Towards a new generation of widgets for supporting software plasticity: the "comet"

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Abstract. This paper addresses software adaptation to context of use. It goes one step further than our early work on plasticity [5]. Here, we propose a revision of the notion of software plasticity that we apply at the widget level in terms of comets. Plasticity is defined as the ability of an interactive system to withstand variations of context of use while preserving quality in use where quality in use refers to the ISO definition. Plasticity is not limited to the UI components of an interactive system, nor to a single platform: adaptation to context of use may also impact the functional core, it may have an effect on the nature of the connectors, and it may draw upon the existence of multiple platforms in the vicinity to migrate all or portions of the interactive system. A new reference framework that structures the development process of plastic interactive systems is presented to cover these issues. The framework is then applied at the granularity of widgets to provide the notion of a comet. A comet is an introspective widget that is able to self-adapt to some context of use, or that can be adapted by a tier-component to the context of use, or that can be dynamically discarded (versus recruited) when it is unable (versus able) to cover the current context of use. To do so, a comet publishes the quality in use it guarantees, the user tasks and the domain concepts that it is able to support, as well as the extent to which it supports adaptation.

1 Introduction

Mobility coupled with the development of a wide variety of access devices has engendered new requirements for HCI such as the ability of interactive systems to run in different contexts of use. By context of use we mean a triple <user, platform, environment> where the user denotes the archetypal person who is intended to use the interactive system; the platform refers to the hardware and software devices available for sustaining the user interaction; the environment describes the physical and social conditions where the interaction takes place. To master the diversity of contexts of use in an economical and ergonomic way, the *plasticity* property has been introduced [31]. Basically, plasticity refers to the adaptation to context of use that preserves the user's needs and abilities. For example, FlexClock [15] is a clock that expands or shrinks its user interface (UI) when the user resizes the window (Fig. 1). The time remains readable during and after the adaptation.

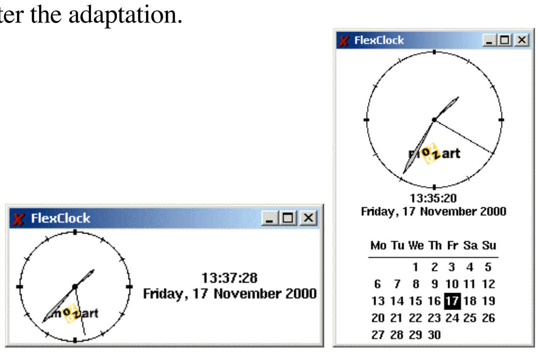

Fig. 1. FlexClock, an example of adaptation to the platform.

When applied at the widget level, the plasticity property gives rise to a new generation of widgets: the *comets* (COntext of use Mouldable widgETs). As a simple example, a set of radio buttons that shrinks into a combo box is a comet (Fig. 2).

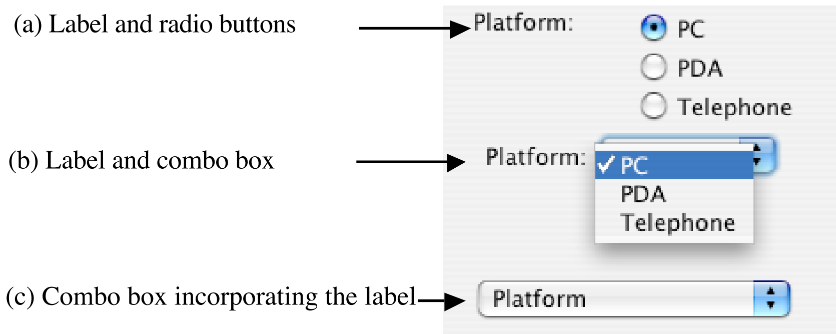

Fig. 2. Three graphical mockups supporting the same task "selecting one option among a set of options" through a) a label and radio buttons; b) a label and a combo box; c) a combo box incorporating the label. The example concerns the specification of the target platform (PC, PDA, telephone) for a centralized UI.

This paper presents our notion of comets. First we present new advances in plasticity to provide sound foundations for their elaboration. Then we focus on the comets per se considering both the design and run time perspective.

2 Foundations for comets: advances in plasticity

This section focuses on the lessons learned from experience that directly underpin the notion of comets. First, we propose a new definition for plasticity, then we examines the property from both a user and a system centered perspective.

2.1 A new definition of plasticity

Plasticity was previously defined as "the capacity of a user interface to withstand variations of context of use while preserving usability" [31]. Based on our experience, we have identified three reasons for revising the definition:

- in reality, plasticity is not limited to the UI components but may also impact the functional core. This occurs typically with services discovery. For example, because Bob has moved and is now in a place that makes a new service available, this service now appears on his PDA. The desktop is reshuffled (or tuned) to incorporate this new service and support an opportunistic interaction. Thus, the scope of the definition must be enlarged: plasticity must refer to the capacity of an *interactive system*, and not only to its UI, to adapt to the context of use;
- the current definition focuses on the preservation of usability only. As a result, utility is implicit. To make explicit the possibility to specify requirements concerning the preservation of functional (and not only non functional) properties (e.g., task accomplishment), the scope of the definition must be enlarged. To do so, we refer to *quality in use* instead of just usability. As defined by ISO [18], quality in use is based on internal and external properties (Fig. 3) including usability (Fig. 4);
- in 2003, reviewers of the European CAMELEON project argued that the current definition was not operational enough. Due to ISO, the definition is now reinforced by a set of reference *characteristics* (factors), *sub-characteristics* (criteria) (Fig. 4) and metrics [19]. The framework QUIM (Quality in Use Integrated Map) [29] also contributes in this area by relating data, metrics, criteria and factors. A sound basis exists in HCI for usability ([1] [17] or more specifically [32] for dialog models).

