BCS Oxfordshire

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State transition testing

A practical workshop in the use of a software testing technique

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the problem...

very large or infinite number of test scenarios

+

finite amount of time

=

impossible to test everything

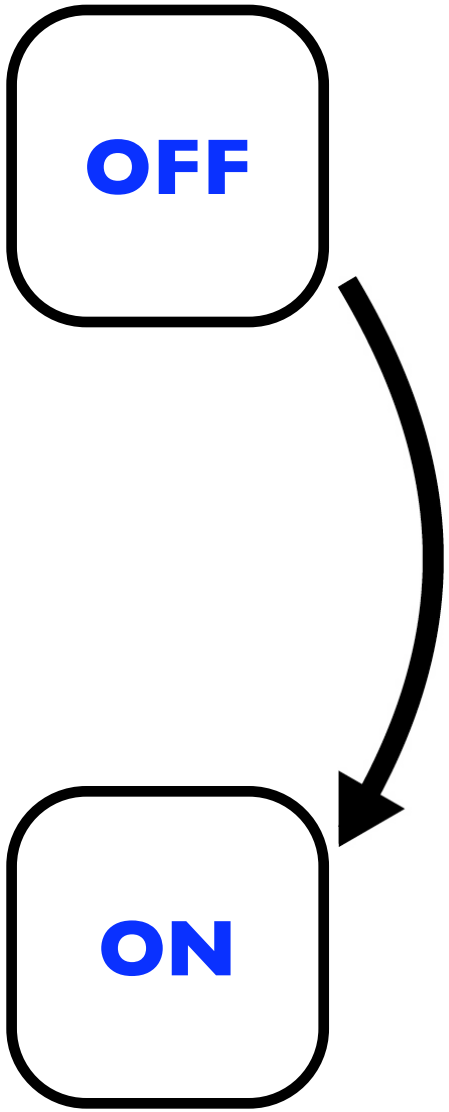
the solution...

Software test techniques exist to reduce the number of tests to be run whilst still providing sufficient coverage of the system under test

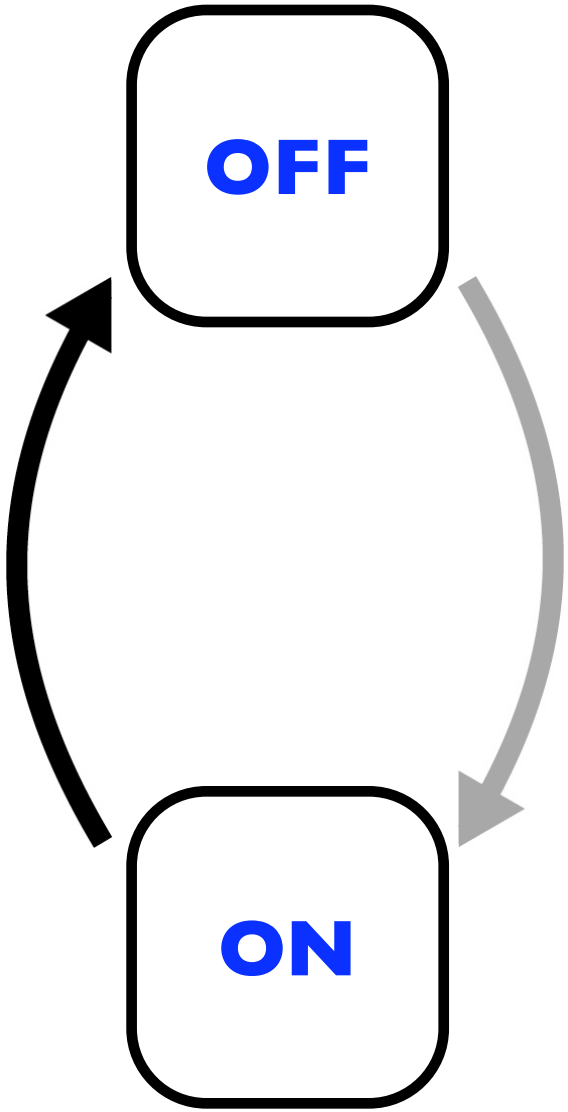
state transition testing

- Models each state a system can exist in
- Models each state transition
- Defines for each state transition
  - start state
  - input
  - output
  - finish state

