# Software Verification & Validation
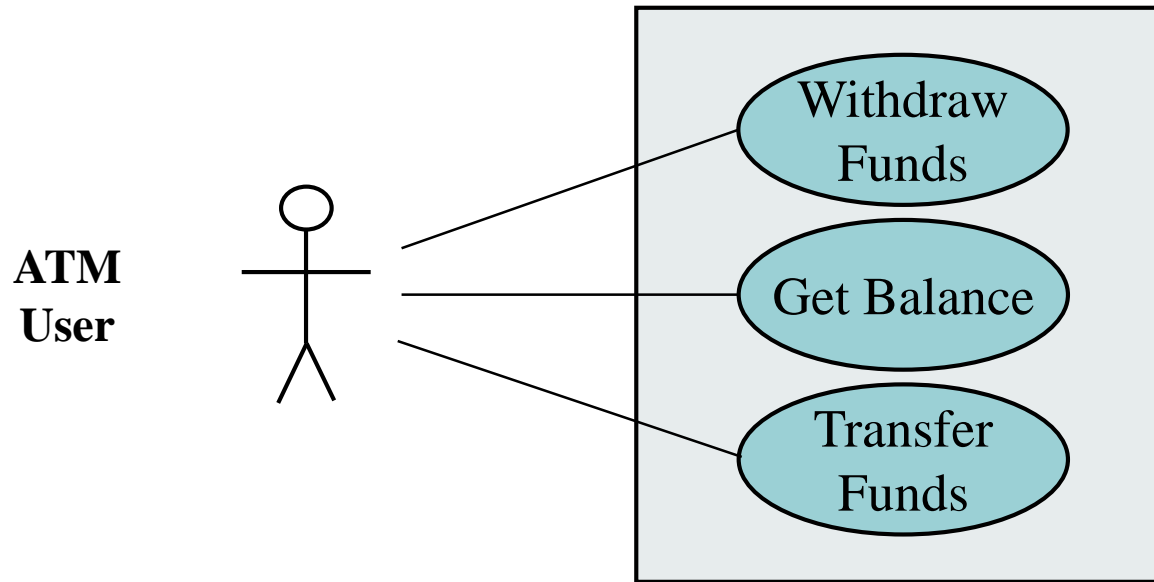
Natthapong Jungteerapanich

Handout 5

# Acknowledgement

- Some slides in this lecture are adapted from

    - **Paul Ammann and Jeff Offutt's** slides for their textbook **"Introduction to Software Testing"**

    - **Lee Copeland's** "**A Practitioner's Guide to Software Test Design**". Artech House, 2004.

# Simple Use Case Example



- <u>Actors</u> : Humans or software components that use the software being modeled
- <u>Use cases</u> : Shown as circles or ovals
- <u>Node Coverage</u> : Try each use case once ...

# Elaboration

- Use cases are commonly elaborated (or documented)

- Elaboration is first written textually

  – Details of operation

  – Alternatives model choices and conditions during execution

# Elaboration of ATM Use Case

- Use Case Name : Withdraw Funds
- Summary : Customer uses a valid card to withdraw funds from a valid bank account.
- Actor : ATM Customer
- Precondition : ATM is displaying the idle welcome message
- Description :
    1) Customer inserts an ATM Card into the ATM Card Reader.
    2) If the system can recognize the card, it reads the card number.
    3) System prompts the customer for a PIN.
    4) Customer enters PIN.
    5) System checks the card's expiration date and whether the card has been stolen or lost.
    6) If the card is valid, the system checks if the entered PIN matches the card PIN.
    7) If the PINs match, the system finds out what accounts the card can access.
    8) System displays customer accounts and prompts the customer to choose a type of transaction.  There are three types of transactions, Withdraw Funds, Get Balance and Transfer Funds.  *(The previous eight steps are part of all three use cases; the following steps are unique to the Withdraw Funds use case.)*

# Elaboration of ATM Use Case

- <u>Description</u> (continued) :

  9) Customer selects Withdraw Funds, selects the account number, and enters the amount.

