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Use Case 2.0: The Hub of Software Development

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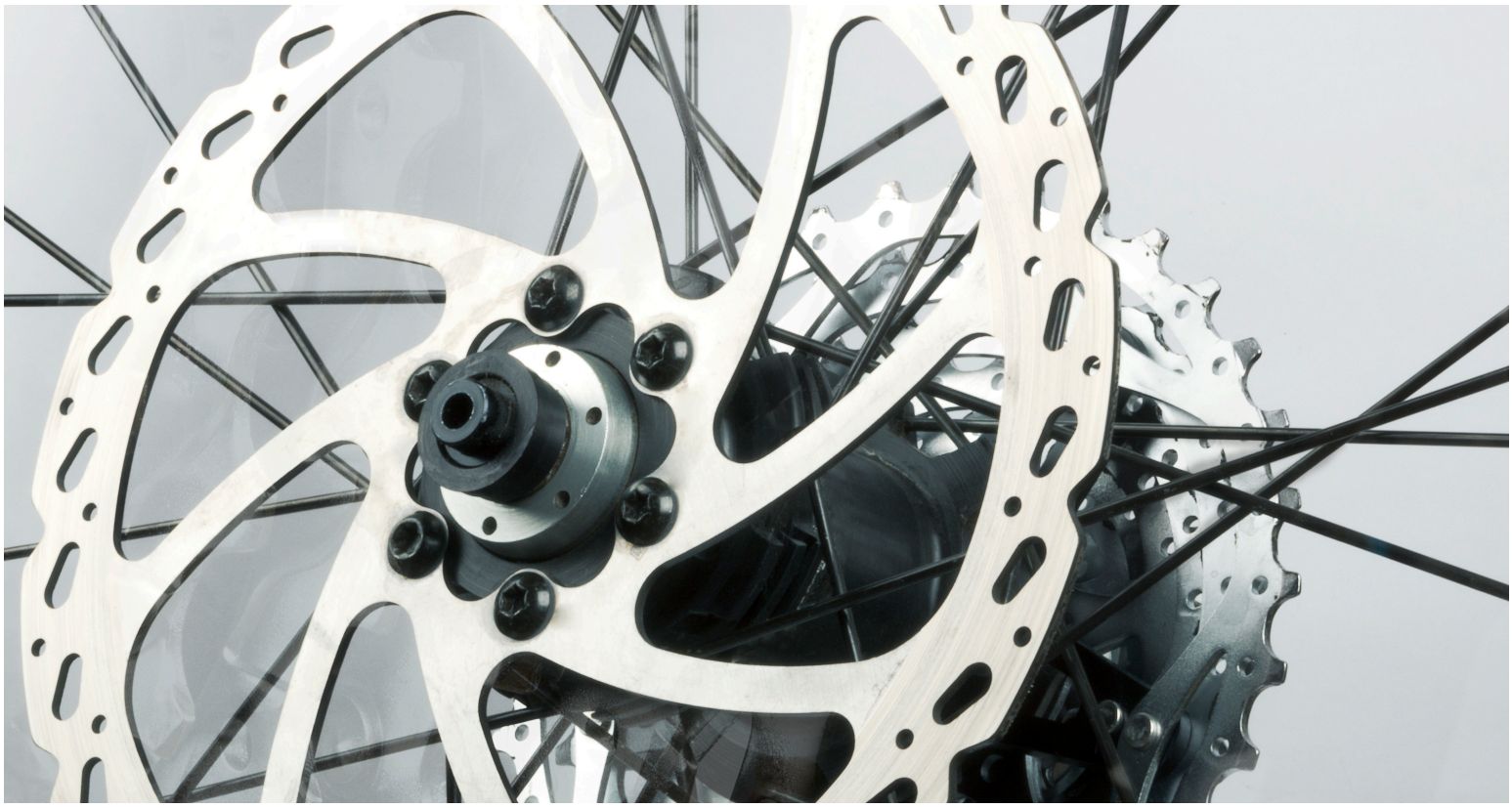

Creating winning teams.

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Abstract

Use cases have been around for almost 30 years as a requirements approach and have been part of the inspiration for more recent techniques such as user stories. Now the inspiration has flown in the other direction. Use-Case 2.0 is the new generation of use-case driven development – light, agile and lean – inspired by user stories, Scrum and Kanban.

Use-Case 2.0 has all the popular values from the past, not just supporting requirements but also architecture, design, test, user experience, and also instrumental in business modeling and software reuse.

Use Case 2.0 has been inspired by user stories to assist with backlogs à la Scrum and one piece flow with Kanban, with the introduction of an important new concept, the Use-Case Slice.

We will make the argument that use cases essentially include the techniques that are provided by user stories but offer significantly more for larger systems, larger teams, and more complex and demanding developments. They are as lightweight as user stories, but can also scale in a smooth and structured way to incorporate as much detail as needed. Most importantly we will show that they drive and connect many other aspects of software development.

Use cases – why still successful and popular?

Use cases were first introduced at OOPSLA 87 [1] although they were not widely adopted until the publication of the 1992 book 'Object-Oriented Software Engineering – a Use-Case Driven Approach' [2]. Since then many other authors have adopted parts of the idea, notably Alistair Cockburn [3] concerning requirements and Larry Constantine [4] regarding designing for better user-experiences. Use cases were adopted as a part of the standard Unified Modeling Language [5] and their diagrams (the use case and the actor icons) are among the most widely used parts of the language. Many other books and papers have been written about use cases for all kinds of systems, not just for software but also business and systems (such as embedded systems) and system of systems. Focusing on today and the future, the latest macro-trend, Internet of Things and Industrial Internet, has made use cases their choice [6].

The use-case practice has evolved over all these years inspired by ideas from many different people, with the newer ideas incorporated into Use-Case 2.0. Thus it seems clear that use cases have stood the test of time and have a very healthy future!