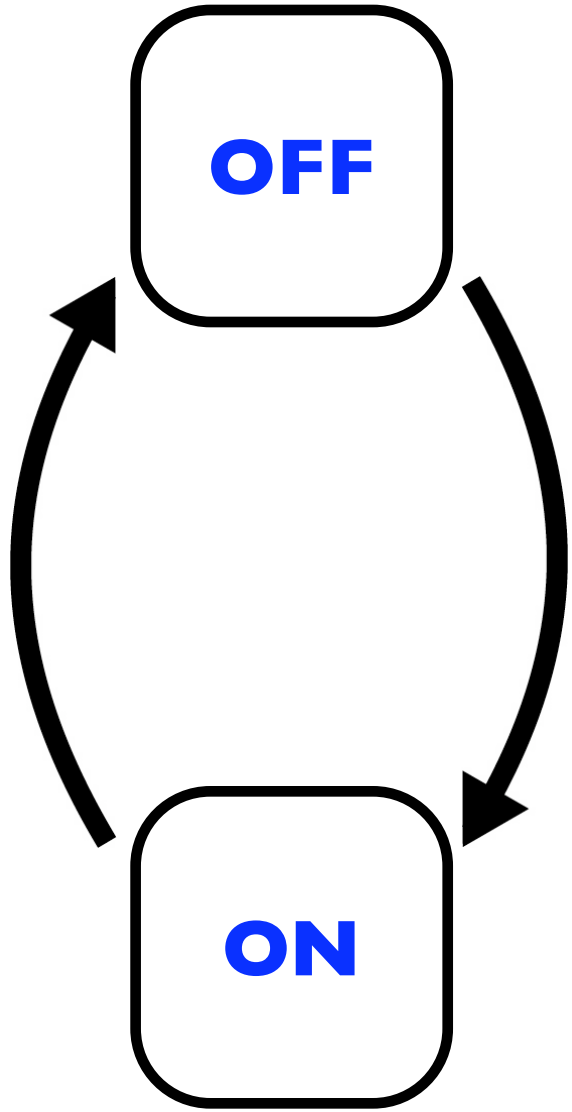
OFF



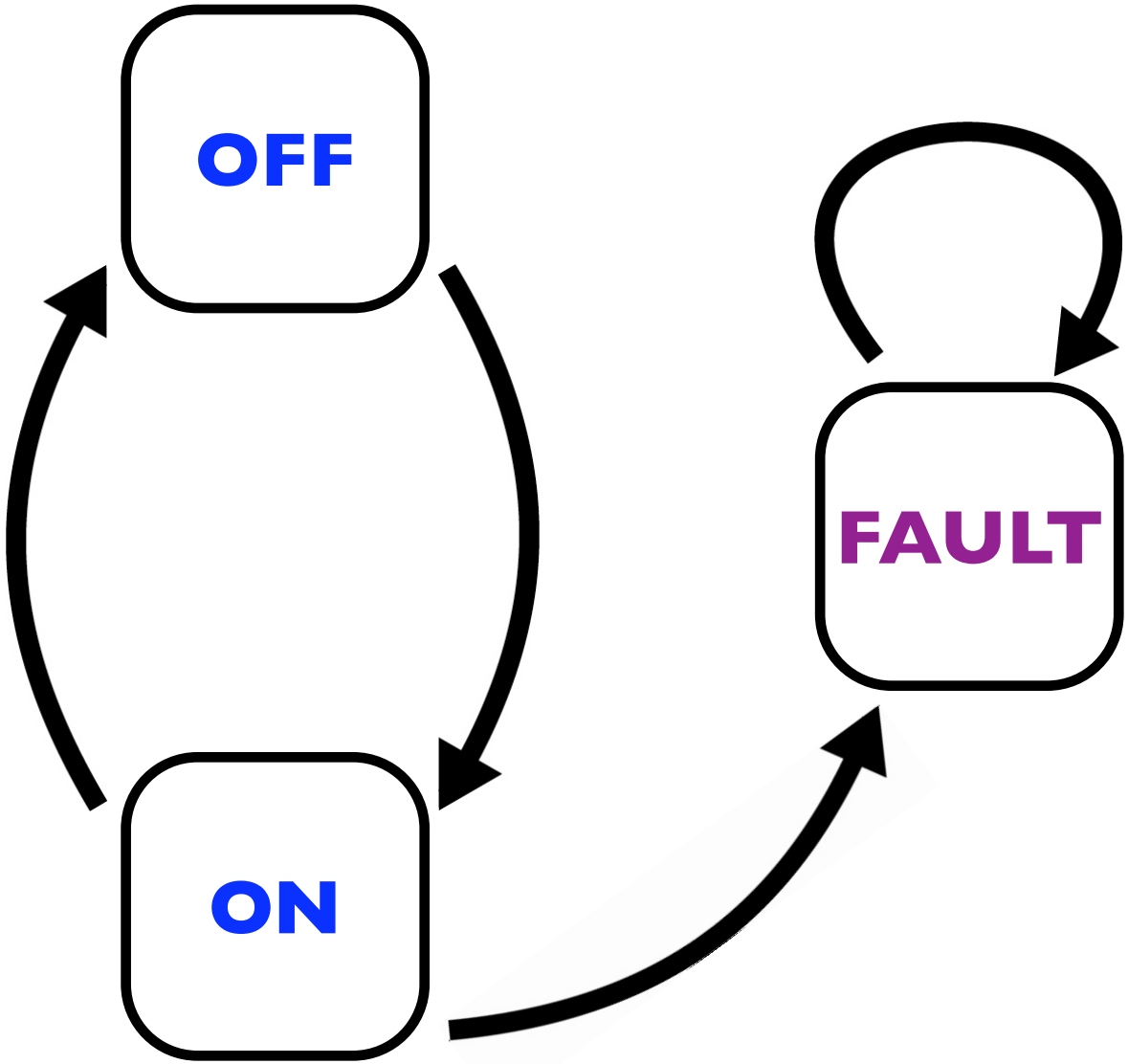
Input: switch on
Output: light on

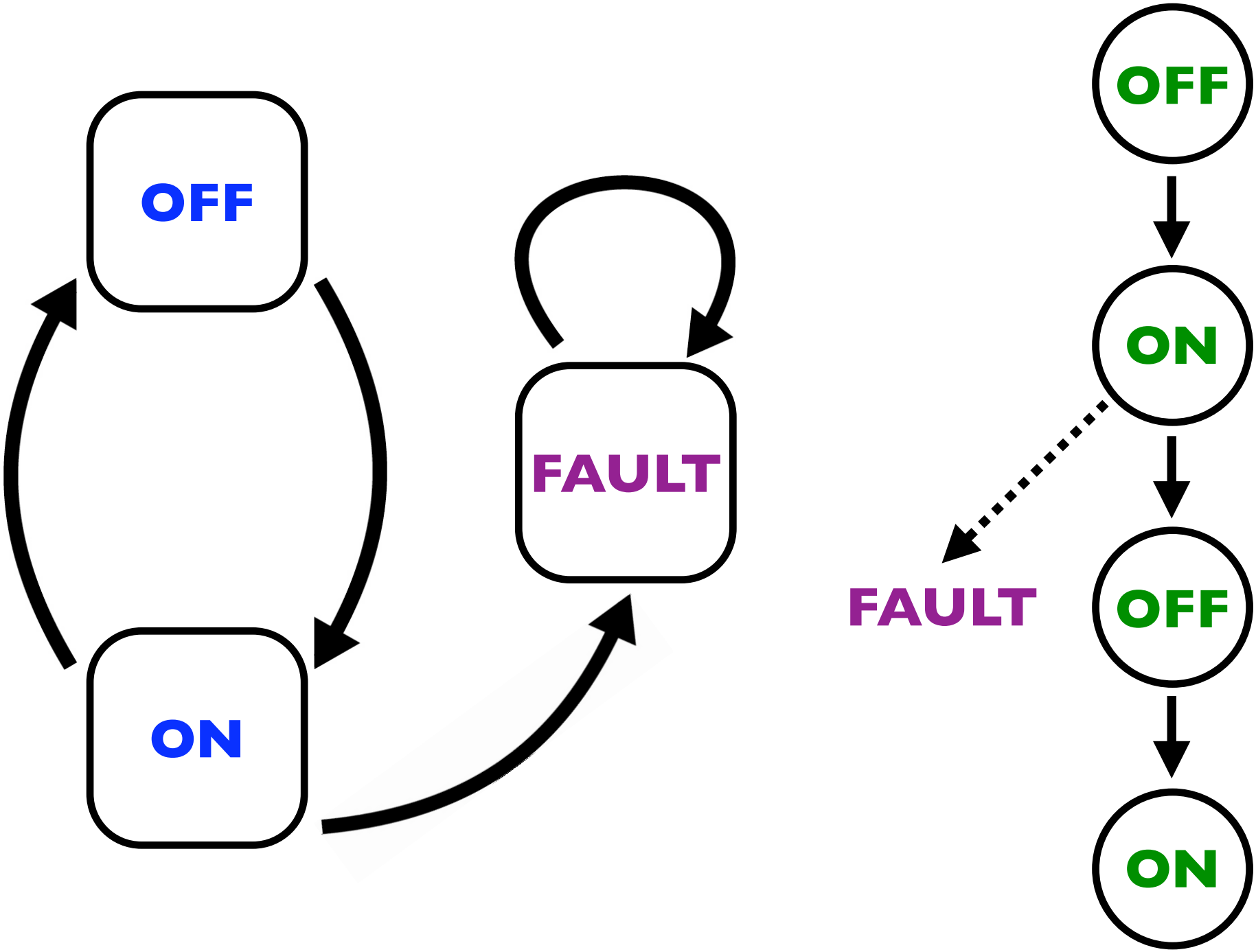


Input: switch off
Output: light off



TEST 1	TEST 2
start state: **off**	start state: **on**
input: **switch on**	input: **switch off**
output: **light on**	output: **light off**
finish state: **on**	finish state: **off**