  10) System checks that the account is valid, makes sure that customer has enough funds in the account, makes sure that the daily limit has not been exceeded, and checks that the ATM has enough funds.

  11) If all four checks are successful, the system dispenses the cash.

  12) System prints a receipt with a transaction number, the transaction type, the amount withdrawn, and the new account balance.

  13) System ejects card.

  14) System displays the idle welcome message.

# Elaboration of ATM Use Case

- Alternatives :
  - 2a) If the system cannot recognize the card, it is ejected and the welcome message is displayed.
  - 5a) If the current date is past the card's expiration date, the card is confiscated and the welcome message is displayed.
  - 5b) If the card has been reported lost or stolen, it is confiscated and the welcome message is displayed.
  - 7a) If the customer entered PIN does not match the PIN for the card, the system prompts for a new PIN. If the customer enters an incorrect PIN three times, the card is confiscated and the welcome message is displayed.
  - 11a) If the account number entered by the user is invalid, the system displays an error message, ejects the card and the welcome message is displayed.
  - 11b) If the request for withdraw exceeds the maximum allowable daily withdrawal amount, the system displays an apology message, ejects the card and the welcome message is displayed.
  - 11c) If the request for withdraw exceeds the amount of funds in the ATM, the system displays an apology message, ejects the card and the welcome message is displayed.

- Postcondition :
  - Funds have been withdrawn from the customer's account.

# Use Cases to Activity Diagrams

- Activity diagrams indicate <u>flow among activities</u>

- Activities should model <u>user level steps</u>

- Two kinds of nodes:
  - <u>Action</u> states
  - <u>Sequential</u> branches

- Use case descriptions become <u>action state nodes</u> in the activity diagram

- Alternatives are <u>sequential branch nodes</u>

- Flow among steps are <u>edges</u>

- Activity diagrams usually have some helpful characteristics:
  - Few loops
  - Simple predicates