Use cases can and should be used to drive the development. They do not prescribe how you should plan or manage your development work, or how you should design, develop or test your system. They do however provide a structure for the successful adoption of your selected management and development practices.

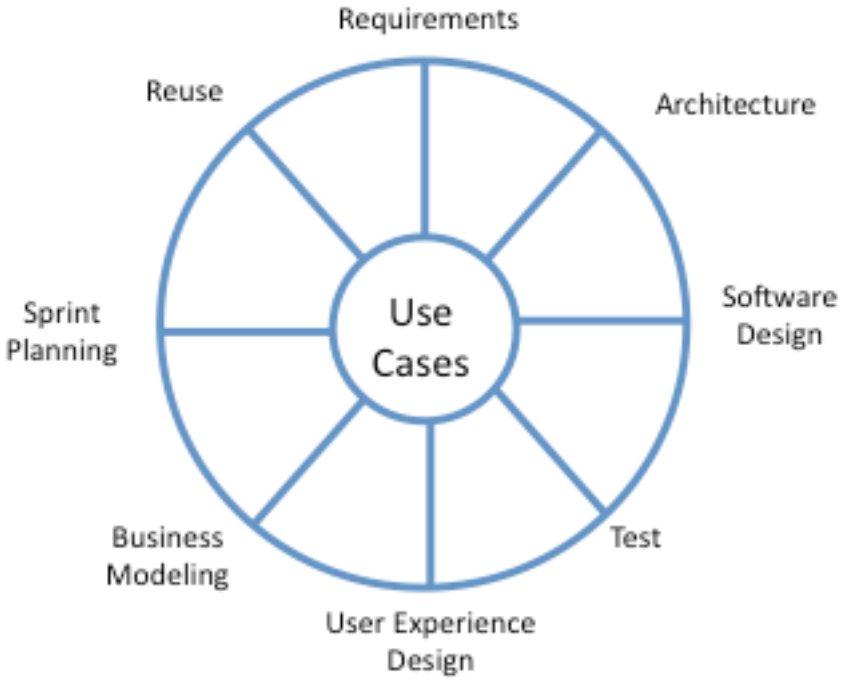

Figure 1: Use cases are the hub of the software development lifecycle.

We believe that the reason for its success is that the use case approach is not just a very practical technique to capture *requirements* from a usage perspective or to design practical *user experiences*, but it impacts the whole development lifecycle. The key use cases or to be more precise the key use case slices (a slice being a carefully selected part of a use case) assist systematically in finding the application *architecture*. They drive the identification of components or other software elements in *software design*. They are the elements that have to go through *test* – and truly support test-driven design. They are the elements to put in the backlog when *planning sprints* or the elements to put on the canvas using Kanban. The use cases of a business are the business processes of the business; thus if doing *business modeling* with use cases the advantage is that it leads directly to finding the use cases of the system to be developed to support the business. Moreover use cases help in finding commonalities, which directs the architecture work to achieve software *reuse*. There are many more similar values in applying use cases, but most important are that the idea of use cases is intuitively graspable. It is lightweight, lean and agile, scalable, versatile, and easy to use. Many people who hear about use cases for the first time takes them to heart; many start using the term in everyday life situations without thinking about all the details that help us with so many aspects of software development – the aspects that are the spokes of the software development wheel in which use cases are the hub. See figure 1.

First Principles for use case adoption

There are six basic principles at the heart of any successful application of use cases:

1. **Keep it simple by telling stories**
2. **Understand the big picture**
3. **Focus on value**
4. **Build the system in slices**
5. **Deliver the system in increments**
6. **Adapt to meet the team's needs**

Principle 1: Keep it simple by telling stories

Storytelling is how cultures survive and progress; it is the simplest and most effective way to pass knowledge from one person to another. It is the best way to communicate what a system should do, and to get everybody working on the system to focus on the same goals.

The use cases capture the goals of the system. To understand a use case we tell stories. The stories cover how to successfully achieve the goal, and how to handle any problems that may occur on the way. Use cases provide a way to identify and capture all the different but related stories in a simple but comprehensive way. This enables the system's requirements to be easily captured, shared and understood.

Principle 2: Understand the big picture

Whether the system you are developing is large or small, whether it is a software system, a hardware system or a business system, it is essential that you understand the big picture. Without an understanding of the system as a whole you will find it impossible to make the correct decisions about what to include in the system, what to leave out of it, what it will cost, and what benefit it will provide.

