Module-4
Software Design and Testing

Vaishnavi
Assistant Professor

Design and implementation

- Software design and implementation is the stage in the software engineering process at which an executable software system is developed.
- Software design and implementation activities are invariably inter-leaved.

  Software design is a creative activity in which you identify software components and their relationships, based on a customer's requirements.

  Implementation is the process of realizing the design as a program.

Build or buy

- In a wide range of domains, it is now possible to buy off- the-shelf systems (COTS) that can be adapted and tailored to the users' requirements.

  For example, if you want to implement a medical records system, you can buy a package that is already used in hospitals. It can be cheaper and faster to use this approach rather than developing a system in a conventional programming language.

- When you develop an application in this way, the design process becomes concerned with how to use the configuration features of that system to deliver the system requirements.

An object-oriented design process

- Object-oriented design processes involve developing a number of diñerent system models.
- They require a lot of effort for development and maintenance of these models and, for small systems, this may not be cost-elective.
- However, for large systems developed by diñerent groups design models are an important communication mechanism.

Process stages

- There are a variety of different object-oriented design processes that depend on the organization using the process.
- Common activities in these processes include: Define the context and modes of use of the system; Design the system architecture; Identify the principal system objects; Develop design models; Specify object interfaces.
- Process illustrated here using a design for a wilderness weather station.

System context and interactions

- Understanding the relationships between the software that is being designed and its external environment is essential for deciding how to provide the required system functionality and how to structure the system to communicate with its environment.
- Understanding of the context also lets you establish the boundaries of the system. Setting the system boundaries helps you decide what features are implemented in the system being designed and what features are in other associated systems.

Context and interaction models

- A system context model is a structural model that demonstrates the other systems in the environment of the system being developed.
- An interaction model is a dynamic model that shows how the system interacts with its environment as it is used.

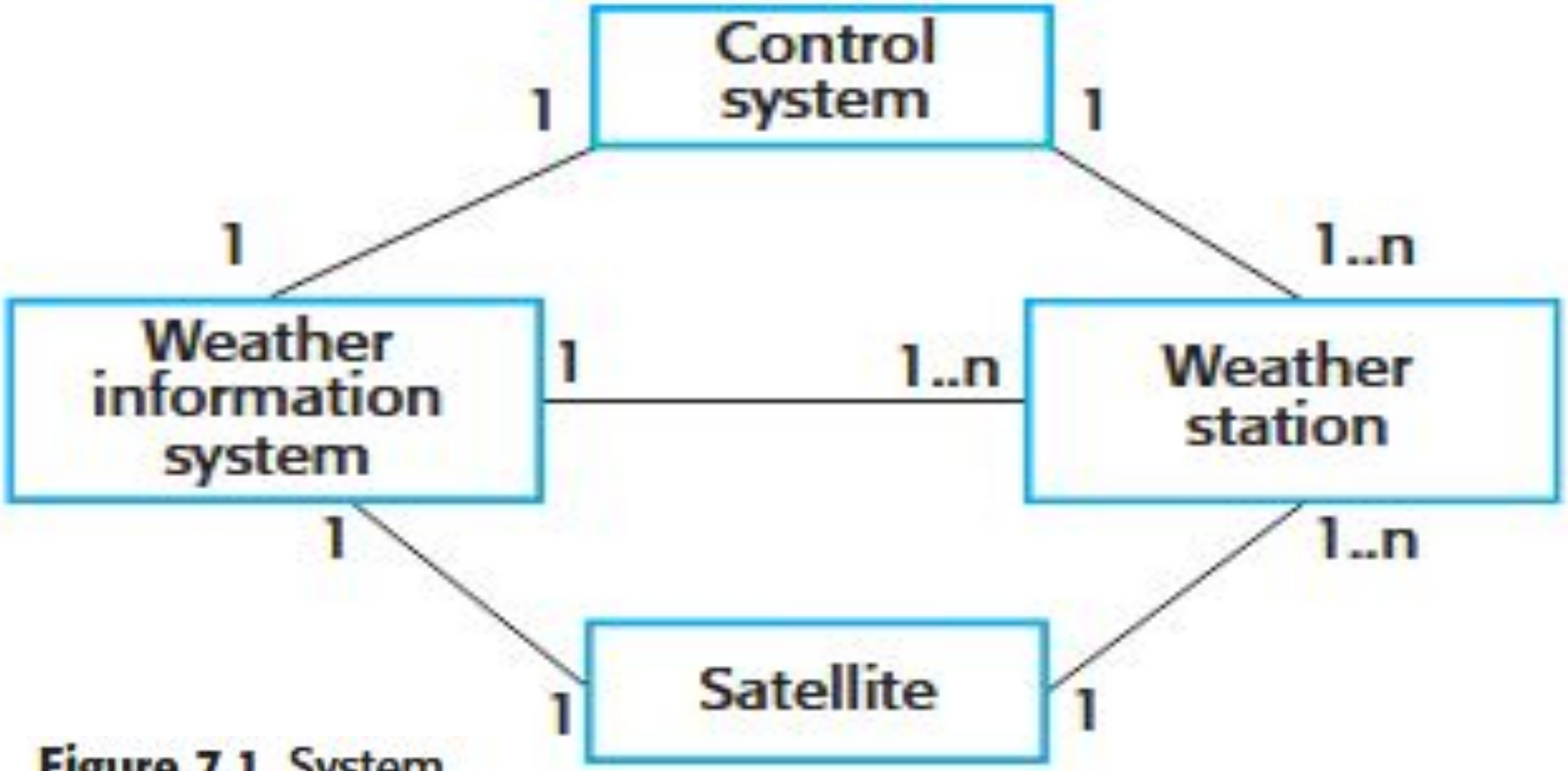


Figure 7.1 System context for the weather station

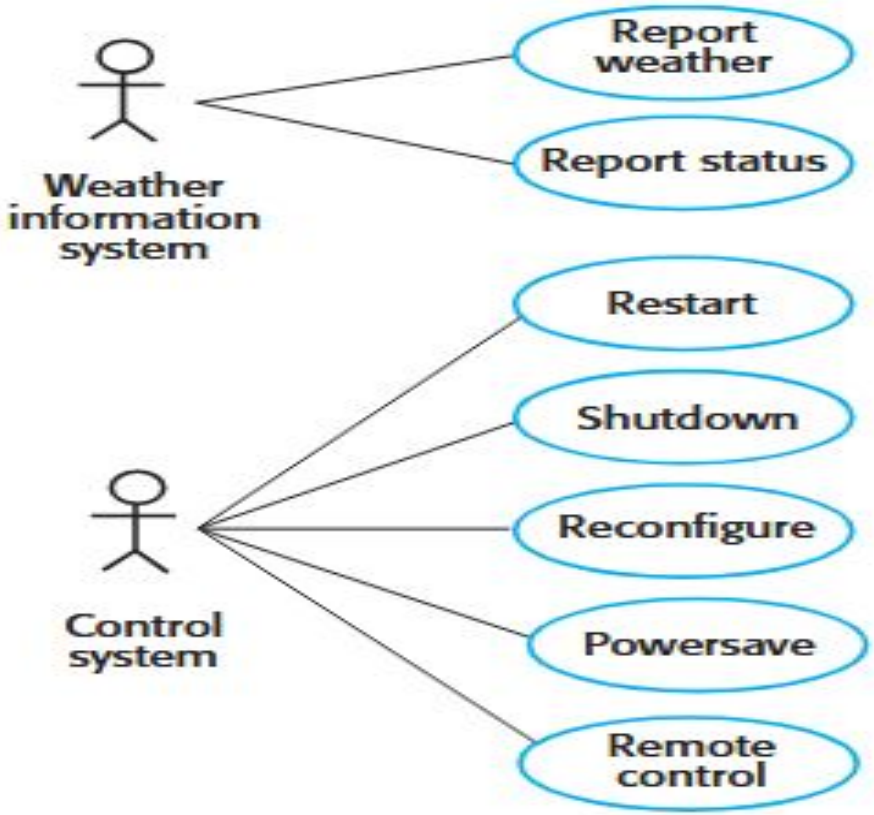


Figure 7.2 Weather station use cases

System	Weather station
Use case	Report weather
Actors	Weather information system, Weather station
Data	The weather station sends a summary of the weather data that has been collected from the instruments in the collection period to the weather information system. The data sent are the maximum, minimum, and average ground and air temperatures; the maximum, minimum, and average air pressures; the maximum, minimum and average wind speeds; the total rainfall; and the wind direction as sampled at 5-minute intervals.
Stimulus	The weather information system establishes a satellite communication link with the weather station and requests transmission of the data.
Response	The summarized data is sent to the weather information system.
Comments	Weather stations are usually asked to report once per hour, but this frequency may differ from one station to another and may be modified in future.

Figure 7.3 Use case description—Report weather

Architectural design

- Once interactions between the system and its environment have been understood, you use this information for designing the system architecture.
- You identify the major components that make up the system and their interactions, and then may organize the components using an architectural pattern such as a layered or client-server model.
- The weather station is composed of independent subsystems that communicate by broadcasting messages on a common infrastructure.