OFF
ON
FAULT

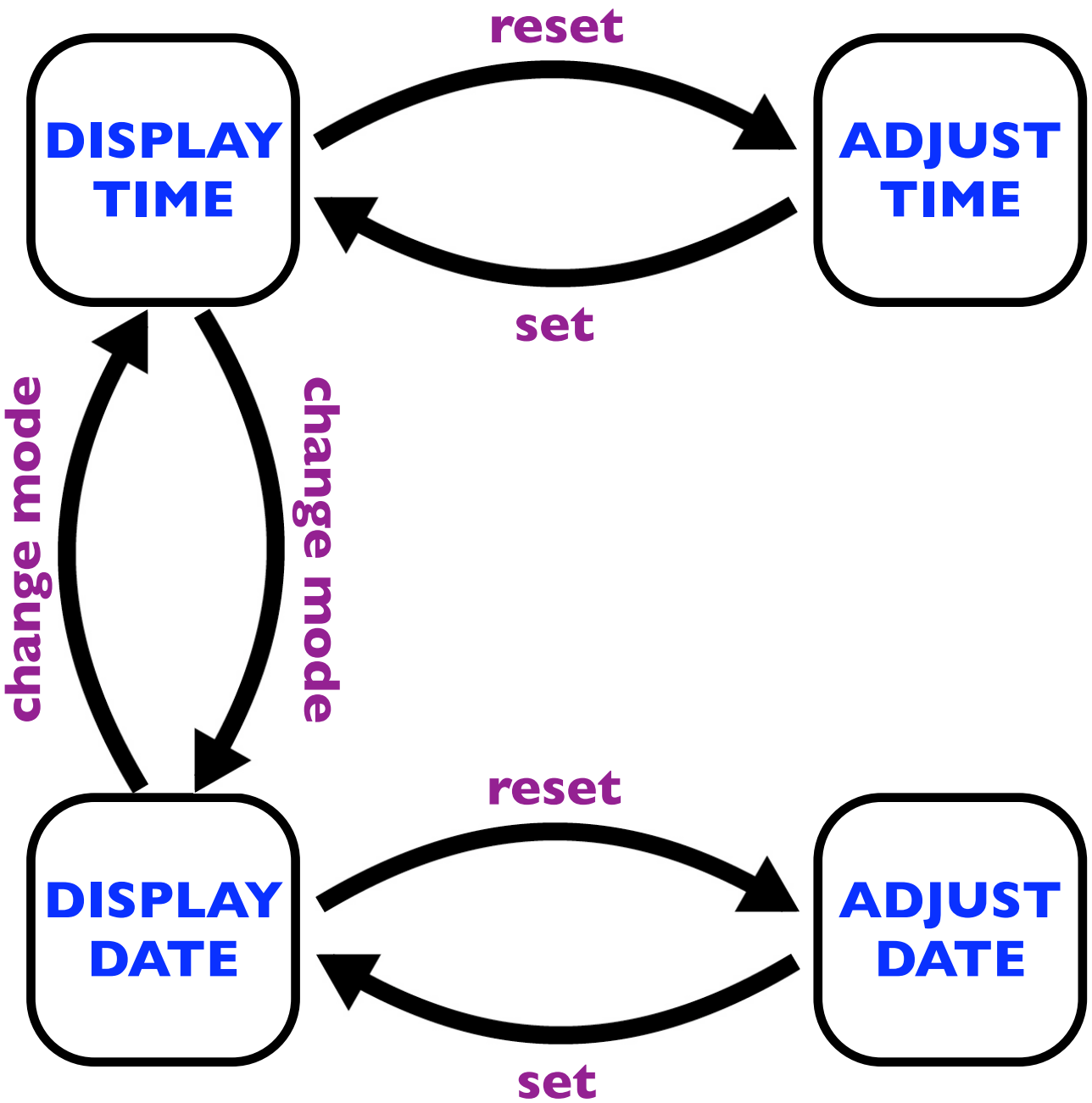

OFF
ON
FAULT
OFF
FAULT
OFF
ON

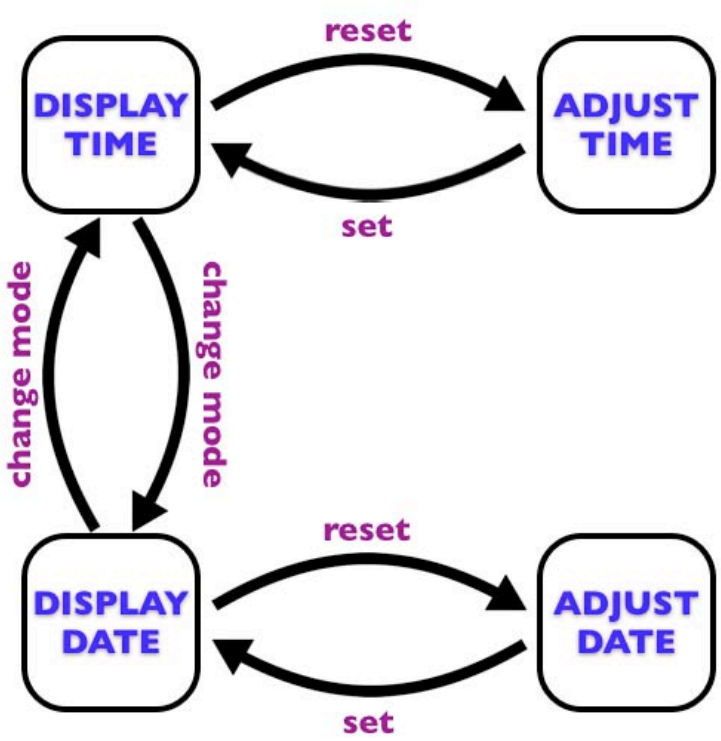
TEST

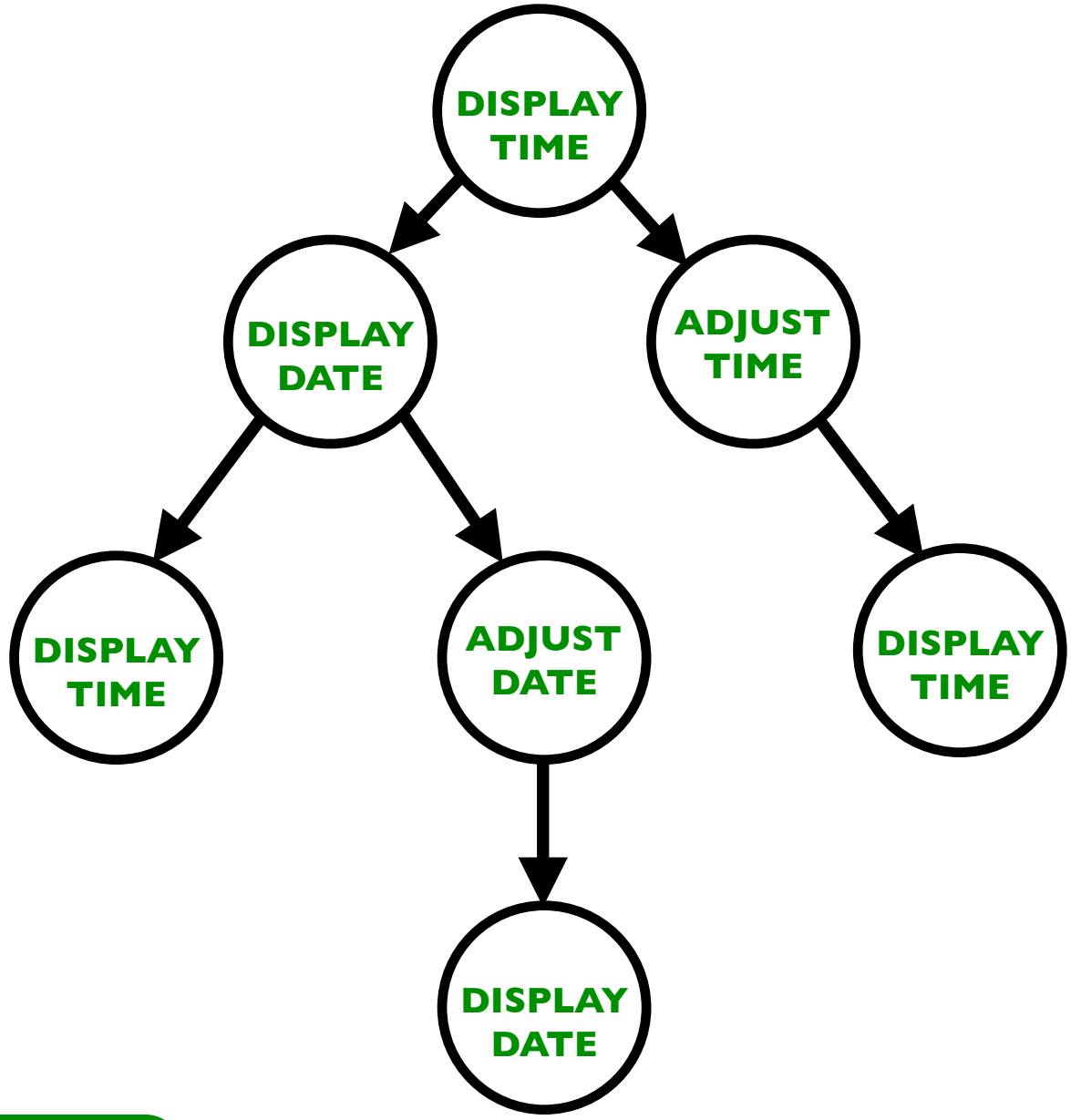
	STEP 1	STEP 2	STEP 3
START STATE	OFF	ON	OFF
INPUT	SWITCH ON	SWITCH OFF	SWITCH ON
OUTPUT	LIGHT ON	LIGHT OFF	LIGHT ON
FINISH STATE	ON	OFF	ON

electronic clock example

- A simple electronic clock has four modes, *display time*, *change time*, *display date* and *change date*
- The *change mode* button switches between display time and display date
- The *reset* button switches from *display time* to *adjust time* or *display date* to *adjust date*
- The *set* button returns from *adjust time* to *display time* or *adjust date* to *display date*


