Deployment diagram tutorial pdf

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Photo by Taylor Vick on Unsplash This tutorial section illustrates the following tasks:•Add a dependency between two artifacts in a Deployment diagram•Add elements to a Deployment diagram•Embed artifacts into a node in a Deployment diagram•Creating artifact elements (for example, properties, operations, nested artifacts)To proceed, run UModel and open the BankView-start.ump project (see also Opening the Tutorial Project). In the Diagram Tree window, under "Deployment Diagrams", double-click the icon next to the "Artifacts" diagram to open it. As illustrated below, this diagram shows the manifestation of the Bank API client and the BankView components, to their respective compiled Java .jar files."Artifacts" diagramThese manifestations were created using a technique similar to other relationships previously illustrated in this tutorial, as follows:1.Click the Manifestation toolbar button.2.Move the mouse cursor over the artifact and drag into the component.Using the same technique, let's also add a dependency between the two .jar files, as follows:1.Click the Dependency toolbar button.2.Move the cursor over the BankView.jar artifact and drag into the BankAPI.jar artifact.3.Select the dependency line and type "Dependency2".In the Diagram Tree window, under "Deployment Diagrams", double-click the icon next to the "Deployment" diagram to open it. This diagram is deliberately incomplete and consists of a single node, which represents a home PC. In the following steps, we will be adding more elements to this diagram. "Deployment" diagramAssuming that the goal is to illustrate a TCP/IP connection between the home PC and a bank, let's add the required elements:1.Click the Node toolbar button, and click right of the Home PC node to insert it.2.Rename the node to "Bank", and drag one of its edges to enlarge it.3.Click the Dependency toolbar button, and then drag from the "Home PC" node to the "Bank" node. This creates a dependency between the two nodes.4.Select the dependency line and enter "TCP/IP" as name of the new dependency. (Alternatively, edit the Name property in the Properties window).In the Model Tree window, expand the "Deployment View" package, and then drag all of the following artifacts into the diagram: BankAddresses.ini, BankAPI.jar, and BankView.jar. The project is preconfigured to include deploy dependencies between these artifacts and the "Home PC" node, so all these dependencies are now visible in the diagram:You can also embed the artifacts into the "Home PC" node, by dragging each of the artifacts into it. Notice that the deploy dependencies are no longer visible on the diagram, although they continue to exist logically.Artifacts embedded into the node can also have dependencies between them. To illustrate this:1.Click the Dependency toolbar button and, holding the Ctrl key pressed, drag from the "BankView.jar" artifact into the "BankAddresses.ini". 2.While holding the Ctrl key pressed, drag from the "BankView.jar" artifact into the "BankAPI.jar" artifact.Note:Dragging an artifact out of a node onto the diagram always creates a deployment dependency automatically.In UML, artifacts can be composed of properties, operations, and other elements, including nested artifacts. To create such nested elements, right-click the artifact in the Model Tree window and select the appropriate action from the context menu (for example, New Element | Operation, or New Element | Property). The new element will appear nested below the selected artifact in the Model Tree window. Introduction to UML Deployment Diagram UML Deployment diagram is one of the types of UML diagram which is used to define the hardware requirements for the particular product to execute the software; basically, it maps the software design requirement to the physical system which executes the software design and visualize how software interacts with hardware to complete the test execution. To design the deployment diagram, node, component, artifact, and interface notation are used. Now let us discuss the purpose of deployment diagrams. The term deployment in the deployment diagram itself specifies the role of this diagram. It is used for describing hardware components where the software components are actually deployed. UML is generally used to describe the software artifacts of a system. However, UML deployment diagrams are a special case of UML diagrams where the main emphasis is on the system’s hardware topology (here, topology means layout). The Main Purpose of the Deployment Diagram To represent the hardware topology of a system. Represent how different hardware components are inter-connected and how these hardware components are used to deploy software components. Symbols and Components Let us first understand two basic terms that we will frequently use (Symbols and Components). Symbols UML deployment diagram symbols represent a node, object, node instance, component instance (here component instance means a replica or copy of component), interface, etc. These symbols help us to create an accurate diagram for documentation. A similar image which could be referred to Components Components represent different hardware nodes in which software resides. Note that it is symbols that connect different components and help