Based on this new definition, an interactive system is said to be "plastic for a set of properties and a set of contexts of use" if it is able to guarantee these properties whilst adapting to cover another context of use. The properties are selected during the specification phase among the set of characteristics and sub-characteristics elicited by ISO (Fig. 4). Thus, plasticity is not an absolute property: it is specified and evaluated against a set of relevant properties (e.g., the latency and stability of the interactive system with regard to the "efficiency" characteristic, "time behavior" sub-characteristic).

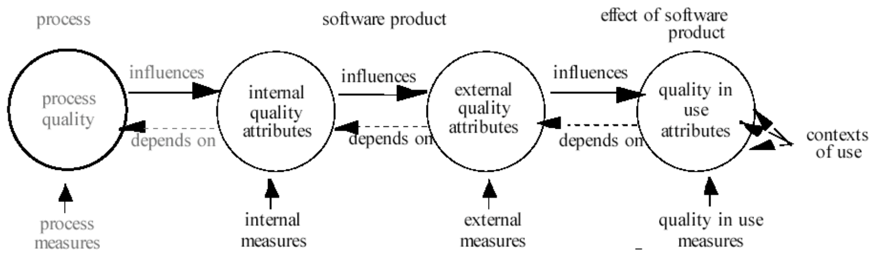

Fig. 3. Relationships between quality in use and internal and external qualities. Extracted from [18].

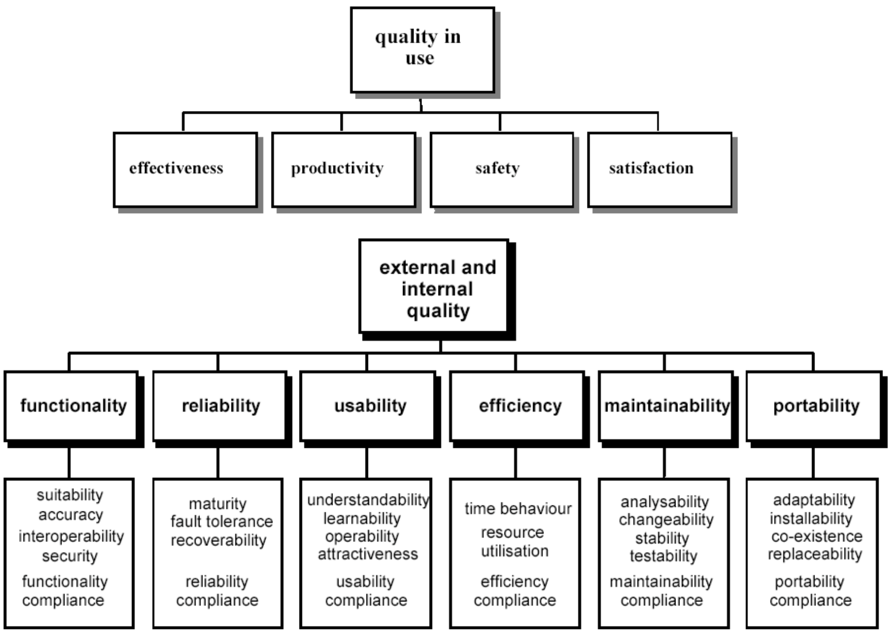

Fig. 4. Quality models for quality in use and internal and external qualities. These ISO models provide a sound basis for specifying and evaluating the extent to which an interactive system is supposed to be plastic. Extracted from [18].

The next section presents how to *plastify* an interactive system from a user centered perspective.

2.2 Plasticity from a user centered perspective

Whilst plasticity has always been addressed from a centralized perspective [5] (the UI was locally tuned as in FlexClock [15]), it is now obvious that ubiquitous computing favors the distribution of the interactive system among a set of platforms. As a result, two means are now available for adaptating:

- recasting the interactive system: this consists in reshuffling the UI, the functional core or the connector between both of these parts locally without modifying its distribution across the different platforms. Figure 1 provides an example of recasting;
- redistributing the interactive system: it consists in migrating all (total migration) or part of (partial migration) the interactive system across the different platforms. Partial migration has been introduced by Rekimoto's painter metaphor [27] [4] and is now a major issue in HCI.