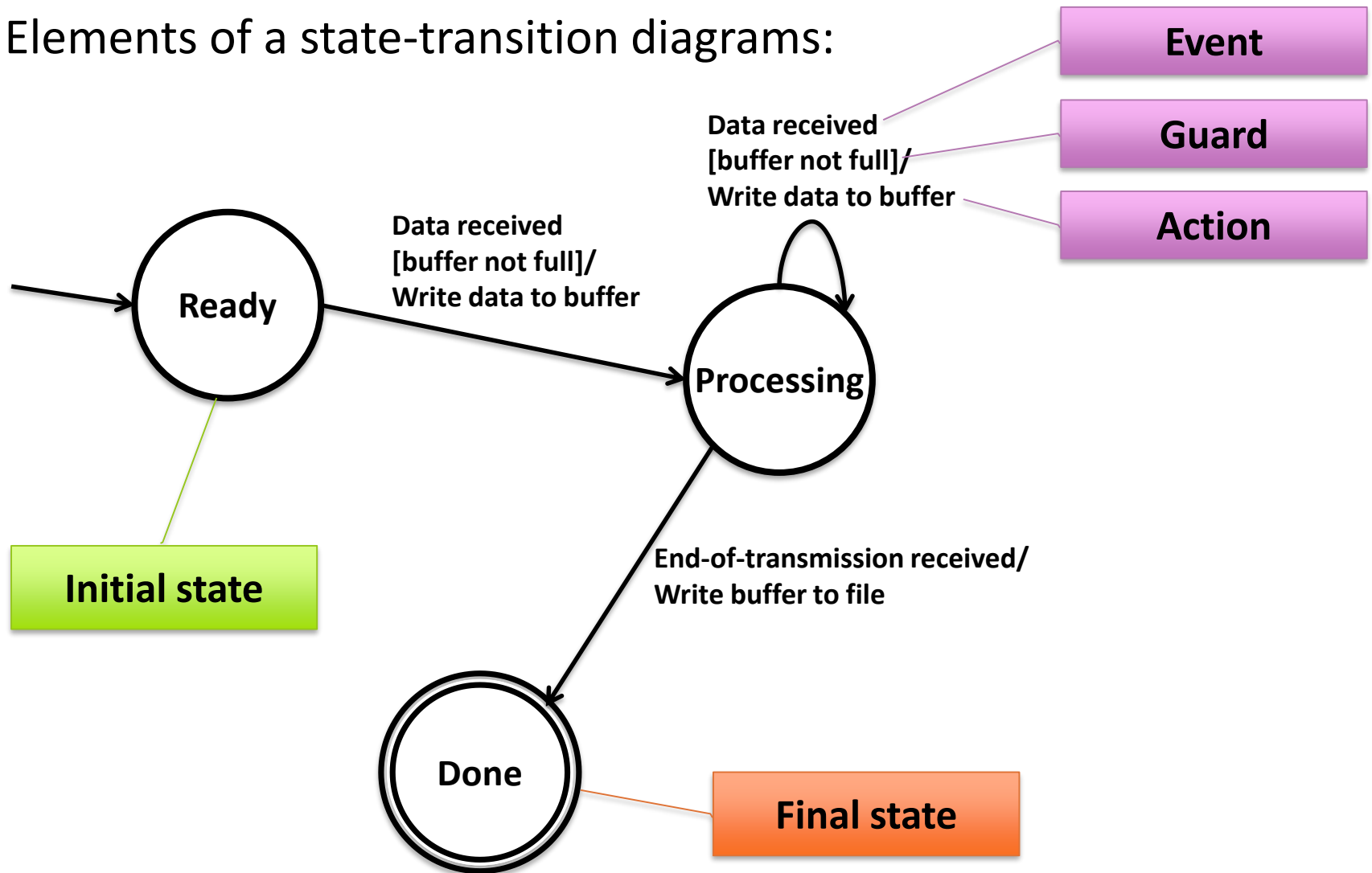# ATM Withdraw Activity Graph
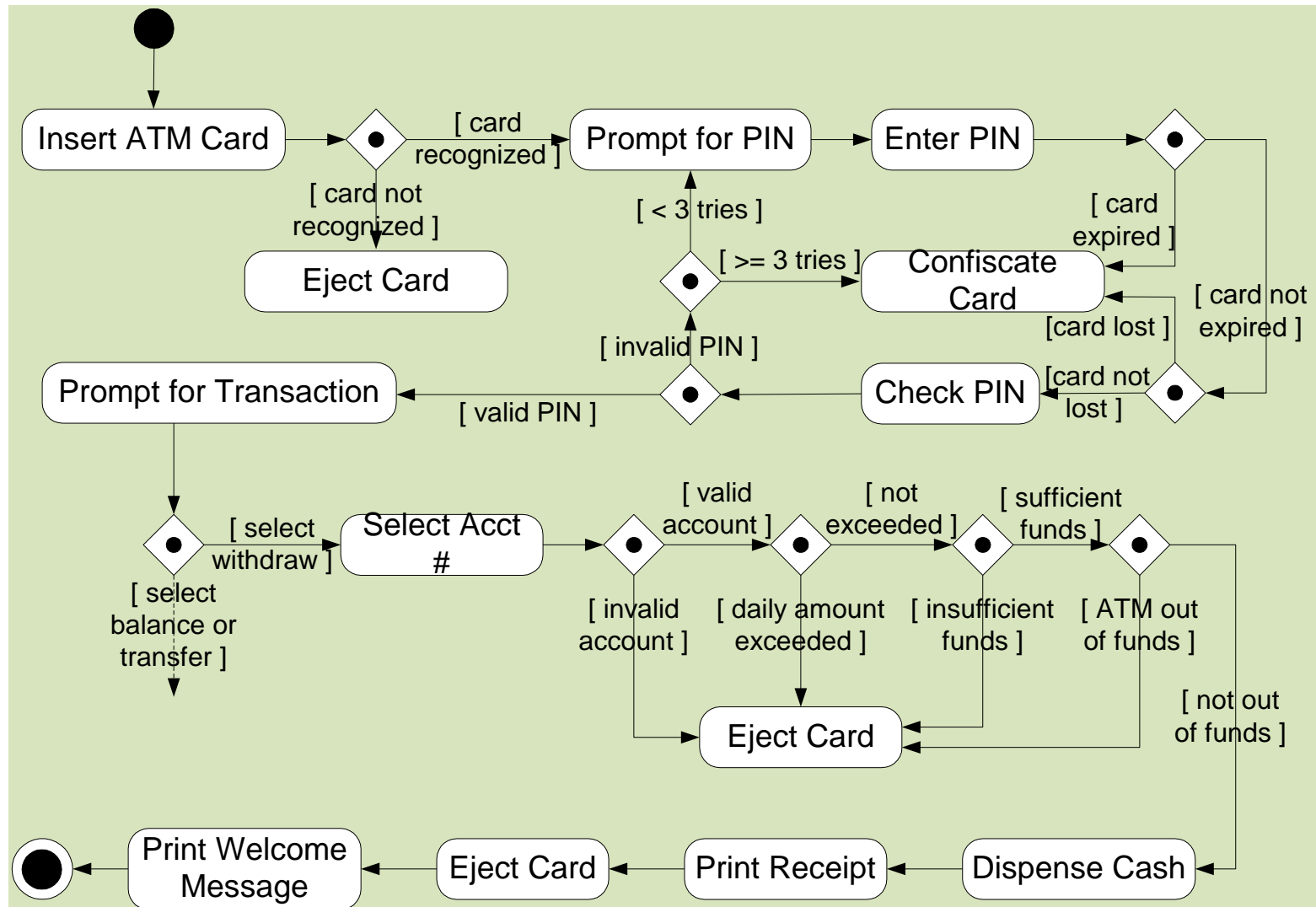
# Covering Activity Graphs

