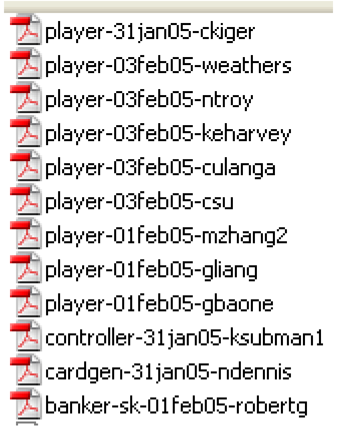


player-31jan05-ckiger
player-03feb05-weathers
player-03feb05-ntroy
player-03feb05-keharvey
player-03feb05-culanga
player-03feb05-csu
player-01feb05-mzhang2
player-01feb05-gliang
player-01feb05-gbaone
controller-31jan05-ksubman1
cardgen-31jan05-ndennis
banker-sk-01feb05-robertg

BlackJack Smart Player, Kiger

- Replica of Basic Player
- Stays with anything above 18: 19,20, 21
- Hits for anything below 13: 12 and lower
- When 13 thru 18, look at Dealers shown card, if value is greater than dealer value plus 10 then stay, otherwise hit
- Betting
  - Start with bet of one, if lose the double to 2, if win then bet one again
  - Every time player loses, bet is doubled, once the player wins, the bet returns to 1 and starts over again

ECE 552
In-Class Project
Blackjack

Brandon Weathers

2.1.05

Overview

Objective

- Given last year’s VHDL files transform basic player module into “smart” player
- Smart players will compete in series of 100 hands played to determine winner
- Must abide by standard blackjack rules

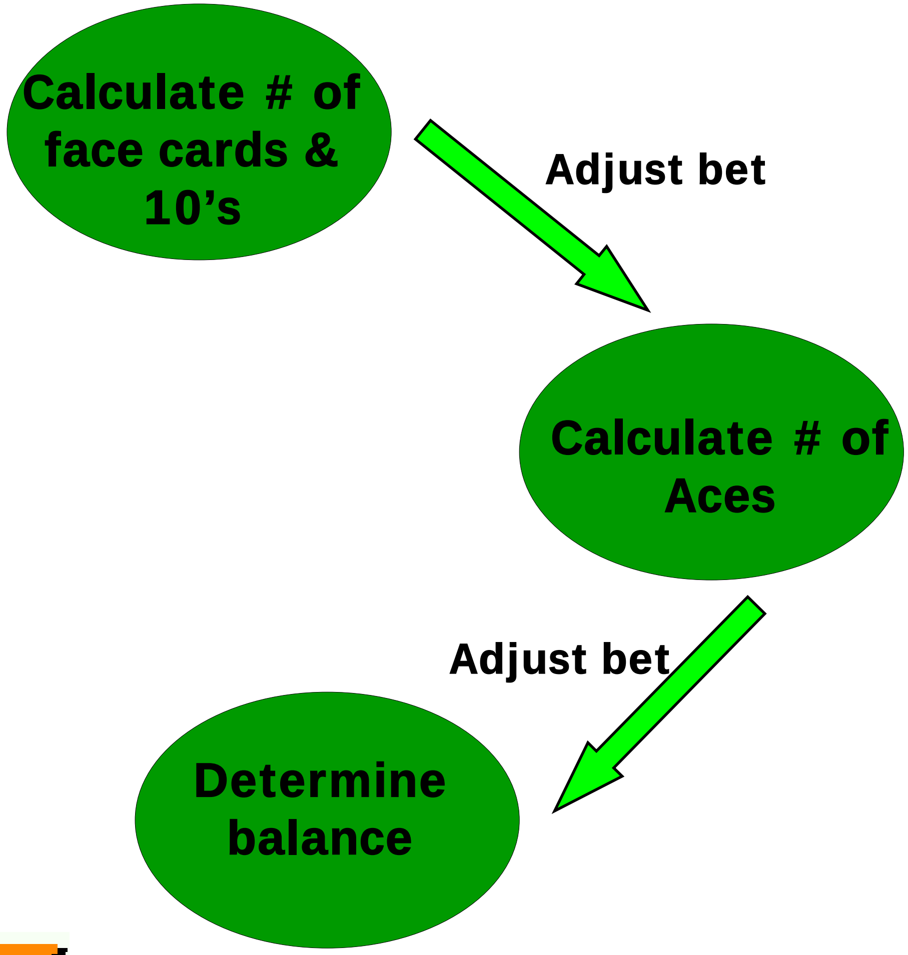
Guidelines

- Bets are made before player sees cards and can not be changed
- Player can only play one hand per game
- Player with most chips after 100 hands wins