DISPLAY TIME
reset
ADJUST TIME
set
change mode
change mode
DISPLAY DATE
reset
ADJUST DATE
set





0-switch or branch coverage

TEST 1

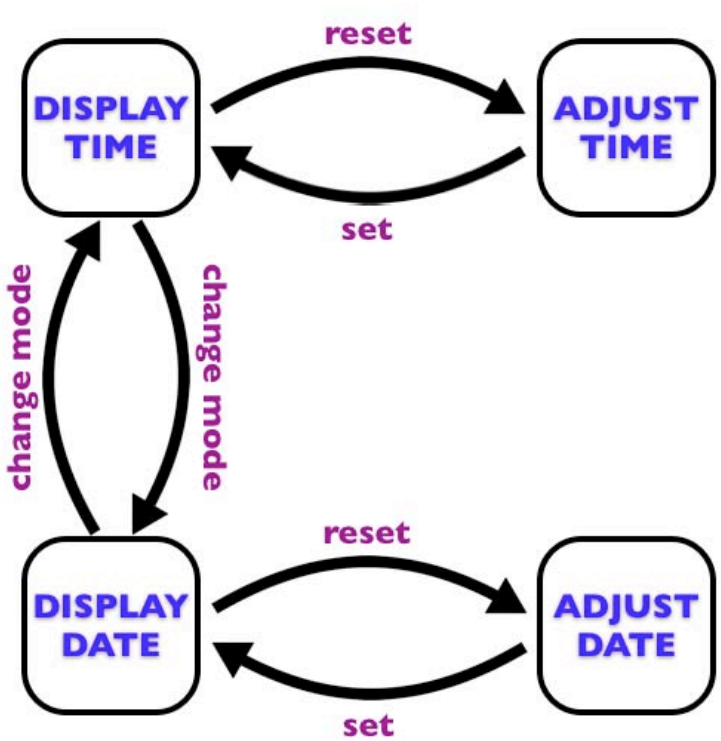
	STEP 1	STEP 2
START STATE	DISPLAY TIME	DISPLAY DATE
INPUT	CHANGE MODE	CHANGE MODE
OUTPUT	DISPLAY DATE	DISPLAY TIME
FINISH STATE	DISPLAY DATE	DISPLAY TIME