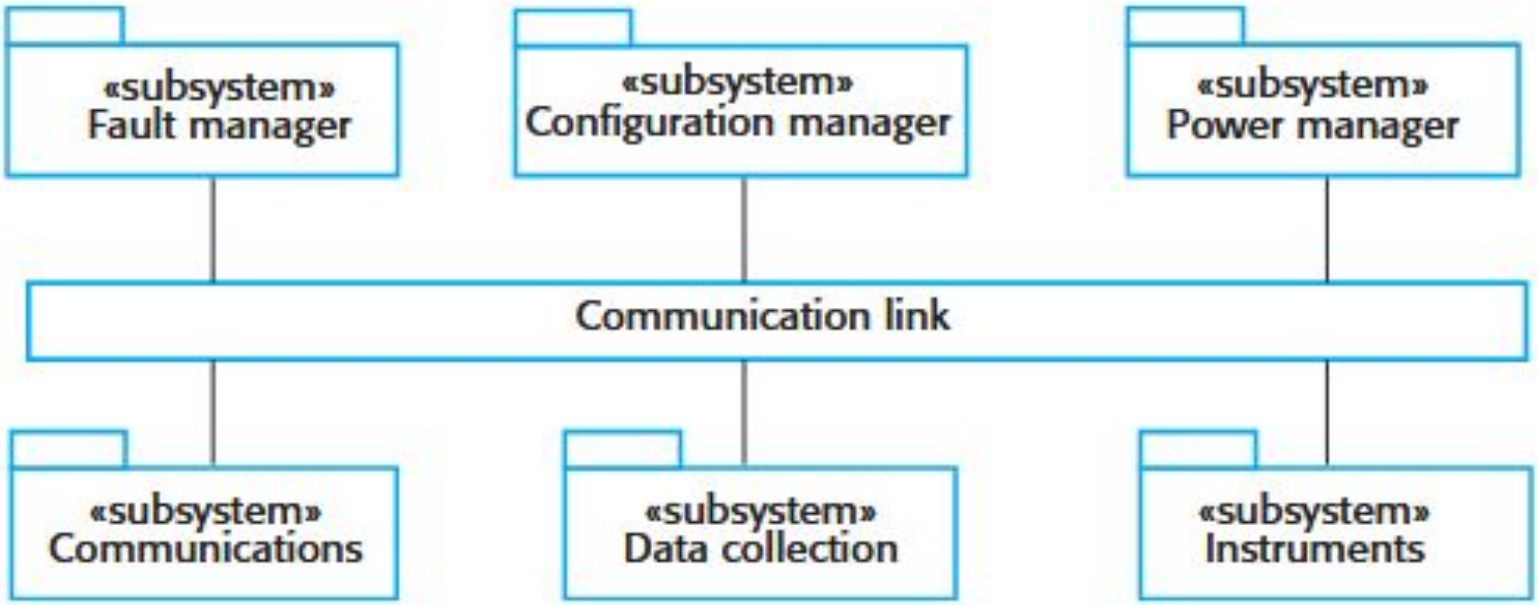


Fig 7.4 High-level architecture of weather station

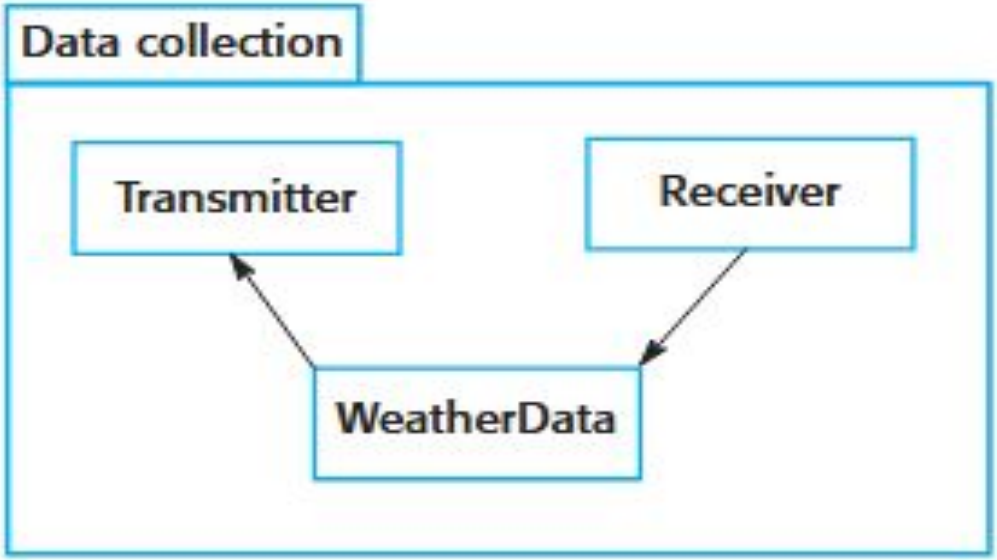


Figure 7.5 Architecture of data collection system

Object class identification

- Identifying object classes is often a difficult part of object oriented design.
- There is no 'magic formula' for object identification. It relies on the skill, experience and domain knowledge of system designers.
- Object identification is an iterative process. You are unlikely to get it right first time.

Approaches to identification

- Use a grammatical approach based on a natural language description of the system.
- Base the identification on tangible things in the application domain.
- Use a behavioural approach and identify objects based on what participates in what behaviour.
- Use a scenario-based analysis. The objects, attributes and methods in each scenario are identified.

Weather Station Object Classes

- Object class identification in the weather station system may be based on the tangible hardware and data in the system:
  - Ground thermometer, Anemometer, Barometer
    - Application domain objects that are ‘hardware’ objects related to the instruments in the system.
  - Weather station
    - The basic interface of the weather station to its environment. It therefore reflects the interactions identified in the use case model.
  - Weather data
    - Encapsulates the summarized data from the instruments.

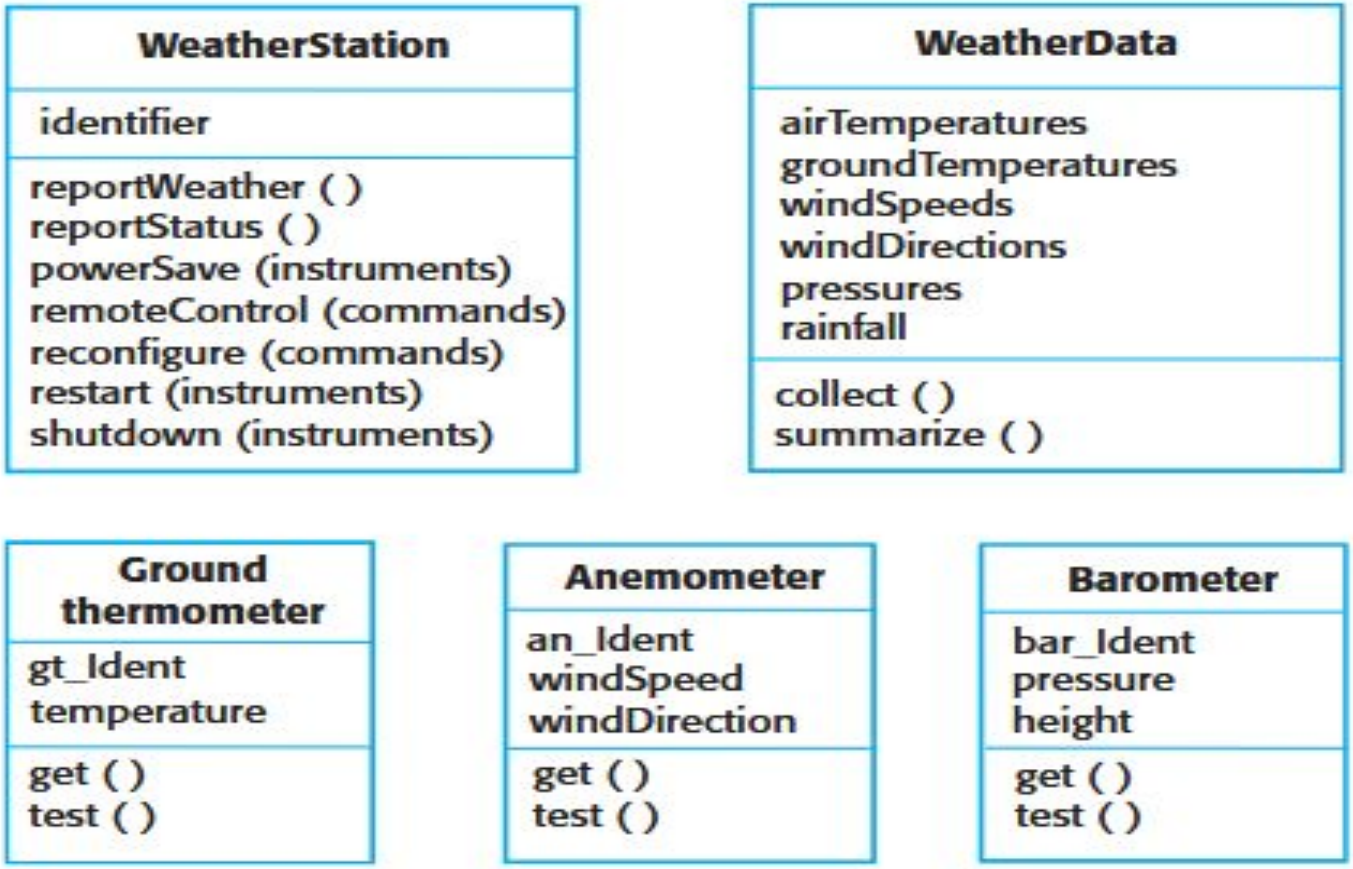


Fig 7.6 Weather station objects

Design models

- Design models show the objects and object classes and relationships between these entities.
- Static models describe the static structure of the system in terms of object classes and relationships.
- Dynamic models describe the dynamic interactions between objects.

Examples of design models

- Subsystem models that show logical groupings of objects into coherent subsystems.
- Sequence models that show the sequence of object interactions.
- State machine models that show how individual objects change their state in response to events.
- Other models include use-case models, aggregation models, generalization models, etc.

Subsystem models

- Shows how the design is organized into logically related groups of objects.
- In the UML, these are shown using packages - an encapsulation construct. This is a logical model. The actual organization of objects in the system may be different.

Sequence models

Sequence models show the sequence of object interactions that take place

-Objects are arranged horizontally across the top;

-Time is represented vertically so models are read top to bottom;

-Interactions are represented by labelled arrows; different styles of arrow represent different types of interaction;

-A thin rectangle in an object lifeline represents the time when the object is the controlling object in the system.

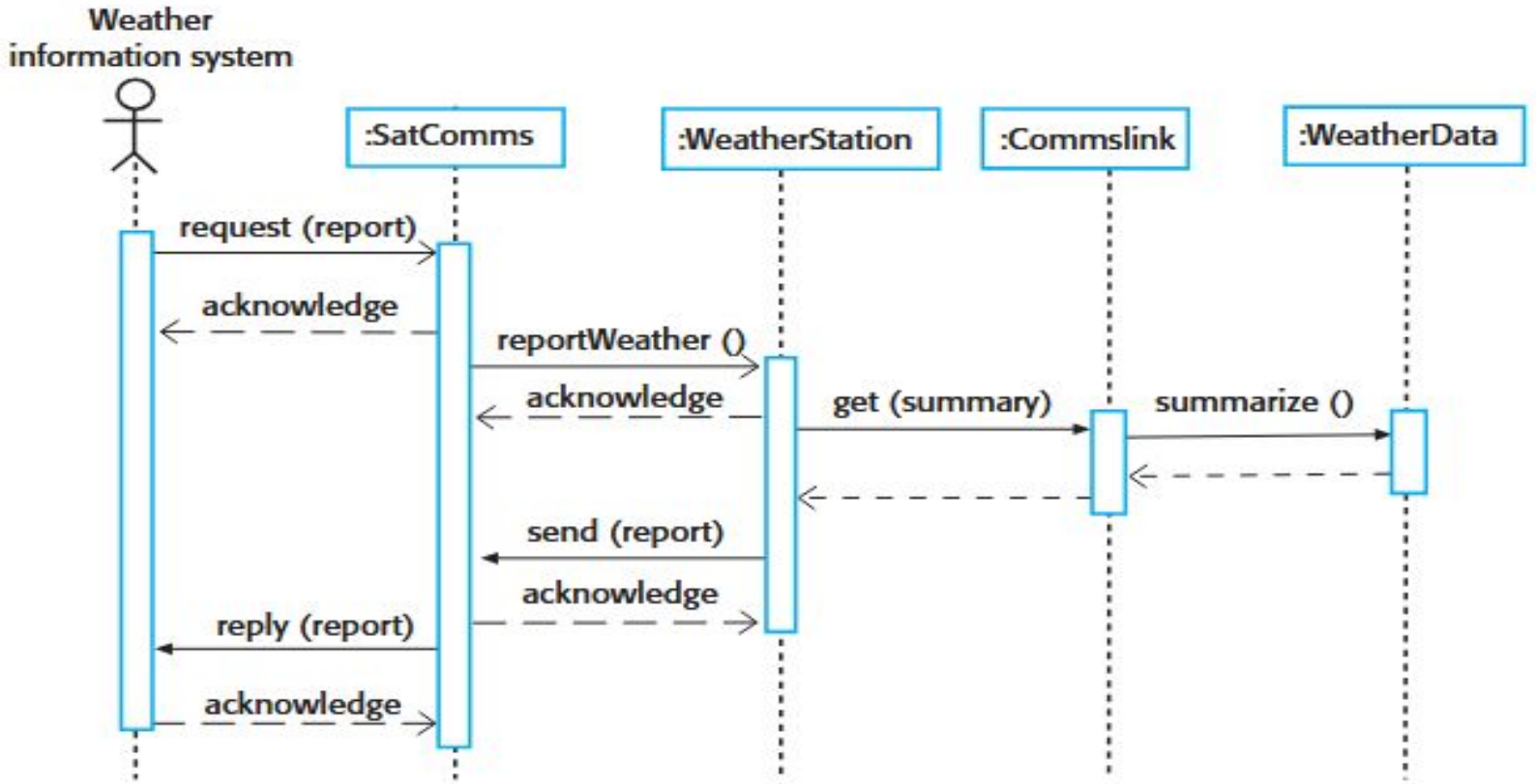
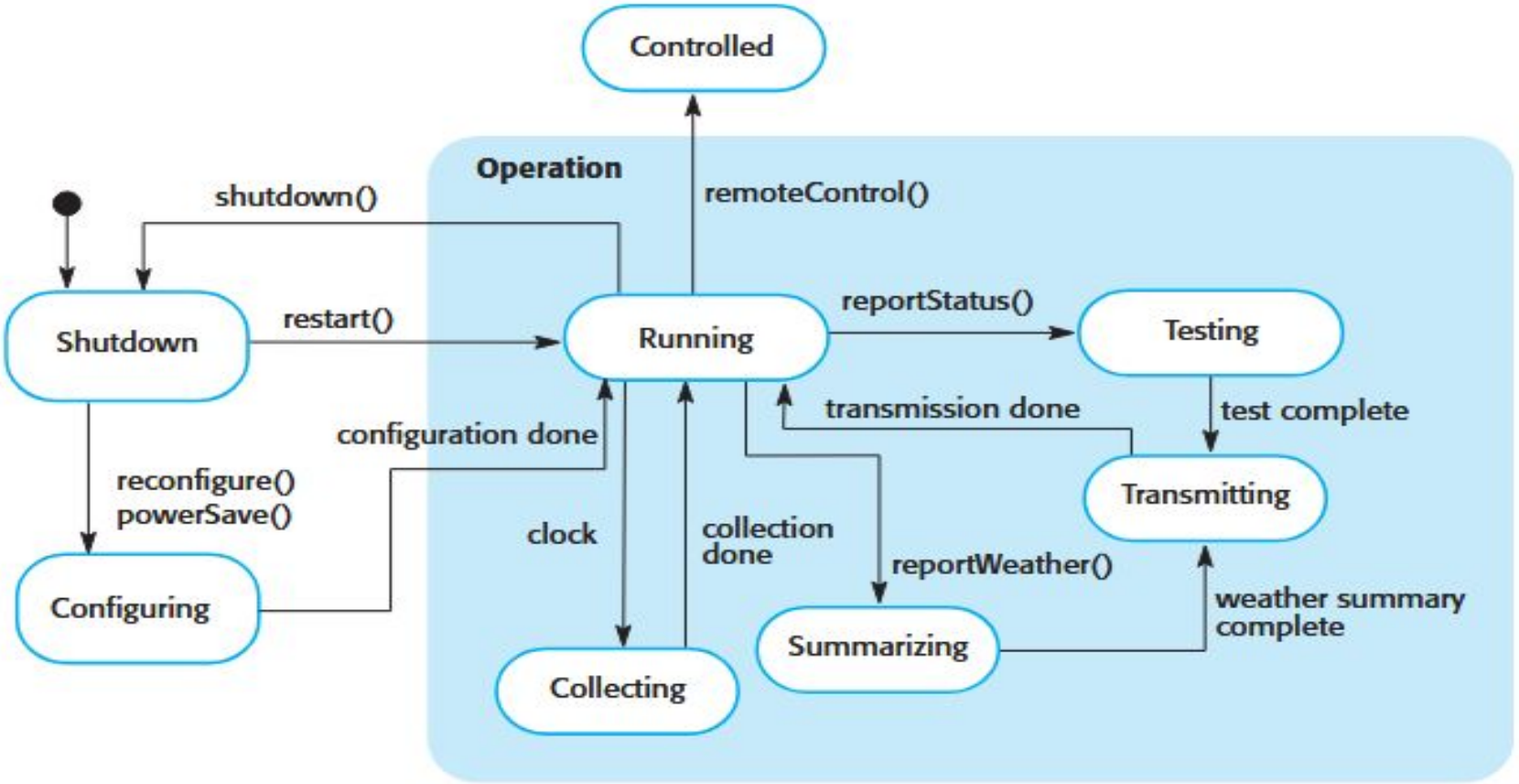