Smart Player Strategy

Betting Strategy

- Splits and double downs not possible
- Must adjust bet made for each hand
- Create state machine to adjust bet for
  - Possibility of blackjack
  - Number of chips left



Calculate # of face cards & 10’s

Adjust bet

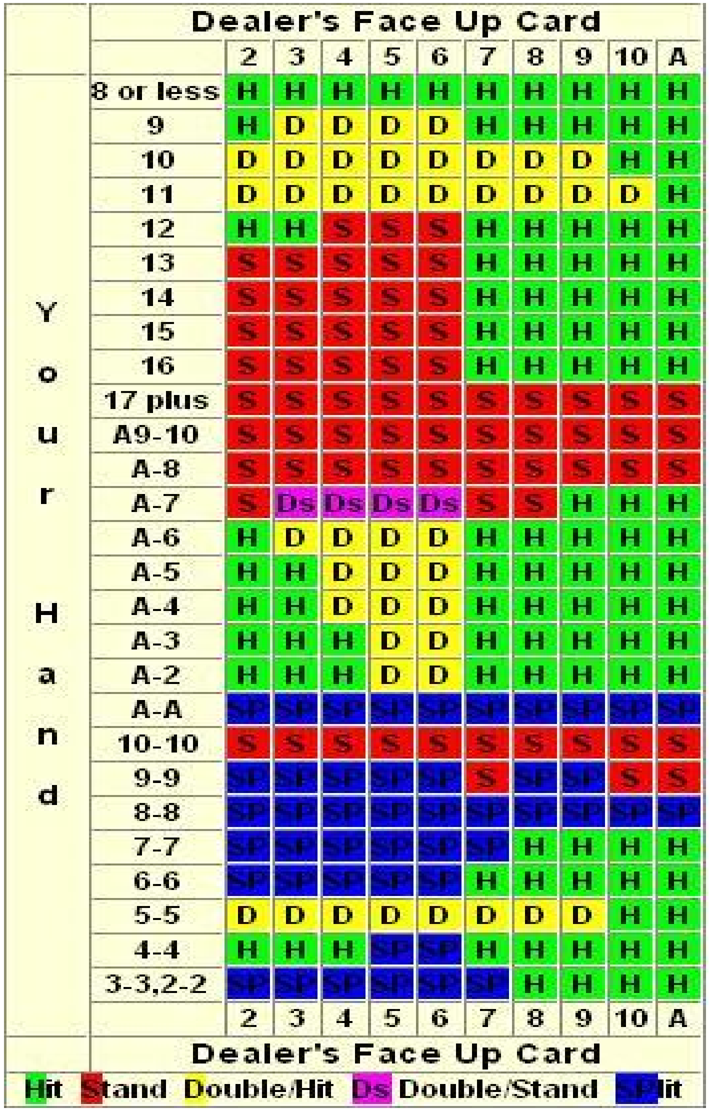
Calculate # of Aces

Adjust bet

Determine balance

Smart Player Strategy

Standard Blackjack Playing Strategy



Your Hand	Dealer's Face Up Card									
	2	3	4	5	6	7	8	9	10	A
8 or less	H	H	H	H	H	H	H	H	H	H
9	H	D	D	D	D	H	H	H	H	H
10	D	D	D	D	D	D	D	D	H	H
11	D	D	D	D	D	D	D	D	D	H
12	H	H	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
14	S	S	S	S	S	H	H	H	H	H
15	S	S	S	S	S	H	H	H	H	H
16	S	S	S	S	S	H	H	H	H	H
17 plus	S	S	S	S	S	S	S	S	S	S
A9-10	S	S	S	S	S	S	S	S	S	S
A-8	S	S	S	S	S	S	S	S	S	S
A-7	S	Ds	Ds	Ds	Ds	S	S	H	H	H
A-6	H	D	D	D	D	H	H	H	H	H
A-5	H	H	D	D	D	H	H	H	H	H
A-4	H	H	D	D	D	H	H	H	H	H
A-3	H	H	H	D	D	H	H	H	H	H
A-2	H	H	H	D	D	H	H	H	H	H
A-A	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
10-10	S	S	S	S	S	S	S	S	S	S
9-9	SP	SP	SP	SP	SP	S	SP	SP	S	S
8-8	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
7-7	SP	SP	SP	SP	SP	SP	H	H	H	H
6-6	SP	SP	SP	SP	SP	H	H	H	H	H
5-5	D	D	D	D	D	D	D	D	H	H
4-4	H	H	H	SP	SP	H	H	H	H	H
3-3,2-2	SP	SP	SP	SP	SP	SP	H	H	H	H
	2	3	4	5	6	7	8	9	10	A