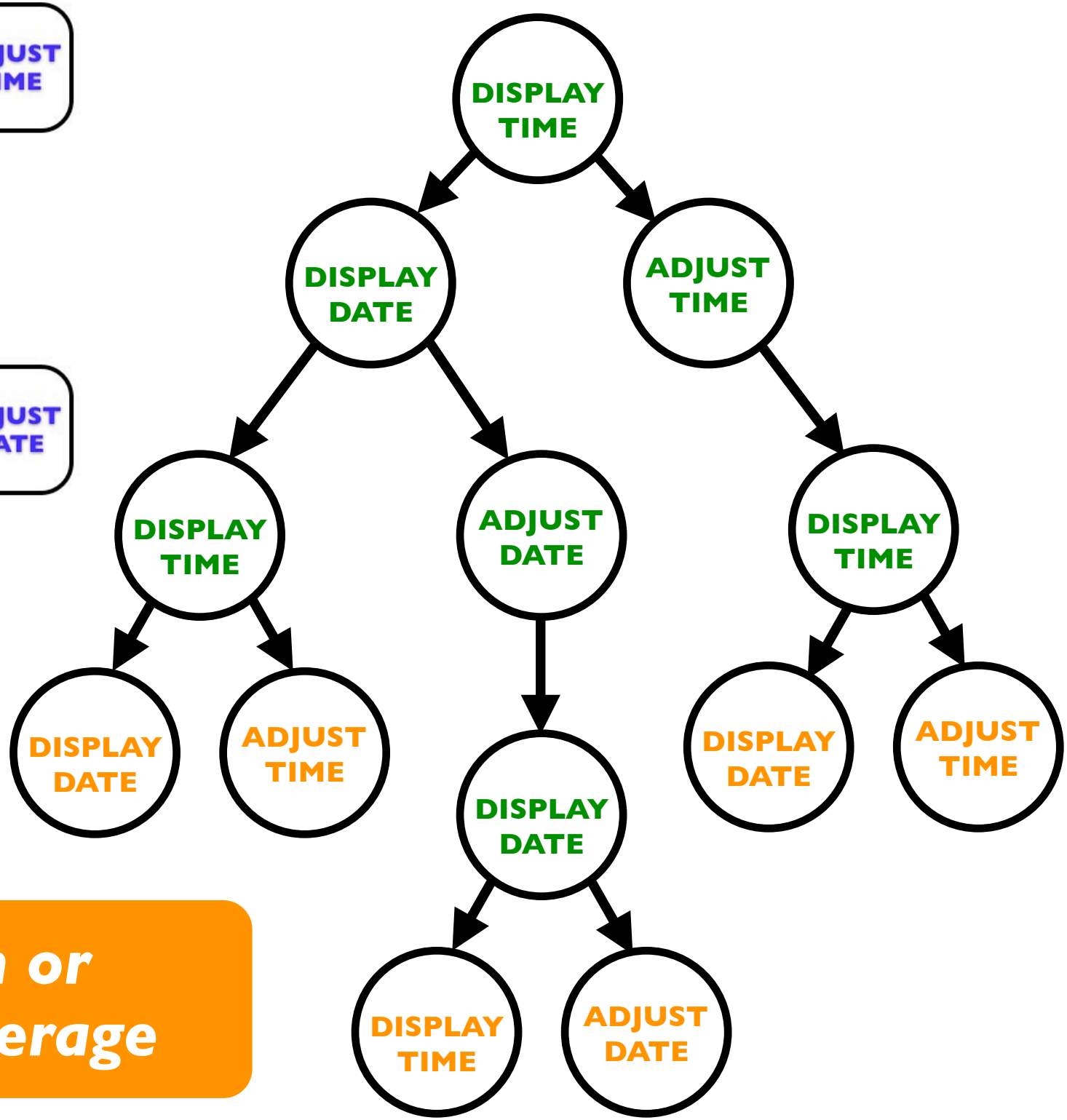
TEST 2

	STEP 1	STEP 2	STEP 3
START STATE	DISPLAY TIME	DISPLAY DATE	ADJUST DATE
INPUT	CHANGE MODE	RESET	SET
OUTPUT	DISPLAY DATE	ADJUST DATE	DISPLAY DATE
FINISH STATE	DISPLAY DATE	ADJUST DATE	DISPLAY DATE

TEST 3

	STEP 1	STEP 2
START STATE	DISPLAY TIME	ADJUST TIME
INPUT	RESET	SET
OUTPUT	ADJUST TIME	DISPLAY TIME
FINISH STATE	ADJUST TIME	DISPLAY TIME





1-switch or switch coverage

TEST 1

	STEP 1	STEP 2	STEP 3
START STATE	DISPLAY TIME	DISPLAY DATE	DISPLAY TIME
INPUT	CHANGE MODE	CHANGE MODE	CHANGE MODE
OUTPUT	DISPLAY DATE	DISPLAY TIME	DISPLAY DATE
FINISH STATE	DISPLAY DATE	DISPLAY TIME	DISPLAY DATE

TEST 2

	STEP 1	STEP 2	STEP 3
START STATE	DISPLAY TIME	DISPLAY DATE	DISPLAY TIME
INPUT	CHANGE MODE	CHANGE MODE	RESET
OUTPUT	DISPLAY DATE	DISPLAY TIME	ADJUST TIME
FINISH STATE	DISPLAY DATE	DISPLAY TIME	ADJUST TIME

TEST 3

	STEP 1	STEP 2	STEP 3	STEP 4
START STATE	DISPLAY TIME	DISPLAY DATE	ADJUST DATE	DISPLAY DATE
INPUT	CHANGE MODE	RESET	SET	CHANGE MODE
OUTPUT	DISPLAY DATE	ADJUST DATE	DISPLAY DATE	DISPLAY TIME
FINISH STATE	DISPLAY DATE	ADJUST DATE	DISPLAY DATE	DISPLAY TIME

TEST 4

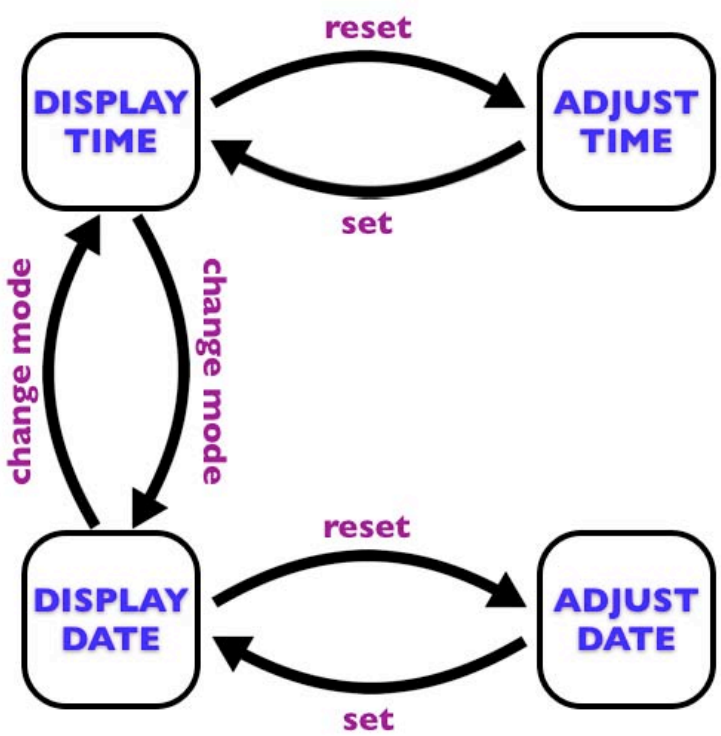
	STEP 1	STEP 2	STEP 3	STEP 4
START STATE	DISPLAY TIME	DISPLAY DATE	ADJUST DATE	DISPLAY DATE
INPUT	CHANGE MODE	RESET	SET	RESET
OUTPUT	DISPLAY DATE	ADJUST DATE	DISPLAY DATE	ADJUST DATE
FINISH STATE	DISPLAY DATE	ADJUST DATE	DISPLAY DATE	ADJUST DATE

TEST 5

	STEP 1	STEP 2	STEP 3
START STATE	DISPLAY TIME	ADJUST TIME	DISPLAY TIME
INPUT	RESET	SET	CHANGE MODE
OUTPUT	ADJUST TIME	DISPLAY TIME	DISPLAY DATE
FINISH STATE	ADJUST TIME	DISPLAY TIME	DISPLAY DATE

