# Components and Deployment Diagrams

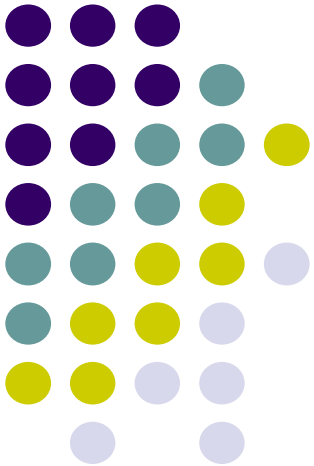
Components and Component Packages

Dependencies

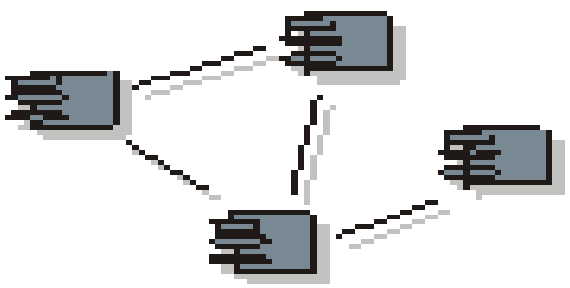
Processors and Devices

Connections

Examples



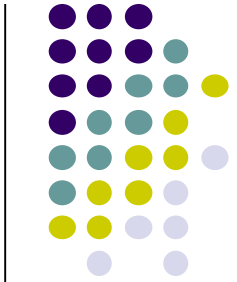
# The Implementation Model in the Component View



An **implementation model** is a collection of components, and the implementation subsystems which contain them.

A **component** diagram has a higher level of abstraction than a Class Diagram - usually a **component** is implemented by one or more classes (or objects at runtime).

# Components



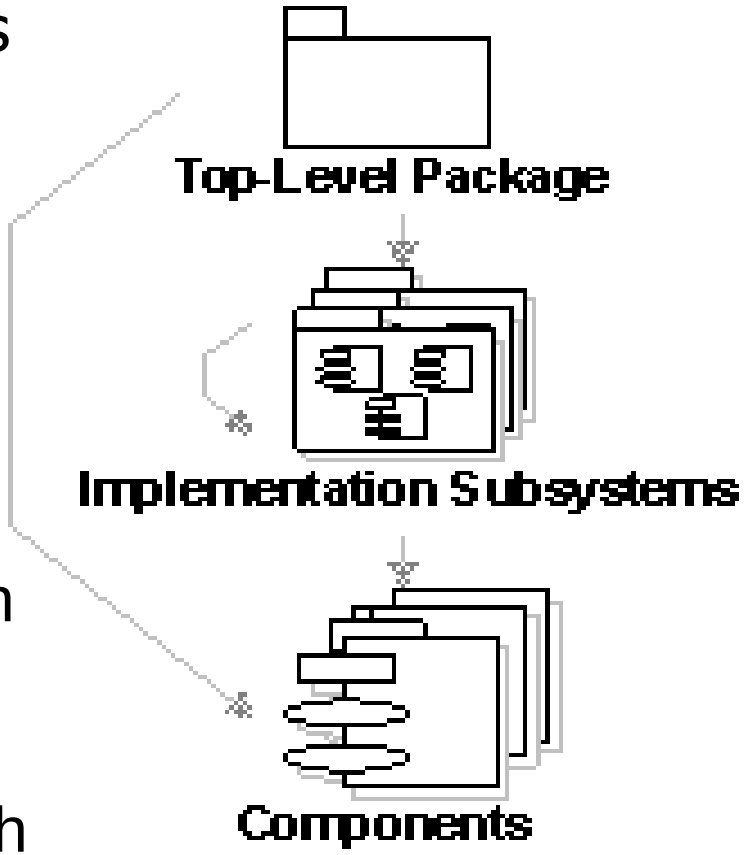
- Components are building blocks so a component can eventually encompass a large portion of a system.

- Components include both deliverable components, such as executables, and components from which the deliverables are produced, such as source code files.

# Implementation Model in the Component View

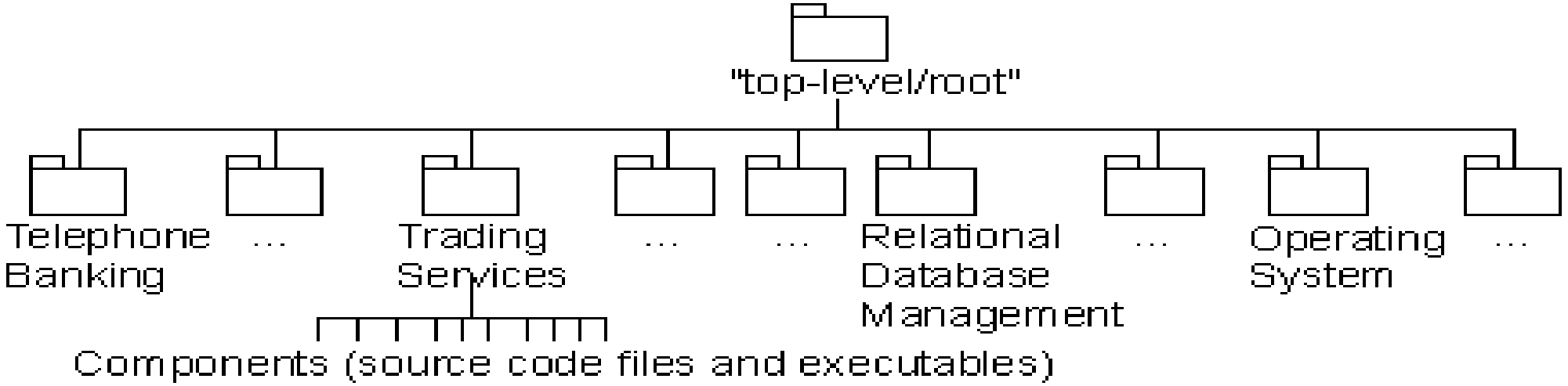
The implementation model is a ***hierarchy of implementation subsystems***, with leaves that are components. There is a package that serves as the top-level (root) node in the implementation model. A subsystem is a collection of components and other subsystems.

The implementation model can be divided into components that are ***deliverables***, such as executables that are delivered to customers; and those ***components from which the deliverables are produced***, such as source code.



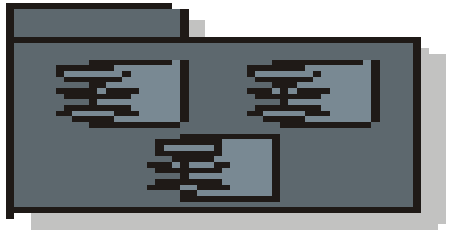
# Implementation Model - Example

Example: In a banking system the implementation subsystems are organized as a flat structure in the top-level node of the implementation model. Another way of viewing the subsystems in the implementation model is in layers.




**The implementation model for a banking system, showing the ownership hierarchy.**

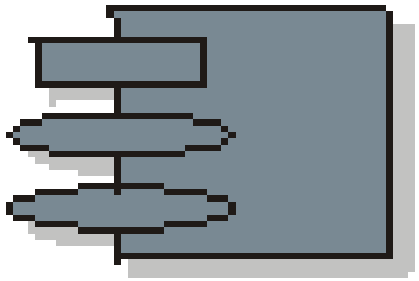
# Implementation Subsystems. Component Packages.



An **implementation subsystem** is a collection of components and other implementation subsystems that are used to structure the implementation model by dividing it into smaller parts.

*Subsystems* take the form of directories, with additional structural or management information. For example, a subsystem can be created as a directory or a folder in a file system, or a subsystems in Rational for C++ or Ada, or packages using Java.
*Component packages* represent clusters of logically related components, or major pieces of your system. Component packages parallel the role played by logical packages for class diagrams. They allow you to partition the physical model of the system.

# Components

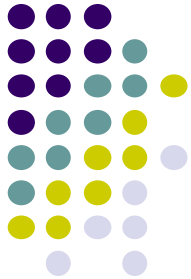


A **component** represents a piece of software code (source, binary or executable, relational schema), or a file containing information.

A component can also be an aggregate of other components (i.e., an application consisting of several executables can be a component).

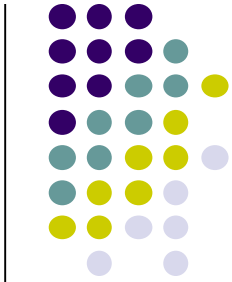
Components may have stereotypes: <<component>>, <<subsystem>>, ….

# Components - examples



| **Examples of deliverable components** | |
|---|---|
| Executables | .exe files |
| Load libraries | .dll files |
| Applets | .class for Java |
| Database tables | SQL scripts |
| **Examples of components from which deliverables are produced** | |
| Source code files | .h, .cpp and .hpp files for C++, CORBA IDL, or .java for Java |
| Binary files | .o files that are linked into executables |

# Components and packages



- Components are similar in practice to package diagrams, as they *define boundaries* and are used to *group elements into logical structures*.

- The difference between package diagrams and component diagrams is that Component Diagrams offer *a more semantically-rich grouping mechanism*.