In ubiquitous computing, the notion of platform is no longer limited to an *elementary platform*, i.e., a set of physical and software resources that function together to form a working computational unit [7]. The notion of platform must definitely be seen as a *cluster*, i.e., a composition of elementary platforms that appear and disappear dynamically. For example, when Alice arrives in Bob's vicinity, her laptop extends the existing cluster composed of Bob's laptop, the PDA and the mobile phone. Bob's current interactive system can partially or fully migrate to Alice's laptop. Typically, to obtain a larger screen, it could be a good option to "bump" [16] the two laptops and split the interactive system between both of them (partial migration) (the *bumping* is illustrated in Figure 5 with two desktops). But when Bob's laptop battery is getting low, a full migration to Alice's laptop seems to be the best option as the screens of the PDA and mobile phone are too small to support a comfortable interaction.

Fig. 5. A partial migration enabled by a top-to-top composition of the screens. Extracted from [9].

The granularity for distribution may vary from the application level to the pixel level [7]:

– at the *application level*, the user interface is fully replicated on the platforms of the target cluster. If the cluster is heterogeneous (e.g., is comprised of a mixture of PC's and PDA's), then each platform runs a specific targeted user interface. All of these user interfaces, however, simultaneously share the same functional core;
– at the *workspace level*, the user interface components that can migrate between platforms are workspaces. A workspace is an interaction space. It groups together a collection of interactors that support the execution of a set of logically connected tasks. In graphical user interfaces, a workspace is mapped onto the notion of windows. The painter metaphor presented in Rekimoto's pick and drop [27] [4] is an example of a distribution at the workspace level: the palettes of tools are presented on a PDA whereas the drawing area is mapped onto an electronic white board. Going one-step further, the tools palette (possibly the drawing area) can migrate at run time between the PDA and the electronic board;
– at the *domain concept level*, the user interface components that can be distributed between platforms are physical interactors. Here, physical interactors allow users to manipulate domain concepts. In Rekimoto's augmented surfaces, domain concepts, such as tables and chairs, can be distributed between laptops and horizontal and vertical surfaces. As for Built-IT [26], the topology of the rendering surfaces matters: objects are represented as 3D graphics interactors on laptops, whereas 2D rendering is used for objects placed on a horizontal surface;
– at the *pixel level*, any user interface component can be partitioned across multiple platforms. For example, in I-LAND [30], a window may simultaneously lie over two contiguous white boards (it is the same case in Figure 5 with two desktops). When the cluster is heterogeneous, designers need to consider multiple sources of disruption. For example, how to represent a window whose content lies across a white board and a PDA? From a user's perspective, is this desirable?

Migration may happen on the fly at run time or between sessions:

– *on the fly migration* requires that the state of the functional core is saved as well as that of the user interface. The state of the user interface may be saved at multiple levels of granularity: with regard to the functional decomposition promoted by Arch [3], when saved at the Dialogue Component level, the user can pursue the job from the beginning of the current task; when saved at the Logical Presentation or at the Physical Presentation levels, the user is able to carry on the current task at the physical action level, that is, at the exact point within the current task. There is no discontinuity;
– *migration between sessions* implies that the user has to quit, then restart the application from the saved state of the functional core. In this case, the interaction process is heavily interrupted.

Recasting and redistribution are two means for adaptation. They may be processed in a complementary way. A full migration between heterogeneous platforms will typically require a recasting for fitting to a smaller screen. Conversely, when the user enlarges a window, a partial migration may be a good option to get a larger interaction surface by using a nearby platform.The next section addresses plasticity from a system's perspective.

2.3 Plasticity from a system centered perspective

The CAMELEON reference framework for plasticity [7] provides a general tool for reasoning about adaptation. It covers both recasting and redistribution. It is intended to serve as a reference instrument to help designers and developers to structure the development process of plastic interactive systems covering both the design time and run time.

The design phase follows a model-based approach [25] (Fig. 6). A UI is produced for a set of *initial models* according to a *reification process*:

- the initial models are specified manually by the developer. They set the applicative domain of the interactive system (concepts, tasks), the predicted contexts of use (user, platform, environment), the expected quality (a set of requirements related to quality in use and external/internal quality) and the adaptation to be applied within as well as outside the current context of use (evolution, transition). The domain models are taken from the literature. Emerging works initiated by [12] [28] deal with the definition and modeling of context of use. The *Quality Models* can be expressed with regard to the ISO models presented in section 2.1. The *Evolution Model* specifies the reaction to be performed when the context of use changes. The *Transition Model* denotes the particular *Transition User Interface* to be used during the adaptation process. A transition UI allows the user to evaluate the evolution of the adaptation process. In Pick and Drop [27], the virtual yellow lines projected on the tables are examples of transition UIs. All of these initial models may be referenced along the development process from the domain specification level to the running interactive system;
- the design process is a three-step process that successively reifies the initial models into the final running UI. It starts at the concepts and tasks level to produce the *Abstract User Interface* (Abstract UI). An abstract UI is a collection of related workspaces called *interaction spaces*. The relations between the interaction spaces are inferred from the task relations expressed in the task model. Similarly, connectedness between concepts and tasks is inferred from the concepts and tasks model. An abstract UI is reified into a *Concrete User Interface* (Concrete UI). A concrete UI turns an abstract UI into an interactor-dependent expression. Although a concrete UI makes explicit the final look and feel of the *Final User Interface* (Final UI), it is still a mockup that runs only within the development environment. The Final UI generated from a concrete UI is expressed in source code, such as Java and HTML. It can then be interpreted or compiled as a pre-computed user interface and plugged into a run-time infrastructure that supports dynamic adaptation to multiple targets.