- Node Coverage

- Edge Coverage

- All-Path Coverage

# Test Case Design from State-Transition Diagrams

- During the design phase, a state-transition diagram is often used to capture how the software system should behave in response to various events.

- State-transition diagrams are used extensively in both hardware and software systems, particularly for embedded systems.

- State-transition diagrams appear under various names and various refinements in computer science and software engineering, such as finite state machines, statecharts, finite automata, transition systems, etc.
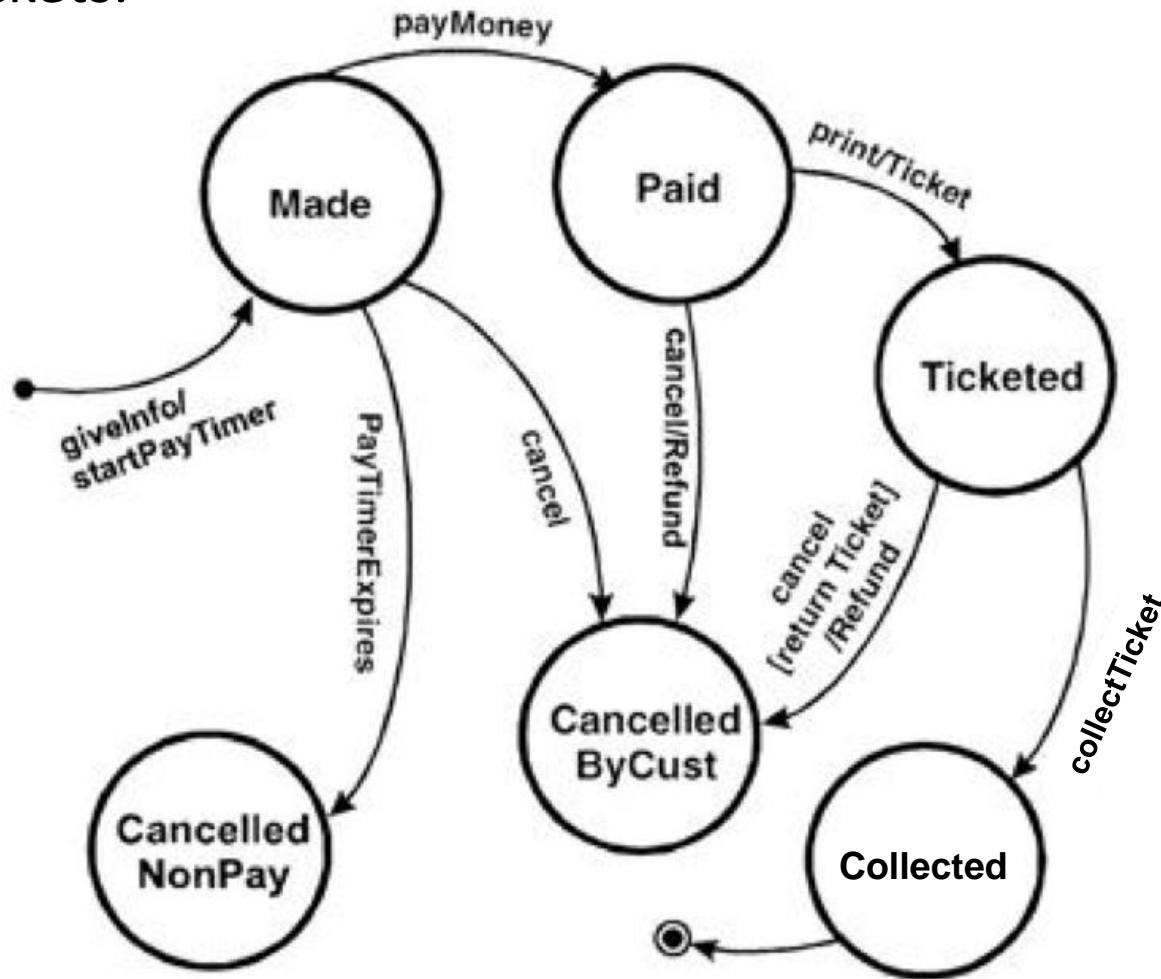
# Test Case Design from State-Transition Diagrams