Dealer's Face Up Card

Hit Stand Double/Hit Ds Double/Stand Split

ECE 552 Blackjack Player

- Neil Troy

Player States

- 0000 Betting Time
  - Set bet
- 0001 Look at 1st Card
  - Check if Ace, track total (assumes Ace is High)
- 0010 Look at 2nd Card
  - Check if Ace, track total (assumes Ace if High)
- 0011 Play Time
  - Check Total (try to maximize if aces are present)
  - Applies logic to determine hit/stand

Player States contd.

- 0100 Settling the Bet
  - Read balance
  - Next state is 0000

Hitting

- If total > 17 Stand
- If total > 13 and dealerShow < 7 Stand
- Else Hit

Suggestions

- Add code to track the game during off time
  - May require rewriting of the states
- Cumulative Probability of Different Sums
  - Answer the question how many cards are there less than x?
- Random Number Generator
  - So all players can 'take a chance'
  - Find way to use /dev/random
  -
    ```
    echo "obase=2; ibase=10; `head -n1 /dev/random | od -D | awk '{print
    $3}' | head -n1`" | bc | cut -c1-16 > seed.txt
    ```

Smart Player

Karen Harvey

How Smart Player Works

- Uses card counting to determine if player should hit or stand
- If total is less than 16 always hit
- If total is 20 then stand
- If total is 16 or greater then check card status to decide to hit

How Smart Player Works

- ▪ Check the number of cards left that would not cause a total over 21

- Check the total number of cards left to be dealt

- If these two numbers are within a certain range then get another card

BlackJack - The Smart Player

Chandradevi U

Current system:

- Process driven by the reset and clock signals.