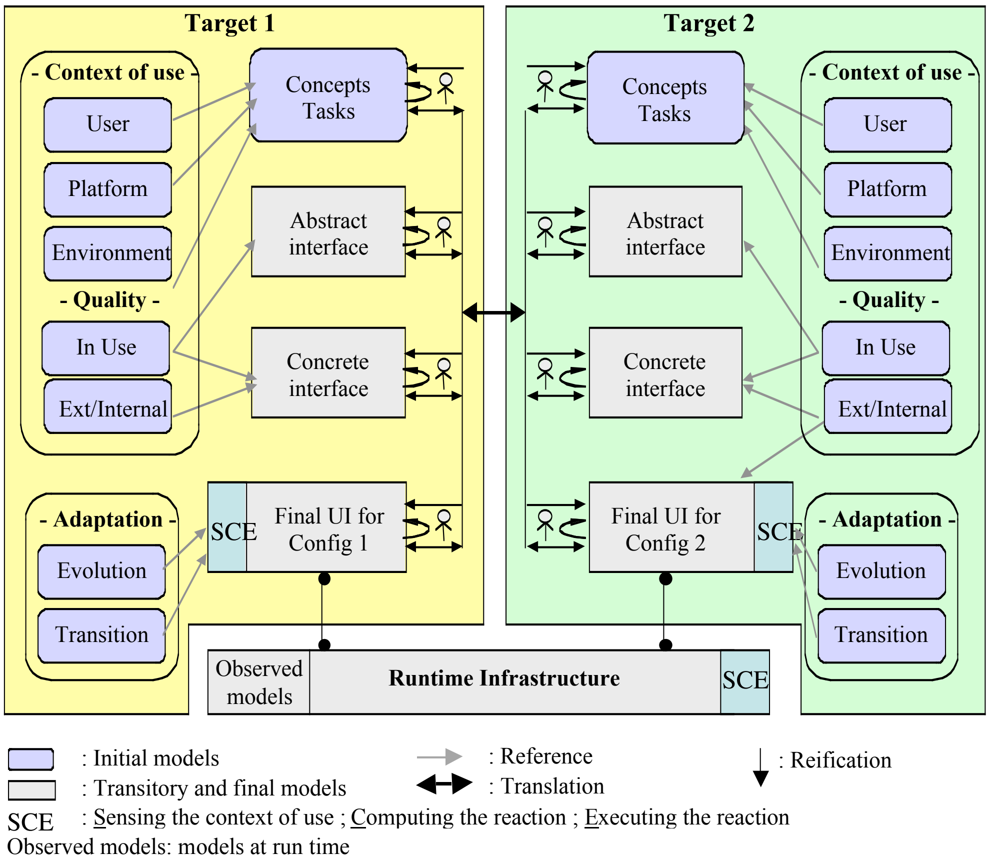

Fig. 6. The Reference Framework for supporting plastic user interfaces. The picture shows the process when applied to two distinct targets. This version is adapted from [7] where the quality models defined in 2.1 are now made explicit. Whilst reifications and translations are exhaustively made explicit, only examples of references are provided. In the example, the reference to the evolution and transition models is made at the latest stage (the final UIs).

At any level of reification:

– references can be made to the context of use. We identify four degrees of dependencies: whether a model makes hypothesis about the context of use; a modality; the availability of interactors; or the renderer used for the final UI. From a software engineering perspective, delaying the dependencies until the later stages of the reification process, results in a wider domain for multi-targeting. Ideally, dependencies to the context of use, to modalities and to interactors are associated with the concrete UI level (Fig. 7 a). In practice, the task model is very often context of use and modality dependent (Fig. 7b). As figure 7 shows, a set of four sliders (or stickers) can be used to locate the dependencies in the reification process. The movement of the stickers is limited by the closeness of their neighbour (e.g., in Figure 7b, the interactor sticker has a wide scope for movement between the concepts and tasks level and the final UI level, respectively corresponding to the position of the modality and renderer stickers;

– the quality properties that must be preserved are elicited (cf. arrows denoted as “reference” in Figure 6);
– translations can be performed to target another context of use.