us make a good UML deployment diagram. How to Draw a Deployment Diagram? This is one of the most important sections of this article, as we are going to discuss how we can draw a deployment diagram. The most important component of a deployment diagram is nodes. Nodes are simply the physical hardware that is used to deploy the application. Therefore, an efficient and good deployment diagram is very important as it covers the following important aspects. These important aspects are as follows: Maintainability: The system designed should be easily maintainable. Portability: The system should be designed in such a way that it is easy to implement new changes. Performance: The system should have high performance. Scalability: The system should be flexible enough so that it could be easily expanded. Before making a deployment diagram, two important artifacts must be identified and should be understood properly, and these two important artifacts are nodes and how these nodes are interconnected. Let us understand this with a simple example. Example Let us prepare a simple deployment diagram that consists of the following components. Server. Modem. Router. User nodes like mobile, printer, etc. This example is assumed to be a web-based simple application hosted in a clustered environment using participated servers. A user node like mobile will connect our application using the internet through modem and routers. A simple deployment diagram considering all the above-mentioned points for all this will be. Now, we can assume that we can make a simple deployment diagram. Let’s do a discussion on our next topic, which is where can we use deployment diagrams. Where to Use UML Deployment Diagrams? System engineers mainly consume deployment diagrams. These diagrams help us to describe the physical components like hardware involved, participant nodes, their distribution and how they are inter-connected Deployment diagrams could be assumed as the hardware components where the software components reside. Deployment Diagrams can be used for the following cases: To visualize the hardware topology of a system. To represent the hardware details of a system. To represent the hardware details of a distributed application. & many more… Conclusion UML deployment diagram is very important as it helps us visualize and helps us better understand the whole system. A simple and efficient UML deployment diagram greatly helps us make a visual diagram of how these hardware components are inter-linked, the relation between each hardware component, and how the software resides in these hardware components. Also, there are other types of UML diagrams that are important to understand for the efficient making of the systems. Recommended Articles This is a guide to UML Deployment Diagram. Here we discuss the purpose of the deployment diagram, how to draw a deployment diagram, where to use UML, symbols, and components with diagrams. You can also go through our other related articles to learn more- In the following unit, we will first look at the task of modeling in general. In the second part, we will learn the first diagram type: deployment diagrams. They are perfect for getting an overview of the parts of the system, which software runs on them and how they communicate. Learning Goals The learning goals specific for this week are the following: Be aware of the overall importance of modeling in engineering. Understand what constitutes a model. Recite different properties of models. Create deployment diagrams. Decide which elements of a deployment diagram are relevant and chose a suitable level of detail. For the Semester Project In the semester project you will provide a systems specification, which is a model, and most of your effort lies in the activity of modelling. You will often need to decide which information to include, and what makes a good model. The second part of this unit about deployment diagrams is also directly relevant as you need to provide several iterations of your system as a deployment diagram. The Problem You are an engineer and should build a new system, an information and communication system for a new airport. You start coding on your laptop, and you manage to create the system all by yourself, in one long session. You think for yourself that Python is a really powerful programming language, and that this programming course really payed off. The next day, a bit tired, you send the code to the airport people and they happily accept your system. Some days after, they send you the money. Doesn't this sound like a nice story? Unfortunately, it's bullshit. --- Why? Systems are rarely created by a single person. Most systems are the effort of a team of developers, or rather several teams of developers, changing over time. Most systems are not just built once, but maintained, extended and adapted over many years. In this process, the code of the system, that is, the machine instructions needed to run it, are only one part of the descriptions and specifications that are created throughout the entire lifecycle of a system. With lifecycle we mean from the beginning of its conception, the idea, its creation and the following maintenance. During these phases, engineers create many documents that describe different aspects of it. Some descriptions have the purpose to make new programmers understand