- Depending on the mode/state of the game, the player reacts by setting signals of hit, stand and bet.
- States/Mode:
  - State “0000” : Start of a game, prompts the player to set a bet. The next state is then set.
  - State “0001” : If a card was issued, the total value of the card is updated and the next state is set.
  - State “0010” : The state when a second card was issued. The total is updated and next state is set.

- State “0011” : State to decide if the player wants to stand or hit.
    - If the total > 16
        - If total > 21 and an ace was issued, the total is corrected for the ace value to be 1 and a loop to the same state is spun.
        - In all other cases, when total > 16, the player stands and the state is set to next state where the balance money is distributed to the players.
    - Else if the total < 16
        - And if a card was issued, the total is updated and the player remains in the same state to decide his next move.
        - If a card was not issued, the hit signal is set and the player waits for a card to be issued.
- State “0100” : State to receive the money when the balance is ready and to set the state for start of the game.

Enhancements

- In State “0011”, when the total is > 16 but less than 21, depending on the cards available in the deck, the player can decide to hit rather than to ‘stand’ always.
- After the balance is distributed, a % won can be calculated and depending on a threshold value the player can decide to stay on in the game or go to silent/watch mode for a game or to quit!

Probable Errors :

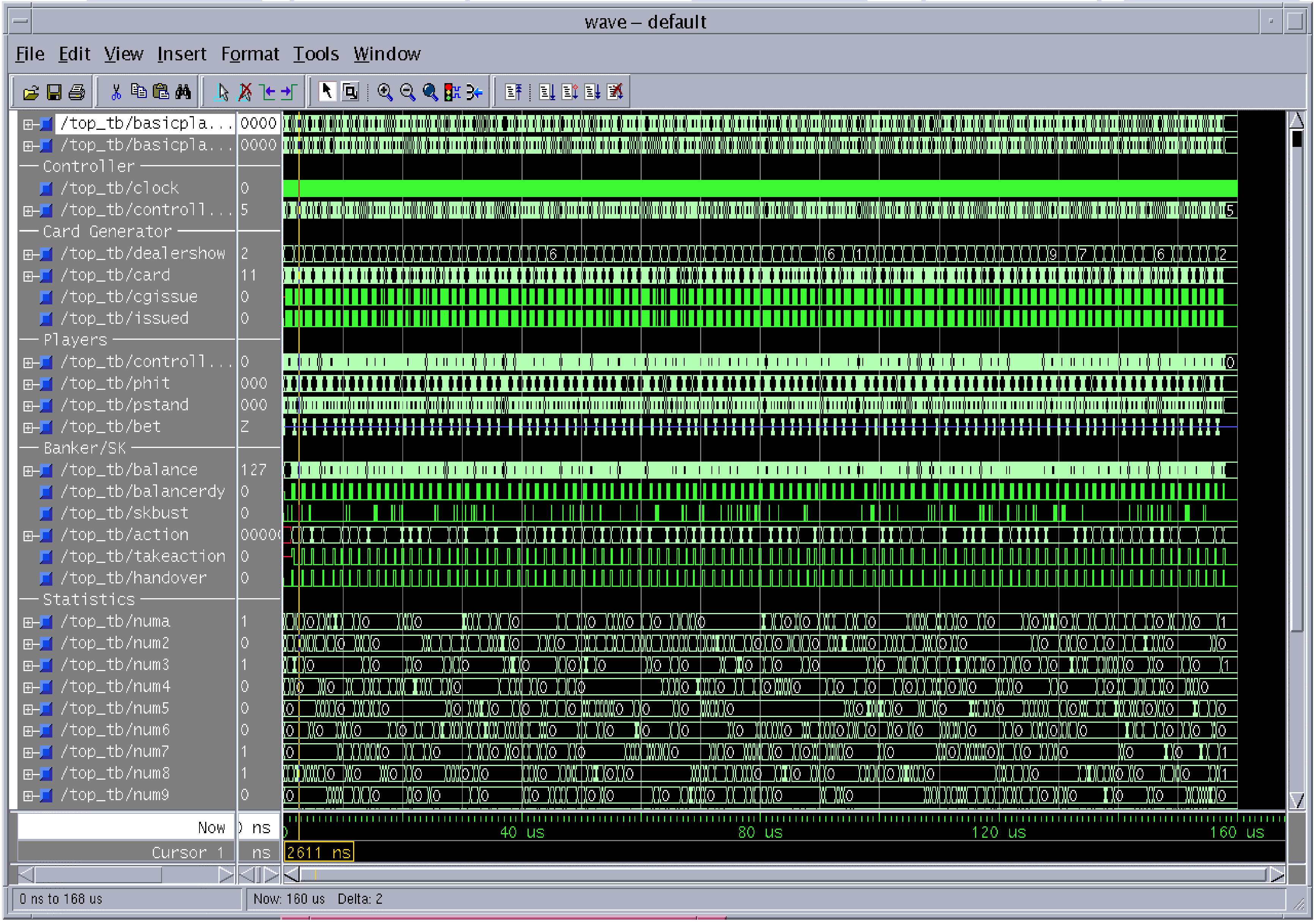
- The bet amount is always set to “1” in basicPlayer