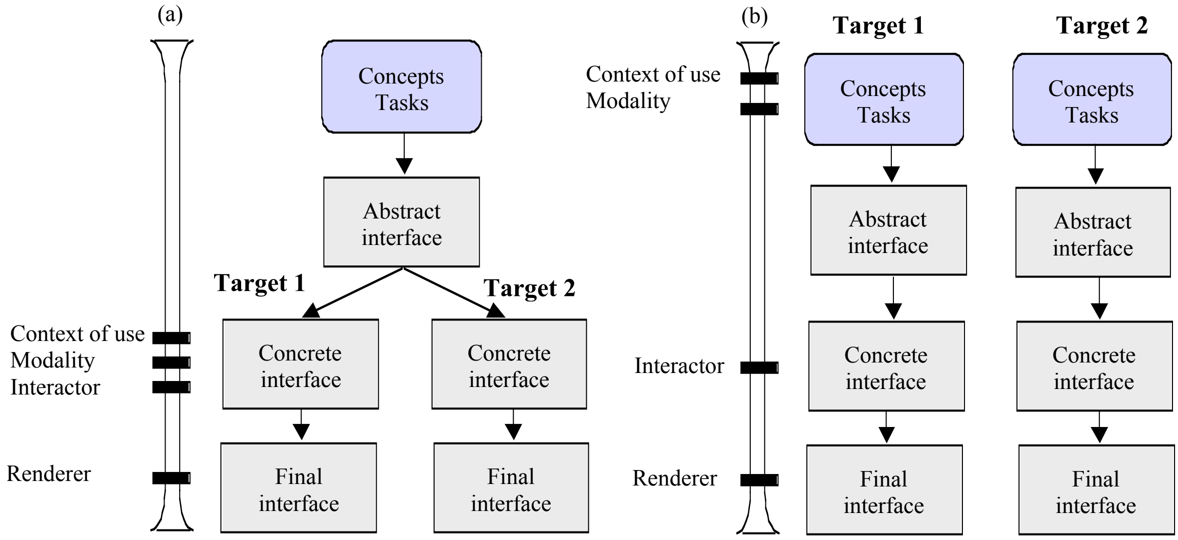

Fig. 7. Two instanciations of the design reference framework. The dependencies to the context of use, modalities, interactors and renderer are localized through stickers.

Reifications and translations may be performed automatically from specifications, or manually by human experts. Because the automatic generation of user interfaces has not found wide acceptance in the past [23], the Reference Framework makes possible manual reifications and translations (Fig. 6).

As for any evolutive phenomenon, the adaptation at run time is structured as a three-step process: sensing the context of use (S), computing a reaction (C), and executing the reaction (E) [6]. Any of these steps may be undertaken by the Final UIs and/or an underlying run time infrastructure (Fig. 6). In the case of distributed UIs, communication between components may be embedded in the components themselves and/or supplied by the runtime infrastructure. As discussed in [24], when the system includes all of the mechanisms and data to perform adaptation on its own (sensing the context of use, computing and executing the reaction), it is said to be *close-adaptive*, i.e., self-contained (autonomous). FlexClock is an example of close-adaptive UI. *Open-adaptiveness* implies that adaptation is performed by mechanisms and data that are totally or partially external to the system. FlexClock would have been open-adaptive if the mechanisms for sensing the context of use, computing the reaction and executing the reaction had been gathered in an external component providing general adaptation services not devoted to FlexClock.

Whether it is close-adaptive or open-adaptive, dynamic reconfiguration is best supported by a component-connector approach [24] [11] [14]. Components that are capable of reflection (i.e., components that can analyze their own behavior and adapt) support close-adaptiveness [21]. Components that are capable of introspection (i.e., components that can describe their behavior to other components) support open-adaptiveness.

The next section applies these advances to the design and run time of comets.

3 The notion of comet

This section relies on the hypothesis that adaptation makes sense at the granularity of a widget. The validity of this hypothesis has not been proven yet, but is grounded in practice: refining an abstract UI into a concrete UI is an experimental composition of widgets with regard to their implicit functional (versus non functional) equivalence or complementarity. For instance, no toolkit makes explicit the fact that the three versions of Figure 2 are functionally but not non functionally equivalent: they support the same task of selecting one option among a set of options, but differ in many ways, in particular, in their pixels cost. Based on this hypothesis, this paper proposes a definition for the notion of comet. A comet is then examined from both the design and run time perspective. It is finally compared to the state of the art.

3.1 Definition

A comet is an introspective interactor that publishes the quality in use it guarantees for a set of contexts of use. It is able to either self-adapt to the current context of use, or be adapted by a tier-component. It can be dynamically discarded (versus recruited) when it is unable (versus able) to cover the current context of use.

The next section presents a taxonomy and a model of comets from a design perspective.

3.2 The comet from the design perspective

Based on the definition of comets and the advances in plasticity (section 2.3), we identify three types of comets (Fig. 8):

– *introspective comets* are comets that are able to publish their functional and non functional properties (Fig. 9). The functional properties do not include adaptation abilities (e.g., sensing the context of use, computing and executing the reaction). They are limited to the applicative domain (e.g., selecting one option among a set of options). To be an introspective comet, the "combo box" has to export the task it supports (i.e., single selection) and its cost (e.g., footprint, interaction trajectory);

- *polymorphic comets* are introspective comets that embed and publish multiple versions of at least one of its components. The polymorphism may rise at the functional core level (i.e., it embeds a set of algorithms for performing the user task; the algorithms may vary in terms of precision, CPU cost, etc.), at the connector level between the functional core and the UI components (e.g., file sharing versus sockets), or at the UI level (e.g., functional core adaptor, dialog controller, logical or physical presentations with regard to Arch). An introspective comet incorporating the three versions of Figure 2 for selecting one option among a set of options would illustrate the polymorphism at the physical level. Polymorphism provides potential alternatives in case of a change in the context of use. For instance, Figure 2c (versus Figure 2a) is appropriate for small (versus large) screens. A polymorphic comet does not embed the mechanisms for taking benefit from its polymorphism. It relies on a tier-component for the deployment of adaptation. It is said to be *open-adaptive* (see section 2.2);
- *self-adaptive comets* are polymorphic comets that are able to self-adapt to the context of use by switching from one "form" to another one. They are close-adaptive (see section 2.2).