Fig 7.7 Sequence diagram describing data collection

State diagrams

- State diagrams are used to show how objects respond to diñerent service requests and the state transitions triggered by these requests.
- State diagrams are useful high-level models of a system or an object's run-time behavior.
- You don't usually need a state diagram for all of the objects in the system. Many of the objects in a system are relatively simple and a state model adds unnecessary detail to the design.

Fig 7.8 Weather station state diagram



Interface specification

- Object interfaces have to be specified so that the objects and other components can be designed in parallel.
- Designers should avoid designing the interface representation but should hide this in the object itself.
- Objects may have several interfaces which are viewpoints on the methods provided.
- The UML uses class diagrams for interface specification but Java may also be used.

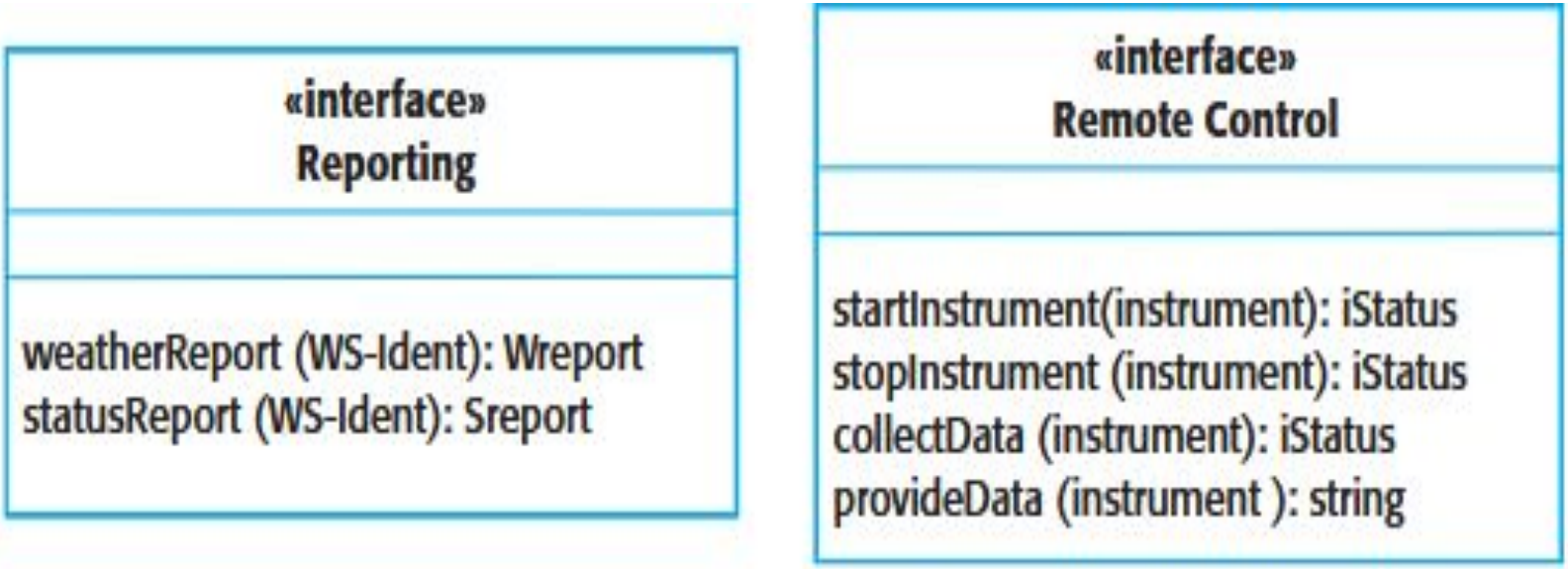


Figure 7.9 Weather station interfaces

Design patterns

- A design pattern is a way of reusing abstract knowledge about a problem and its solution.
- A pattern is a description of the problem and the essence of its solution.
- It should be sufficiently abstract to be reused in different settings.
- Pattern descriptions usually make use of object-oriented characteristics such as inheritance and polymorphism.

Patterns

- *Patterns and Pattern Languages are ways to describe best practices, good designs, and capture experience in a way that it is possible for others to reuse this experience.*

Pattern elements

- Name

  A meaningful pattern identifier.

- Problem description.
- Solution description.

  Not a concrete design but a template for a design solution that can be instantiated in different ways.

- Consequences

  The results and trade-offs of applying the pattern.

The Observer pattern

- Name

  Observer.

- Description

  Separates the display of object state from the object itself.

- Problem description

  Used when multiple displays of state are needed.

- Solution description

  See slide with UML description.

- Consequences

  Optimizations to enhance display performance are impractical.

Pattern name: Observer

Description: Separates the display of the state of an object from the object itself and allows alternative displays to be provided. When the object state changes, all displays are automatically notified and updated to reflect the change.

Problem description: In many situations, you have to provide multiple displays of state information, such as a graphical display and a tabular display. Not all of these may be known when the information is specified. All alternative presentations should support interaction and, when the state is changed, all displays must be updated.

This pattern may be used in situations where more than one display format for state information is required and where it is not necessary for the object that maintains the state information to know about the specific display formats used.

Solution description: This involves two abstract objects, Subject and Observer, and two concrete objects, ConcreteSubject and ConcreteObject, which inherit the attributes of the related abstract objects. The abstract objects include general operations that are applicable in all situations. The state to be displayed is maintained in ConcreteSubject, which inherits operations from Subject allowing it to add and remove Observers (each observer corresponds to a display) and to issue a notification when the state has changed.

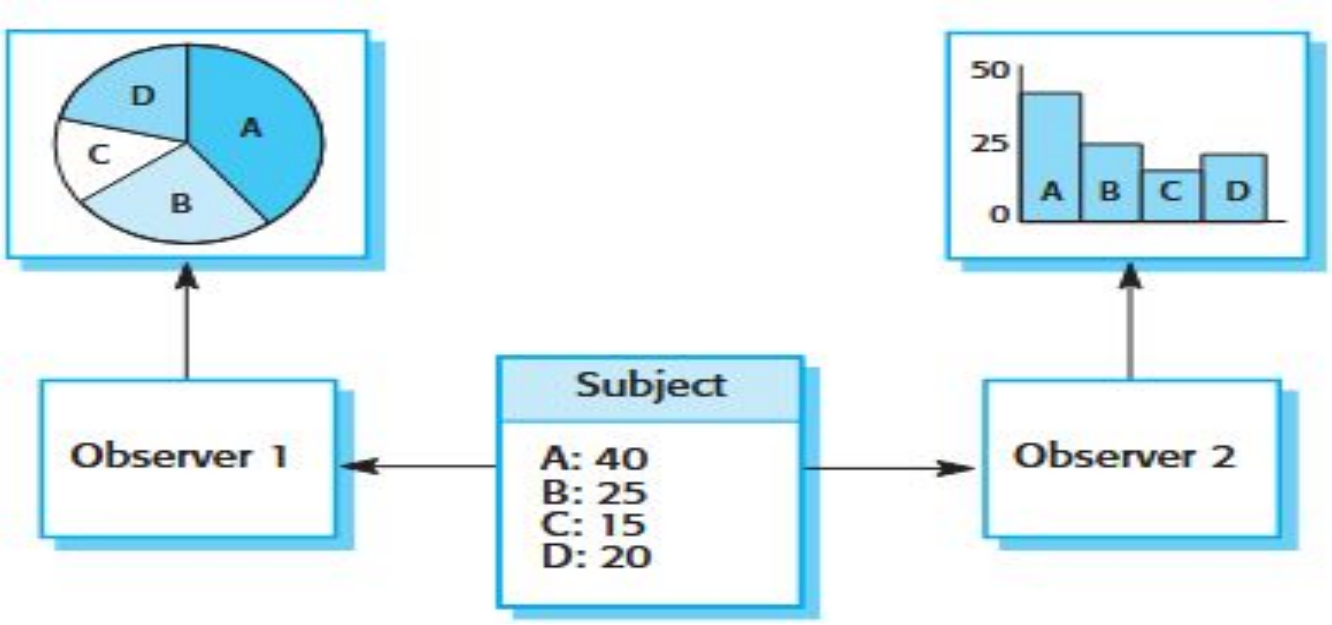
The ConcreteObserver maintains a copy of the state of ConcreteSubject and implements the Update() interface of Observer that allows these copies to be kept in step. The ConcreteObserver automatically displays the state and reflects changes whenever the state is updated.

The UML model of the pattern is shown in Figure 7.12.

Consequences: The subject only knows the abstract Observer and does not know details of the concrete class. Therefore there is minimal coupling between these objects. Because of this lack of knowledge, optimizations that enhance display performance are impractical. Changes to the subject may cause a set of linked updates to observers to be generated, some of which may not be necessary.