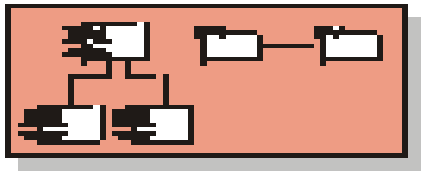
# Components – presentation and specification

An interface circle attached to the component icon means that the component supports that particular interface. There is no explicit relationship arrow between a component and its interfaces.

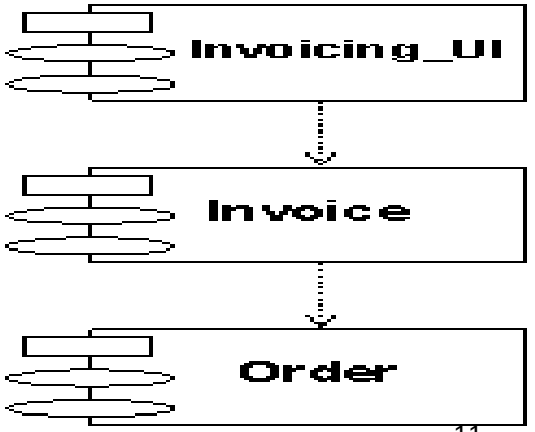

Component Specification contains tabs such as:

- General – ***stereotypes*** (Main Program, Package Body, Package Specification, Subprogram Body, Subprogram Specification, Task Body, and Task Specification) and ***language***
- Detail – ***declarations*** (as **`#Include`**)
- Realizes – classes building the component
- Files - attached files or URLs

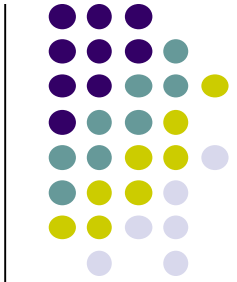
# Component Diagrams. Dependencies

| | |
|---|---|
|  | A **component diagram** shows a collection of declarative (static) model elements, such as components, and implementation subsystems, and their relationships. |
|  | A **dependency** from a component A to a component B indicates component A has a *compilation* dependency, or a *run-time* dependency to B. |

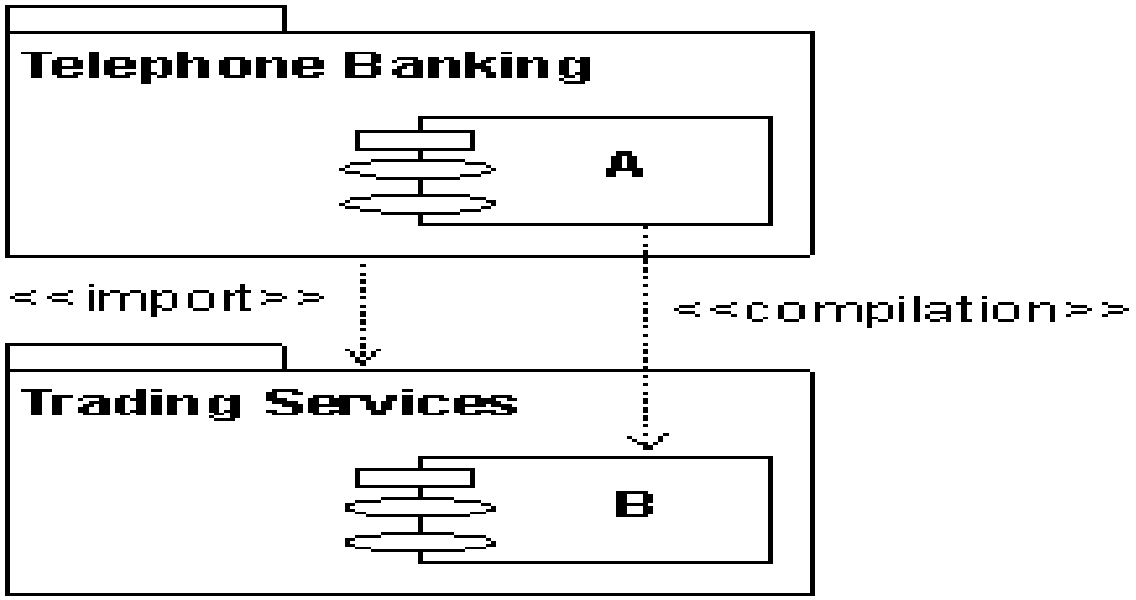
A **compilation dependency** exists from one component to the components that are needed to compile the component (i.e., **`#include`** statements in C++, or **`import`** in Java).
Example: Invoicing_UI (the top), requires Invoice, which requires Order to compile.



# Import Dependency Among Packages



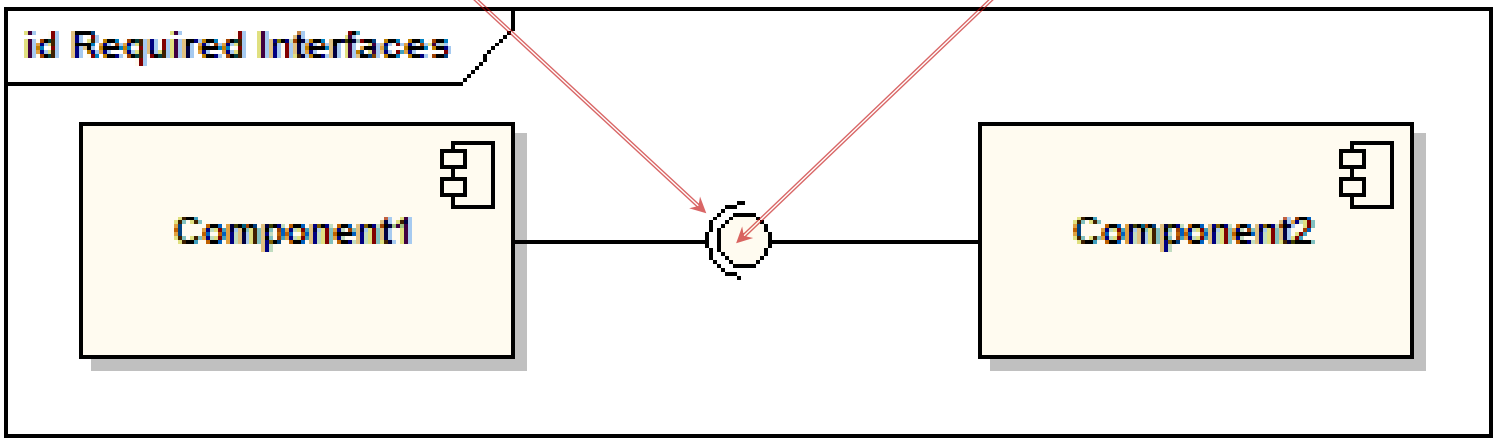
- An **import dependency** in the implementation model is a stereotyped dependency whose **source** is an *implementation subsystem* and whose **target** is another *implementation subsystem*.
- A component in a client subsystem can only compile against components in a supplier subsystem, if the client subsystem imports the supplier subsystem.




**The subsystem Telephone Banking has an import dependency to the subsystem Trading Services, allowing components in Telephone Banking to compile against public (visible) components in Trading Services.**

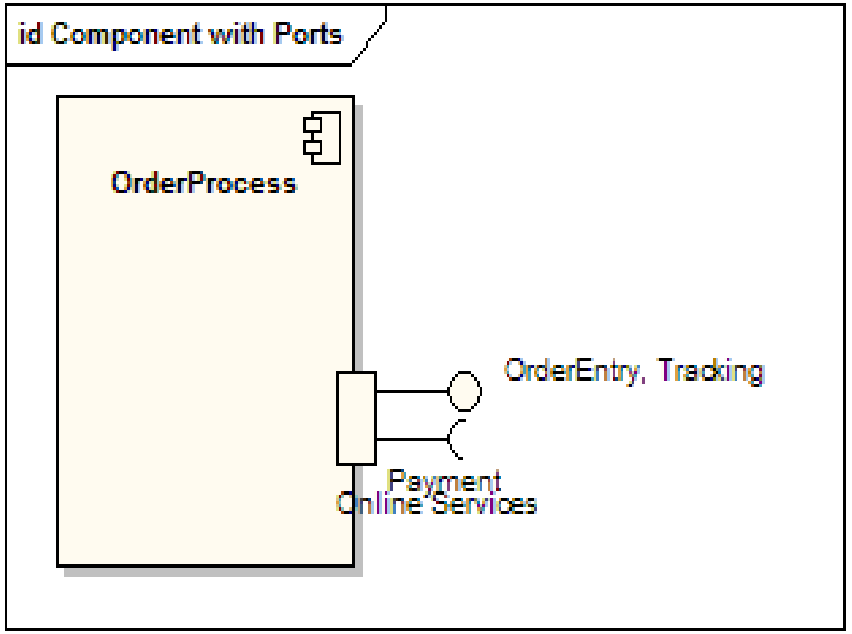
# Assembly connectors (UML 2.*)

- The assembly connector bridges a component's *required interface* (Component1) with the *provided interface* of another component (Component2);
- The assembly connector allows one component to provide the services (the boll) that another component requires (the socket).