what has already been built and how the different parts of the system work together. Other descriptions are suitable to simulate the system, so we can check it for important properties like safety, security or performance. Yet again other descriptions are only created temporarily, before making a technical decision. Modeling Creating descriptions of something means to create a model, and the activity is called modeling. In this course, we learn how to apply modeling to systems, so that we can create high-quality systems. Models are Everywhere Modeling means to represent something so we can find out more about it, play with it and work on it. Many tasks of engineers are related to models. In some disciplines this is more obvious than others. For example: A plan (or model) of a plane. A plan (or model) of a building. A plan (or model) of a software system. Models allow to do a crash test on a car using a computer simulation, to check how fire and smoke propagate through a building, and they allow to study how a building looks before it is even built. If we were doing engineering without models, we would only be able to work with the real thing. As you can imagine, this is often impossible, prohibitively expensive or unethical. But models are also useful in less dramatic and obvious cases. We are so used to working on models that we often don't think about it. Let's have a closer look what models are and which properties they can have: Models can be physical, like a wooden model of a car, or digital, like a digital plan of a building. A diagram on a piece of paper or whiteboard is somewhere between these two. Models can be textual descriptions, like a step-by-step description of a business process, or expressed graphically, like a flowchart. Models can be expressed by mathematical formulas, like Newton's law of gravity that is a model for how masses attract each other. This list is not intended to be complete, but should just illustrate the wide variety of models there are. Depending on what we want to find out, we can use different models. The same concept can have several models at the same time, each showing different aspects of it. Depending on what we want to find out, a model may also cover some aspects very well, while being less precise on others. Newton's law of gravity, for instance, is a good model to describe the movement of the planets, but it is ultimately not as precise as Einstein's relativity theory, which is another model that involves gravity. A crash test model for a car is suitable to understand how the car behaves in an accident, but is useless when we want to decide which colors we should chose for the dashboard buttons. Models of Software Of course, like we can have models of planes and buildings, we can also have models of a system that mainly consists of software. But there's one thing that is special with software: Software is made up of digital artifacts, and therefore virtual in nature. (Virtual means you can't touch it.) While it is easy to distinguish the model of a house from the house itself, it is harder to distinguish the model of a piece of software from the software itself. One could also argue that code itself is a model, since it describes a way of executing an algorithm. This is why we sometimes confuse software models and programs. In some cases, the lines are even more blurry when we generate code from models automatically, or take the model and interpret it by a machine that then effectively executes it. But more on that later. Why Modeling Software? Let's think one again, why we use models in general, and why models make sense also for software: We use models for planning ahead and estimate how long the construction of something will take. With software, we also need to plan ahead and plan who is doing what and when. Is it useful to have models for that? Of course! Study properties and behavior of a system before it is built. For software, this means for instance that we can play with a model to talk through some use cases of a system without building the real thing. Sometimes such models are done only with paper. Sometimes they are programmed quickly but without all functions behind the buttons. These models are also called mock-ups. When a model has a more mathematical or formal character, we can also simulate it or analyze it thoroughly. One obvious, but often underestimated value is communication with other developers, or sometimes customers. Altogether, through modeling all participants in a development project can gain a better understanding of the system --- before it's built, during its constructions, and afterwards during maintenance and extensions or adaptations. Where Does Modeling Happen? We have seen that models come in a variety of forms. There's no specific property models needs to have to be called model other than being a model of something. If it represents something, it's a model. If we can use it to find out more about what we are working on, it's a useful model. The act of modeling can therefore take place in different forms: In your head. This is kind of obvious. Engineers have a representation of the system they work in their heads. These are models, too. The only problem of these models is that they are local and hard to transfer from one developer to another. At a whiteboard or on a piece of paper. When