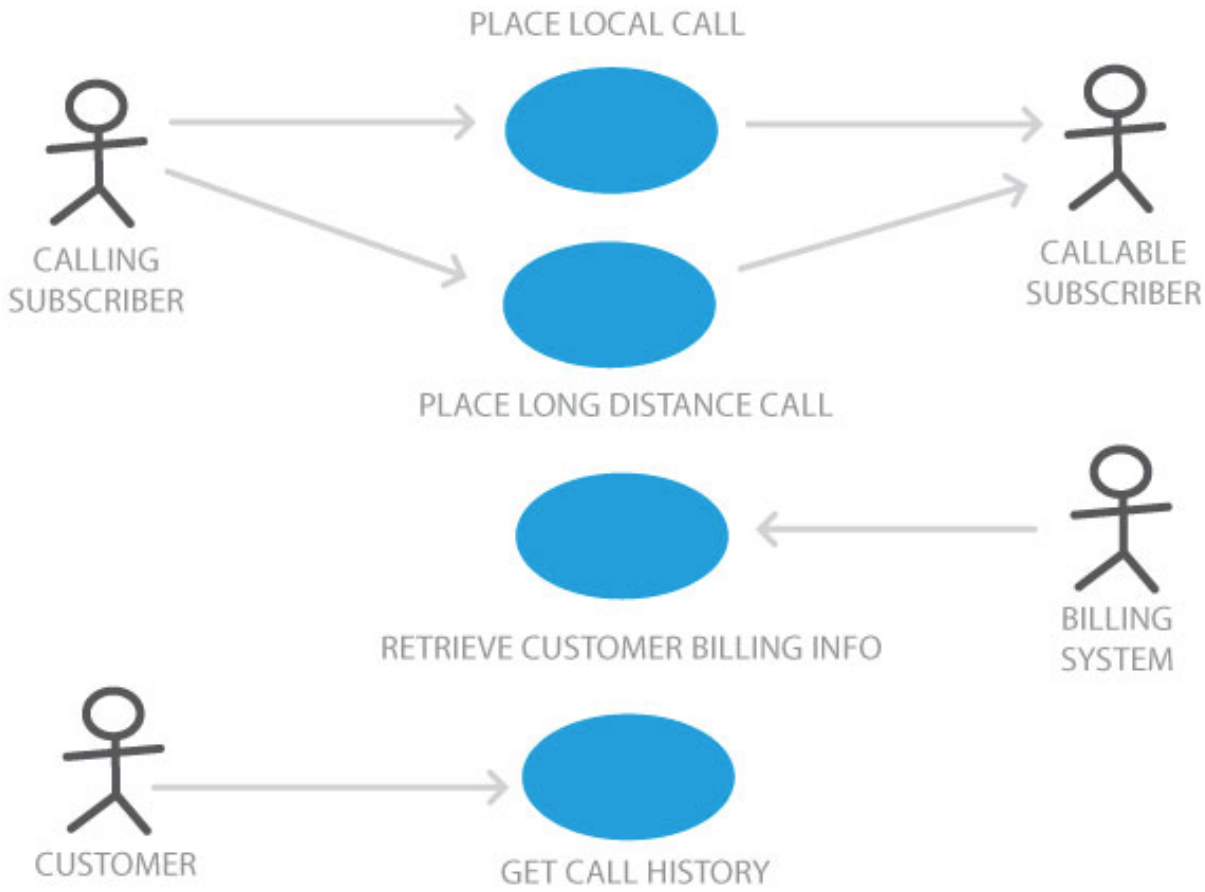

Figure 2: The use-case diagram for a simple telephone system

A use-case diagram is a simple way of presenting an overview of a system's requirements. Figure 2 shows the use-case diagram for a simple telephone system. From this picture you can see all the ways the system can be used, who starts the interaction, and any other parties involved. For example a Calling Subscriber can place a local call or a long-distance call to any of the system's Called Subscribers. You can also see that the users don't have to be people but can also be other systems, and in some cases both (for example the role of the Called Subscriber might be an answering machine and not a person).

Principle 3: Focus on value

When trying to understand how a system will be used it is always important to focus on the value it will provide to its users and other stakeholders. Value is only generated if the system is actually used; so it is much better to focus on how the system will be used than on long lists of the functions or features it will offer.

Use cases provide this focus by concentrating on how the system will be used to achieve a specific goal for a particular user. They encompass many ways of using the system; those that successfully achieve the goals, and those that handle any problems that may occur.

Figure 3 shows a use-case narrative structured in this way for the Withdraw Cash use case of a cash machine. The simplest way of achieving the goal is described by the basic flow. The others are presented as alternative flows. In this way you create a set of flows that structure and describe the stories, and help us to find the test cases that complete their definition.

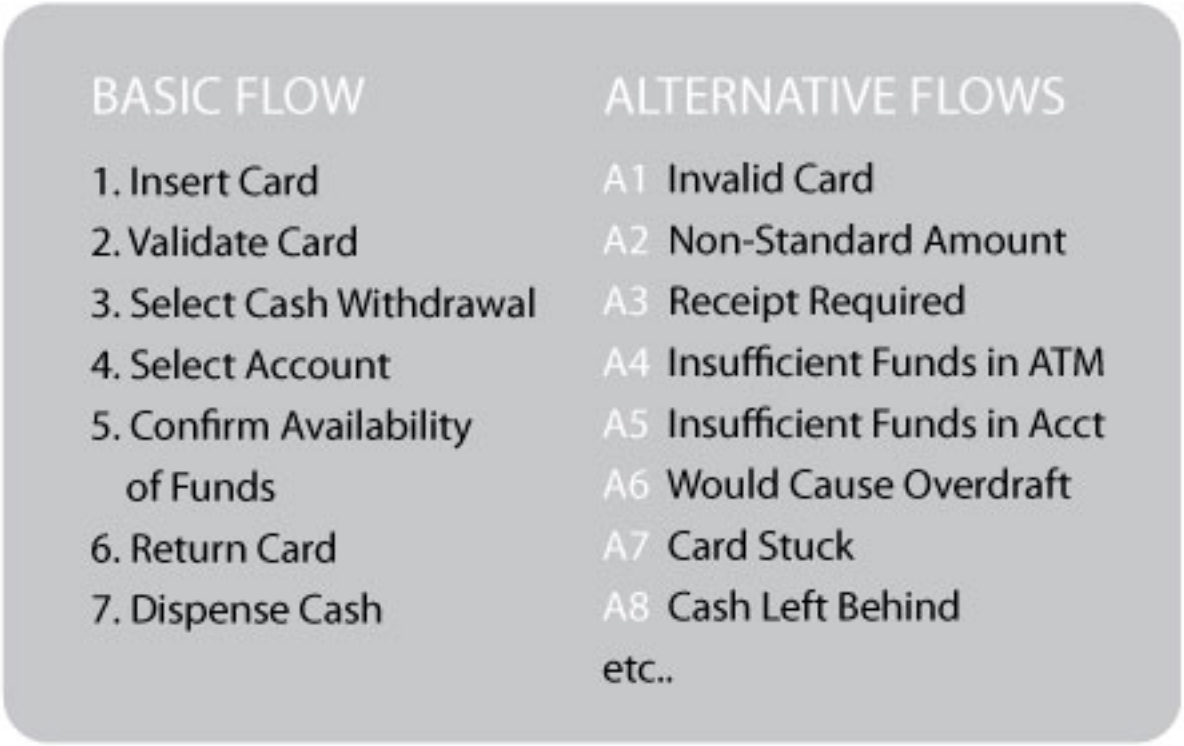

Figure 3: The structure of a use-case narrative

This kind of bulleted outline may be enough to capture the stories and drive the development, or it may need to be elaborated as the team explores the detail of what the system needs to do.