TEST 6

	STEP 1	STEP 2	STEP 3
START STATE	DISPLAY TIME	ADJUST TIME	DISPLAY TIME
INPUT	RESET	SET	RESET
OUTPUT	ADJUST TIME	DISPLAY TIME	ADJUST TIME
FINISH STATE	ADJUST TIME	DISPLAY TIME	ADJUST TIME



n-switch or boundary interior

- execute each loop n times
- at least twice
- tests each loop irrespective of the start/end point
- 6 loops to be tested in this case

n-switch or boundary interior

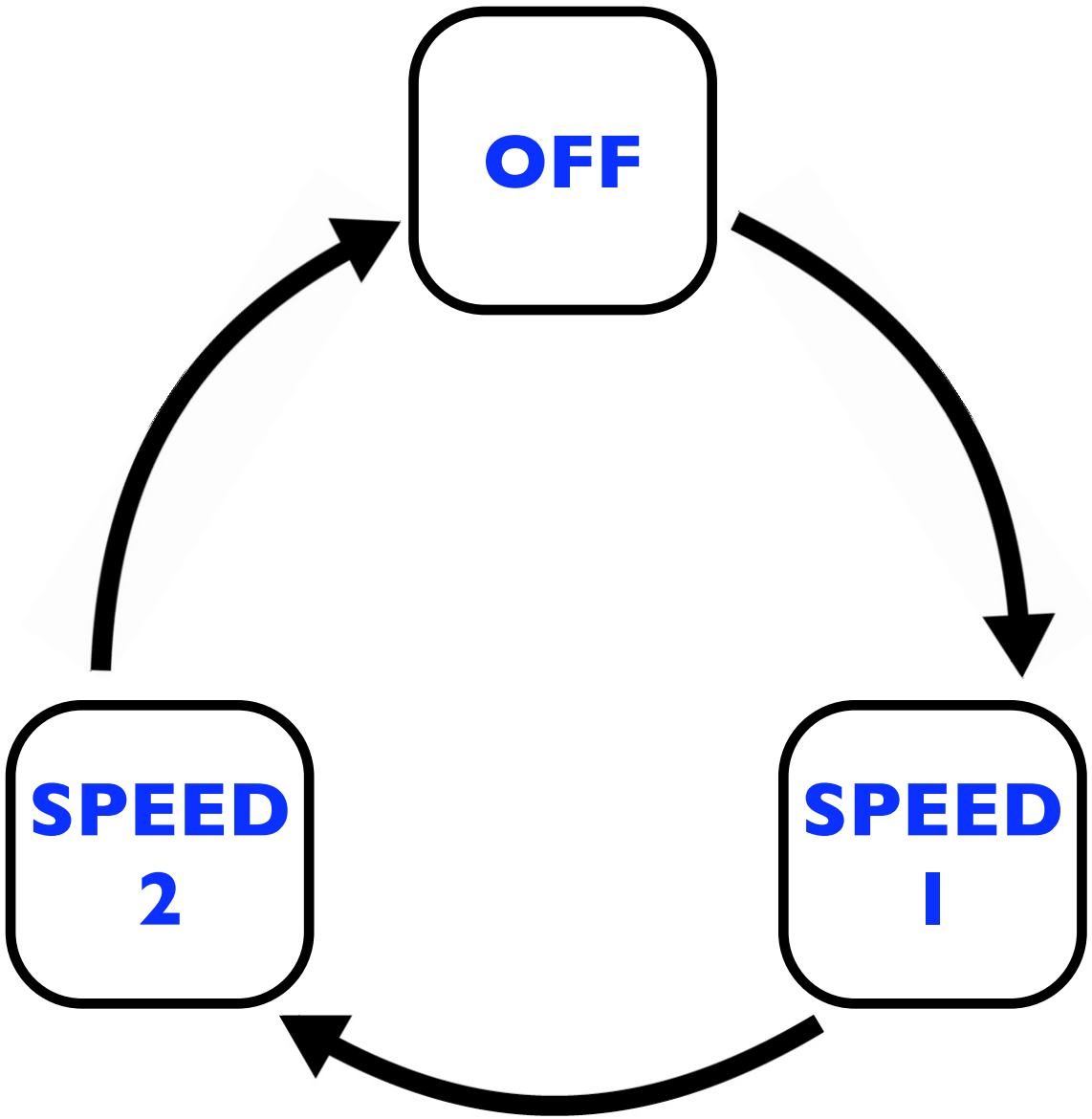
for each exercise...

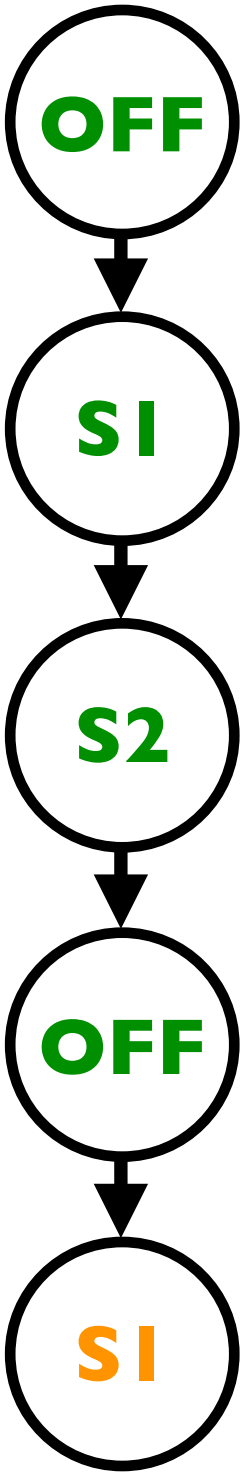
- Draw a state transition diagram
  - draw the states
  - mark the state transitions
  - define input and output for each state transition
- Determine the level of coverage
  - 1-switch/switch coverage for these exercises
- Draw a testing tree
- Define the tests

electric toothbrush

A two-speed electric toothbrush is operated by pressing its one button. The first press of the button turns the toothbrush from off to speed one, the second press of the button turns it to speed two