```
 when "0000" =>                    -- Bet Mode
        myBet := "0000000001";    -- use smarts to set this
        bet <= myBet;
```

- The ace for the house player is counted as “1010”.
- The stand flag is also set when the bet is decided.

Thank you.

Black Jack Simulation



/top_tb/basicpla...	0000
/top_tb/basicpla...	0000
Controller	
/top_tb/clock	0
/top_tb/controll...	5
Card Generator	
/top_tb/dealershow	2
/top_tb/card	11
/top_tb/cgissue	0
/top_tb/issued	0
Players	
/top_tb/controll...	0
/top_tb/phit	000
/top_tb/pstand	000
/top_tb/bet	Z
Banker/SK	
/top_tb/balance	127
/top_tb/balancerdy	0
/top_tb/skbust	0
/top_tb/action	0000(
/top_tb/takeaction	0
/top_tb/handover	0
Statistics	
/top_tb/numa	1
/top_tb/num2	0
/top_tb/num3	1
/top_tb/num4	0
/top_tb/num5	0
/top_tb/num6	0
/top_tb/num7	1
/top_tb/num8	1
/top_tb/num9	0
Now	) ns
Cursor 1	ns

2611 ns

0 ns to 168 us

Now: 160 us Delta: 2

Card Generator

- The previous cardgenerator.vhd uses LFSR (Linear Feedback Shift Register) to generate pseudo random numbers
- Uniform random variable can be used to replace LFSR
- The algorithm used to generate Uniform random variables is Linear Congruential Method (LCM)

  a is a constant mutiplier

  c is called the increment

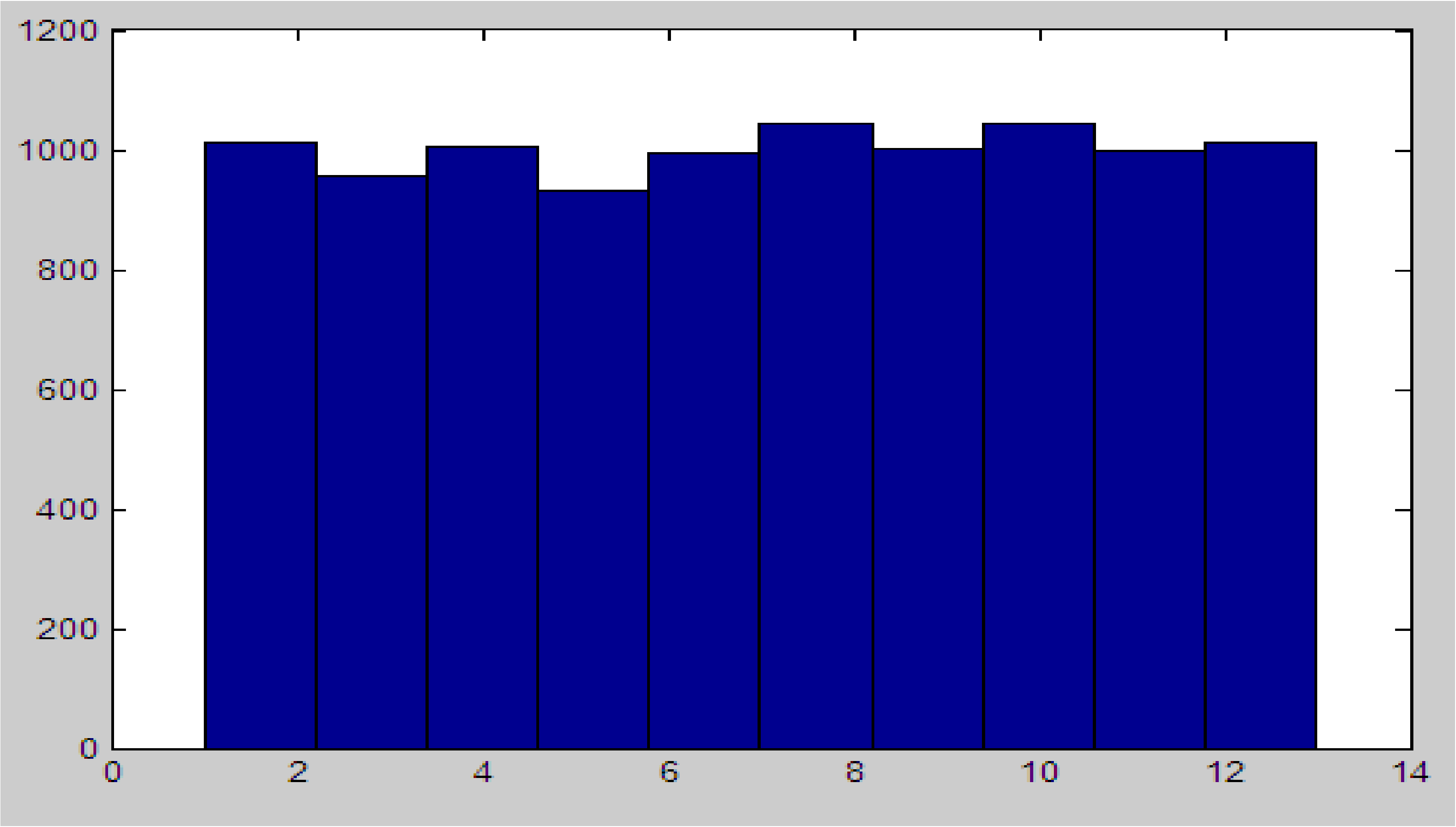
  m is the modulus

$$X_{i+1} = (aX_i + c) \bmod m$$

$$i = 1,2,3,4..$$

Matlab

Histogram of Uniform Distribution



Monte Carlo Simulation

- **Monte Carlo simulation** techniques may be applied in the cardgenerator.vhd
- **Monte Carlo simulation**, which randomly generates values for uncertain variables over and over to simulate a model.
- Normal RV, Uniform RV, Exponential RV or other type RV may be used to model card generation.

Player- Basic Strategy

- Stay, when the value of card greater than 18.
- Hit, when the value of card less than 18 or less than house player.
- Increase the number of chips when I am winning
- Decrease the number of chips when I am losing

ECE552 Project “Backjack” Report1

Student: Mo Zhang

Role: Player

Date: Feb 1, 2005

Blackjack Rules

- 01. 4 decks of cards are used for this game.
- 02. Play 100 hands or until all players are out.
- 03. In all the games the player competes only against the dealer, not other players.
- 04. At first each player starts with 50 chips and House player with unlimited chips.