Figure 7.10 The Observer pattern

Multiple displays using the Observer pattern



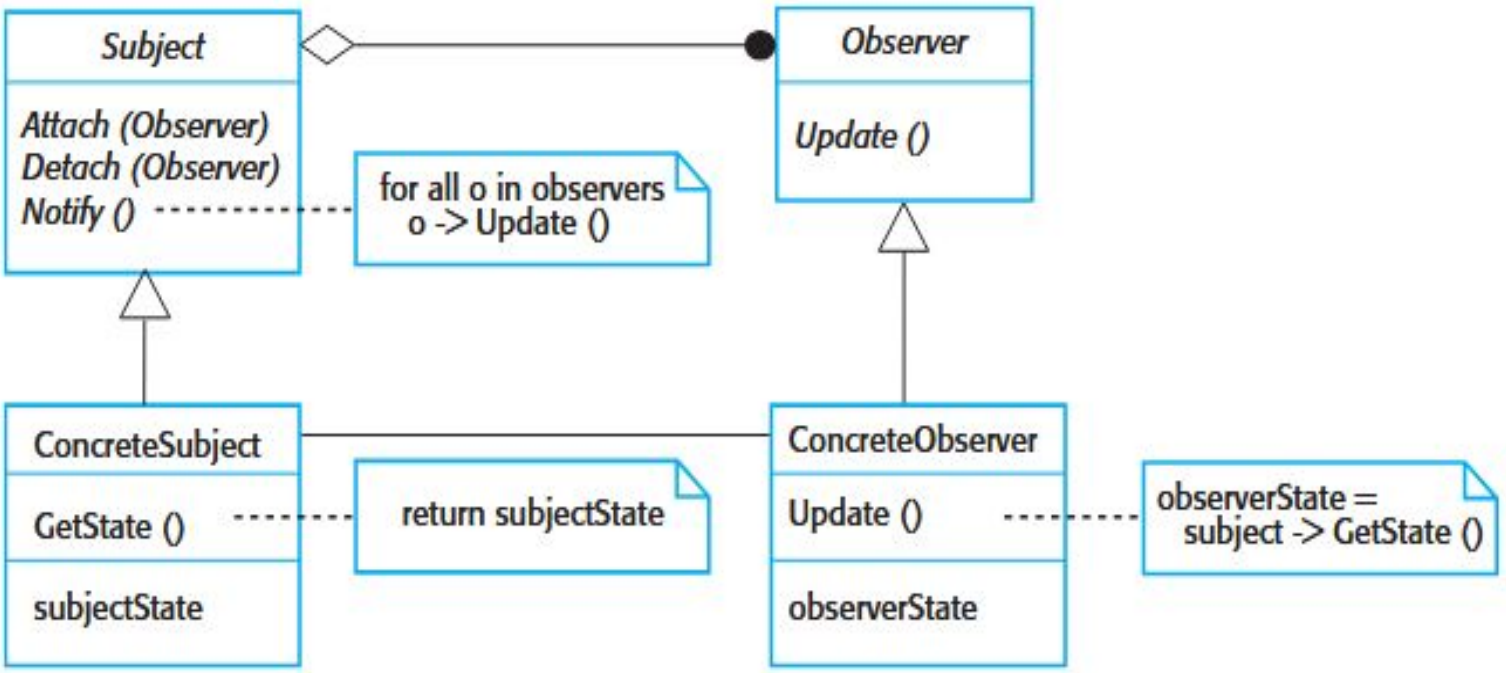


Figure 7.12 A UML model of the Observer pattern

Design problems

- To use patterns in your design, you need to recognize that any design problem you are facing may have an associated pattern that can be applied.

  -Tell several objects that the state of some other object has changed (Observer parern).

  -Tidy up the interfaces to a number of related objects that have often been developed incrementally (Facade pattern).

  -Provide a standard way of accessing the elements in a collection, irrespective of how that collection is implemented (Iterator pattern).

  -Allow for the possibility of extending the functionality of an existing class at run-time (Decorator pattern).

Implementation issues

- Focus here is not on programming, although this is obviously important, but on other implementation issues that are often not covered in programming texts:

  - **Reuse Most modern software** is constructed by reusing existing components or systems. When you are developing software, you should make as much use as possible of existing code.
  - **Configuration management** During the development process, you have to keep track of the many different versions of each software component in a configuration management system.
  - **Host-target development** Production software does not usually execute on the same computer as the software development environment. Rather, you develop it on one computer (the host system) and execute it on a separate computer (the target system).

Reuse

- From the 1960s to the 1990s, most new software was developed from scratch, by writing all code in a high- level programming language.

  The only significant reuse or software was the reuse of functions and objects in programming language libraries.

- Costs and schedule pressure mean that this approach became increasingly unviable, especially for commercial and Internet-based systems.

- An approach to development based around the reuse of existing software emerged and is now generally used for business and scientific software.

Reuse levels

- The abstraction level

  At this level, you don't reuse software directly but use knowledge of successful abstractions in the design of your software.

- The object level

  At this level, you directly reuse objects from a library rather than writing the code yourself.

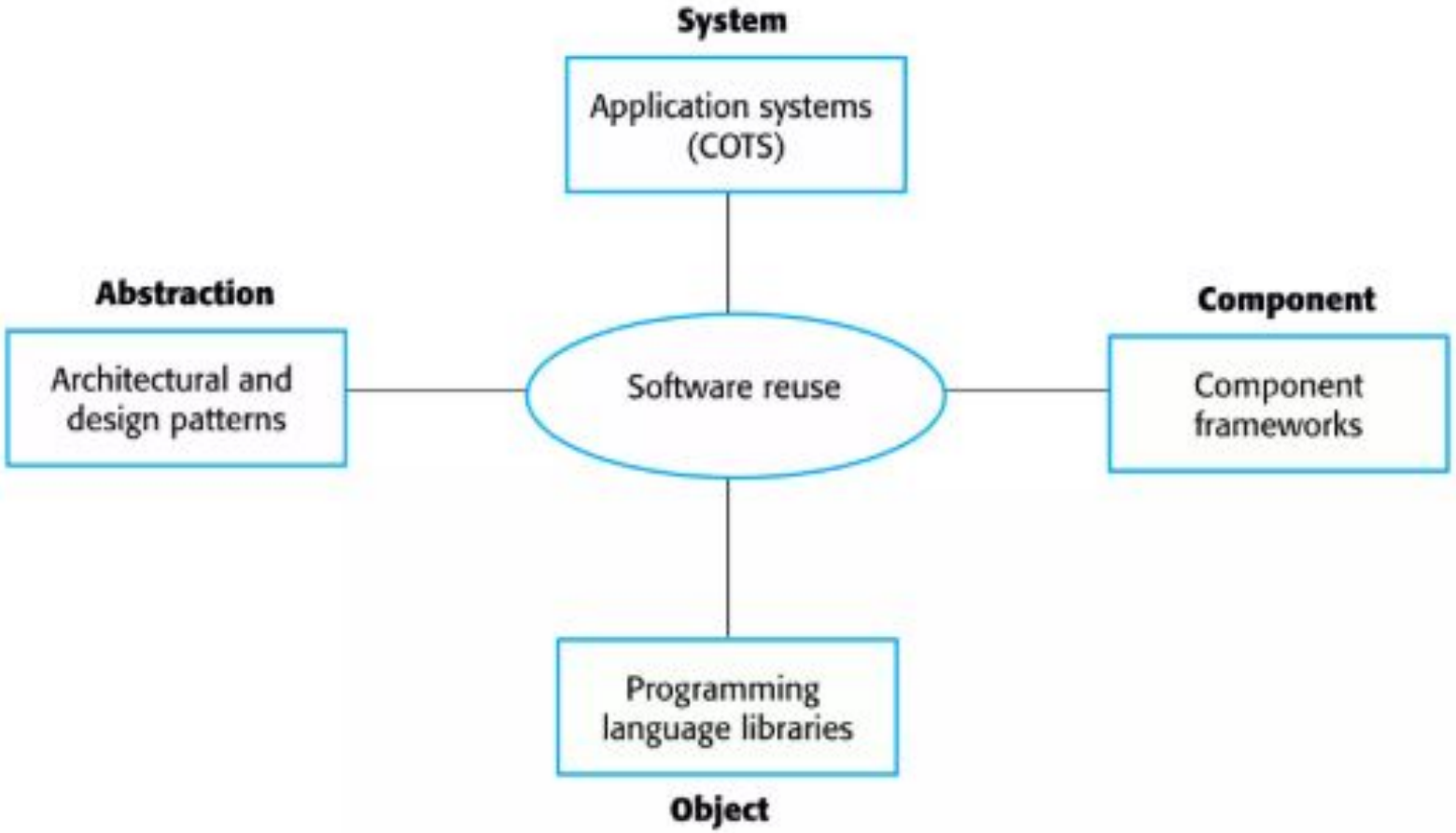
- The component level

  Components are collections of objects and object classes that you reuse in application systems.

- The system level

  At this level, you reuse entire application systems.

Software reuse



Reuse costs

- The costs of the time spent in looking for software to reuse and assessing whether or not it meets your needs.
- Where applicable, the costs of buying the reusable software. For large off-the-shelf systems, these costs can be very high.
- The costs of adapting and configuring the reusable software components or systems to reflect the requirements of the system that you are developing.
- The costs of integrating reusable software elements with each other (if you are using software from diñerent sources) and with the new code that you have developed.

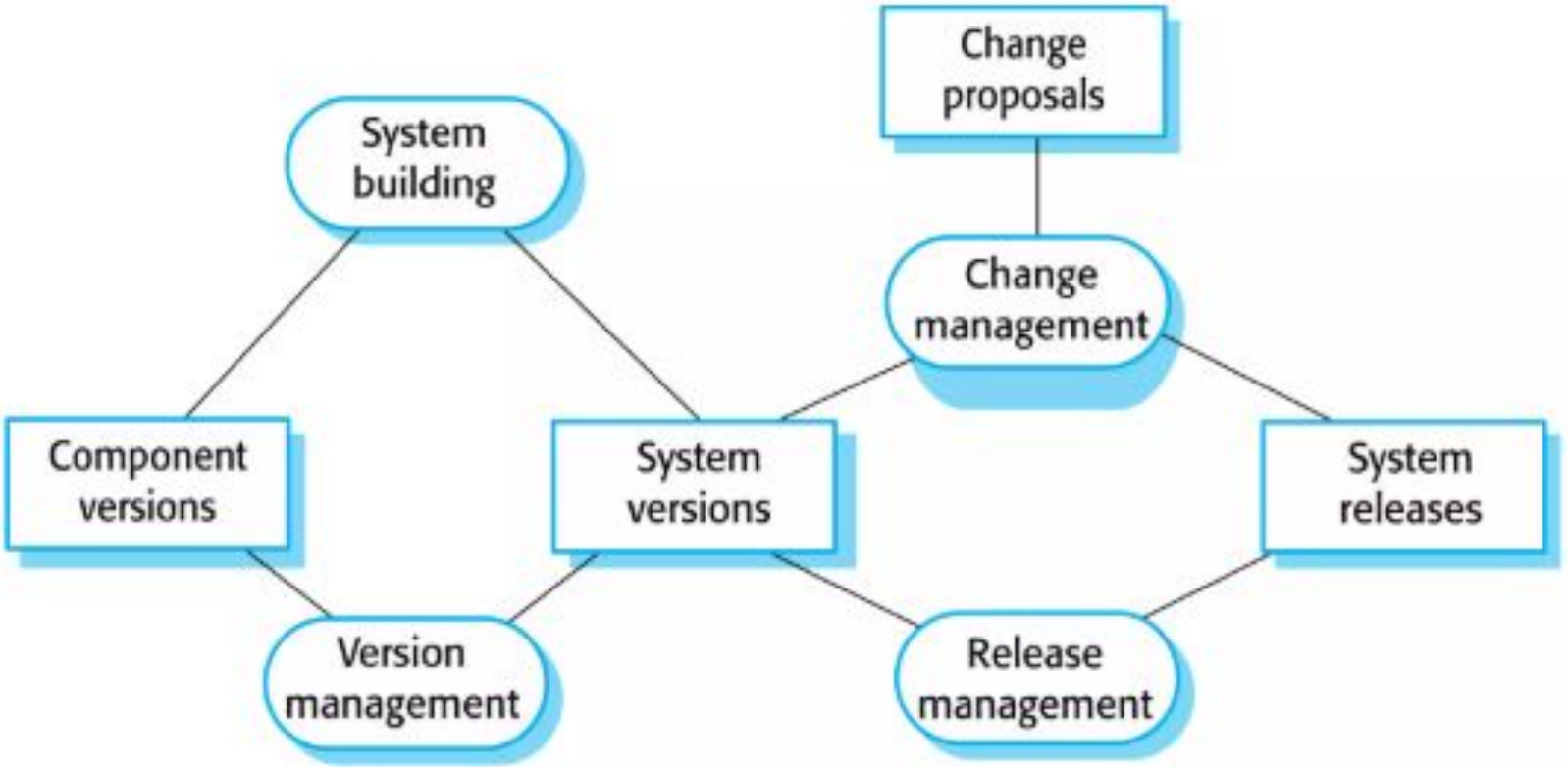
Configuration management

- Configuration management is the name given to the general process of managing a changing software system.
- The aim of configuration management is to support the system integration process so that all developers can access the project code and documents in a controlled way, find out what changes have been made, and compile and link components to create a system.