discussing, engineers often draw spontaneously to illustrate a part of a system, so that they can understand a system aspect better or communicate it to other developers. In a general-purpose graphical editor. For documentation or planning, engineers create more detailed models using graphical editors. General-purpose means that the editor is not specific for software but for drawing diagrams in general. Text can also be part of that description. In a modeling editor. In contrast to a general-purpose editor, a modeling editor knows more about the type of models you want to create. With this knowledge, it can for instance offer connections between modeling elements, or check if there are errors in the model. Any of these models can be valuable, and one is not inherently more valuable than another. Models are always as valuable as they contribute to clarify and increase system quality. A model is not more valuable just because it is done in a tool, its value depends on its context. With regard to this course, we focus in the first three: You will be able to improve the models you have of a system in your own head. I also want you to get much better at just taking a pen during a discussion and sketching a relevant model on a whiteboard to show to some colleagues. This is an underestimated skill. Finally, once you should produce a delivery document or plan ahead your project in greater detail, you will also be able to create some decent diagrams. The UML specification is currently in version 2.5.1, and has 751 pages. If you are curious, you can have a look at the document, but it is not a good source to learn the language or anything about modeling. It's a detailed specification for toolmakers and those who need to know all the details. There are lots of languages, notations or standards for modeling software. In this course, we will use the Unified Modeling Language (UML) as a basis. Some of you have already heard about UML, and among all modeling languages it is probably the one you will come most likely into contact with later in your job. This is because UML is not a single language, but a selection of notations that have each been around for a while. Sequence diagrams or state machines, for instance, have existed for a long time before UML. UML tries to unify them. However, UML itself is not really important in this course. This is not a UML course. It's a course about designing systems, and we happen to use UML notation. UML has several hundred different modeling elements and eleven different graphical notations. We will look only at the following: Deployment Diagrams Use Case Diagrams State machine diagrams Interaction Diagrams For each of these diagrams, we only look at a subset of the modeling elements, and shy away from some more obscure constructs. The course is therefore not very syntax heavy. However, you will need to apply the syntax consistently. This is because we want to convey information with the diagrams. We want the diagrams to be valuable. For that reason, we need to stick to some conventions. Therefore, we are strict with the syntax that we will use. Degrees of UML Depending on how and when we create our models and which details they show, we can use UML in fundamentally different ways. We can roughly outline three degrees, levels or modes how UML can be used: UML as Sketch: This means to use UML in a very informal way, maybe without paying too much attention on the detailed syntax. The sketches can be done on a whiteboard during a discussion or a piece of paper. The point may only be to illustrate a certain point and then throw the diagram away again. A UML sketch of a system can also be a simple diagram in a document that highlights some aspect of a system. This kind works both forwards and backwards, this means we can either first sketch the system and then build it (forward) or first program the system and then illustrate it (backwards). UML as Blueprint: At this level, modeling can also happen forward or backward, but the models are much more complete and describe to a much higher degree what has been built or what needs to be built. Plans can be made based on these models, and teams can share work based on them. Often, UML as a blueprint is supported by special tools for computer-aided systems engineering (CASE). UML as Programming Language: Finally, at this level UML is used like a (graphical) programming language from which the system can be implemented or executed directly. This implies that UML is used on a very detailed level. There exists an "executable" version of UML that has exactly this as an aim. Depending on whom you ask, you may hear very strong arguments for any of these ways of using UML. Which one is the "right" one depends on many factors, and may differ from project to project and development team. But independent of that, any of these levels can produce models that have some value: "Just sketching" doesn't mean a model is not valuable. In this course, we are going to use UML mostly as a blueprint and as a sketch. Views and Diagrams The model of a building can have different views, like showing the building from different perspectives. There can also be plans for different parts of the infrastructure, like one plan showing the electricity, one focusing on ventilation and another on fire safety. Similarly, the UML model of a system