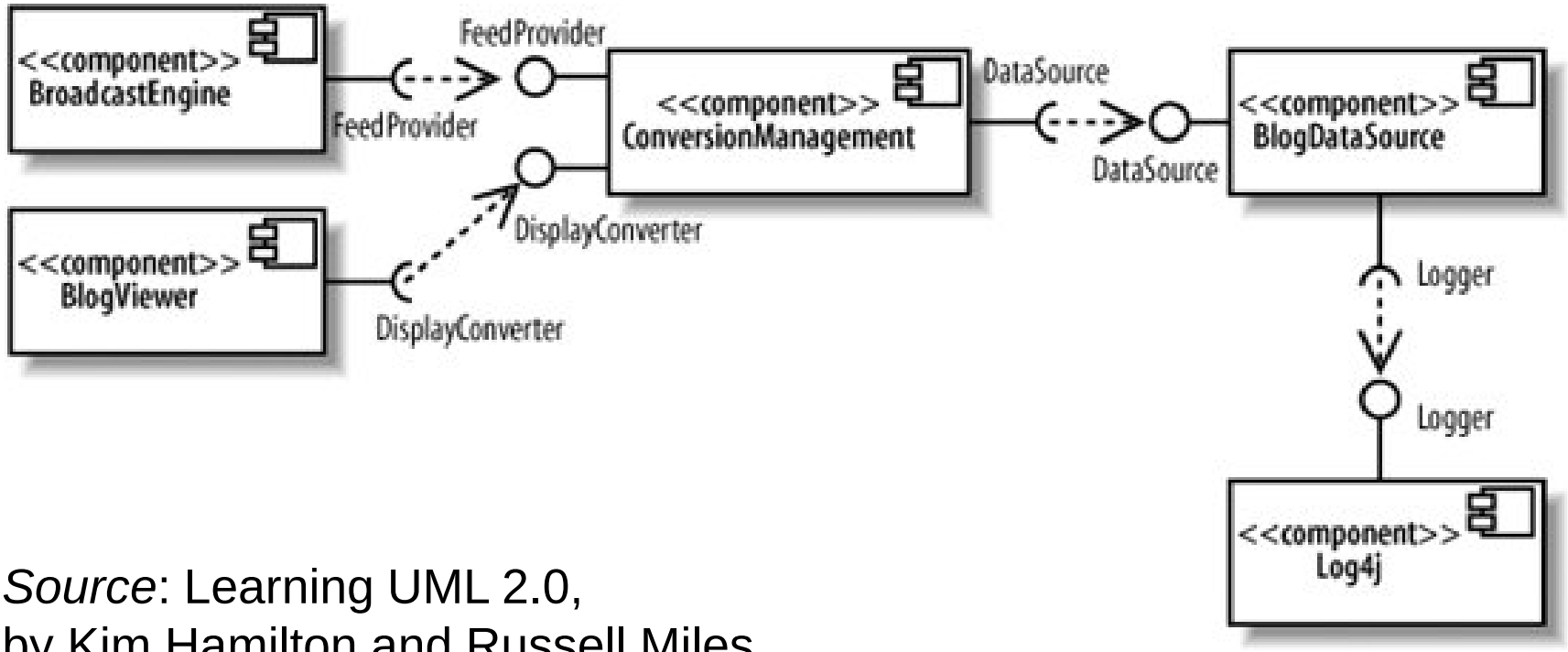


# Components with *ports* (UML 2.*)

- ***Ports*** model related interfaces
- They allow for a service or behavior to be specified to its environment as well as a service or behavior that a component requires.
- Ports may specify inputs and outputs as they can operate bi-directionally.
- Example: a component with a port for online services along with *two provided interfaces order entry and tracking as well as a required interface payment.*

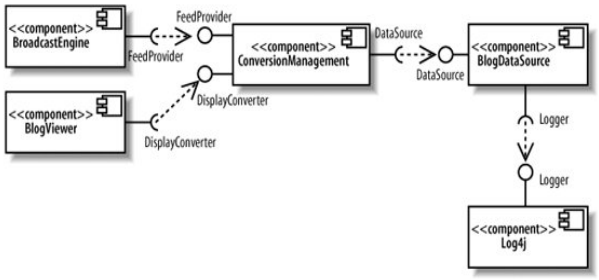


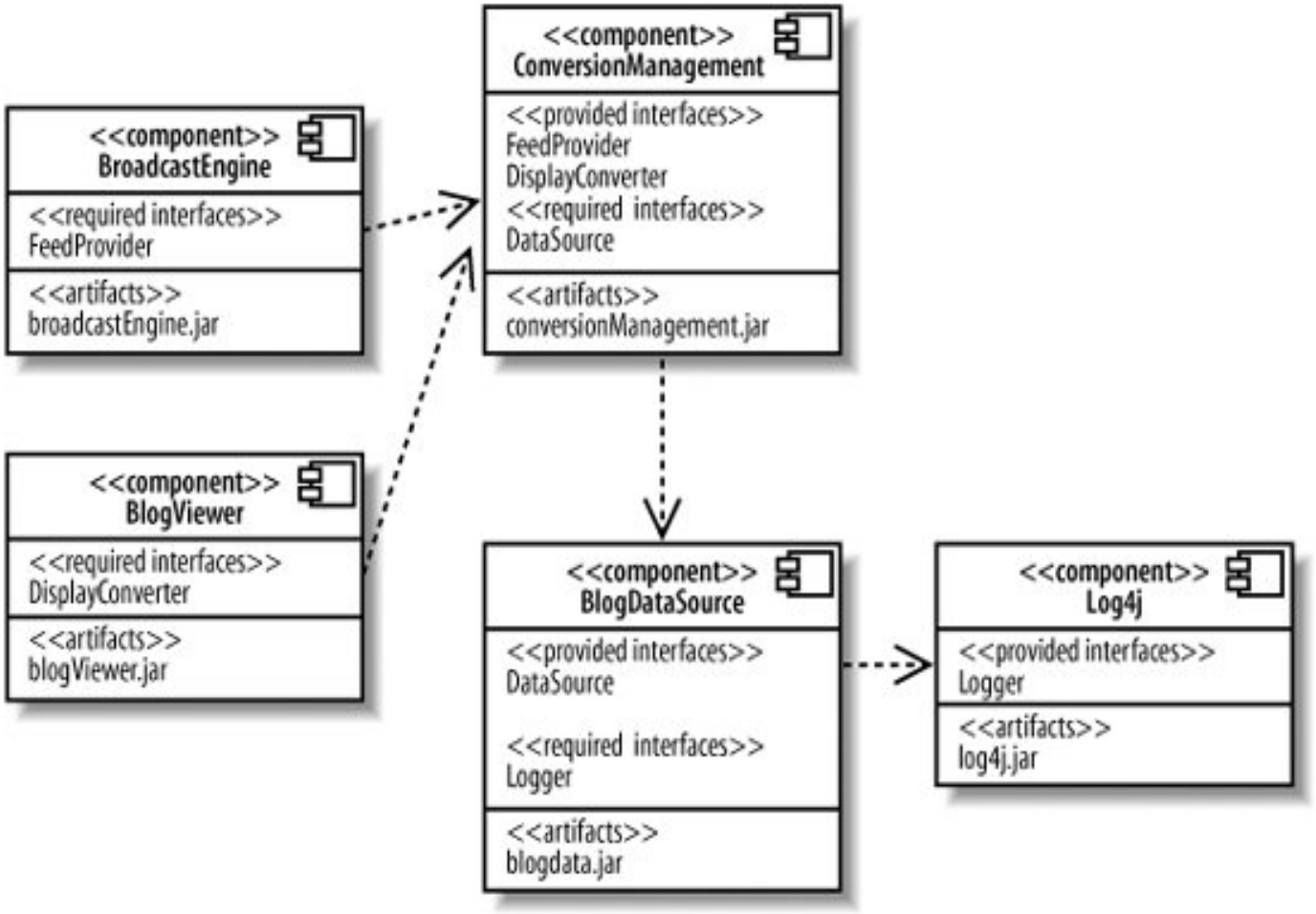
# Focusing on the key components and interfaces




*Source*: Learning UML 2.0,
by Kim Hamilton and Russell Miles,
O'Reilly 2006.