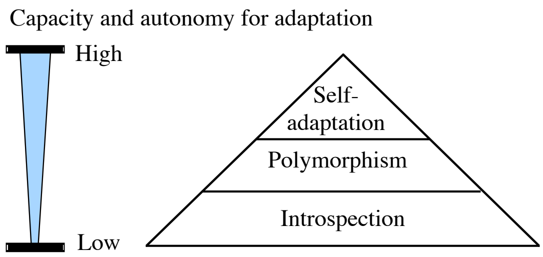

Fig. 8. A taxonomy of comets.

Introspection is the keystone capability of the comet. Properties can be ranked against two criteria (Fig. 9): the type of the property (functional versus non functional) and the type of the service (domain versus adaptation). Examples of properties are provided in Figure 9. Recent research focuses on the notion of *continuity of interaction* [13]. The granularity of distribution and state recovery presented in section 2.2 belong to this area.

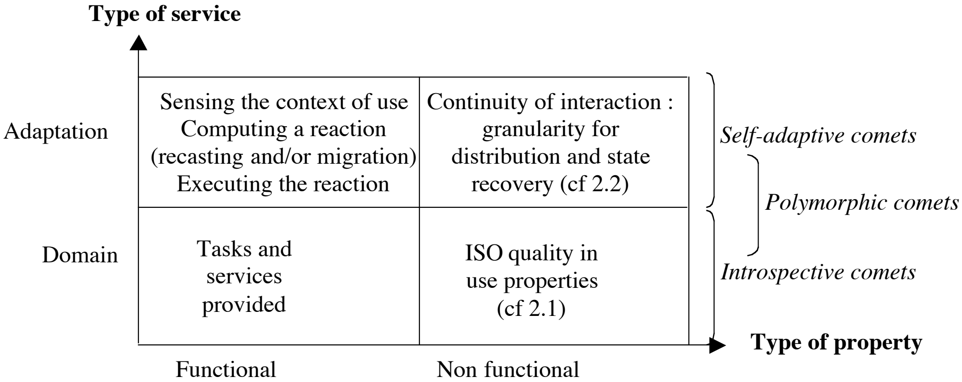

Fig. 9. A taxonomy of properties for structuring introspection.

The generality of the functional domain services differentiates comets supporting basic tasks (i.e., those that are supported by classical widgets such as radio buttons, labels, input fields or sliders) and comets that support specific tasks. Our *PlasticClock* comet is a kind of specific comet: it simultaneously makes observable the time at two locations (for instance, Paris and New York in Figure 10). PlasticClock is self-adaptive. It relies on two kinds of polymorphism, thus extending FlexClock:

- polymorphism of abstraction: PlasticClock is able to compute the times in both an absolute and a relative way. The absolute version consists in getting the two times on web sites. Conversely, the relative way requests one time only and computes the second one according to the delay;
- polymorphism of presentation: as shown in Figure 10, PlasticClock is able to switch from a large presentation format putting the two times side by side, to a more compact one gathering the two times on a same clock. Two hands (hours and minutes) are devoted to Paris. The third one points out the hours in New York (the minutes are the same). Allen's relations [2] provide an interesting framework for comparing these two presentations according to spatio-temporal criteria.

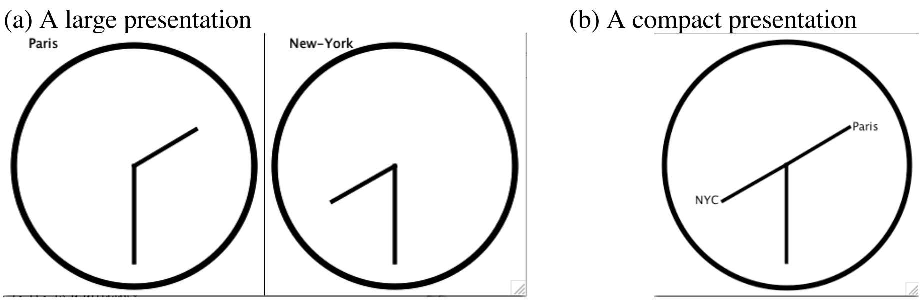

Fig. 10. PlasticClock.

The specific comets raise the question of the threshold between an interactive system and a comet. Under which criteria is PlasticClock considered to be a comet or a specific interactive system? Our response is grounded in software engineering: it depends on the expected reusability. Reusability will vary from one company to another one. As a result, the same reference framework can be applied for modeling interactive systems and comets. Figure 11 provides an UML class diagram for the notion of comet. It is obtained by applying the reference framework presented in section 2.3 at the granularity of comets and is enriched to cover the taxonomy of comets.