Configuration management activities

- Version management, where support is provided to keep track of the different versions of software components. Version management systems include facilities to coordinate development by several programmers.
- System integration, where support is provided to help developers define what versions of components are used to create each version of a system. This description is then used to build a system automatically by compiling and linking the required components.
- Problem tracking, where support is provided to allow users to report bugs and other problems, and to allow all developers to see who is working on these problems and when they are fixed.

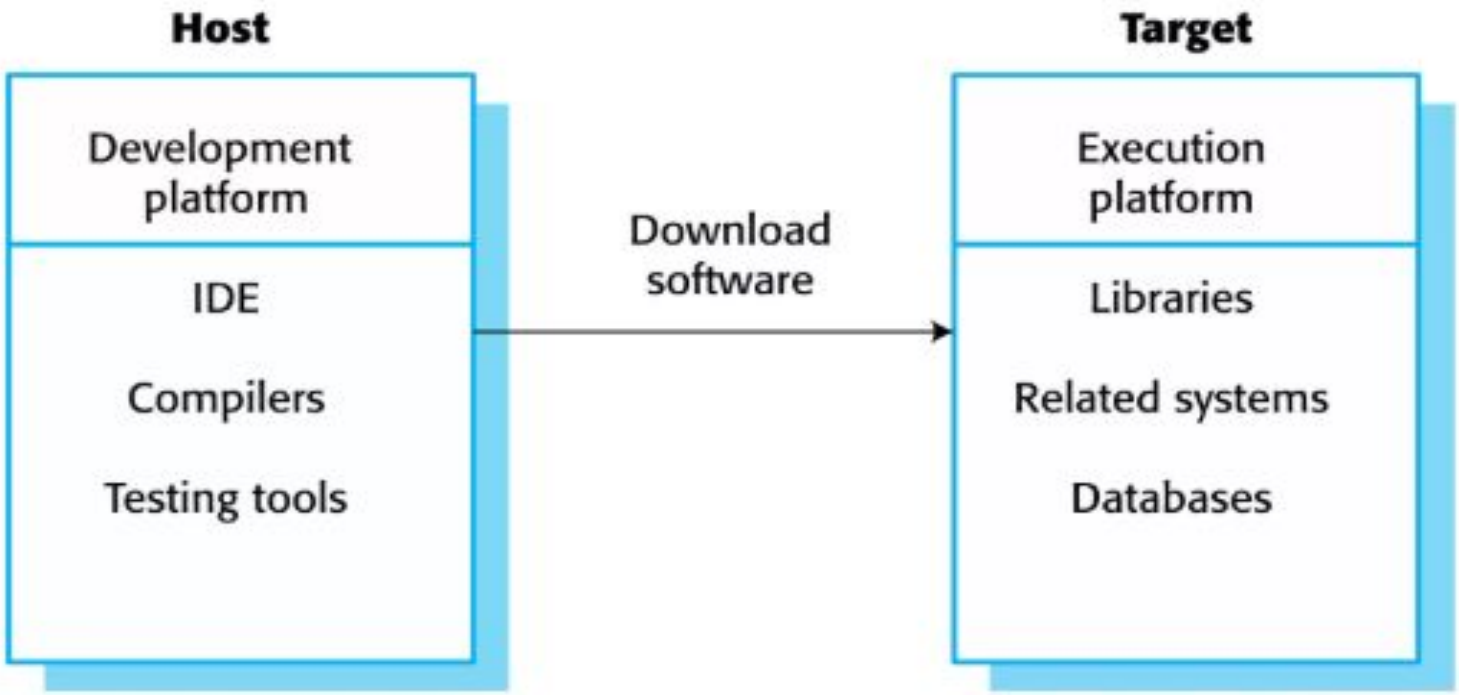
Configuration management tool interaction



Host-target development

- Most software is developed on one computer (the host), but runs on a separate machine (the target).
- More generally, we can talk about a development platform and an execution platform.
  - A platform is more than just hardware.
  - It includes the installed operating system plus other supporting software such as a database management system or, for development platforms, an interactive development environment.
- Development platform usually has different installed software than execution platform; these platforms may have different architectures.

Host-target development



Development platform tools

- An integrated compiler and syntax-directed editing system that allows you to create, edit and compile code.
- A language debugging system.
- Graphical editing tools, such as tools to edit UML models.
- Testing tools, such as Junit that can automatically run a set of tests on a new version of a program.
- Project support tools that help you organize the code for different development projects.

Integrated development environments (IDEs)

- Software development tools are often grouped to create an integrated development environment(IDE).
- An IDE is a set of software tools that supports diñerent aspects of software development, within some common framework and user interface.
- IDEs are created to support development in a specific programming language such as Java. The language IDE may be developed specially, or may be an instantiation of a general-purpose IDE, with specific language-support tools.

Component/system deployment factors

- If a component is designed for a specific hardware architecture, or relies on some other software system, it must obviously be deployed on a platform that provides the required hardware and software support.
- High availability systems may require components to be deployed on more than one platform. This means that, in the event of platform failure, an alternative implementation of the component is available.
- If there is a high level of communications traffic between components, it usually makes sense to deploy them on the same platform or on platforms that are physically close to one other. This reduces the delay between the time a message is sent by one component and received by another.

Software Testing

Program testing

- Testing is intended to show that a program does what it is intended to do and to discover program defects before it is put into use. It is a dynamic validation technique.
- To test software, you execute a program using artificial data.
- check the results of the test run for errors, anomalies or information about the program's non-functional attributes.
- Can reveal the presence of errors Not their absence.

  - Testing is part of a more general verification and validation process, which also includes static validation techniques.

Testing goals

- To demonstrate that *software meets its requirements*.
  - For custom software, at least one test for every requirement in the requirements document.
  - For generic software products, have tests for all of the system features AND feature combinations.
- To discover situations in which the behavior of the software is *incorrect or undesirable*.
  - Defect testing is concerned with rooting out undesirable system behavior such as system crashes, unwanted interactions with other systems, incorrect computations and data corruption.

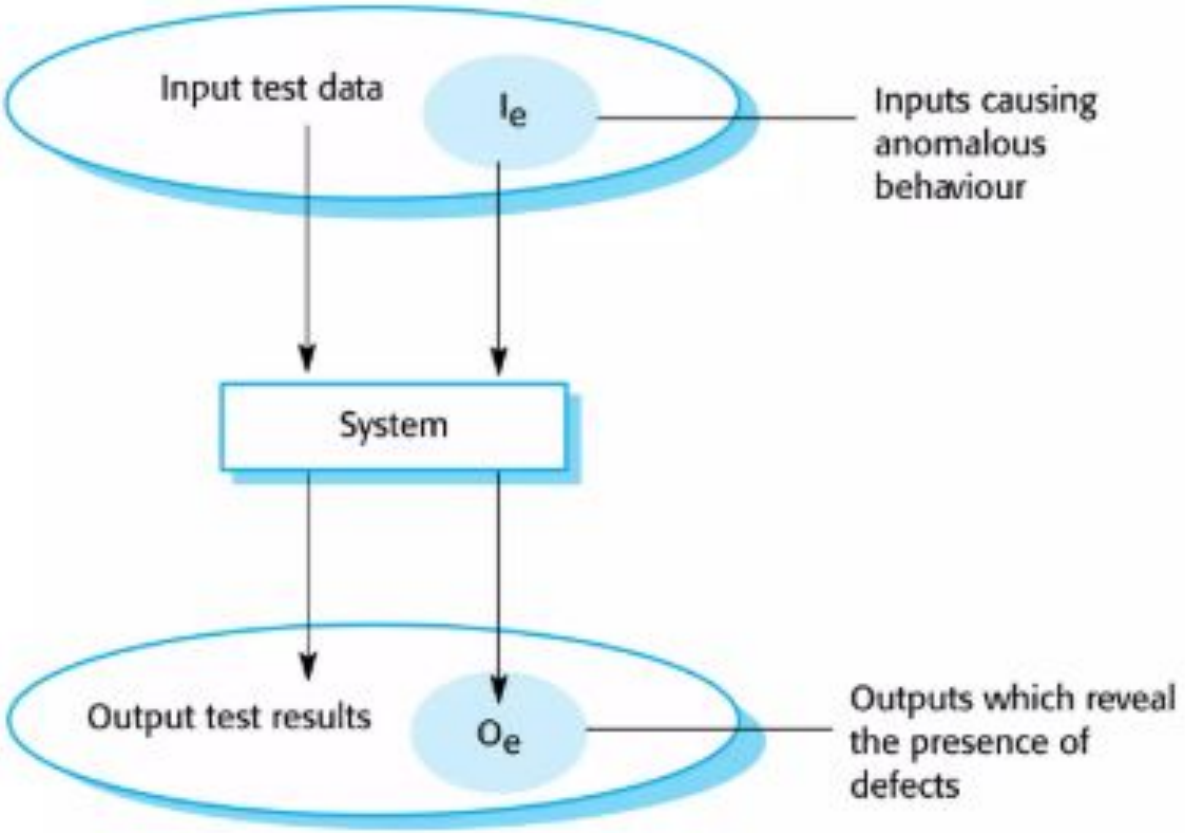
Validation and defect testing

- The first goal leads to validation testing
  - You expect the system to perform correctly using a given set of test cases that reflect the system's expected use.
- The second goal leads to defect testing
  - The test cases are designed to expose defects. The test cases in defect testing can be deliberately obscure and need not reflect how the system is normally used.

Testing process goals

- Validation testing
  - To demonstrate to the developer and the system customer that the software meets its requirements
  - A successful test shows that the system operates as intended.
- Defect testing
  - To discover faults or defects in the software where its behaviour is incorrect or not in conformance with its specification
  - A successful test is a test that makes the system perform incorrectly and so exposes a defect in the system.

An input-output model of program testing



Verification vs validation

- Verification:
  "Are we building the product right".
- The software should conform to its specification.
- Validation:
  "Are we building the right product".
- The software should do what the user really requires.