Blackjack Rules

- 05. The "card-generator" generates fixed sequence or random sequence of cards. The "controller" controls the sequence generation.
- 06. All cards are dealt face up for the players.
- 07. P1 (player at position 1) is always given the first card (face up) and then all other players and the house player receive the first card (face up). Then second card is given just like the first card except the house player receives 2nd card face down.

Blackjack Rules

- 08. The goal of this game is to draw cards until your hand adds up to 21, or comes as close as possible without going over 21 (called "bust"). An ace can either be counted as 11 or 1, which depends on the players wish.
- 09. "card-counter" displays the compressed list of remaining cards (also the last n number of cards played).
- 10. Players should bet 1 chip to play a hand.

Blackjack Rules

- 11. P1 starts playing first asking for "hit" or "stand" and then followed by all other players. A player may "stand" -- play just the two cards originally dealt or may "Hit"-- take another card. After being dealt an additional card, the player may stop or may take still another card. A player may take as many cards as he or she wants, but as soon as the player's total exceeds 21, the player loses.
- 12. Any player who got a total of 21 with his two cards given, he is a "BLACKJACK" and he is not allowed to play that hand (since he already won).

Blackjack Rules

- 13. After all players have drawn, the house player's remaining card is exposed. Then house player asks for "hit" or "stand" and according to the final result, the "Score-Keeper" decides the scores (win, loss).
- 14. If house player "busts" by going over 21, any players still in the game win. Otherwise, players with totals higher than the dealer win, while players with totals less than the dealer lose. In case of a tie, or "push" the player's bet is returned.

Blackjack Rules

- 15. Player who won gets 2 chips, "blackjack" gets 3 chips, and "push" gets 1 chip.
- 16. Scorekeeper keeps the statistics of the wins and the losses of each player and finally it calculates rank of each player.

Vhdl file Explanation

- Player1 basicPlayer.vhd bet=1
- Player2 fileBasicPlayer.vhd bet=3
- Player4 housePlayer.vhd bet=1023

Vhdl file Explanation

- basicPlayer.vhd