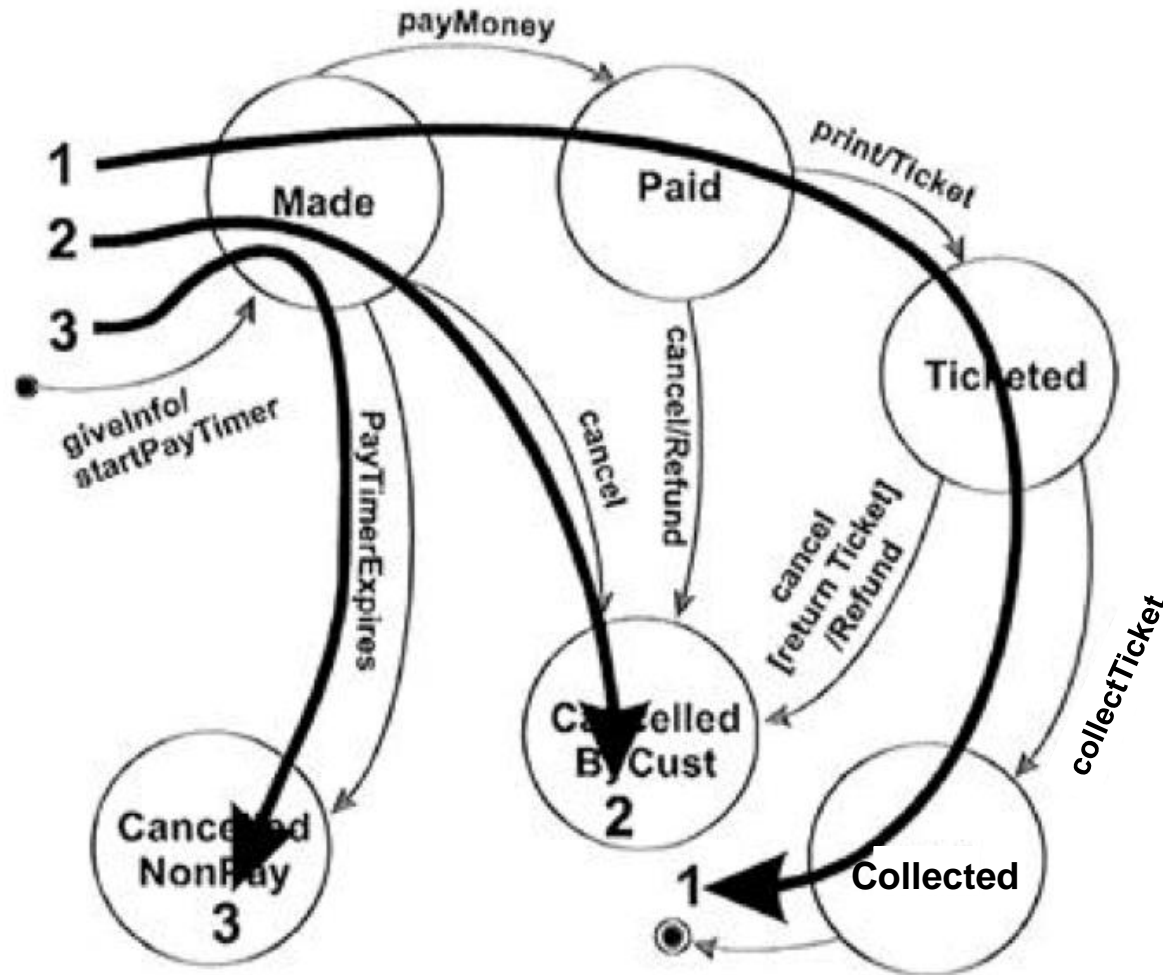- Elements of a state-transition diagrams:



**Event**

**Guard**

**Action**

Data received
[buffer not full]/
Write data to buffer

**Ready**

Data received
[buffer not full]/
Write data to buffer

**Processing**

**Initial state**

End-of-transmission received/
Write buffer to file

**Done**

**Final state**

# Test Case Design from State-Transition Diagrams

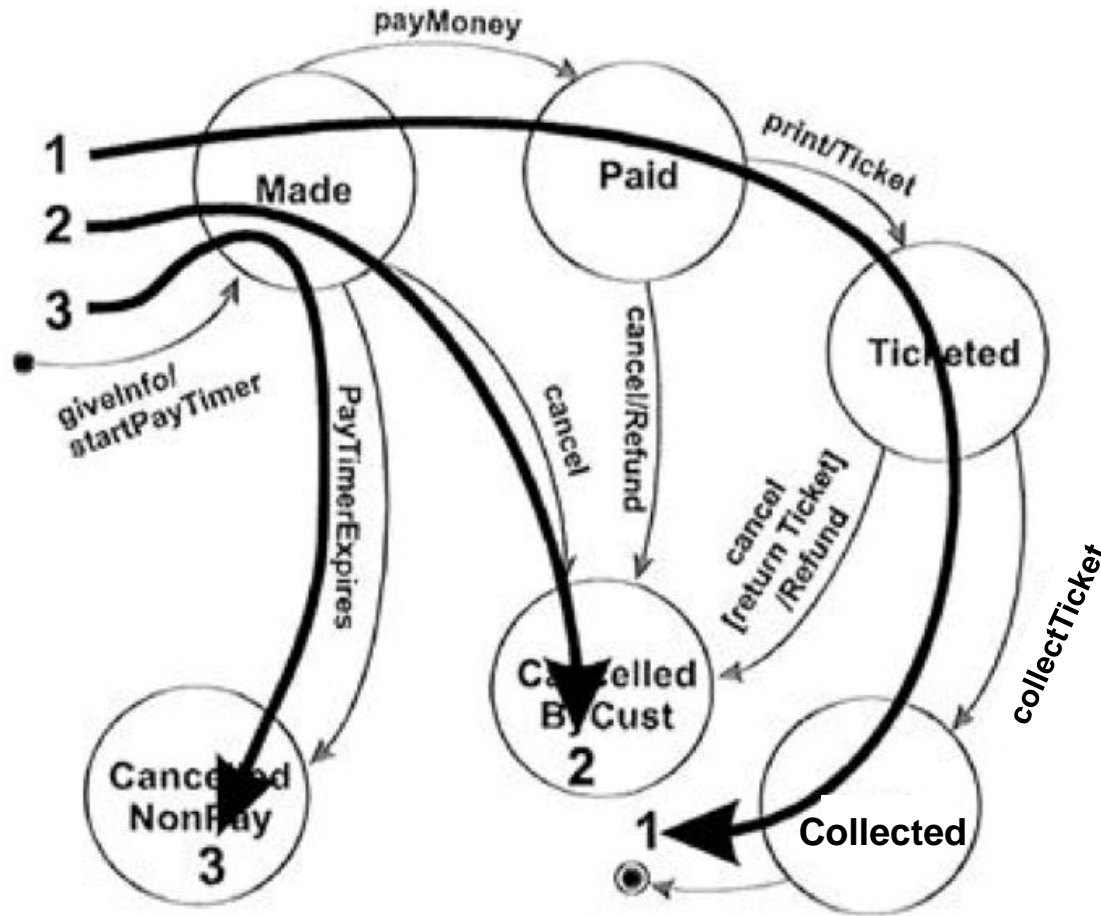- An example of a state-transition diagram of a kiosk for purchasing plane tickets.