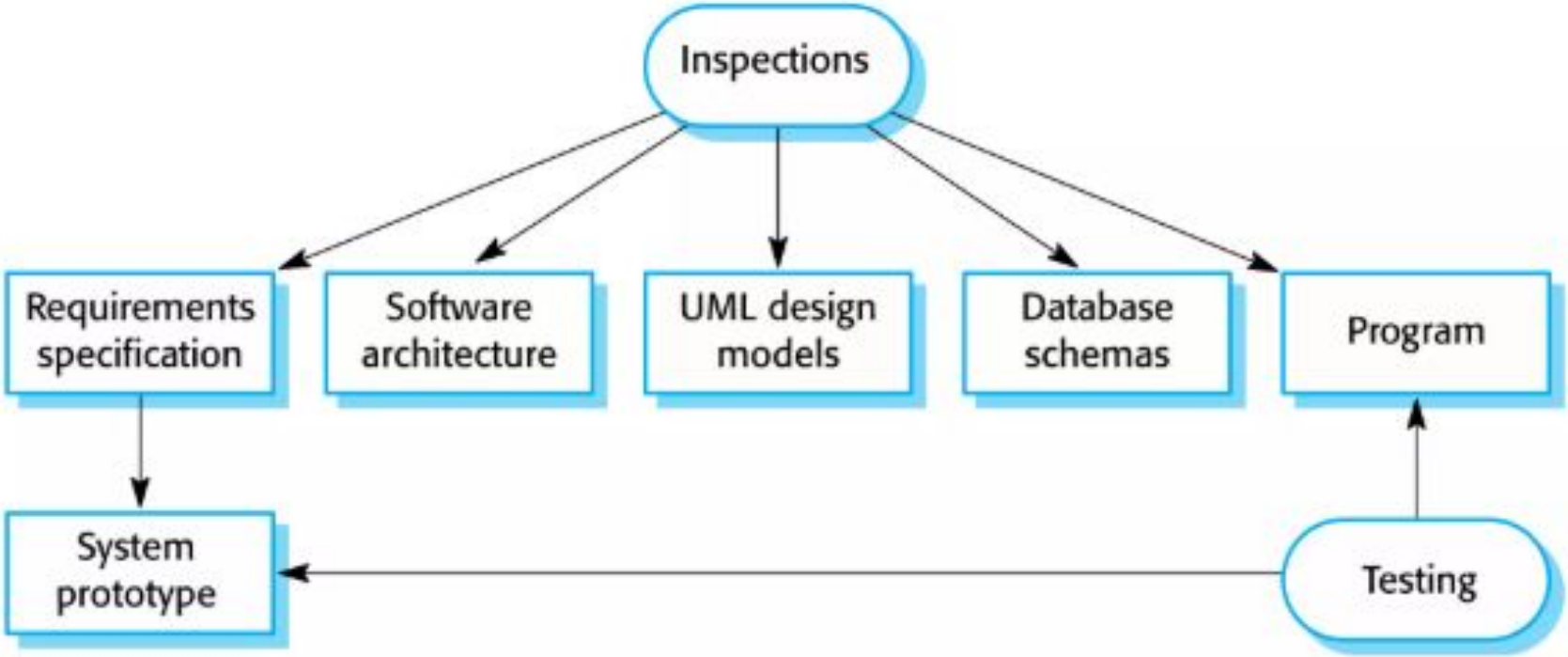
V & V confidence

- Aim of V & V is to establish confidence that the system is 'fit for purpose'.
- Depends on system's purpose, user expectations and marketing environment
  - Software purpose
    - The level of confidence depends on how critical the software is to an organisation.
  - User expectations
    - Users may have low expectations of certain kinds of software.
  - Marketing environment
    - Getting a product to market early may be more important than finding defects in the program.

Inspections and testing

- ✧ Software inspections Concerned with analysis of the static system representation to discover problems (static verification)
  - May be supplement by tool-based document and code analysis.
  - Discussed in Chapter 15.
- ✧ Software testing Concerned with exercising and observing product behaviour (dynamic verification)
  - The system is executed with test data and its operational behaviour is observed.

Inspections and testing



Software inspections

- These involve people examining the source representation with the aim of discovering anomalies and defects.
- Inspections not require execution of a system so may be used before implementation.
- They may be applied to any representation of the system (requirements, design,configuration data, test data, etc.).
- They have been shown to be an effective technique for discovering program errors.

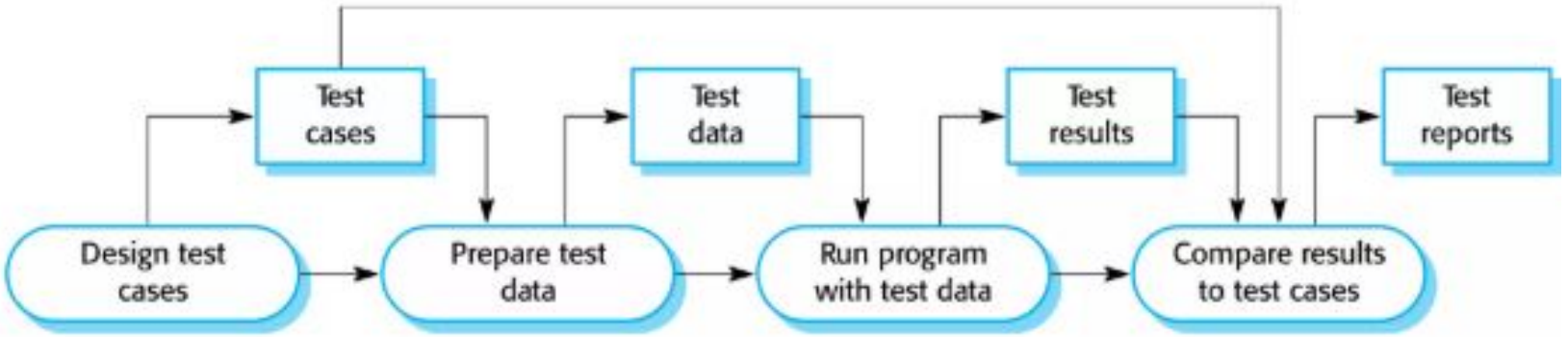
Advantages of inspections

- During testing, errors can mask (hide) other errors. Because inspection is a static process, you don't have to be concerned with interactions between errors.
- Incomplete versions of a system can be inspected without additional costs. If a program is incomplete, then you need to develop specialized test harnesses to test the parts that are available.
- As well as searching for program defects, an inspection can also consider broader quality attributes of a program, such as compliance with standards, portability and maintainability.

Inspections and testing

- Inspections and testing are complementary and not opposing verification techniques.
- Both should be used during the V & V process.
- Inspections can check conformance with a specification but not conformance with the customer's real requirements.
- Inspections cannot check non-functional characteristics such as performance, usability, etc.

A model of the software testing process



Stages of testing

- Development testing, where the system is tested during development to discover bugs and defects.
- Release testing, where a separate testing team test a complete version of the system before it is released to users.
- User testing, where users or potential users of a system test the system in their own environment.

Development testing

- Development testing includes all testing activities that are carried out by the team developing the system.
  - Unit testing, where individual program units or object classes are tested. Unit testing should focus on testing the functionality of objects or methods.
  - Component testing, where several individual units are integrated to create composite components. Component testing should focus on testing component interfaces.
  - System testing, where some or all of the components in a system are integrated and the system is tested as a whole. System testing should focus on testing component interactions.

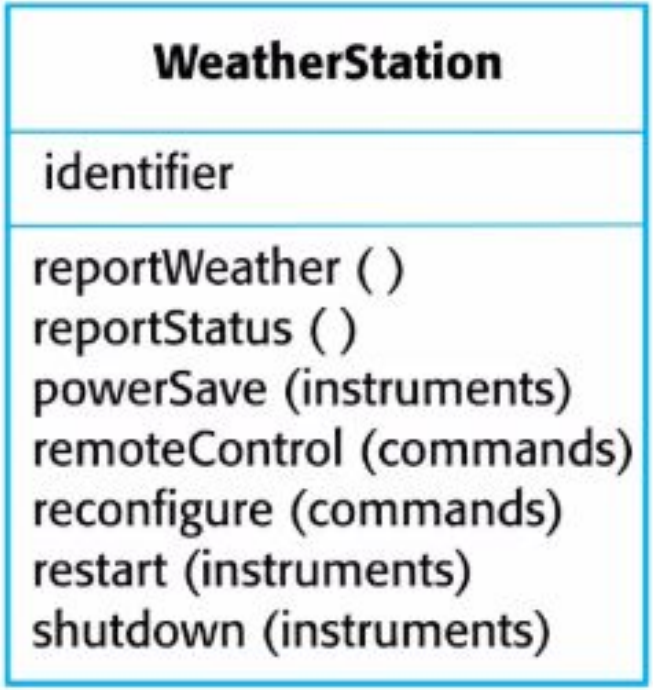
Unit testing

- Unit testing is the process of testing individual components in isolation.
- It is a defect testing process.
- Units may be:
  - Individual functions or methods within an object
  - Object classes with several attributes and methods
  - Composite components with defined interfaces used to access their functionality.

Object class testing

- Complete test coverage of a class involves
  - Testing all operations associated with an object
  - Setting and interrogating all object attributes
  - Exercising the object in all possible states.
- Inheritance makes it more difficult to design object class tests as the information to be tested is not localised.

The weather station object interface



Weather station testing

- Need to define test cases for reportWeather, calibrate, test, startup and shutdown.
- Using a state model, identify sequences of state transitions to be tested and the event sequences to cause these transitions
- For example:
  - Shutdown -> Running-> Shutdown
  - Configuring-> Running-> Testing -> Transmitting -> Running
  - Running-> Collecting-> Running-> Summarizing -> Transmitting -> Running

Automated testing

- Whenever possible, unit testing should be automated so that tests are run and checked without manual intervention.
- In automated unit testing, you make use of a test automation framework (such as JUnit) to write and run your program tests.
- Unit testing frameworks provide generic test classes that you extend to create specific test cases. They can then run all of the tests that you have implemented and report, often through some GUI, on the success of otherwise of the tests.

Automated test components

- A setup part, where you initialize the system with the test case, namely the inputs and expected outputs.
- A call part, where you call the object or method to be tested.
- An assertion part where you compare the result of the call with the expected result. If the assertion evaluates to true, the test has been successful if false, then it has failed.

Choosing unit test cases

- The test cases should show that, when used as expected, the component that you are testing does what it is supposed to do.
- If there are defects in the component, these should be revealed by test cases.
- This leads to 2 types of unit test case:
  - The first of these should reflect normal operation of a program and should show that the component works as expected.
  - The other kind of test case should be based on testing experience of where common problems arise. It should use abnormal inputs to check that these are properly processed and do not crash the component.

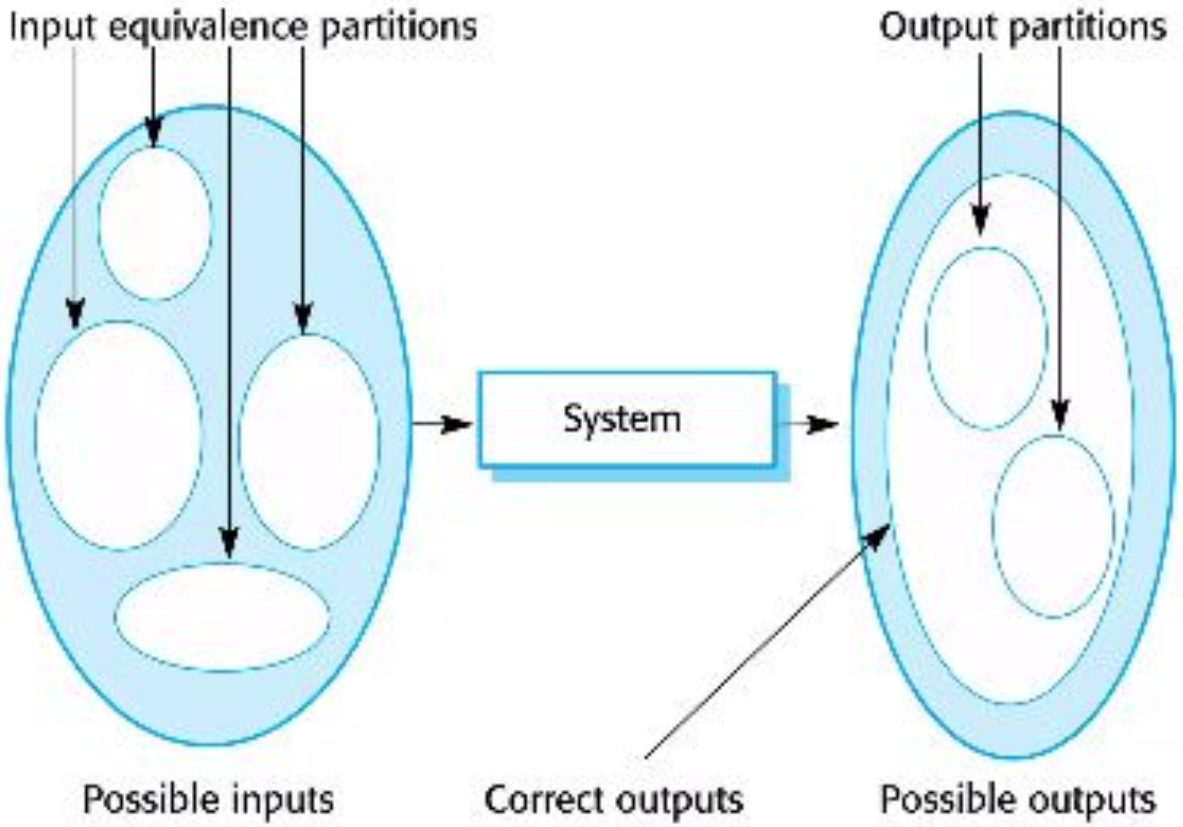
Testing strategies

- Partition testing, where you identify groups of inputs that have common characteristics and should be processed in the same way.
  - You should choose tests from within each of these groups.
- Guideline-based testing, where you use testing guidelines to choose test cases.
  - These guidelines reflect previous experience of the kinds of errors that programmers often make when developing components.