Thus, a comet is a final interaction object that is produced through a series of reifications and/or abstractions and/or translations. It can successively be abstracted into a set of concrete interaction objects (CIOs), abstract interaction objects (AIOs) and abstractions. Conversely, when reified, each of these objects finally produces the comet. At any level of reification, the resulting components are introspective, i.e., aware of their dependencies (in terms of context of use, modality, interactor and renderer) and quality of service (QoS) (the quality in use they guarantee for a set of contexts of use). Specifically, each component publishes additional information:

- The domain for the abstraction (the supported concepts and user task);
- The structure of the AIO in terms of interaction spaces;
- The style of the CIO (for instance, the style "button") and an assessment of whether it is typical or not to use this CIO for the given domain and context of use.

The comet may embed an evolution and a transition model for controlling adaptation. The comet publishes its polymorphism and self-adaptiveness capabilities for a set of contexts of use. Going one step further, it directly publishes its plasticity property for a set of properties $\mathbf{P}$ and a set of contexts of use $\mathbf{C}$. It is plastic if any property of $\mathbf{P}$ is preserved for any context of $\mathbf{C}$.

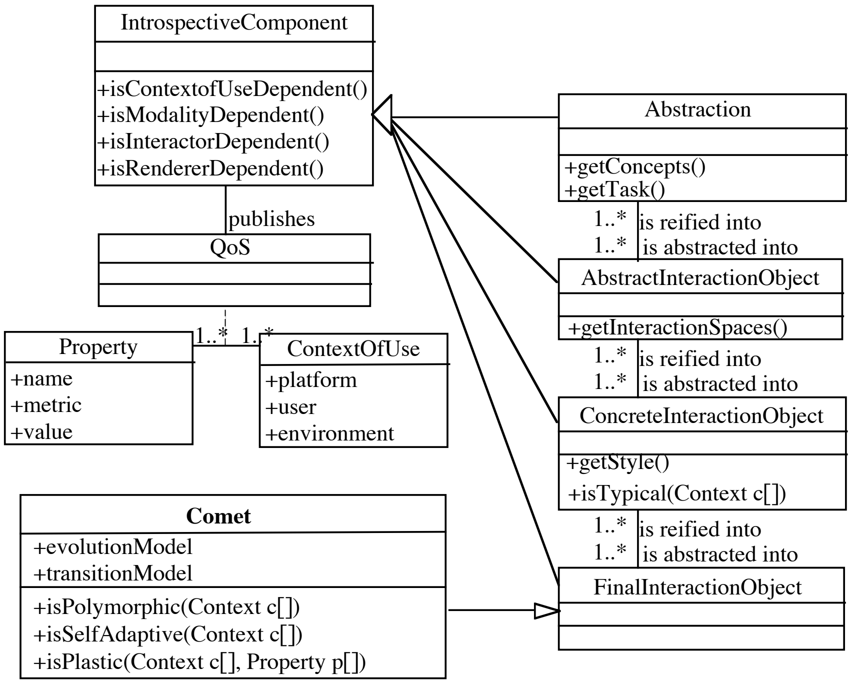

Fig. 11. A comet modeling taking benefit from both the reference framework and the taxonomy of comets.

The next section deals with the comets at run time.

3.3 The comet from the run time perspective

This section addresses the execution of comets. It elicits a set of strategies and policies for deploying plasticity. It proposes a software architecture model for supporting adaptation.

We identify four classes of strategies:

- adaptation by *polymorphism*. This strategy preserves the comet but changes its *form*. The change may be performed at any level of reification according to the three following cardinalities, 1-1, 1-N, N-1 depending on the fact that the original form is replaced by another one (cardinality 1-1), by N forms (cardinality 1-N) or that N forms, including the original form, are aggregated into an unique one (cardinality N-1). For instance, in Figure 2, when the comet switches from a to b, it performs a 1-1 polymorphism: the radio buttons are replaced with a combo box. When it switches from b to c, it performs a 2-1 polymorphism (respectively switching from c to b is a 1-2 polymorphism);
- adaptation by *substitution*. In opposition to the adaptation by polymorphism, this strategy does not preserve the comet. Rather, it is replaced by another one (cardinal-

ity 1-1) or N comets (cardinality 1-N) or is aggregated with neighbor comets (cardinality N-1);
- adaptation by *recruiting* consists in adding comets to the interactive system. This strategy supports, for instance, a temporary need for redundancy [1];
- adaptation by *discarding* is the opposite strategy to the recruiting strategy. Comets may be suppressed because the tasks they support no longer make sense.

At run time, the strategies may be chosen according to the evolution model of the comet. The selected strategy is performed according to a policy.

The policies depend on the autonomy of the comets for processing adaptation. We identify three types of policies:
- an *external non-concerted policy* consists in fully subcontracting the adaptation. Everything is performed externally by a tier-component (e.g. another comet or the runtime infrastructure) without any contribution of the comet. This policy is suitable for comets which are unable to deal with adaptation. In practice, this is an easy way for guarantying the global ergonomic consistency of the interactive system. In this case, adaptation may be centralized in a dedicated agent (the tier-component);
- conversely, the *internal non-concerted policy* consists in achieving adaptation in a fully autonomous way. Everything is performed inside the comet, without cooperating with the rest of the interactive system. The open issue is how to maintain the global ergonomic consistency of the interactive system;
- intermediary policies, said *concerted policies*, depend on an agreement between the comet and tier-components. An *optimistic* version consists in applying the decision before it is validated by peers, whilst in a *pessimistic* version the comet waits for an authorization before applying its decision. The optimistic version is less time consuming but requires an undo procedure to cancel a finally rejected decision.