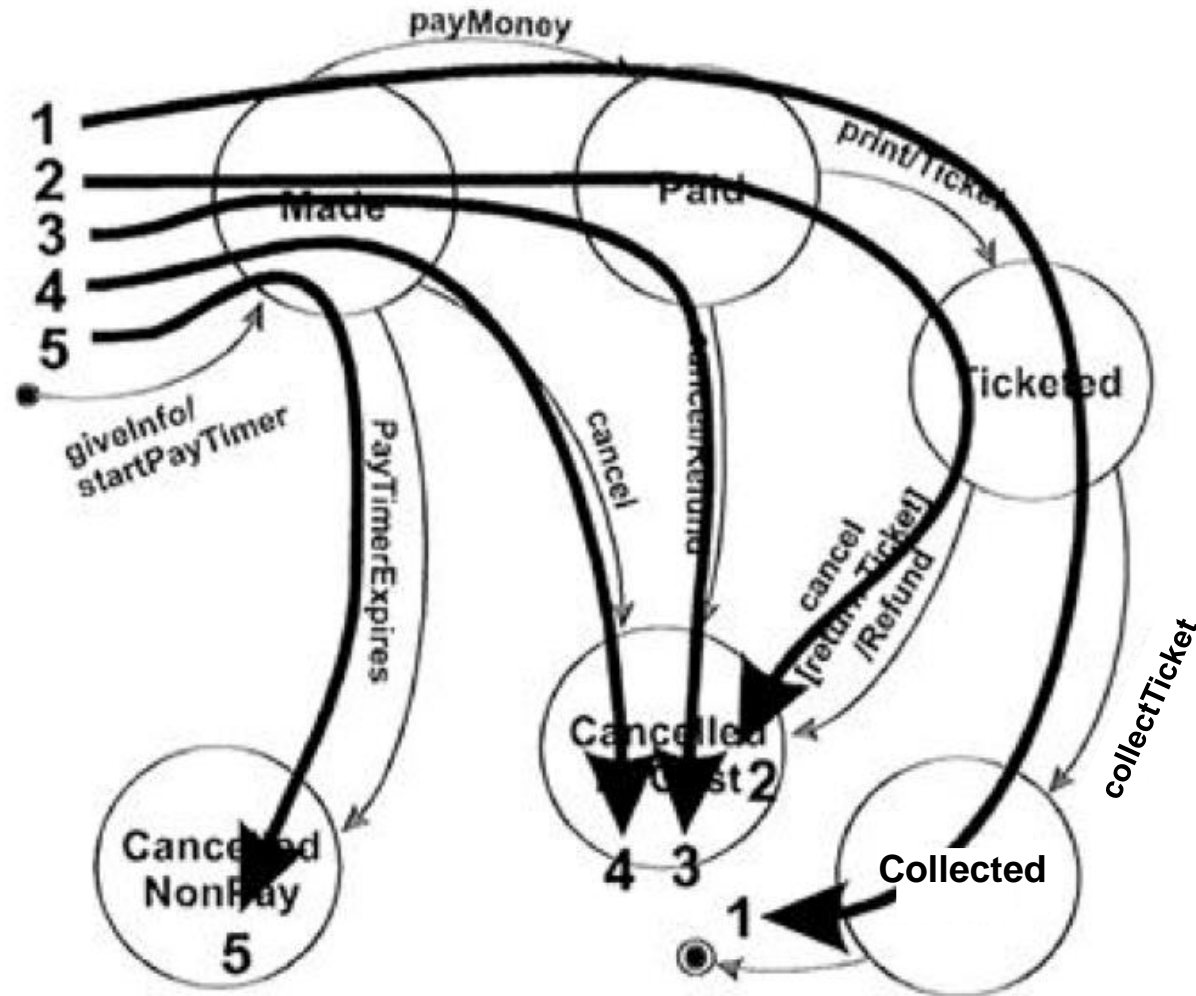- **All-state coverage criterion** : Each state is visited by some test path.