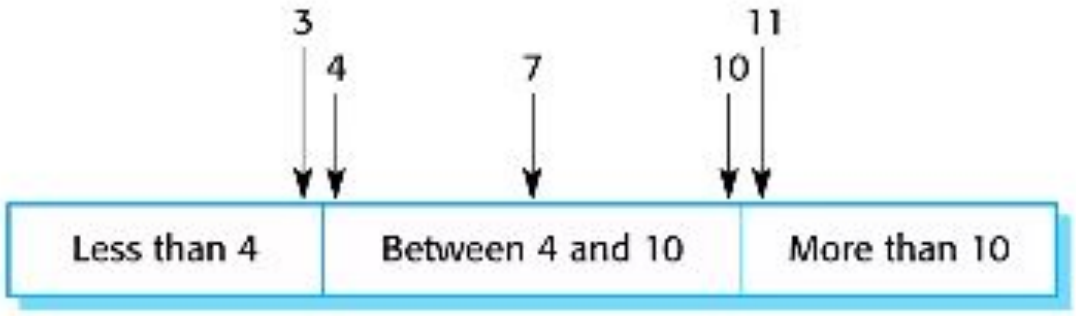
Partition testing

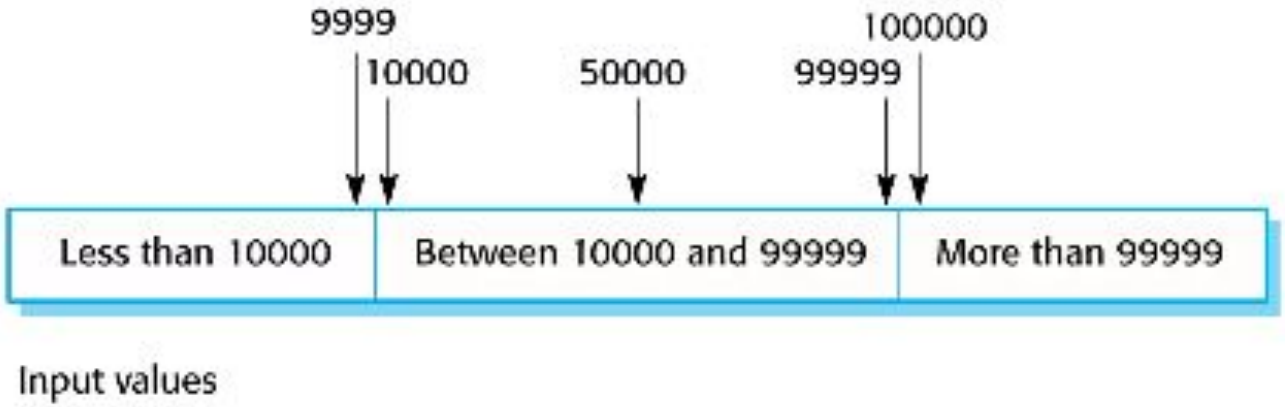
- Input data and output results often fall into different classes where all members of a class are related.
- Each of these classes is an **equivalence partition** or domain where the program behaves in an equivalent way for each class member.
- Test cases should be chosen from each partition.

Equivalence partitioning



Equivalence partitions





Testing guidelines (sequences)

- Test software with sequences which have only a single value.
- Use sequences of different sizes in different tests.
- Derive tests so that the first, middle and last elements of the sequence are accessed.
- Test with sequences of zero length.

General testing guidelines

- Choose inputs that force the system to generate all error messages
- Design inputs that cause input buffers to overflow
- Repeat the same input or series of inputs numerous times
- Force invalid outputs to be generated
- Force computation results to be too large or too small.

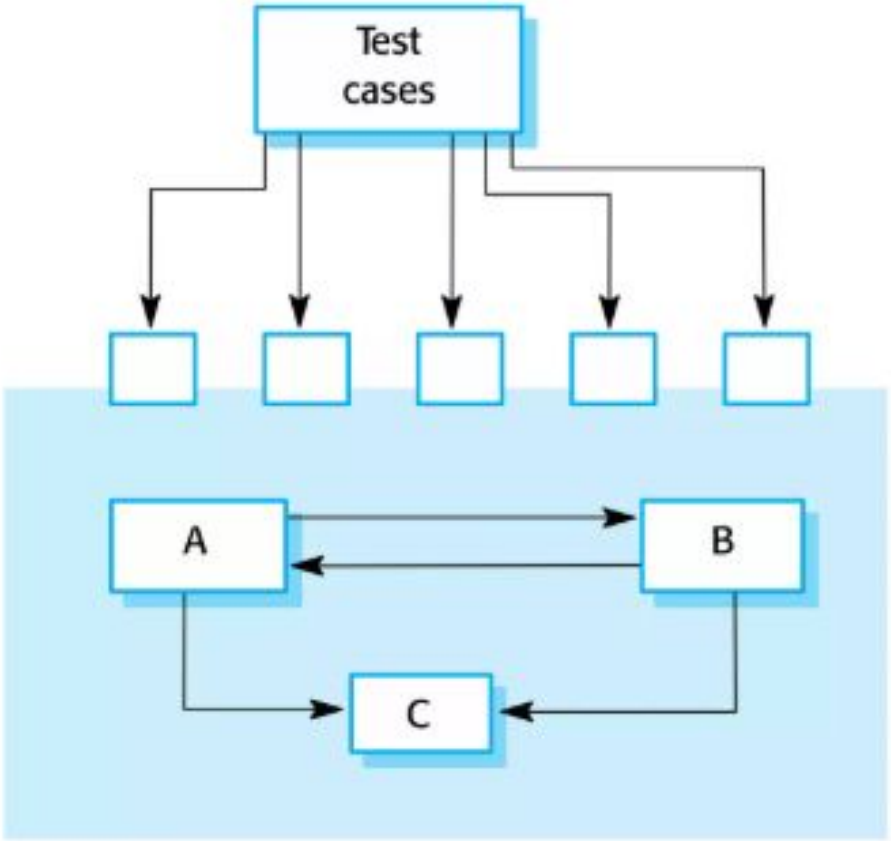
Component testing

- Software components are often composite components that are made up of several interacting objects.
  - For example, in the weather station system, the reconfiguration component includes objects that deal with each aspect of the reconfiguration.
- You access the functionality of these objects through the defined component interface.
- Testing composite components should therefore focus on showing that the component interface behaves according to its specification.
  - You can assume that unit tests on the individual objects within the component have been completed.

Interface testing

- Objectives are to detect faults due to interface errors or invalid assumptions about interfaces.
- Interface types
  - Parameter interfaces Data passed from one method or procedure to another.
  - Shared memory interfaces Block of memoty is shared between
    procedures or functions.
  - Procedural interfaces Sub-system encapsulates a set of procedures to be called by other sub-systems.
  - Message passing interfaces Sub-systems request services from other sub-systems

Interface testing



Interface errors

A Interface misuse

- A calling component calls another compOnent and makes an error in its use of its interface e.g. parameters in the wrong order.

A Interface misunderstanding

- A calling component embeds assumptions about the behaviour of the called component which are incorrect.

A Timing errors

- The called and the calling component operate at different speeds and out-of-date information is accessed.

Interface testing guidelines

- ✧ Design tests so that parameters to a called procedure are at the extreme ends of their ranges.
- ✧ Always test pointer parameters with null pointers.
- ✧ Design tests which cause the component to fail.
- ✧ Use stress testing in message passing systems.
- ✧ In shared memory systems, vary the order in which components are activated.

System testing

- System testing during development involves integrating components to create a version of the system and then testing the integrated system.
- The focus in system testing is testing the interactions between components.
- System testing checks that components are compatible, interact correctly and transfer the right data at the right time across their interfaces.
- System testing tests the emergent *behavior* of a system.

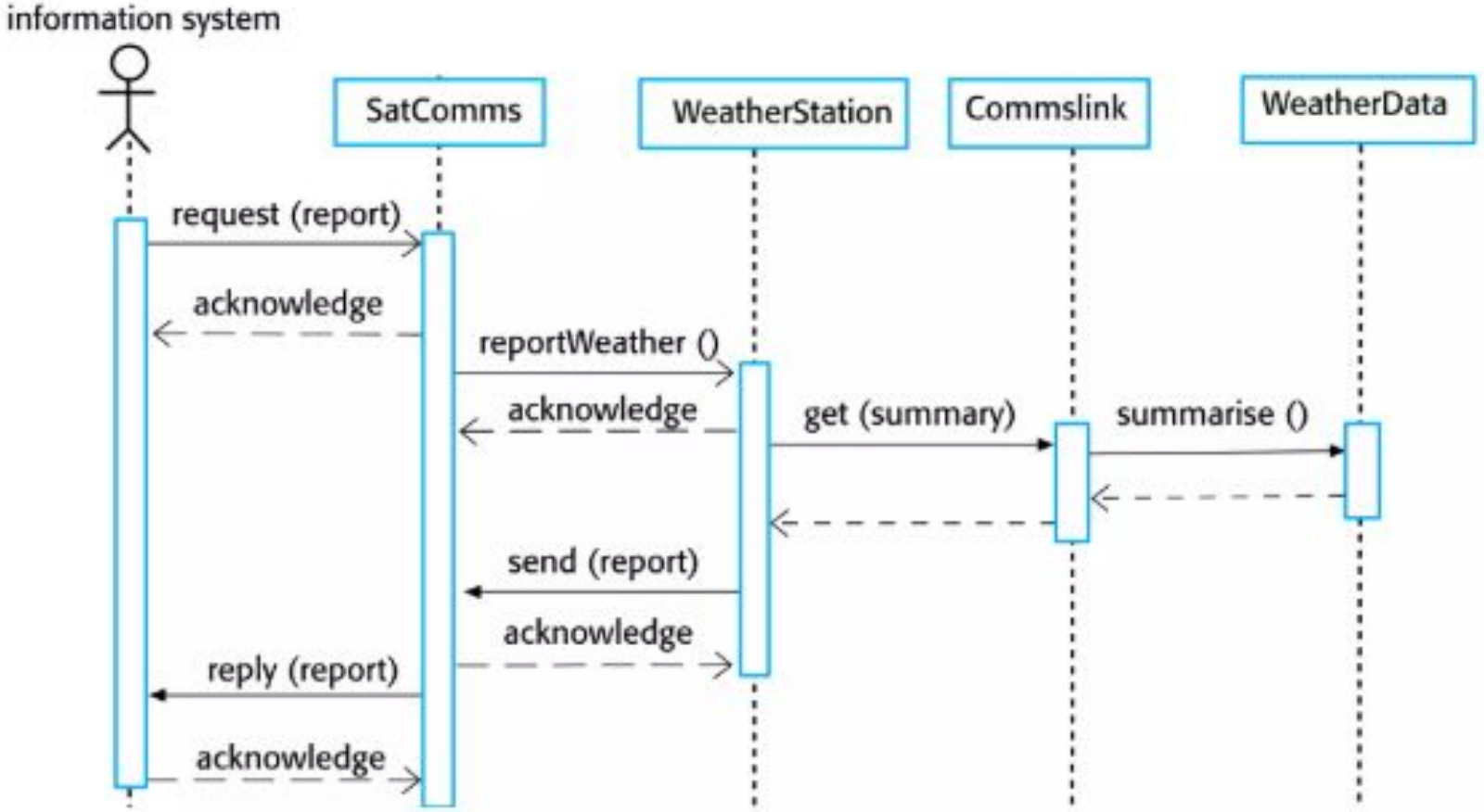
Differences between System and component testing

- During system testing, reusable components that have been separately developed and off-the-shelf systems may be integrated with newly developed components. The complete system is then tested.
- Components developed by different team members or sub-teams may be integrated at this stage. System testing is a collective rather than an individual process.
  - In some companies, system testing may involve a separate testing team with no involvement from designers and programmers.