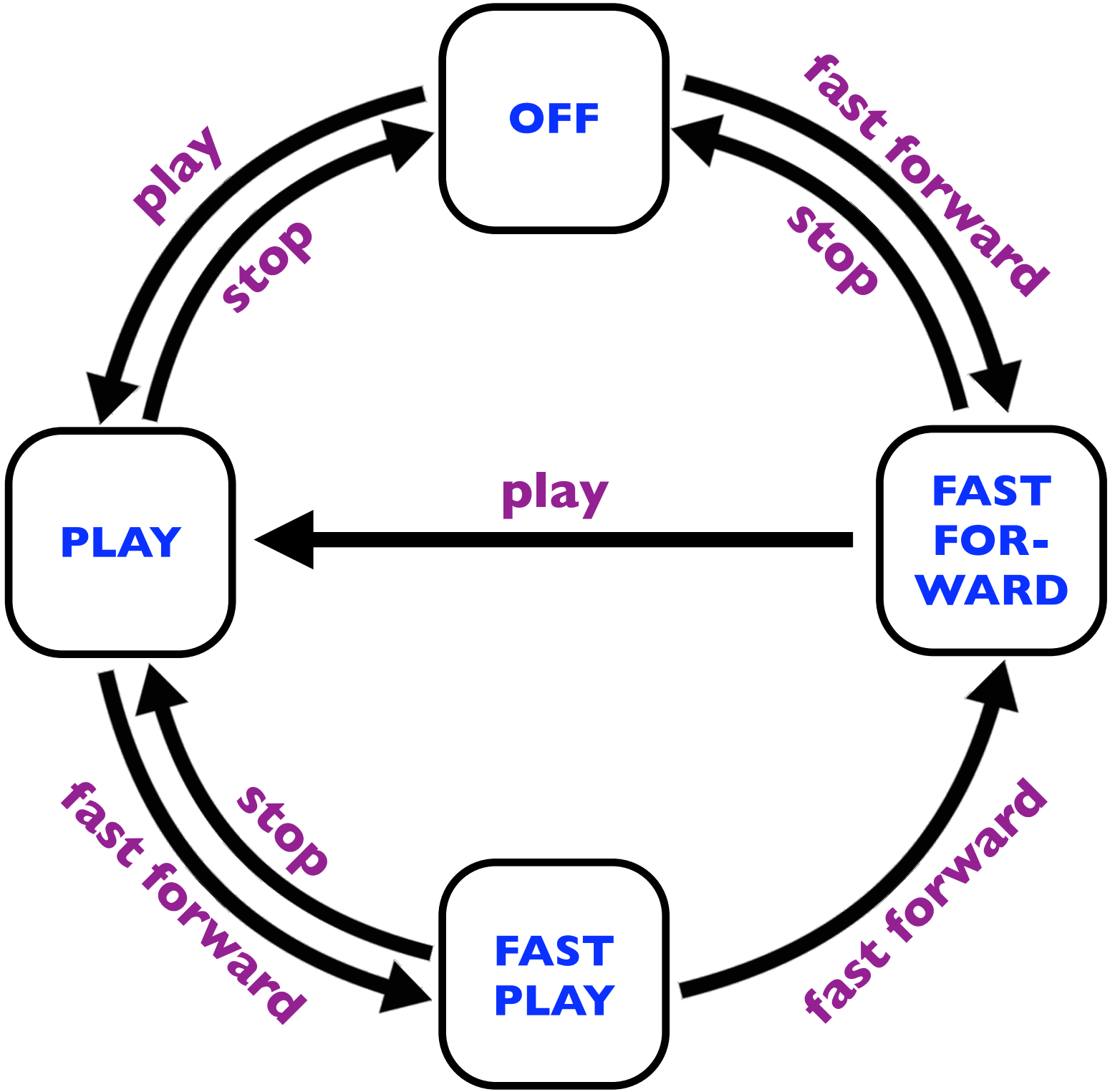
When the button is pressed for a third time the electric toothbrush is turned off

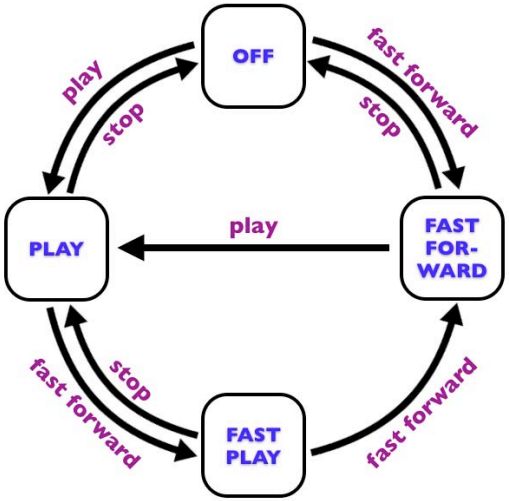

OFF
SPEED 1
SPEED 2


OFF
S1
S2
OFF
S1

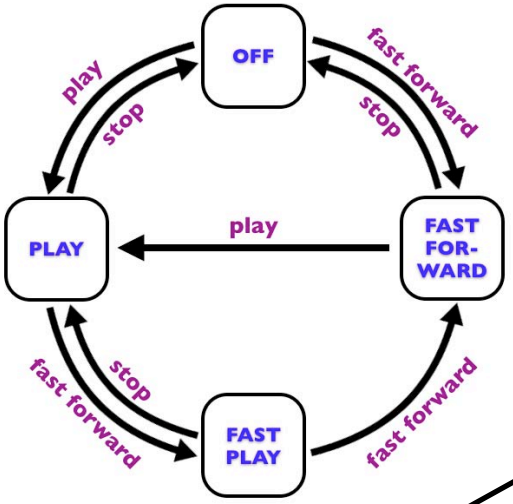
tape cassette player

A tape player has three operations: play, fast forward and fast play. Play and fast forward are activated using the play and fast forward button respectively. These operations can be cancelled using the stop button. When in play mode, the fast forward can be used to fast play. When in fast play mode, the fast forward button can be pressed again to enter fast forward or the stop button can be used to return to play. When in fast forward the play button can be pressed to enter play mode directly.


OFF
play
stop
fast forward
stop
PLAY
play
FAST
FOR-
WARD
fast forward
stop
FAST
PLAY
stop
fast forward



0-switch or branch coverage



1-switch or switch coverage

conclusions...

- There are many useful techniques available
  - state transition testing is only one of the many
- A finite number of tests can be defined from an infinite number of test scenarios and a level of coverage can still be achieved
- The process for state transition testing:
  - draw state transition diagram
  - determine start state, input, output and finish state
  - determine coverage level to be achieved
  - draw testing tree
  - define tests

thank you very much...

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