In practice, the policy decision will be chosen against criteria such as performance (c.f. the efficiency characteristic, time behavior sub-characteristic in section 2.1). The following software architecture model has been designed to take into account such an issue.

PlasticPAC is an instanciation of the PAC (Presentation Abstraction Control) [8] model specifically devoted to plasticity. PAC is an agent-based software architecture model that identifies three recurrent facets in any component of an interactive system: an abstraction, a presentation and a control that assures the coherence and communication between the abstraction and the presentation facets. According to the "separation of concerns" principle promoted by software engineering, PlasticPAC splits up each facet of the PAC model in two slices, thus isolating a logical part from physical implementations in each facet (Fig. 12):
- Abstraction: as with the functional core adaptor in Arch, the logical abstraction acts as an API for the physical abstraction. It contains the mechanisms to switch between physical abstractions (i.e., the functional core(s) of the comet; they may be multiple in case of polymorphism at this level). It may maintain the current state of the comet;

_ Presentation: in a symmetric way, as with the presentation component in Arch, the logical presentation acts as an API for the physical presentation part. The physical part gathers the available presentation(s) for the comet (they are multiple in case of polymorphism at this level). The mechanisms for switching between presentations are implemented in the logical part;
_ Control: the logical part of the control assumes its typical role of coherence and communication between the logical abstraction and the logical presentation. The physical part, called "Plastic" (Fig. 12), is responsible for (a) receiving and/or sensing and/or transmitting the context of use whether the comet embeds or not any sensors (i.e., the Sensing step of the Reference Framework), (b) receiving and/or computing and/or transmitting the reaction to apply in case of changes of context of use (i.e., the Computation step of the Reference Framework), and (c) eventually performing the reaction (i.e., the Execution step of the Reference Framework). The reaction may consist of switching between physical abstractions and/or presentations. The computation is based on a set of pairs composed of compatible physical abstractions and presentations. At any point in time, one or many physical abstractions and or presentations may be executed. Conversely, logical parts are only instanciated once per comet.

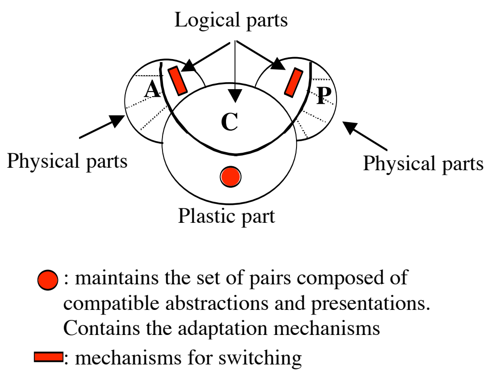

Fig. 12. The PlasticPAC software architecture model, a version of the PAC model (Presentation, Abstraction, Control) specifically mold for plasticity.

As in PAC, an interactive system is a collection of PlasticPAC agents. Specific canals of communication can be established between the plastic parts of the controls to propagate information in a more efficient way and/or to control ergonomic consistency in a more centralized way. PlasticPAC is currently under implementation as discussed in the conclusion. The next section analyses the notion of comet with regard to the state of the art.

3.4 Comets and the state of the art

Plasticity is a new property that has mostly been addressed at the granularity of interactive systems. The widget level has rarely been considered. For these works, we note that:

- most of the works focus on the software architecture models. Based on the identification of two levels of abstraction (AIOs and CIOs) [33], recent works propose conceptual and implementational frameworks for supporting adaptation [22] [20] [10]. However, in the models, adaptation is limited to the presentation level [20] [10];
- adaptations going from the dialog controller for a tasks modification, to the functional core for a modification of the domain concepts are not addressed in the literature. In that sense, our model subsumes the state of the art. But of course, working solutions, in particular based on multimodality [10], need now to be implemented according to our model. Integrating multimodality as a means for adaptation belongs to our perspectives.

4 Conclusion and perspectives

Based on a set of recent advances in plasticity, this paper introduces a new generation of widgets: the notion of comets. A comet is an interactor mold for adaptation: it can self-adapt to some context of use, or be adapted by a tier-component, or be dynamically discarded (versus recruited) when it is unable (versus able) to cover the current context of use. To do so, a comet publishes the quality in use it guarantees, the user tasks and domain concepts it is able to support, as well as the extent to which it supports adaptation. The reasoning relies on a scientific hypothesis which is as yet unvalidated: the fact that adaptation makes sense at the widget level. The idea is to promote task-driven toolkits where widgets that support the same tasks and concepts are aggregated into a unique polymorphic comet. Such a toolkit, called "Plasturgy studio" is currently under implementation. For the moment, it focuses on the basic graphical tasks: specification (free specification through text fields, specification by selection of one or many elements such as radio buttons, lists, spinners, sliders, check boxes, menus, combo boxes), activation (button, menu, list) and navigation (button, link, scroll). This first toolkit will provide feedback about both the hypothesis and the appropriate granularity for widgets. If successful, the toolkit will be extended to take into account multimodality as a means for adaptation.

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