provides different views on it using various diagrams. These diagrams are like a window into the model. For instance, a physical view can show how a system is organized into nodes and distributed (deployment diagram). Another dynamic view can show how a component behaves in terms of state machines and interactions. Yet another structural view can show how the use cases in a system are organized. These different views all provide perspectives on the same model, and ideally, are consistent with each other. Deployment diagrams are useful at all stages of development. They provide a physical view of the system, and show the files and the devices they run on. In particular, they show: the coarse structure of a system which devices are involved how devices are connected to each other which devices run which software Below is an example for a deployment diagram, showing the elements of a fitness tracker (here a Fitbit) and how it works together with a mobile phone and the server backend. Deployment diagram for a health monitor, consisting of server, PC and mobile pone and the actual health monitoring device. What can we learn from this diagram? To the left, there is the Fitbit server, which is connected via HTTPS to a PC and the mobile phone of a user. On the PC, a browser is running. On the mobile phone, we have an application. The Fitbit is connected to PC and mobile phone via Bluetooth. When we apply some color, we can see that deployment diagrams basically consist of three types of modeling elements: Nodes that represent hardware devices and software execution environments (in blue). In other words, locations in the system that can execute software. Connections that represent communication between nodes (in red). Software artifacts that are assigned to nodes (in yellow). Colored version of the original deployment diagram. Nodes: Devices Devices are shown as a 3D-box with «device» printed at its top. The funny brackets are called guillemets and are each a single character. This is a notation for stereotypes, which are a kind of marker in UML. Examples for devices are: PC Raspberry Pi Mobile Phone Tablet iPhone server gateway ... These device types are not built into UML, you can decide on your own. Which ones make sense depends on your project. Is it relevant and informative that you are talking about a Raspberry Pi? If yes, fine! If it doesn't matter, use a more generic device type. Nodes: Execution Environments Software does often not directly run on hardware, but on some execution environment. If you want to show this, you can use a node (again with 3D effect) and the stereotype «execution environment». Examples for execution environments are runtime environment, application server, web server, operating system, Java virtual machine (JVM) or a container system like Docker. Nested Nodes In some cases it makes sense to show nested nodes. You can show a device inside a device, for instance when you want to show a disk inside a PC or a trusted computation element in a phone. Other hardware elements within a device can be memory. You should only show such elements if there is something special you want to point out. Like a special type of memory that is critical for the system, or the trusted computation element that enables new use cases. Usually, execution environment are contained within devices, since software needs to run on some hardware. The only reason not to show a device and have an execution as its own top-level element is when the hardware it necessarily runs on is obvious from the context or not important at all. One thing is sure, however: execution environments cannot contain devices. In some cases, you might want to points out that an execution environment is nested inside another execution environment, like when you want to point out that Python runs within Docker, in a Linux operating system on a server. Again---assess for your specific case which information is relevant. Devices can be nested inside devices, if it is worth emphasizing them. Showing Node Instances Sometimes you want to show several nodes of the same type, but want to express that these are different instances. Example, an airport gate with several passenger turnstiles, that are physical identical. For that, you just include the instance name in front of a colon, like t1: Turnstile. In addition, you underline to make clear that you refer to a specific instance. Two instances of the same type of device. Communication Paths When two nodes communicate, they are connected by a solid line. This line can be labelled with a stereotype that says something about the way of communication, by referring to a standard or a protocol, as for instance: «http» «mqtt» «amqp» «tcp/ip» or «tcp» «bluetooth» «CoAP» Artifacts The software itself that runs on hardware and inside execution environments comes in the form of artifacts. They are shown as simple rectangles, with «artifact» written at the top. They can represent any artifact we find in software, for example: Database firmware device driver configuration files (.xml, .txt, .properties,...) source files (.java, .py, .c) library files (.dll, .jar) executable files (.exe, .jar, .c) Deploying Artifacts Software artifacts run within an execution environment or directly in a hardware nodes. There are two ways to assign a software artifact into a node: Simply