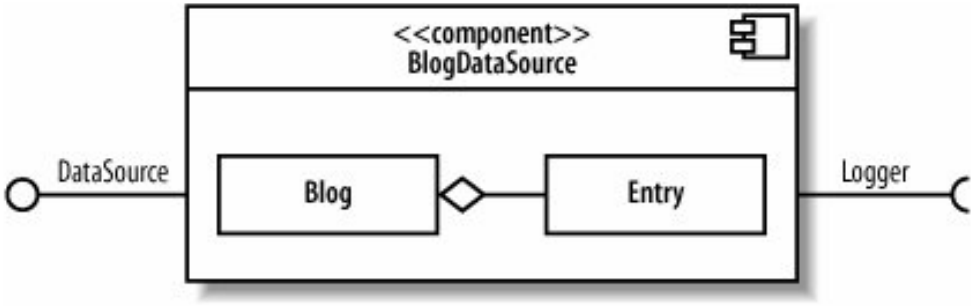
# Focusing on component dependencies and manifesting interfaces

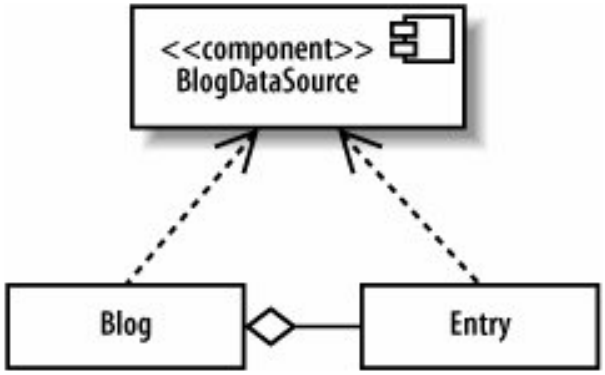


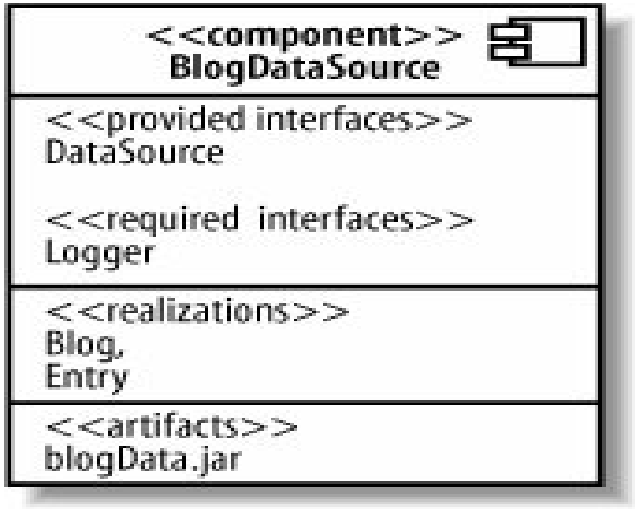




*Source*: Learning UML 2.0, by Kim Hamilton and Russell Miles, O'Reilly 2006.

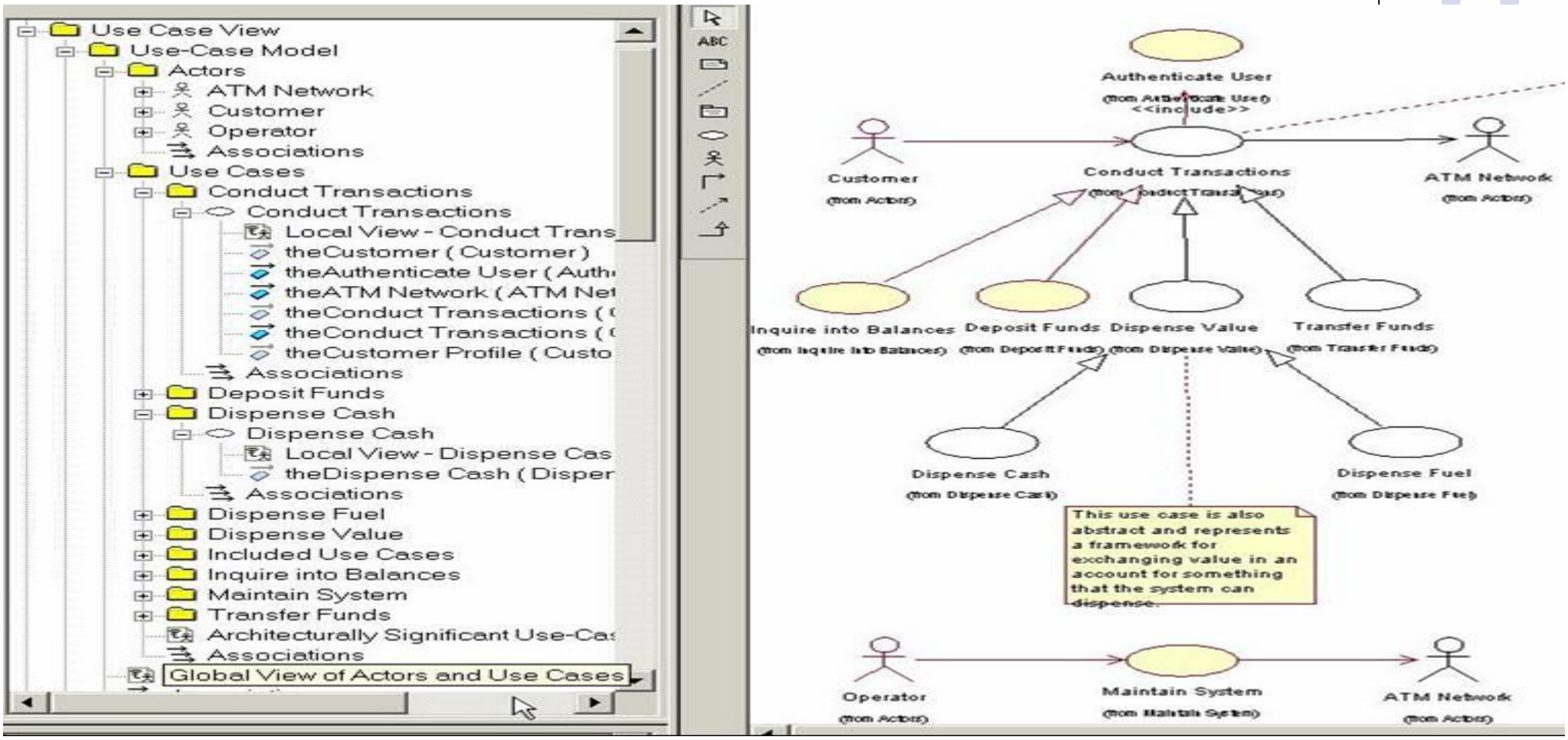
# Classes realizing a component – alternative views



