and under what conditions. This would be important input to further requirements work, for instance knowing that preparatory info about the patient should be possible to acquire while driving the car, the system must be able to provide this info to the home care assistant as audio, either from mobile equipment or equipment belonging to the car, since if the assistant has to use his hands or eyes a lot to get the info, this could interfere with safe driving.

A possible disadvantage of these annotations is that they might clutter up the diagram with a lot of extra nodes. In the next diagram another approach is shown, redefining the usage of swimlanes. Now, these are no longer used for indicating the organizational WHO but instead to show WHERE. For WHO, stick figures are used instead, since this is more consistent with some other diagram types in UML (e.g., use case diagrams). However, this diagram has another disadvantage, namely that a lot of edges are needed to indicate who performs which task, especially for the “Homecare assistant” who performs most of the tasks.

Hence, Fig. 3 looks a lot messy and worse than Fig. 2 at this point. An attempt to mend it is shown in Fig. 4, where the parenthesis “all other activities” is added

to the name of the Homecare assistant actor, so that the connecting lines can be dropped. In addition to the mentioned parenthesis, the stick figure for the HCA is also made bigger to indicate that this is the prime actor of the process. However, this would only work nicely if there is one particular actor who is responsible for most of the activities in a diagram. If there are several actors each responsible for a number of activities, it would be impossible to avoid the mess of a lot of edges.



**Fig. 2.** Home care example with annotations showing place and context

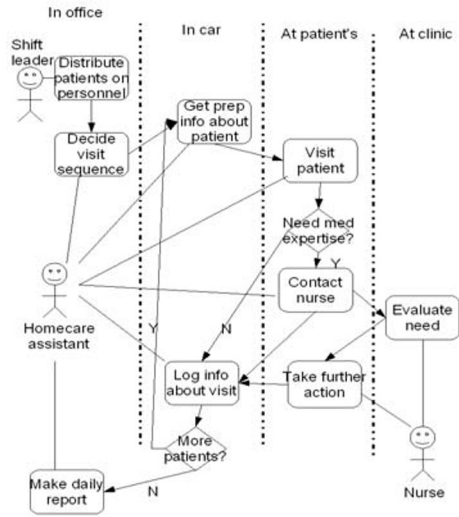


Fig 3. Home care example with redefined swimlanes

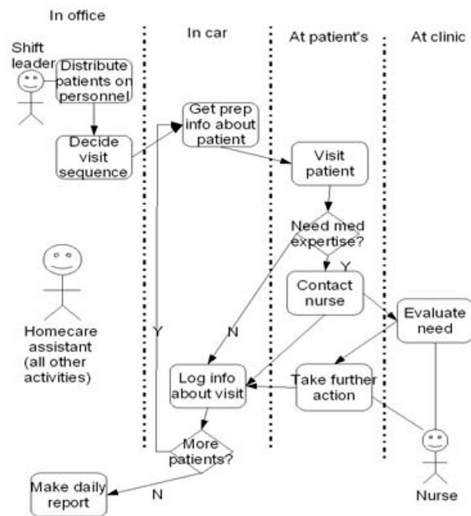


Fig. 4. Attempt to improve on Fig. 3

Another idea could be the use of colour, such as in Fig. 5 (a).

The disadvantage is that a colour legend has to be established, but if the same colours are then used consistently over a number of modelling projects, this will be a small investment, and gradually it might be less needed to have the legend visible in every diagram. Alternatively there might just be a link to the legend so that it could be accessed if needed. Another advantage of the color version, as illustrated in Fig 5 (b) is that if several process design alternatives are put side by side, it becomes very easy to quickly spot differences in planned locations of activities. The reader would see almost immediately that the only differences between the two diagrams is that the prep info and logging activities are performed in different places (car vs. office, car vs. patients' home). This notation might therefore be particularly useful for easily discussing alternative process designs by means of location. Also, since the use of colors means that one avoids to add extra nodes (in contrary to the annotation variant) or extra edges (with the stick figure actor variant), diagram complexity is not so much increased here, except the reader must of course understand the usage of the colors. Alternatively patterns can be used instead of colours. It is of course possible to illustrate differences between process design alternatives by the other approaches, too. But for the annotation version Fig. 2 in particular this would be a lot more subtle, the differences only being shown as different texts within annotation rectangles, therefore needing close inspection of the model to be discovered by the user. Another possible advantage of color is if there are different options for how to perform an activity, e.g., if the worker has a personal choice whether to do the prep info activity in office or while driving the car. With the color approach, this could easily be shown by having two different colors inside the node for that particular process step, again easy for the reader to spot quickly and not increasing diagram complexity that much as shown in Fig.6.

