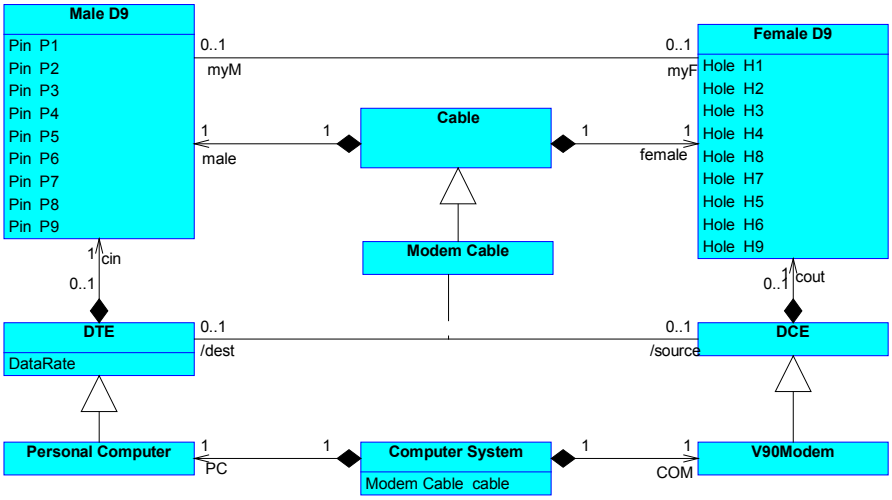
The UML™ for Systems Engineering Initiative Part Three

Introduction. In the last two articles we looked at the background to SysML, which areas of UML may be modified to support systems engineering, and at some of the new diagrams. In this article, we will look at some of the modifications that will be made to the Structure Diagram, a new UML 2.0 diagram. This diagram is used to show structures, parts of those structures, ports, which are the interfaces to the structures and their contained elements, and connectors, which connect Structured Classes and parts. In this article, I will concentrate on the extensions made for SysML. For more information on the Structure Diagram, refer to the UML 2.0 specification.

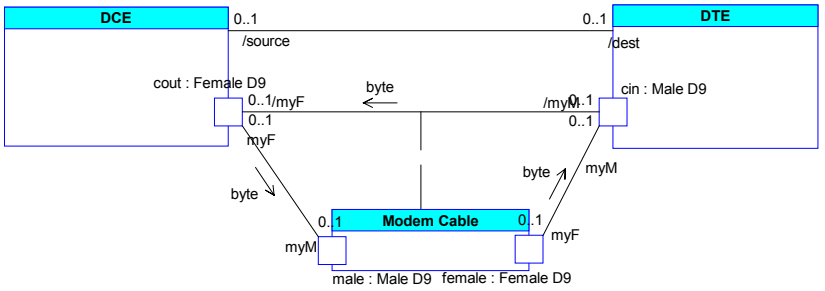
SysML extends UML classes, which describe the parts of an object, and links between the parts. Each instance of the Structured Class has the same pattern of interconnected parts. This means that complex architectures can be defined and reused throughout the model. The structure of these Classes may be applied recursively to define hierarchical composition of arbitrary depth. Of course, structure is not exclusively through recursive decomposition, as a component based architecture based on a network or collaborating components is equally valid. Structured Classes can represent any level of the system hierarchy, including the top-level system, a subsystem, or logical or physical component of a system or environment.

Parts are roles in a Structured Class that are filled by particular objects when the class is instantiated. Similarly, connectors between the parts/roles are filled by links between the particular objects when the Structured Class is instantiated. Ports are a special kind of part that gives access to internal structure from the outside of a composite object. In SysML, unlike UML, Ports can also be complex hierarchical structures. Composite class structures can be the basis for defining interactions between parts. Part connectors can support many forms of interaction, from static, such as a force balance across a physical interface, to dynamic, such as continuous flow of current through a terminal or a discrete series of calls to software services. This will allow Systems Engineers to more correctly describe systems with UML that are not purely software.