Principle 4: Build the system in slices

Most systems require a lot of work before they are usable and ready for operational use. They have many requirements, most of which are dependent on other requirements being implemented before they can be fulfilled and value delivered. It is always a mistake to try to build such a system in one go. The system should be built in slices, each of which has clear value to the users.

The recipe is quite simple. First, identify the most useful thing that the system has to do and focus on that. Then take that one thing, and slice it into thinner slices. Decide on the test cases that represent acceptance of those slices. Choose the most central slice that travels through the entire concept from end to end, or as close to that as possible. Estimate it as a team and start building it.

This is the approach taken by Use-Case 2.0, where the use cases are sliced up to provide suitably sized work items, and where the system itself is evolved slice by slice.

Although use cases have traditionally been used to help understand and capture requirements, they have always been about more than this. The use-case slices slice through more than just the requirements, they also slice through all the other aspects of the system and its documentation, including the design, implementation, test cases and test results.

Principle 5: Deliver the system in increments

Most software systems evolve through many generations. They are not produced in one go; they are constructed as a series of releases each building on the one before. Even the releases themselves are often not produced in one go, but are evolved through a series of increments. Each increment provides a demonstrable or usable version of the system. This is the way that all systems should be produced.

Figure 4 shows the incremental development of a release of a system. The first increment only contains a single slice: the first slice from use case 1. The second increment adds another slice from use case 1 and the first slice from use case 2. Further slices are then added to create the third and fourth increments. The fourth increment is considered complete and useful enough to be released.

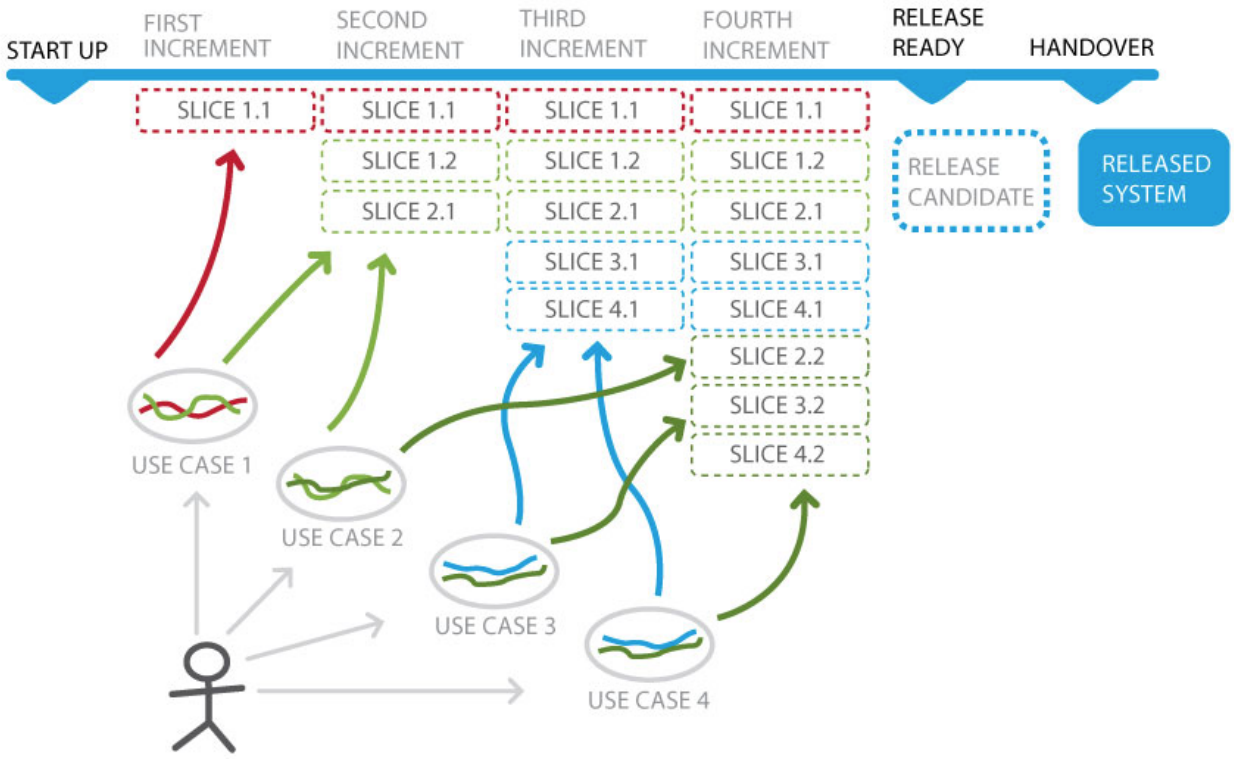

Figure 4: Use cases, use-case slices, increments, and releases

Principle 6: Adapt to meet the team's needs

Unfortunately there is no 'one size fits all' solution to the challenges of software development; different teams and different situations require different styles and different levels of detail. Regardless of which practices and techniques you select you need to make sure that they are adaptable enough to meet the ongoing needs of the team.

Use-Case 2.0 is designed with this in mind, and is as light as you want it to be. Small, collaborative teams can have very lightweight use-case narratives that capture the bare essentials of the stories. These can be hand written on simple index cards. Large distributed teams can have more detailed use-case narratives presented as documents. It is up to the team to decide whether or not they need to go beyond the essentials, adding detail in a natural fashion as they encounter problems that the bare essentials cannot cope with.