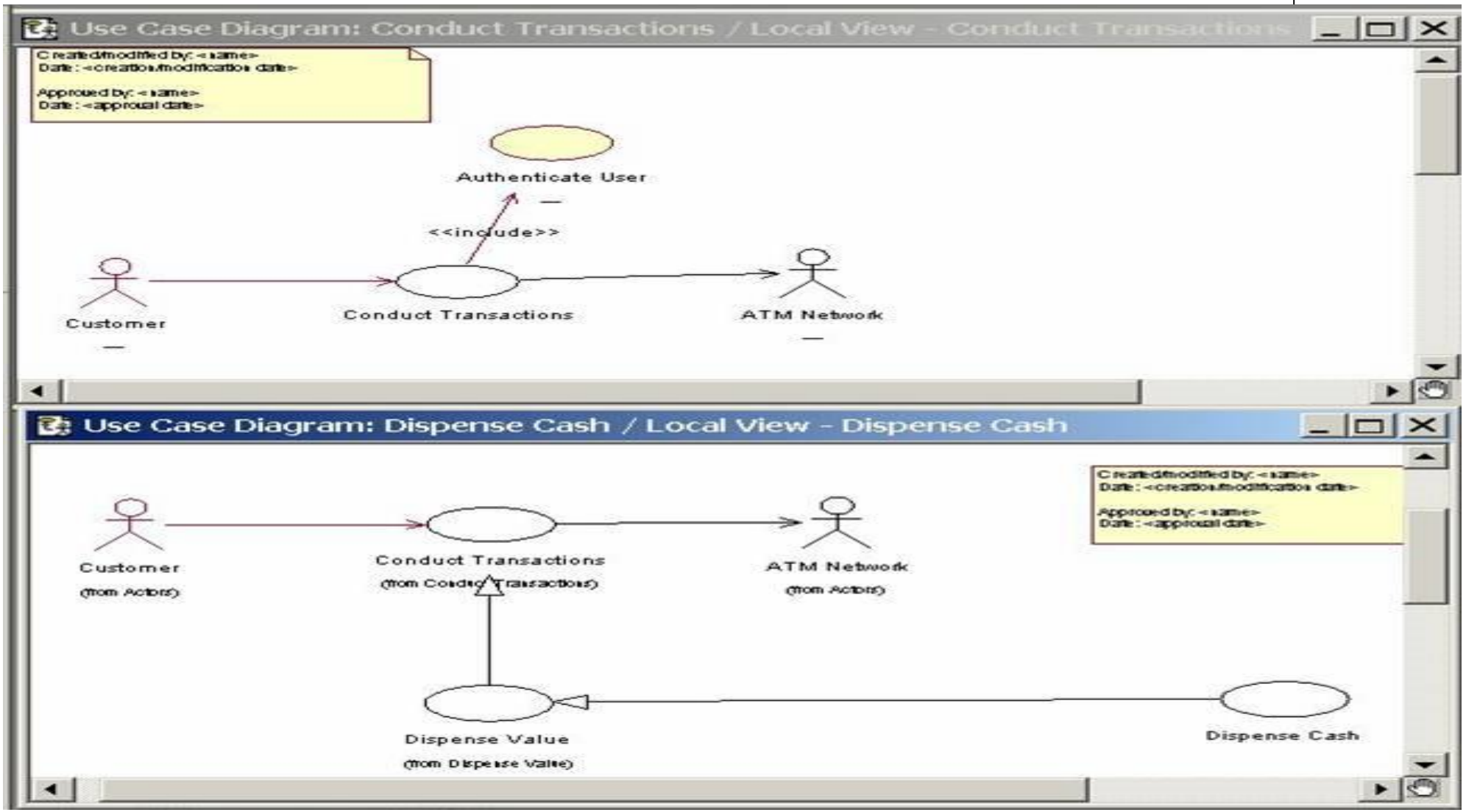



# Case Study: ATM example (IBM Rose XDE)

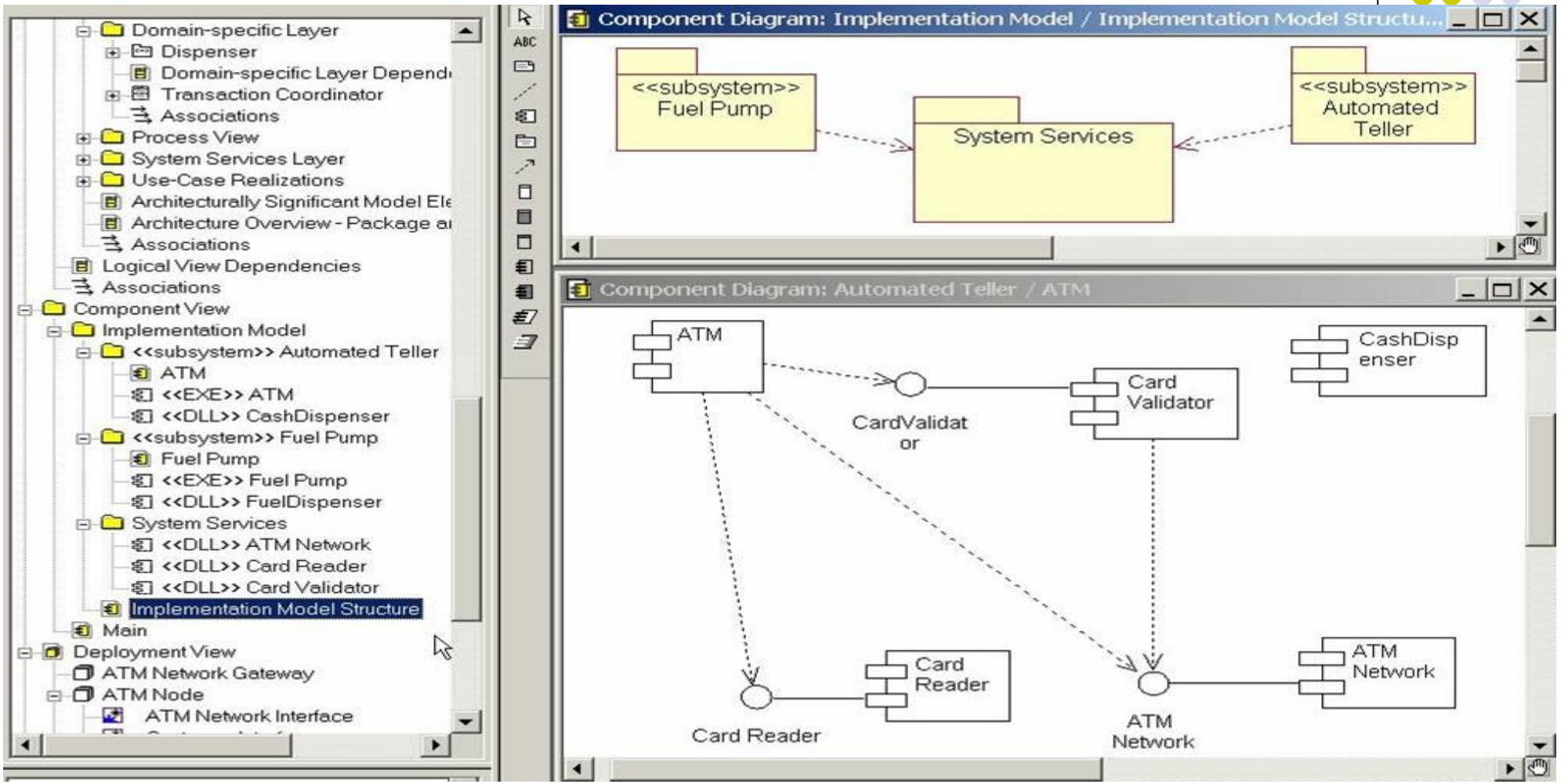



ATM Use Cases and Actors – Global View

# ATM Example – Use Cases Local Views

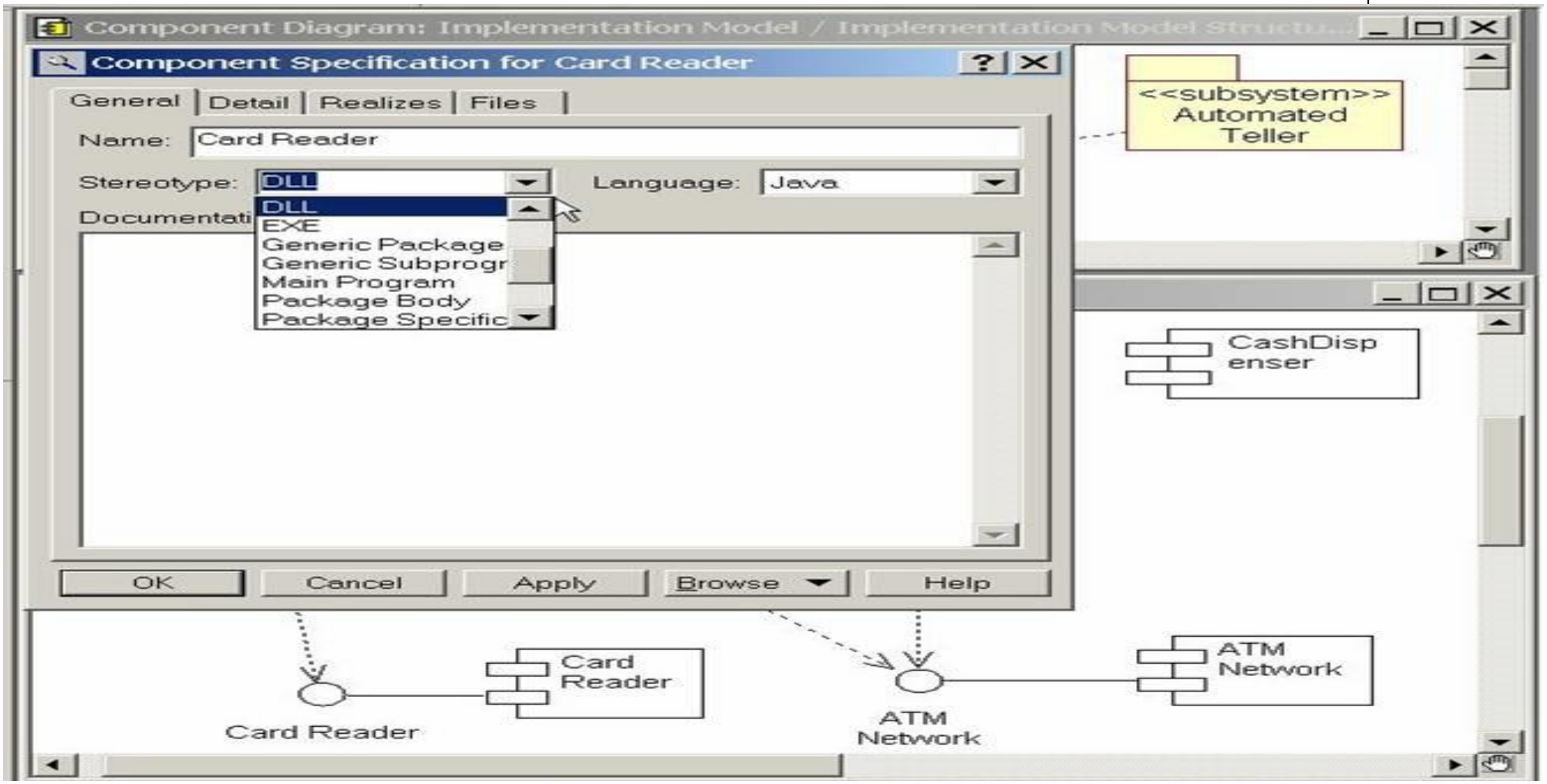


# ATM Example – Component View

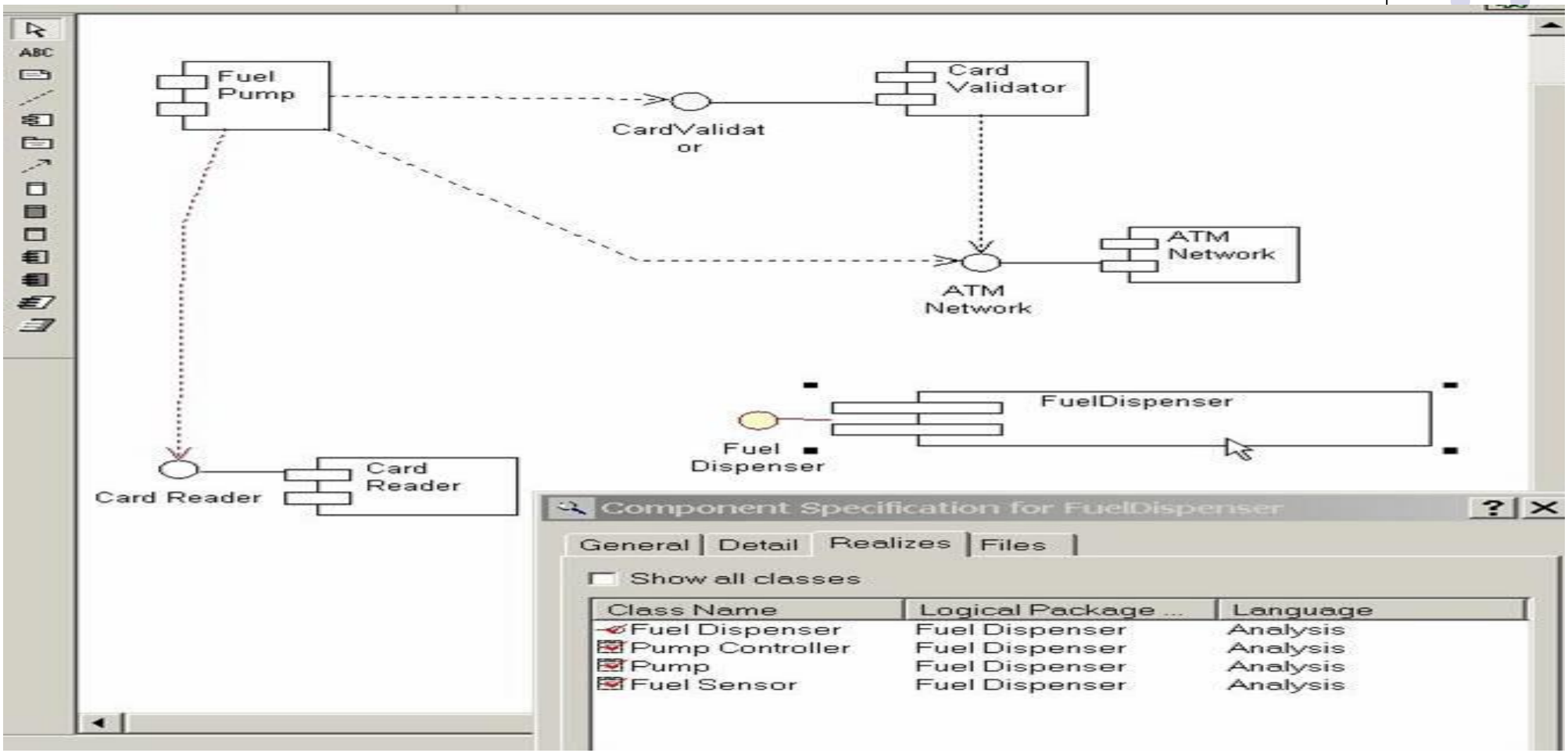



The implementation model is built by three subsystems

# ATM Example: Component Specification

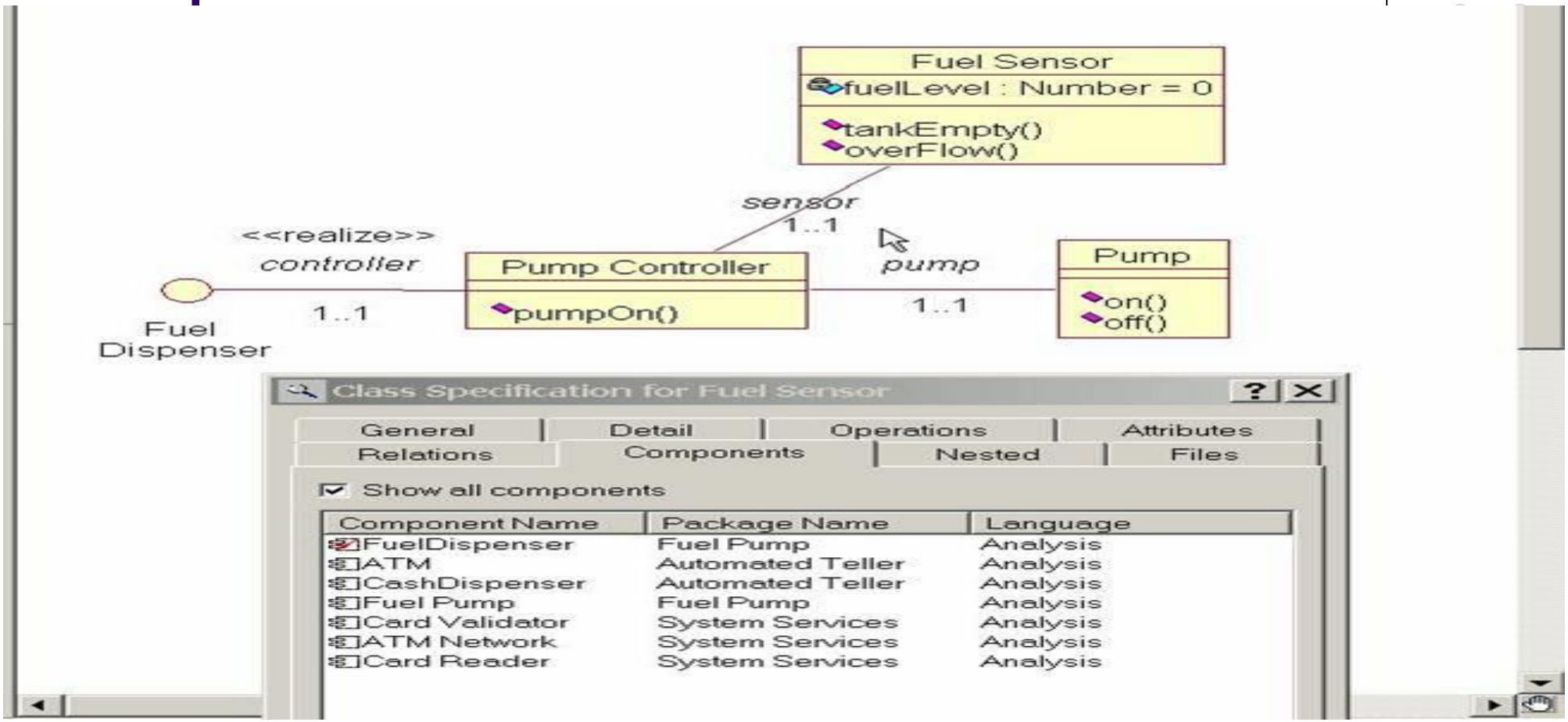


# ATM Example: Component Specification - 2



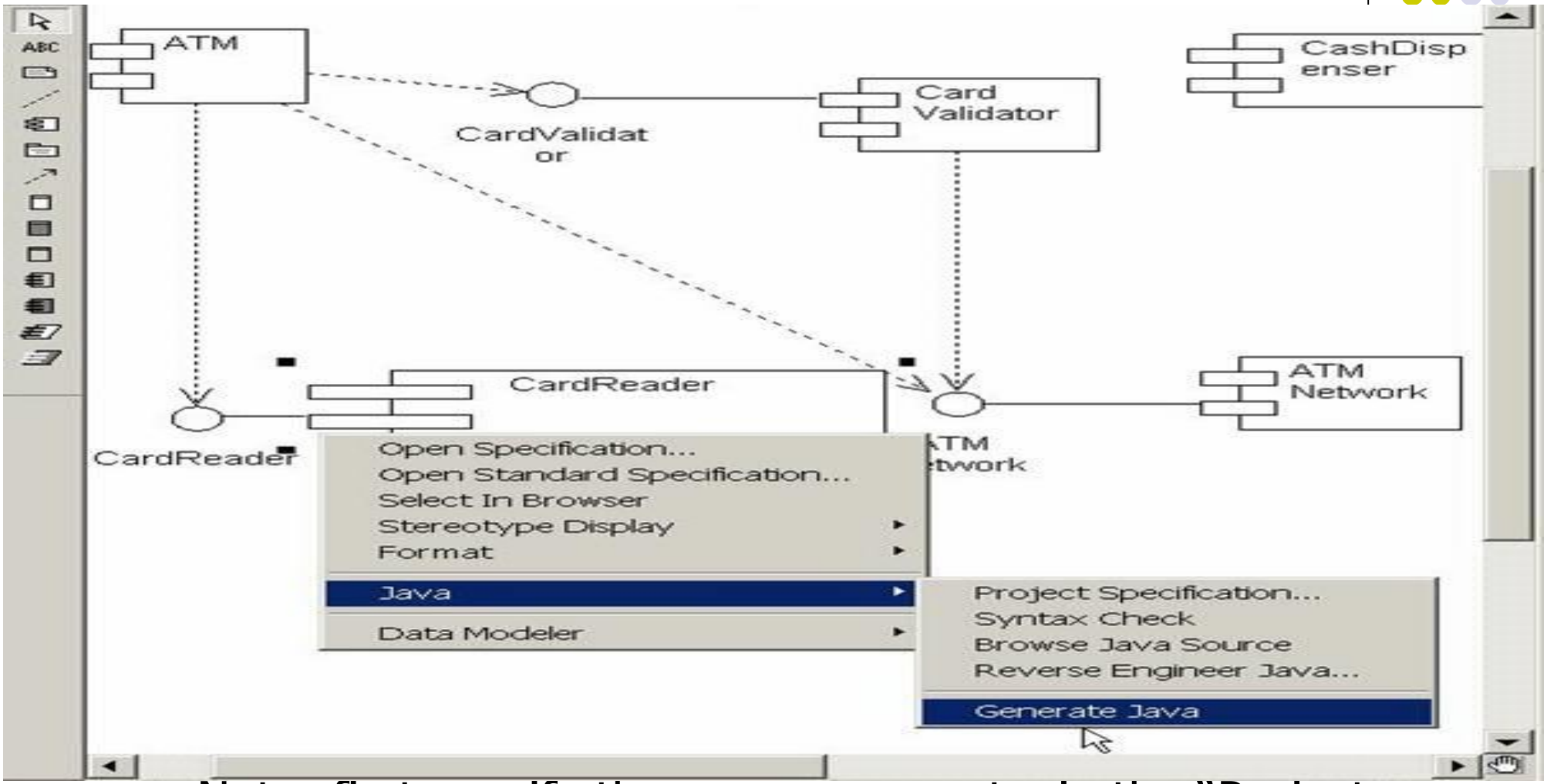

The Fuel Dispenser component realizes one interface and three classes

# ATM Example: Class Specification shows Built Components




The Fuel Sensor is one of the classes building the Fuel Dispenser component

# ATM Example: Code Generation




Note: first specify the **`Classpath`** etc. in the "Project Specification..." menu

# Deployment Diagrams

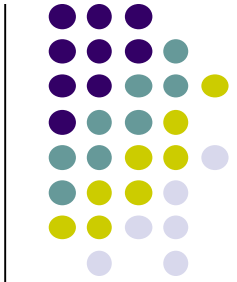