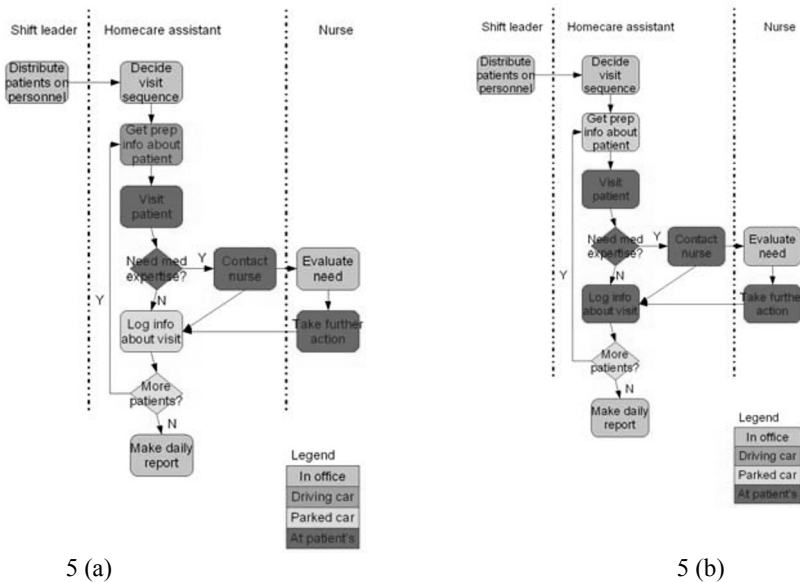


Fig 5. Example using color

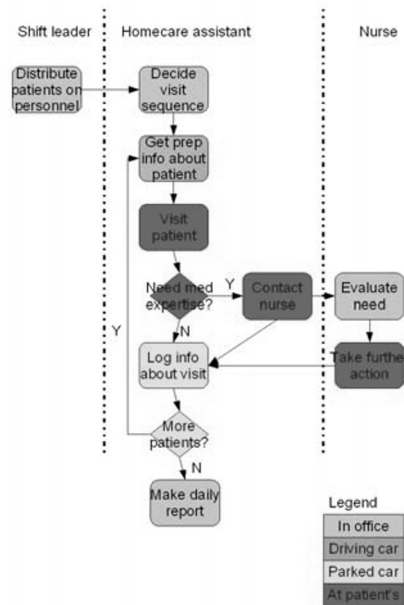


Fig. 6. Including an optional choice of location for a process step

## 4. Evaluation

In this paper we used the home care system [9] at Trondheim city in Norway as a case study. The UML diagram notations presented in section 1.3 is based on a simple task in the complete home care system. It is regarded more important to understand alternate notations in view with mobile information systems than presenting the whole scenario of mobile care system. Before evaluation of these notations it is necessary to understand the some information about mobile care system at Trondheim [9]. *The home care involves services being offered in the home of the customer, including practical help and home nursing care. In the 'Mobile Care'-project, it is planned to better support the mobile aspects of the home care service by providing the employees continuous access to Gerica and other relevant systems from wherever they are using a PC/PDA-solution. This is seen in connection to the 'Wireless Trondheim'-project, which is currently building a mobile broadband for Trondheim. In other parts of Trondheim, one so far has only UMTS or GPRS coverage (i.e. with lower bandwidth for data transfer).*