The Use-Case 2.0 Practice

The Use-Case 2.0 practice describes the key concepts to work with, the work products used to describe them, and a set of activities.

Things to Work With

The subject of Use-Case 2.0 is the requirements, the system to be developed to meet the requirements, and the tests used to demonstrate that the system meets the requirements. At the heart of Use-Case 2.0 are the *use case*, the *story* and the *use-case slice*.

The use cases capture the requirements and each use case is scope managed by slicing it up into a set of use-case slices, which can be worked on independently. Telling stories bridges the gap between the stakeholders, the use cases and the use-case slices. It is how the stakeholders communicate their requirements and explore the use cases. Understanding the stories is also the mechanism for finding the right use-case slices to drive the implementation of the system.

Use Cases

A use case is:

- A sequence of actions a system performs that yields an observable result of value to a particular user.
- That specific behavior of a system, which participates in a collaboration with a user to deliver something of value for that user.
- The smallest unit of activity that provides a meaningful result to the user.
- The context for a set of related requirements.

Taken together the set of all the use cases gives us all the functional requirements of the system.

To understand a use case we tell stories. The stories cover both how to successfully achieve the goal and how to handle any problems that occur on the way. They help us to understand the use case and implement it slice by slice.

A use case undergoes several defined state changes from initially just having its Goal Established, through Story Structure Understood, Simplest Story Fulfilled, Sufficient Stories Fulfilled, to All Stories Fulfilled. The states constitute important waypoints in the understanding and implementation of the use case.

Use-Case Slices

Use cases cover many related stories of varying importance and priority. There are often too many stories to deliver in a single release and generally too many to work on in a single increment. Because of this we need a way to divide the use cases into smaller pieces.

A use-case slice is one or more stories selected from a use case to form a work item that is of clear value to the customer. It acts as a placeholder for all the work required to complete the implementation of the selected stories. As we saw earlier when we discussed how the use-case slices are more than just requirements and test cases, the use-case slice evolves to include the corresponding slices through design, implementation and test.

The use-case slice is the most important element of Use-Case 2.0, as it is not only used to help with the requirements but to drive the development of a system to fulfill them.

A use-case slice undergoes several state changes from its initial identification where it is Scoped, through being Prepared, Analyzed, Implemented to being finally Verified. These states allow you to plan and track the understanding, implementation and testing of the use-case slice.

To the casual observer glancing at the states, this might look like a waterfall process. There's a big difference, though, as here we are dealing with an individual use-case slice. Across the set of slices all the activities could be going on in parallel. While one use-case slice is being verified, another use-case slice is being implemented, a third is being prepared, and a fourth being analyzed.

Stories

Telling stories is how we explore the use cases with our stakeholders. Each story of value to the users and other stakeholders is a thread through one of the use cases. The stories can be functional or non-functional in nature.

A story is described by part of the use-case narrative, one or more flows and special requirements, and one or more test cases. The key to finding effective stories is to understand the structure of the use-case narrative. The network of flows can be thought of as a map that summarizes all the stories needed to describe the use case. In our previous cash machine example in Figure 3 we could identify specific stories such as 'Withdraw a standard amount of $100', 'Withdraw a non-standard amount of $75 and get a receipt', or 'Respond to an invalid card'.

Each story traverses one or more flows starting with the use case at the start of the basic flow and terminating with the use case at the end of the basic flow. This ensures that all the stories are related to the achievement of the same goal, are complete and meaningful, and are complementary as they all build upon the simple story described by the basic flow.

Work Products

The use cases and the use-case slices are supported by a number of work products that the team uses to help share, understand, and document them.

A *Use-Case Model* visualizes the requirements as a set of use cases, providing an overall big picture of the system to be built. The model defines the use cases and provides the context for the elaboration of the individual use cases.

The use cases are explored by telling stories. Each use case is described by 1) a *Use-Case Narrative* that outlines its stories as a set of flows, and 2) a set of *Test Cases* that complete the stories. These can be complemented with a set of special requirements that apply to the whole use case and are often non-functional. These will influence the stories, help you assign the right stories to the use-case slices for implementation, and most importantly define the right test cases.

The use-case model is complemented by Supporting Information. This captures the definitions of the terms used in the use-case model and when outlining the stories in the use case narratives. It also captures any system-wide requirements that apply to all of the use-cases.

A Use-Case Realization can be created to show how the system's elements collaborate together to perform a use case. You can think of the use-case realization as providing the 'how' to complement the use-case narratives 'what'. Common ways of expressing use-case realizations include simple tables, story-boards, or sequence diagrams.

Working with the use cases and use-case slices

As well as creating and tracking the work products, you will also need to track the states and properties of the use cases and the use-case slices. This can be done in many ways and in many tools. The states can be tracked very simply using post-it notes or spreadsheets. If more formality is required one of the many commercially available requirements management, change management or defect tracking tools could be used.

Figure 5 shows a use case and some of its slices captured on a set of post-it notes.

Figure 5: Capturing the properties of a use case and its slices using Post-It notes

The use case shown is use-case '7. Browse and Shop' from an on-line shopping application. Slices 1 and 2 of the use case are based on individual stories derived from the basic flow: 'Select and buy 1 Product' and 'Select and buy 100 Products'. Slice 3 is based on multiple stories covering the availability of the various support systems involved in the use case.

The essential properties for a use case are its name, state and priority. In this case the popular MoSCoW (Must, Should, Could, Would) prioritization scheme has been used. The use cases should also be estimated. In this case a simple scheme of assessing their relative size and complexity has been used.

The essential properties for a use-case slice are 1) a list of its stories, 2) references to the use case and the flows that define the stories, 3) references to the tests and test cases that will be used to verify its completion, and 4) an estimate of the work needed to implement and test the slice. In this example the stories are used to name the slice and the references to the use case are implicit in the slices number and list of flows. The estimates have been added later after consultation with the team. These are the large numbers towards the bottom right of each post-it note. In this case the team has played planning poker to create relative estimates using story points.