The **deployment architectural view** shows the configuration of run-time processing elements and the software processes living in them. **Deployment diagrams** are created to show the different nodes along with their connections in the system. They represent system topology and mapping executable subsystems to processors.

Issues concerned:

- processor architecture
- speed
- inter-process communication and synchronization
- etc.

A deployment diagram shows processors, devices, and connections. Each model contains a single deployment diagram which shows the connections between its processors and devices, and the allocation of its processes to processors.

# Nodes

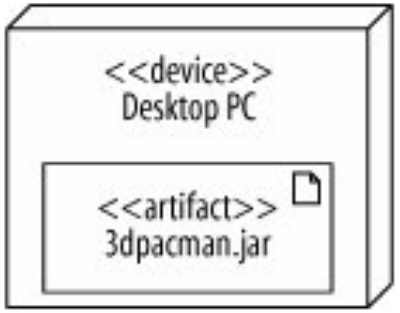


A *node* is a hardware or software resource that can host software or related files. You can think of a software node as an application context; generally not part of the software you developed, but a third-party environment that provides services to your software

| hardware nodes | execution environment nodes |
|---|---|
| Server<br>Desktop PC<br>Disk drives | Operating system<br>J2EE container<br>Web server<br>Application server |

# Artifacts within nodes

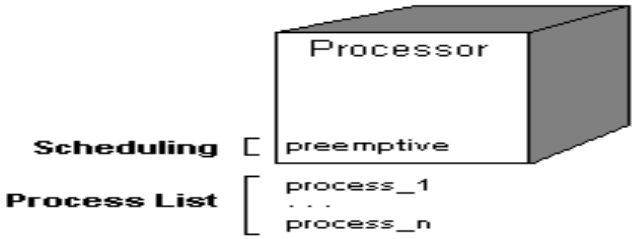
- Drawing an artifact inside a node shows that the artifact is deployed to the node
- But where is JVM? ->




- Your deployment diagrams should contain details about your system that are important to your audience. If it is important to show the hardware, firmware, operating system, runtime environments, or even device drivers of your system, then you should include these in your deployment diagram.

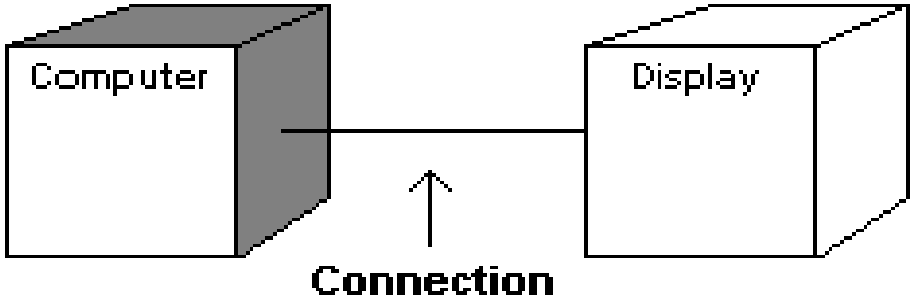
# Processors, Devices and Connections

**Processor** - identify its processes and specify the type of process scheduling (preemptive, non-preemptive, cyclic, executive, manual).

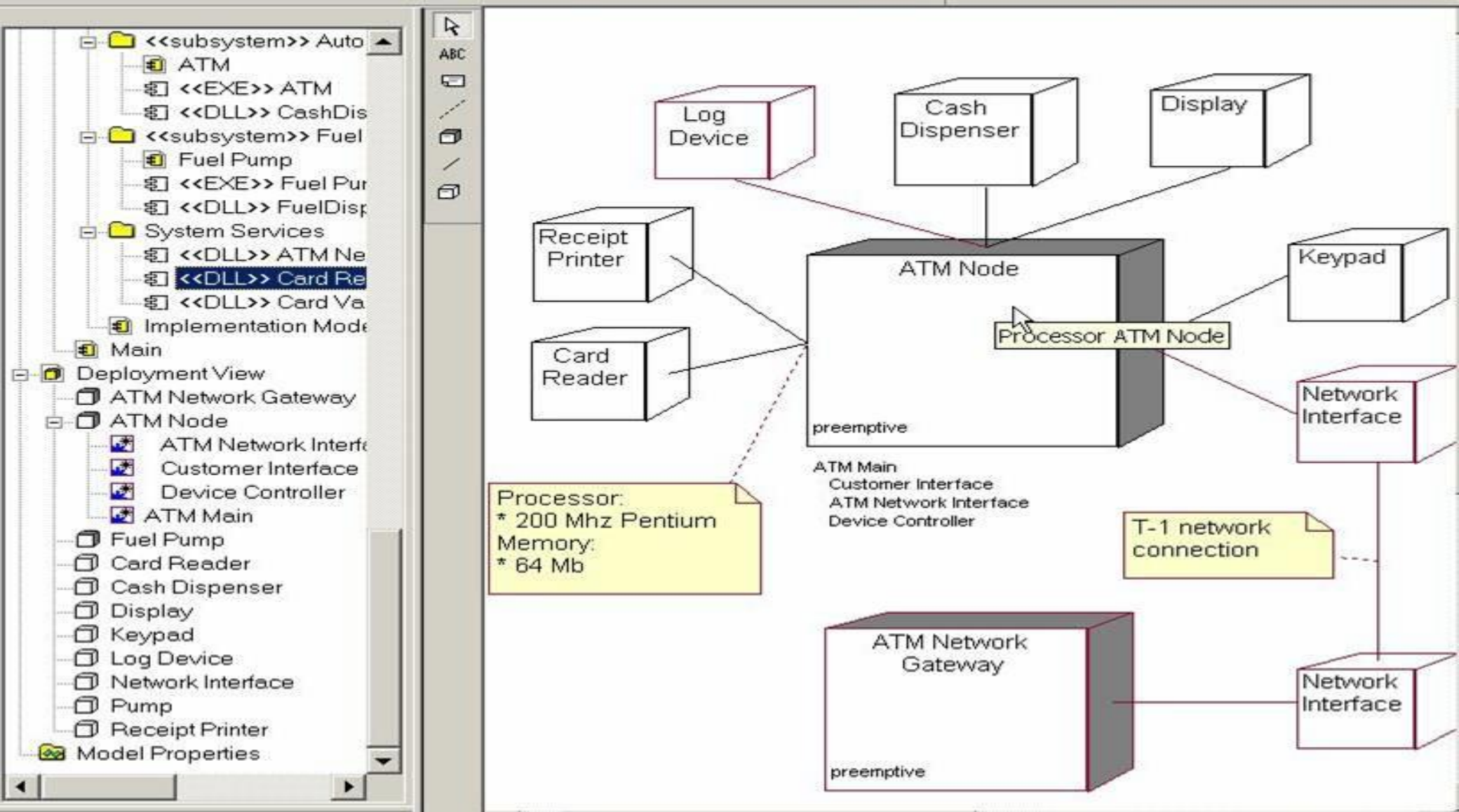



**Device** – in some models: a hardware component with no or restricted computing power (i.e., "modem" or "terminal"); in others: specialization of node.