# Test Case Design from State-Transition Diagrams

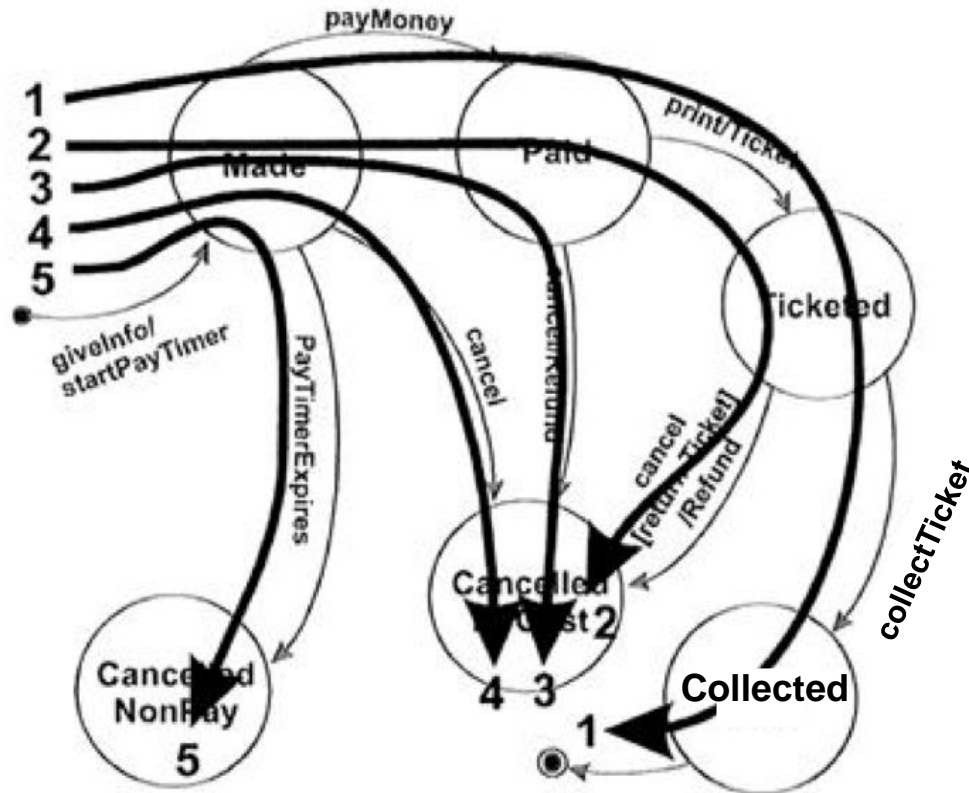- **All-event coverage criterion** : Each event occurs on some test path.

# Test Case Design from State-Transition Diagrams

- **All-transition coverage criterion** : Each transition is visited by some test path.

# Test Case Design from State-Transition Diagrams

- **All-paths coverage criterion** : Every (feasible) path is visited by some test path.



- Not practical (sometime not possible) in a diagram which has a loop.