The use cases and the use-case slices should also be ordered so that the most important ones are addressed first.

Keeping work products as lightweight as appropriate

All of the work products are defined with a number of levels of detail. The first level of detail defines the bare essentials, the minimal amount of information that is required for the practice to work. Further levels of detail are defined to help the team cope with any special circumstances they might encounter. For example, this allows small, collaborative teams to have very lightweight use-case narratives defined on simple index cards and large distributed teams to have more detailed use-case narratives presented as documents. The teams can then grow the narratives as needed to help with communication, or thoroughly define the important or safety critical requirements.

The good news is that you always start in the same way, with the bare essentials. The team can then continually adapt the level of detail in their use-case narratives to meet their emerging needs.

Things to do

Use-Case 2.0 breaks the work up into a number of essential activities that need to be done if the use cases are to provide real value to the team.

The '*Find Actors and Use Cases*' activity will produce a use-case model that identifies the use cases, which will be subsequently '*Sliced*'. These use-case slices will then be '*Prepared*' by describing the related stories in the use-case narrative and defining the test cases. The slice is '*Analyzed*' to work out how the system elements will interact to perform the use case, then '*Implemented*' and '*Tested*' as a slice. Use-Case 2.0 can be considered a form of test driven development as it creates the test cases for each slice up-front. Finally the whole system is "*Tested*' to ensure that all the slices work together when combined.

The activities themselves will all be performed many times in the course of your work. Even a simple activity such as 'Find Actors and Use Cases' may need to be performed many times to find all the use cases, and may be conducted in parallel with, or after, the other activities. For example, whilst continuing to 'Find Actors and Use Cases' you may also be implementing some of the slices from those use cases found earlier.

As the project progresses priorities change, lessons are learnt and changes are requested. These can all have an impact on the use cases and use-case slices that have already been implemented, as well as those still waiting to be progressed. This means there will be an ongoing '*Inspect and Adapt*' activity for the use cases. This will also adapt the way of working with the Use Case 2.0 practice to adjust the size of slices or the level of details in work products to meet the varying demands of the project and team.

Using Use-Case 2.0

Many people think that use cases are only applicable to user-intensive systems where there is a lot of interaction between the human users and the system. This is strange because the original idea for use cases came from telecom switching systems, which have both human users (subscribers, operators) and machine users, in the form of other interconnected systems. Use cases are of course applicable for all systems that are used – and that means all systems.

..It's not just for user-intensive applications

In fact use cases are just as useful for embedded systems with little or no human interaction as they are for user intensive ones. People are using use cases in the development of all kinds of embedded software in domains as diverse as the motor, consumer electronics, military, aerospace, and medical industries. Even real-time process control systems used for chemical plants can be described by use cases where each use case focuses on a specific part of the plant's process behavior and automation needs.

..It's not just for software development

The application of use cases is not limited to software development. They can also help you to understand your business requirements, analyze your existing business, design new and better business processes, and exploit the power of IT to transform your business. By using use cases recursively to 1) model the business and its interactions with the outside world and 2) model the systems needed to support and improve the business you can seamlessly identify where the systems will impact on the business and which systems you need to support the business.

..Handling all types of requirements

Although they are one of the most popular techniques for describing systems' functionality, use cases are also used to explore their non-functional characteristics. The simplest way of doing this is to capture them as part of the use cases themselves. For example, relate performance requirements to the time taken between specific steps of a use case or list the expected service levels for a use case as part of the use case itself.

Some non-functional characteristics are more subtle than this and apply to many, if not all, of the use cases. This is particularly true when building layered architectures including infrastructure components such as security, transaction management, messaging services, and data management. The requirements in these areas can still be expressed as use cases – separate use cases focused on the technical usage of the system. We call these additional use cases *infrastructure use cases* [8] as the requirements they contain will drive the creation of the infrastructure that the application will run on.

..Applicable for all development approaches

Use-Case 2.0 works with all popular software development approaches including:

- Backlog-driven iterative approaches such as Scrum, EssUP and OpenUP
- One-piece flow based approaches such as Kanban
- All-in-one go approaches such as the traditional Waterfall

Use-Case 2.0 and backlog-driven iterations

Before adopting any backlog-driven approach you must understand what items will go in the backlog. There are various forms of backlog that teams use to drive their work including product backlogs, release backlogs, and project backlogs. Regardless of the terminology used they all follow the same principles. The backlog itself is an ordered list of everything that might be needed and is the single source of requirements for any changes to be made.

When you use Use-Case 2.0, the use-case slices are the primary backlog items. The use of use-case slices ensures that your backlog items are well-formed, as they are naturally independent, valuable and testable. The structuring of the use-case narrative that defines them makes sure that they are estimable and negotiable, and the use-case slicing mechanism enables you to slice them as small as you need to support your development team.

When you adopt a backlog-driven approach it is important to realize that the backlog is not built and completed up-front but is continually worked on and refined. The typical sequence of activities for a backlog-driven, iterative approach is shown in Figure 6.6