The 4 alternate process notations presented in section 1.3 just reflect the same task by home care assistant who visits patients according to the list given by shift leader. Using Gerica on PDA, the home care assistant logs the info about patients on the go intimating patient health status to the nurse at hospital receive further



info about the logs. By Fig. 1 notations, these tasks performed can be understood but it lags the information where it is done. Also it hard to make dynamic log change for example the shift leader wants to prioritise patients schedule could not reflect in this notation. Fig. 1 notation is not reflecting the state of art use of mobile technologies in home care system. In Fig. 2, the notations are better than Fig. 1 comparatively to have where the tasks are carried out. At the cost of extra nodes in Fig. 2, where the activities and under what conditions has notified. But these extra nodes will be disadvantage if the same notation is used to represent entire home care system. The swim lanes and stick diagrams are representing where and who respectively in Fig. 3. This notation has a disadvantage of lot of edges on who performs the tasks can be overcome by assigning HCA to all other activities as in Fig. 4. Keeping a colour legend and assigning consistently through modelling project is performed by notation in Fig. 5. This notation seems to be simple and easy to perform a large project for example home care system provided a colour legend established and used consistently throughout the project. The same notation is improved in Fig. 6 showing optional choice of performing tasks. On using patterns instead of colour, certainly patterns have an advantage with respect to colour-blindness, on the other hand patterns might be slightly more difficult to distinguish quickly, especially if there are many locations/contexts that must be differentiated between so that one has to use many different patterns, which would make them more subtle and therefore require closer inspection of the model.

With the annotation approach it could be described in text in the rectangle, e.g., “In office or while driving to patient’s home, according to worker’s preference” – easily understandable but needing closer inspection to spot. (and also causing annotation texts to be longer, which might mean that rectangles would have to be bigger, thereby cluttering up the diagram more, etc.). With the swimlane + stick figure approach, it gets very hard to illustrate such optional choices. Of course, an activity could be put on the boundary between two swimlanes, but this will only work if the alternative locations are actually on adjacent swimlanes. In other cases, one would simply have to put occurrences of the same activity step in several swimlanes and perhaps indicating the choice with a decision diamond, which would increase the diagram complexity quite a lot. Also, it might overload the decision diamond if this is used both for decisions concerning what to do, and decisions concerning where to do it.

**Table 1.** Evaluation of proposed notations with simple and large models

Notation	Min. deviation from standard		Expressiveness		Intuitive / Easy to read		Less Complexity	
	Simple	Large	Simple	Large	Simple	Large	Simple	Large
Trad. UML	++	++	--	--	++	++	++	++
Annotated	+	+	+	+	-	--	+	--
Loc.Swimlanes	-	-	+	+	-	--	+	--
Loc.Swiml. with big actor	-	-	+	+	-	--	+	-
colours	-	-	++	++	+	+	++	++
Colours with optional choice	-	-	++	++	+	+	++	++

**Table 2.** Evaluation of proposed notations with SEQUAL framework

Notation	SEQUAL Framework on Language Quality		
	Organizational Appropriateness	Domain Appropriateness	Comprehensibility Appropriateness
Traditional UML Act. Diag.	+	+	++
Annotated	+	+	++
Location Swimlanes	+	+	-
Loc. Swim. with big actor	+	+	+
colours	++	++	++
Colours with opt. choice	++	++	++

In Table 1, the proposed notations for small and large models are evaluated against four key features viz, minimal deviation from standard, expressiveness, intuitive/easy to read and less complexity of models. In Table 2, by using SEQUAL framework, the notations are evaluated against its language quality viz, organizational, domain and comprehensibility appropriateness.

## 5. Conclusion and Future Work

This paper analyse all the stated notations including the standard UML activity diagram and proposes alternate possible notations to specify mobile information systems. This specification analysis is performed with simple model in home care system starting with with UML activity diagram notation. The same is carried out with different alternate possible notations so that it can completely provide informations on what, who, how, why and where aspects and evaluated in the above section. Although to some extent it can be realised that some diagrams are better or worse than others, e.g., that Fig. 3 is a way too messy, empirical investigations are needed to make strong conclusions about what ideas are worth pursuing. Evaluation results are tabulated in Table 1 and 2 concluding colours and colours with optional choice have more positive features than other proposed notations. A wide range of different experiments can be envisioned where competing notations are compared to each other and the different notations would not have to be UML either, they could also be based on other modelling languages.

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