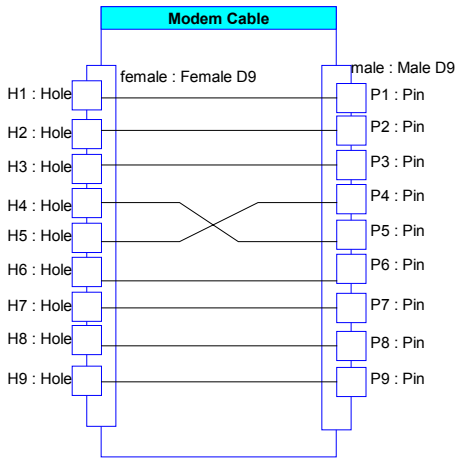
To illustrate these concepts, I'll use the well-understood example of a modem connecting two computers together. The class diagram shows a Computer System class at the bottom, with a Modem cable attribute. The Cable class in the centre is a composite aggregation of a Male D9, and a Female D9 class. The Male D9 contains numbered Pins and the Female D9 contains numbered Holes. These D9 classes are also associated with each other. Finally, towards the bottom of the diagram, the Modem Cable is a type of Cable that connects a DTE and DCE, which contain respectively Male and Female D9 classes. A Personal Computer is a type of DTE, and a V90 Modem is a type of DCE.



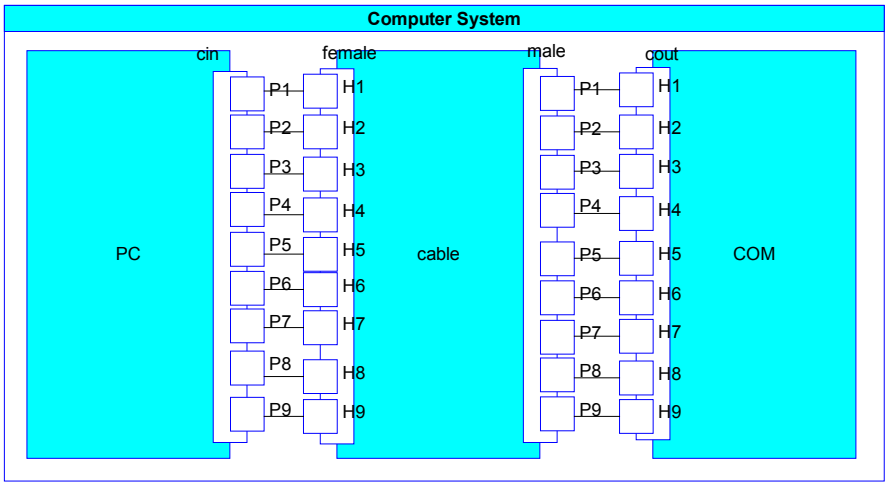
This is illustrated in the following SysML System Structure Diagram. The DCE and DTE are connected, with roles marked as source and destination. The Modem Cable is the association class modelling the connection between the two ports, which are marked as Male and Female D9 connectors. There are flows shown on the connections showing bytes flowing between the two systems in this example. Structure Diagrams can also depict the flow of electrical characteristics of the connectors such as voltage or current.



The Modem Cable is detailed next. As shown in the class diagram, it contains two ports, a Male D9 and a Female D9. Again, the Female D9 contains 9 Holes and the Male D9 contains 9 Pins. This type of complex interface would not be possible with UML 2.0. Also note that it is possible to show crossovers in the modem cable. The example shows a crossover between Pins and Holes 4 and 5.



In the final diagram, all this is brought together. The Computer System is made up of a Personal Computer (PC), and a COM device, which is an instance of a Modem, which is connected together by the cable. Flows can also be shown on the links, if required. As with the rest of SysML, work is still being done on these diagrams and may change before the final specification is released. This is currently scheduled for August 2004.



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If you have any questions, please feel free to email me at MatthewH@Artisansw.com. These can be obtained from the OMG and SysML web sites. More information on SysML in general can be found at www.sysml.org.