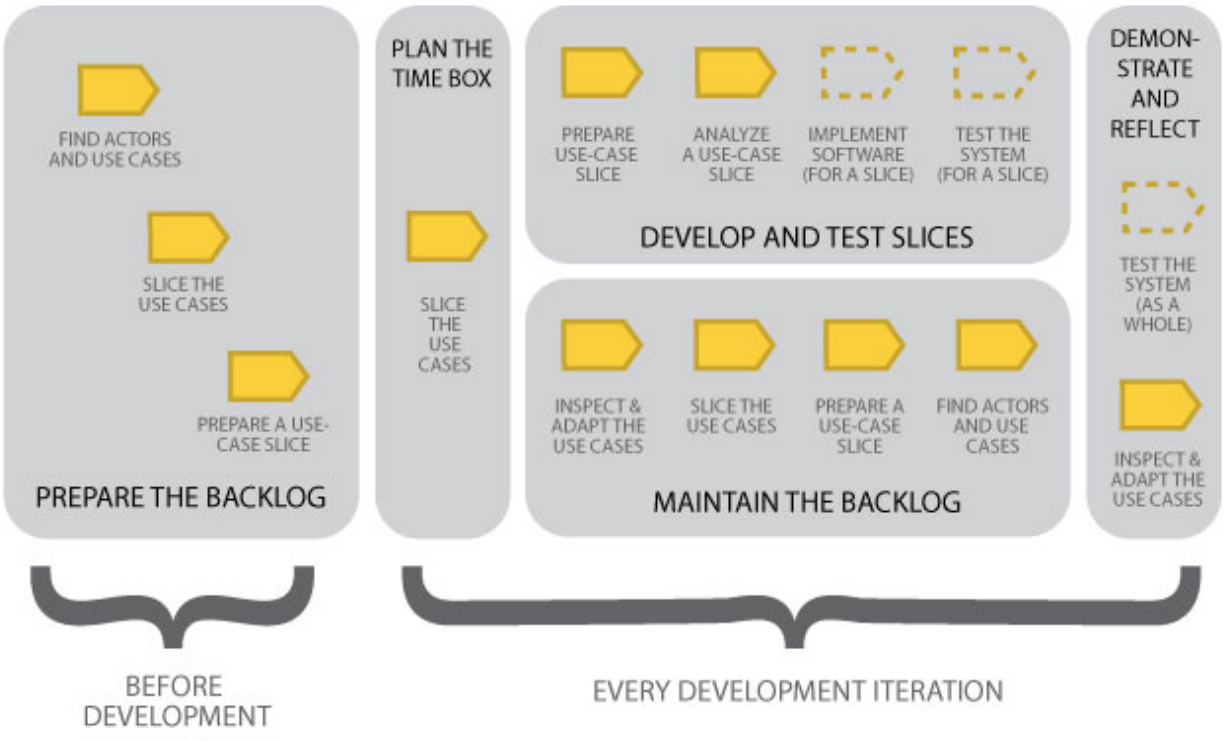

Figure 6: Use-case 2.0 activities for iterative development approaches

Use-Case 2.0 and one-piece flow

One-piece flow is a technique taken from lean manufacturing that avoids the batching of the requirements seen in the iterative and waterfall approaches. Each requirements item flows quickly through the development process but for this to work effectively you need small, regularly sized items. Use cases would be too irregularly sized and too big to flow through the system. Use-case slices though can be sized appropriately and tuned to meet the needs of the team.

One-piece flow doesn't mean that there is only one requirements item being worked on at a time or that there is only one piece of work between one workstation and the next. There needs to be enough items in the system to keep the team busy. Work in progress limits are used to level the flow and prevent any wasteful backlogs from building up Figure 7 shows a simple Kanban board for visualizing the flow of use case slices.

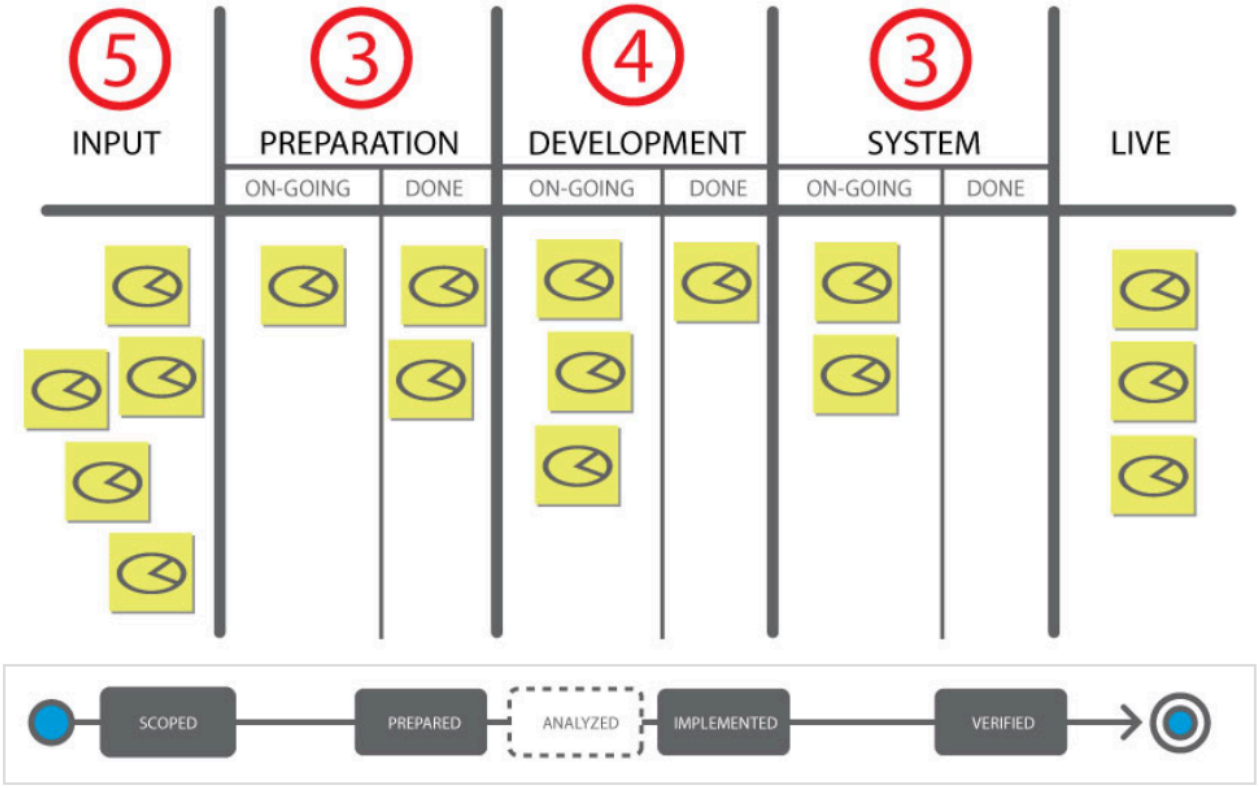

Figure 7: Use-case slices on a Kanban board

The work in progress limits are shown in red. Reading from left to right you can see that slices have to be identified and scoped before they are input to the team. Here there is a work in progress limit of 5, and the customers, product owner or requirements team that are the source of the requirements try to keep 5 use-case slices ready for implementation at all times.