**Connection** - represents some type of hardware coupling between two entities. An entity is either a processor or a device. The hardware coupling can be direct, such as an RS232 cable, or indirect, such as satellite-to-ground communication.



# ATM Example: Deployment Diagram



# UML deployment diagram [Bruegge & Dutoit]

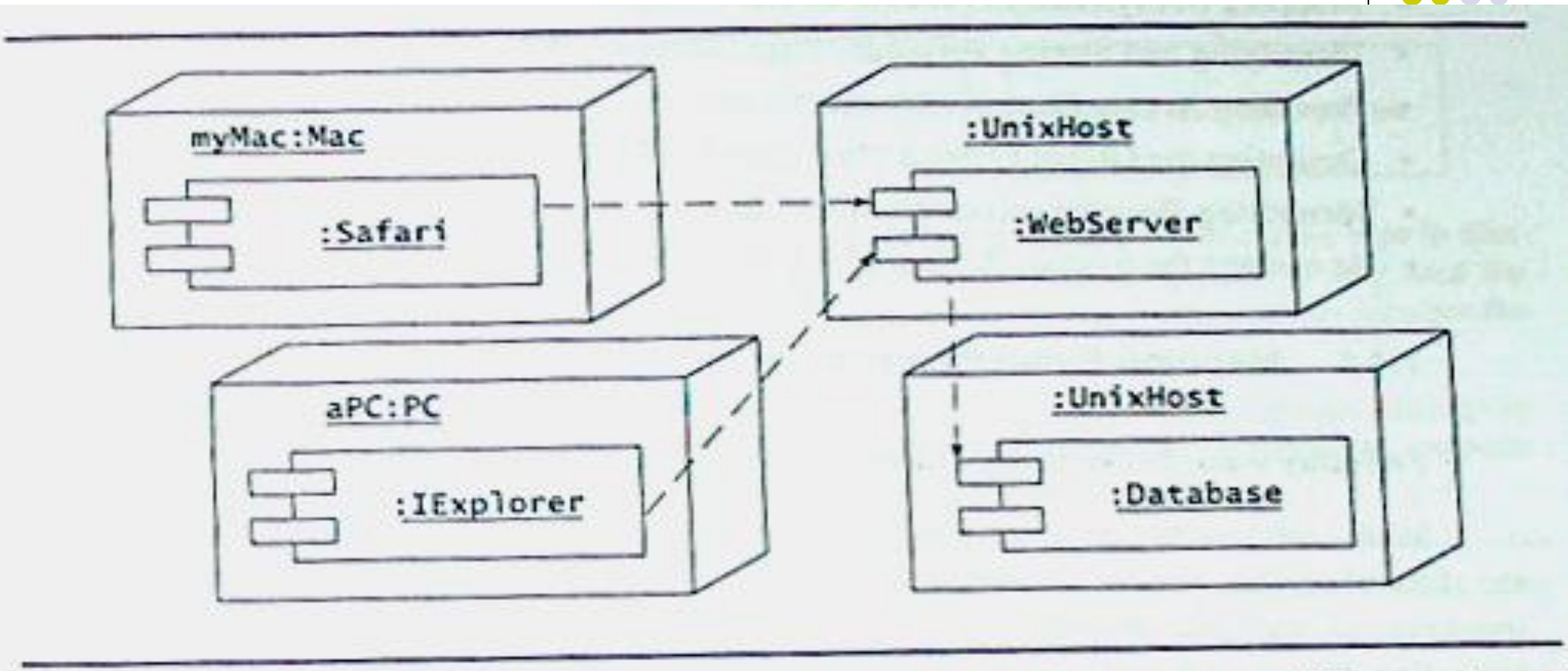



**Figure 7-2** A UML deployment diagram representing the allocation of components to different nodes and the dependencies among components. Web browsers on PCs and Macs can access a WebServer that provides information from a Database.

# The refined diagram [Bruegge & Dutoit]

The deployment diagram in Figure 7-2 focuses on the allocation of components to nodes and provides a high-level view of each component. Components can be refined to include information about the interfaces they provide and the classes they contain. Figure 7-3 illustrates the GET and POST interfaces of the WebServer component and its containing classes.

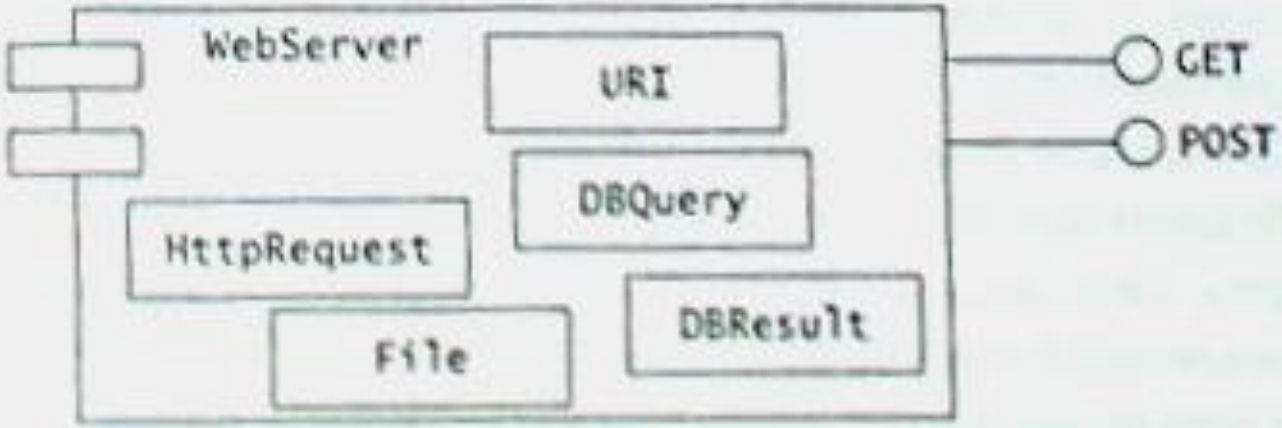
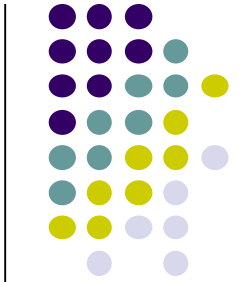



Figure 7-3 Refined view of the WebServer component (UML deployment diagram). WebServer provides two interfaces: a browser can either GET the content of a file referred by a URL or POST a form.

# The MyTrip example [Bruegge & Dutoit]



In MyTrip, we deduce from the requirements that PlanningSubsystem and RoutingSubsystem run on two different nodes: the former is a Web-based service on an Internet host, the latter runs on the onboard computer. Figure 7-4 illustrates the hardware allocation for MyTrip with two nodes called :OnBoardComputer and :WebServer.

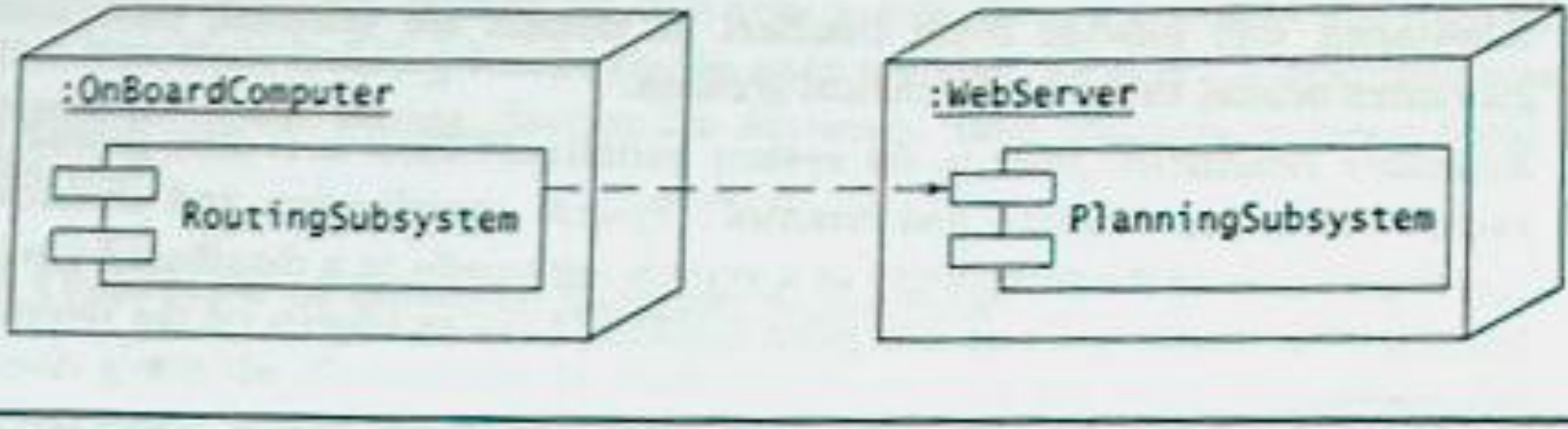



**Figure 7-4** Allocation of MyTrip subsystems to hardware (UML deployment diagram). RoutingSubsystem runs on the OnBoardComputer; PlanningSubsystem runs on a WebServer.

# A real example