Use-case testing

- The use-cases developed to identify system interactions can be used as a basis for system testing.
- Each use case usually involves several system components so testing the use case forces these interactions to occur.
- The sequence diagrams associated with the use case documents the components and interactions that are being tested.

Collect weather data sequence chart



Test cases derived from sequence diagram

- An input of a request for a report should have an associated acknowledgement. A report should ultimately be returned from the request.
  - You should create summarized data that can be used to check that the report is correctly organized.
- An input request for a report to WeatherStation results in a summarized report being generated.
  - Can be tested by creating raw data corresponding to the summary that you have prepared for the test of SatComms and checking that the WeatherStation object correctly produces this summary. This raw data is also used to test the WeatherData object.

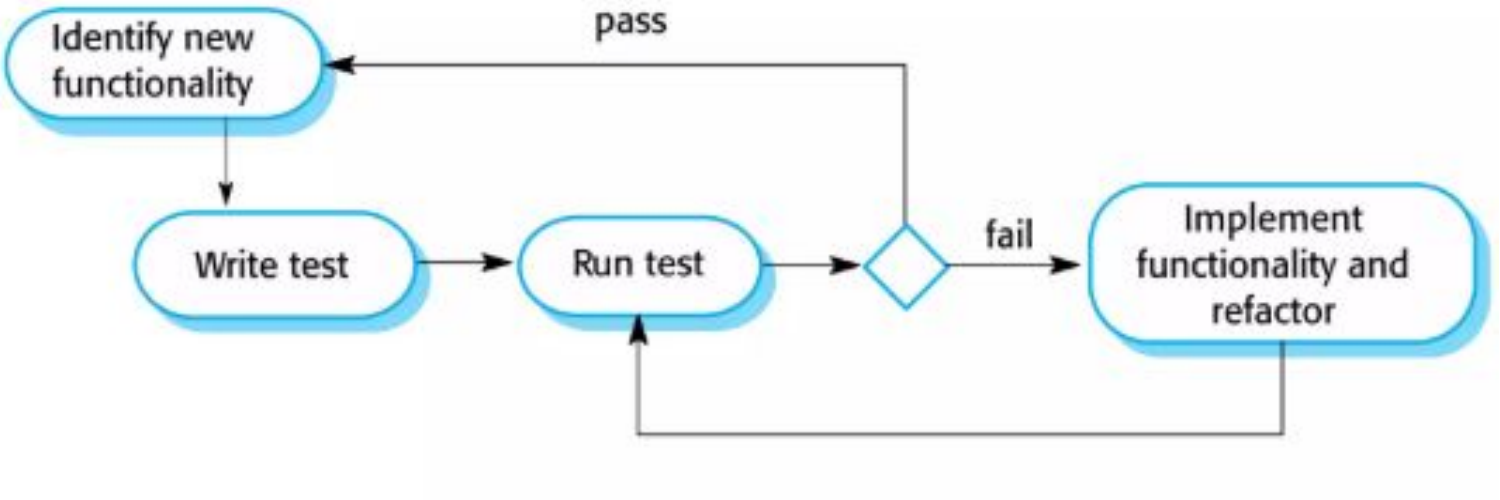
Testing policies

- Exhaustive system testing is impossible so testing policies which define the required system test coverage may be developed.
- Examp1es of testing policies:
  - All system functions that are accessed through menus should be tested.
  - Combinations of functions (e.g. text formatting) that are accessed through the same menu must be tested.
  - Where user input is provided, all functions must be tested with both correct and incorrect input.

Test-driven development

- Test-driven development (TDD) is an approach to program development in which you inter-leave testing and code development.
- Tests are written before code and 'passing' the tests is the critical driver of development.
- You develop code incrementally, along with a test for that increment. You don't move on to the next increment until the code that you have developed passes its test.
- TDD was introduced as part of agile methods such as Extreme Programming. However, it can also be used in plan-driven development processes.

Test-driven development



TDD process activities

- Start by identifying the increment of functionality that is required. This should normally be small and implementable in a few lines of code.
- Write a test for this functionality and implement this as an automated test.
- Run the test, along with all other tests that have been implemented. Initially, you have not implemented the functionality so the new test will fail.
- Implement the functionality and re-run the test.
- Once all tests run successfully, you move on to implementing the next chunk of functionality.

Benefits of test-driven development

- Code coverage
  - Every code segment that you write has at least one associated test so all code written has at least one test.
- Regression testing
  - A regression test suite is developed incrementally as a program is developed.
- Simplified debugging
  - When a test fails, it should be obvious where the problem lies. The newly written code needs to be checked and modified.
- System documentation
  - The tests themselves are a form of documentation that describe what the code should be doing.

Regression testing

- Regression testing is testing the system to check that changes have not 'broken' previously working code.
- In a manual testing process, regression testing is expensive but, with automated testing, it is simple and straightforward. All tests are rerun every time a change is made to the program.
- Tests must run 'successfully' before the change is committed.

Release testing

- Release testing is the process of testing a particular release of a system that is intended for use outside of the development team.
- The primary goal of the release testing process is to convince the supplier of the system that it is good enough for use.
  - Release testing, therefore, has to show that the system delivers its specified functionality, performance and dependability, and that it does not fail during normal use.
- Release testing is usually a black-box testing process where tests are only derived from the system specification.

Release testing and system testing

- ✧ Release testing is a form of system testing.
- ✧ Important differences:
  - A separate team that has not been involved in the system development, should be responsible for release testing.
  - System testing by the development team should focus on discovering bugs in the system (defect testing). The objective of release testing is to check that the system meets its requirements and is good enough for external use (validation testing).

Requirements based testing

- Requirements-based testing involves examining each requirement and developing a test or tests for it.
- Mentcare system requirements:
  - If a patient is known to be allergic to any particular medication, then prescription of that medication shall result in a warning message being issued to the system user.
  - If a prescriber chooses to ignore an allergy warning, they shall provide a reason why this has been ignored.

Requirements tests

- Set up a patient record with no known allergies. Prescribe medication for allergies that are known to exist. Check that a warning message is not issued by the system.
- Set up a patient record with a known allergy. Prescribe the medication to that the patient is allergic to, and check that the warning is issued by the system.
- Set up a patient record in which allergies to two or more drugs are recorded. Prescribe both of these drugs separately and check that the correct warning for each drug is issued.
- Prescribe two drugs that the patient is allergic to. Check that two warnings are correctly issued.
- Prescribe a drug that issues a warning and overrule that warning. Check that the system requires the user to provide information explaining why the warning was overruled.

A usage scenario for the Mentcare system

George is a nurse who specializes in mental healthcare. One of his responsibilities is to visit patients at home to check that their treatment is effective and that they are not suffering from medication side effects.

On a day for home visits, George logs into the Mentcare system and uses it to print his schedule of home visits for that day, along with summary information about the patients to be visited. He requests that the records for these patients be downloaded to his laptop. He is prompted for his key phrase to encrypt the records on the laptop.

One of the patients that he visits is Jim, who is being treated with medication for depression. Jim feels that the medication is helping him but believes that it has the side effect of keeping him awake at night. George looks up Jim's record and is prompted for his key phrase to decrypt the record. He checks the drug prescribed and queries its side effects. Sleeplessness is a known side effect so he notes the problem in Jim's record and suggests that he visits the clinic to have his medication changed. Jim agrees so George enters a prompt to call him when he gets back to the clinic to make an appointment with a physician. George ends the consultation and the system re-encrypts Jim's record.

After, finishing his consultations, George returns to the clinic and uploads the records of patients visited to the database. The system generates a call list for George of those patients who He has to contact for follow-up information and make clinic appointments.

Features tested by scenario

- ✧ Authentication by logging on to the system.
- ✧ Downloading and uploading of specified patient records to a laptop.
- ✧ Home visit scheduling.
- ✧ Encryption and decryption of patient records on a mobile device.
- ✧ Record retrieval and modification.
- ✧ Links with the drugs database that maintains side-effect information.
- ✧ The system for call prompting.

Performance testing

- Part of release testing may involve testing the emergent properties of a system, such as performance and reliability.
- Tests should reflect the profile of use of the system.
- Performance tests usually involve planning a series of tests where the load is steadily increased until the system performance becomes unacceptable.
- Stress testing is a form of performance testing where the system is deliberately overloaded to test its failure behaviour.

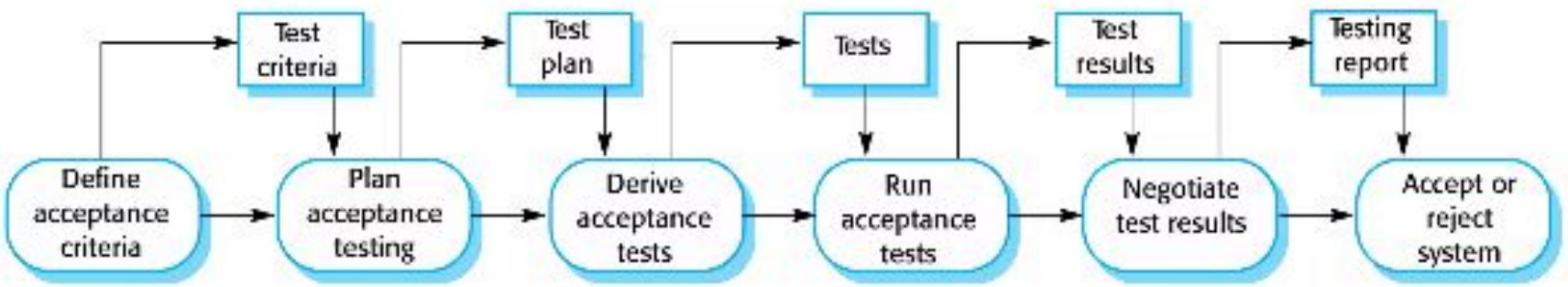
User testing

- User or customer testing is a stage in the testing process in which users or customers provide input and advice on system testing.
- User testing is essential, even when comprehensive system and release testing have been carried out.
  - The reason for this is that influences from the user's working environment have a major effect on the reliability, performance, usability and robustness of a system. These cannot be replicated in a testing environment.

Types of user testing

- Alpha testing
  - Users of the software work with the development team to test the software at the developer's site.
- Beta testing
  - A release of the software is made available to users to allow them to experiment and to raise problems that they discover with the system developers.
- Acceptance testing
  - Customers test a system to decide whether or not it is ready to be accepted from the system developers and deployed in the customer environment. Primarily for custom systems.

The acceptance testing process



Stages in the acceptance testing process

- ✧ Define acceptance criteria
- ✧ Plan acceptance testing
- ✧ Derive acceptance tests
- ✧ Run acceptance tests
- ✧ Negotiate test results
- ✧ Reject/accept system

Agile methods and acceptance testing

- In agile methods, the user/customer is part of the development team and is responsible for making decisions on the acceptability of the system.
- Tests are defined by the user/customer and are integrated with other tests in that they are run automatically when changes are made.
- There is no separate acceptance testing process.
- Main problem here is whether or not the embedded user is 'typical' and can represent the interests of all system stakeholders.

Demonstrate scenario testing with an example.

Scenario Testing is a Software Testing Technique that uses scenarios i.e. speculative stories to help the tester work through a complicated problem or test system. The ideal scenario test is a reliable, complicated, convincing or motivating story the outcome of which is easy to assess. It is performed to ensure that the end to end functioning of software and all the process flow of the software are working properly.

In scenario testing:

The testers assume themselves to be the end users and find the real world scenarios or use cases which can be carried out on the software by the end user.

The testers take help from clients, stakeholders and developers to create test scenarios. A test scenario is a story which describes the usage of the software by an end user.

Application: ATM Machine
Scenario: "Withdraw cash successfully"
Steps:
User inserts ATM card. → Expected: Machine asks for PIN.
User enters correct PIN. → Expected: Access granted.
User selects "Withdraw Cash" option. → Expected: Withdrawal menu appears.
User enters amount (e.g., ₹500). → Expected: Machine checks balance.
Balance is sufficient. → Expected: Cash is dispensed, receipt printed, balance updated.

Thank You