An important thing to note about Kanban is that there is no definitive Kanban board or set of work in progress limits; it is dependent on your team structure and working practices. You should tune the board and the work in progress limits as you tune your practices. The states for the use-case slices are a great aid to this kind of work design as they can clearly define what state the slice should be in when it is to be handed on to the next part of the chain.

Use-Case 2.0 and waterfall

For various reasons you may find that you need to develop your software within the constraints of some form of waterfall governance model. This typically means that some attempt will be made to capture all the requirements up-front before they are handed over to a third-party for development.

When you adopt a waterfall approach the use cases are not continually worked on and refined to allow the final system to emerge but are defined in one go at the start of the work.

The 'one thing at a time' nature of the waterfall approach means that the make-up of the team is continually changing over time, and so the ability to use to face-to-face communication to share the stories is very limited. To cope with this you need to turn up the level of detail on the work products, going beyond the bare essentials.

Use-Case 2.0 – It's not just for one type of team

Another important aspect of Use-Case 2.0 is its ability to adapt to existing team structures and job functions whilst encouraging teams to eliminate waste and increase efficiency. To this end, Use-Case 2.0 does not predefine any particular roles or team structures, but it does define a set of states for each of the central elements (the use case and the use-case slice).

As illustrated by the discussion on Use-Case 2.0 and one-piece flow, the states indicate when the items are at rest and could be handed-over from one person or team to another. This allows the practice to be used with teams of all shapes and sizes from small cross-functional teams with little or no handovers to large networks of specialist teams where each state change is the responsibility of a different specialist. Tracking the states and handovers of these elements allows the flow of work through the team (or teams) to be monitored, and teams to adapt their way-of-work to continuously improve their performance.

Scaling to meet your needs – scaling in, scaling out and scaling up

No one, predefined approach fits everyone so we need to be able to scale our use of Use- Case 2.0 in a number of different dimensions:

1. Use cases *scale in* to provide more guidance to less experienced practitioners (developers, analysts, testers, etc.) or to practitioners who want or need more guidance.

2. They *scale out* to cover the entire lifecycle, covering not only analysis, design, coding and test but also operational usage and maintenance.

3. They *scale up* to support large and very large systems such as systems of systems: enterprise systems, product lines, and layered systems. Such systems are complex and are typically developed by many teams working in parallel, at different sites, possibly for different companies, and reusing many legacy systems or packaged solutions.

Regardless of the complexity of the system you are developing you always start in the same way by identifying the most important use cases and creating a big picture summarizing what needs to be built. You can then adapt Use-Case 2.0 to meet the emerging needs of the team. In fact the Use-Case 2.0 practice insists that you continuously inspect and adapt its usage to eliminate waste, increase throughput and keep pace with the ever-changing demands of the team.

User Stories and Use Cases – what is the difference?

The best way to answer this question is start by looking at their common properties, the things that make them both work well as backlog items and enable them both to support popular agile approaches such as Scrum, Kanban, Test-Driven Development, and Specification by Example.

Use-Case slices and User Stories [9] share many common characteristics, for example:

- *They both define slices of the functionality that teams can get done in a sprint*

- *They can both be sliced up if they are too large resulting in smaller items*

- *They can both be written on index cards*

- *They both result in test cases that represent the acceptance criteria*

- *They are both placeholders for a conversation and benefit from the 3C's invented by Ron Jefferies - Card, Conversation, and Confirmation*

- *They can both be estimated with techniques such as Planning Poker*

So given that they share so many things in common what is it that makes them different?

Use cases and use-case slices provide added value:

- Provide a big picture to help people understand the extent of the system and the value it provides
- Increased understanding of what the system does and how it does it
- Better organization, understanding, application and maintenance of your test assets
- Easy test case generation and analysis
- Support for on-going impact analysis
- Active scope management allowing you to focus easily on providing the minimal viable product
- Flexible, scalable documentation to help cope with traceability or other contractual constraints
- Support for simple systems, complex systems and systems-of-systems.
- Easier identification of missing and redundant functionality

The question still remains, which technique should I use, which once you go beyond personal preferences, is very context dependent. Consider the following factors:

- how much access there is to the Subject Matter Experts (SME),

- and how severe requirements errors will be if they escape to a live environment.

The sweet spot for user stories is when you have easy access to a SME and when the severity of errors is low, and use cases and use-case slices are more suitable when applied for when there is no easy access to a SME or when error consequences are high. However, since the use case approach can scale down to the sweet spot of user stories, you may still want to apply them. If the subject system will always be in the sweet spot of user stories, then user stories are fine, but if you expect it to grow outside that area you should consider use cases and use-case slices.

Conclusion

Use-Case 2.0 exists as a proven and well-defined practice, one that is compatible with many other software development practices such as Continuous Integration, Intentional Architecture, and Test-Driven Development. It also works with all popular management practices. In particular it has the lightness and flexibility to support teams that work in an agile or lean fashion. It also has the completeness and rigor required to support teams that are required to work in a more formal or waterfall environment.

More details about the fully documented Use Case 2.0 practice are available at **www.ivarjacobson.com**

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About Ivar Jacobson International

IJI is a global services company providing high quality consulting, coaching and training solutions for customers seeking the benefits of enterprise-scale agile software development.

We are passionate about improving the performance of software development teams, and maximizing the delivery of business value through technology.

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