by drawing it into the node, that means, graphically by nesting. By connecting them with a dashed line arrow labelled «deploy» Below you see the two ways of deploying an artifact into a node. Both are semantically equivalent (they mean the same thing), but the graphics are different. Depending on how many artifacts to deploy and other layout constraints, either of them can be more compact and practical to use. Two ways of showing deployment. Both ways have the same meaning, but look different graphically. Manifestation The software in an artifact can itself represent something we have modeled, like a UML component. This means that an artifact manifests other modeling elements. In the example below, we show that the UML component Traffic Light Logic is manifested by the artifact traffic-light-firmware.c, using a dashed arrow with the stereotype «manifest». This means that there is a UML description of a traffic light encapsulated by the component Traffic Light Logic. This can be for example a state machine that describes in which sequences the traffic light cycles through red, yellow and green. (We will work with state machines later.) The state machines and the component, however, are only descriptions but cannot be executed on their own. For that, we need the code provided here by the artifact traffic-light-firmware.c, which implements for instance the component and state machines for the traffic light. With the stereotype «manifest» we can show that a UML element (here a component) is used to describe the contents of a software artifact. Hint: The difference between artifacts and nodes may appear subtle in some cases. Nodes that are devices describe physical pieces of hardware that you can touch. Artifacts, on the other side are often files, like source files or executable files for a program. They are real, but you cannot touch them. Execution environments, which are nodes, are a bit more subtle. You cannot touch them, but they provide a place of executing software, which comes in the form of artifacts. Notes Similar to comments and documentation in source code, UML diagrams can contain notes. They can capture additional information that cannot be expressed by other elements. Notes can show additional information that is difficult to express in other ways. Multiplicities In some cases we can add useful information to the deployment diagram by showing how many instances of a pair of nodes are connected with each other. A multiplicity specification is a tuple in the form n..m where n denotes the lower bound and m the upper one. (This implies that n is smaller than m.) To keep the upper value unbounded, we use the asterisk *. This leads to the following possible combinations in practice: Multiplicity Shorthand Meaning n..m Minimum n elements, maximum m. (m>n) 0..1 optional value 1..1 1 exactly one 0..* any number of elements, "many" n..* n or more n..n n exactly n Most of the practical combinations of multiplicity bounds. The first column shows the multiplicity in n..m format. The second columns shows an equivalent shorthand notation if there is one, and the third column how the multiplicity it to be understood or pronounced in words. We can use these multiplicities at both sides of a connection between nodes. If no multiplicity is specified, it means *, which implies many. In most practical cases, you don't need to worry much about the multiplicities because they are often implicitly clear from the context. But in some cases you can emphasize details that you consider important. Typical examples are: One Fitbit only can sync with a single mobile phone, emphasized by a one-to-one relationship. One server is connected to many gateways. If the number varies at runtime, use 0..* or * in short, just implying many. Examples of multiplicity between nodes. We have seen above that some nodes in a deployment diagram can contain other nodes, depending on the node types. The following containments are typical: An execution environment can run in a device. An artifact is deployed in a device. An artifact is deployed in an execution environment. The following containments are also possible, but maybe less common. Use them if you want to show a detail that is important to point out, and consider if that makes sense. A device can contain a device. For instance, a computer (device) can contain a harddisk. An execution environment can contain another execution environment. For instance, a virtual operating system container could rund a Python runtime. An artifact could be composite, like a file stored in an archive. The following combinations make no sense: An execution environment cannot contain a device. An artifact cannot contain a device. An artifact cannot contain an execution environment. Communication Path «TCP/IP» «MQTT» «AMQP» «RMI» «CoAP» Nodes «execution environment» «application server» «web server» «operating system» «device» «server» «gateway» «desktop PC» «artifact» «data base» «firmware» «device driver» configuration files source files library files executable files The opinion among student about this series of videos is divided; some find them very useful, others not so much. So have a look at some and decide for yourself. If you want, have a look at the following videos that show how to create deployment diagrams.

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