```
(line 3)      case state is
(line 4)        when "0000" =>      -- Bet Mode
(line 14)       when "0001" =>      -- get Card 1
(line 38)       when "0010" =>      -- get Card 2
(line 121)        when "0011" =>      -- Game Interaction (adjusting...)
(line 180)      when "0100" =>      -- Settle me up
```

Vhdl file Explanation

- basicPlayer.vhd

(line 97) ----”state 0001 or 0010”

```
if card = "0001" then      -- if ace
  ace := ace+1;            -- increment number of aces
  total := total + "1011";   (total=total+11)
```

(line 125) ----”state 0011(adjusting)”

```
if total > "010000" then
if total > "010101" and ace > 0 then  -- not a bust?  (total>21 & ace>0)
-- account for aces
  ace := ace - 1;
  total := total - "1010";      (total=total-10)
```

```
bet <= (OTHERS => 'Z');   --set the bus, and every digit of "bet", to be high impedance
```

Example of results

- playerOut.txt

(line 1)

```
receiving card1 = 1
receiving card2 = 2
initial total = 13

hitting on 13, card received = 11
total = 23
adjusting total for Ace
total = 13
hitting on 13, card received = 4
total = 17
standing on 17
---------------------------------
```

Example of results

- playerOut.txt

(line 485)

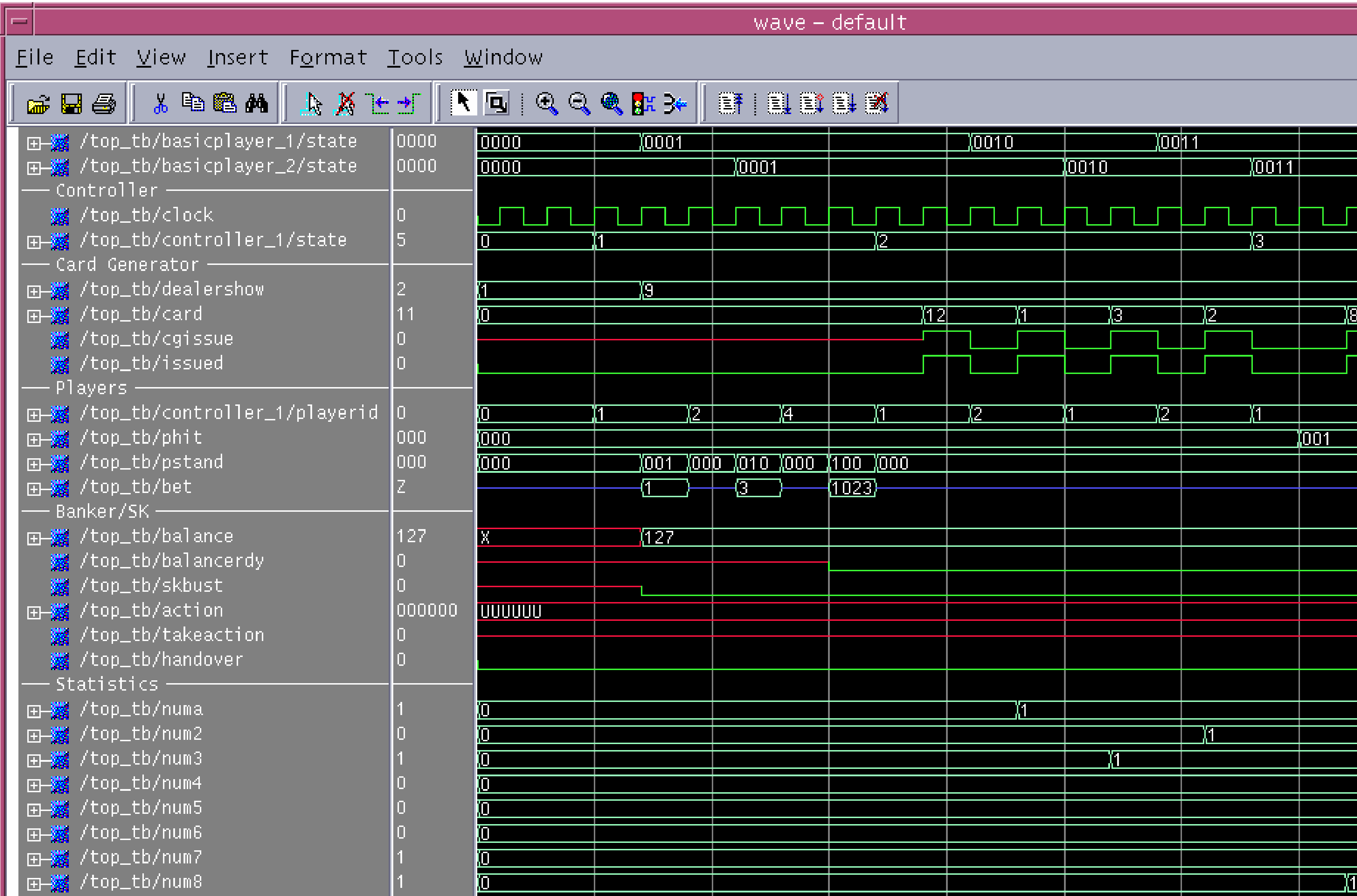
receiving card1 = 11   (total=total+10)

receiving card2 = 1   (total=total+11)

initial total = 21   (10+11=21)

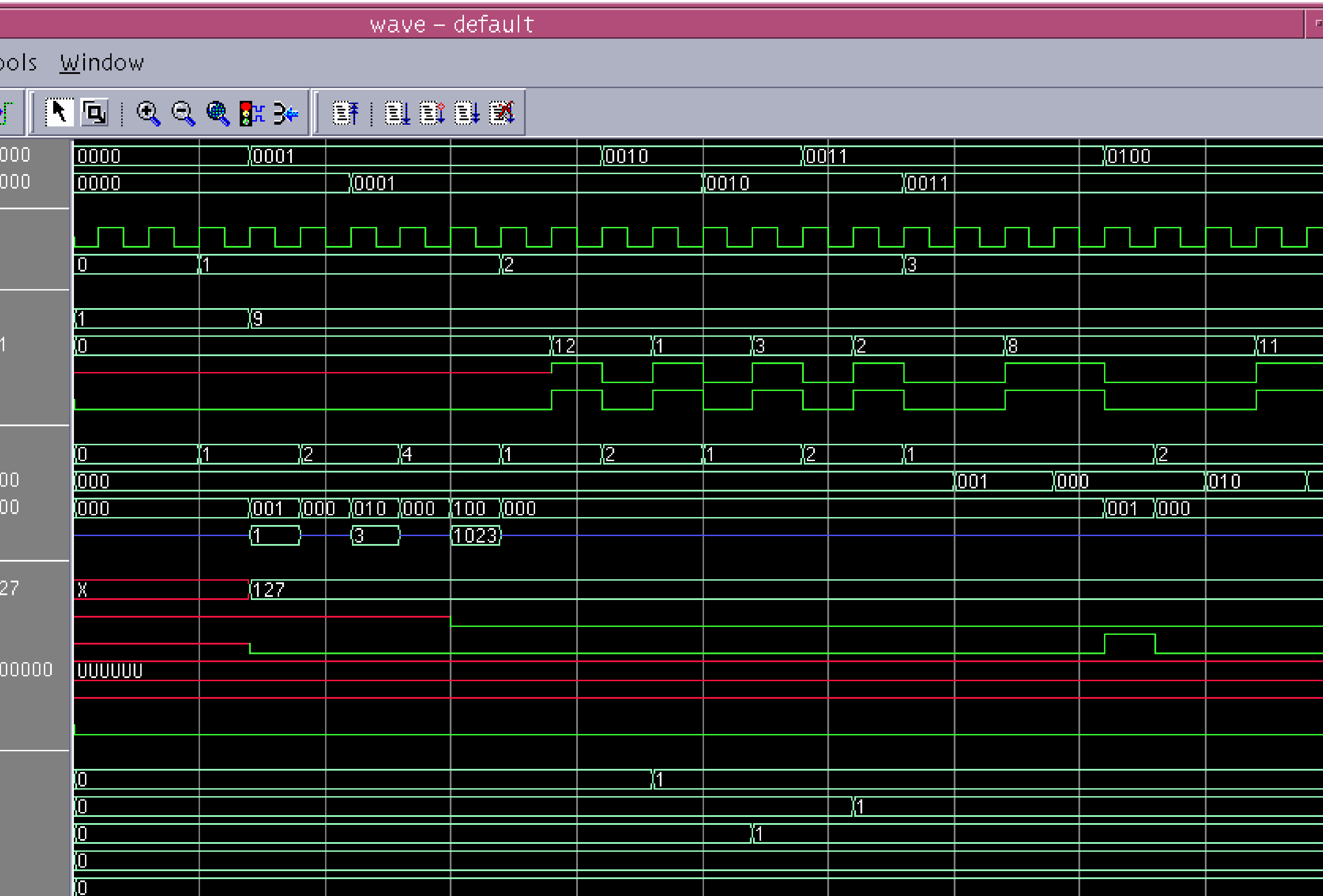
standing on 21

Simulation 0-0.8us

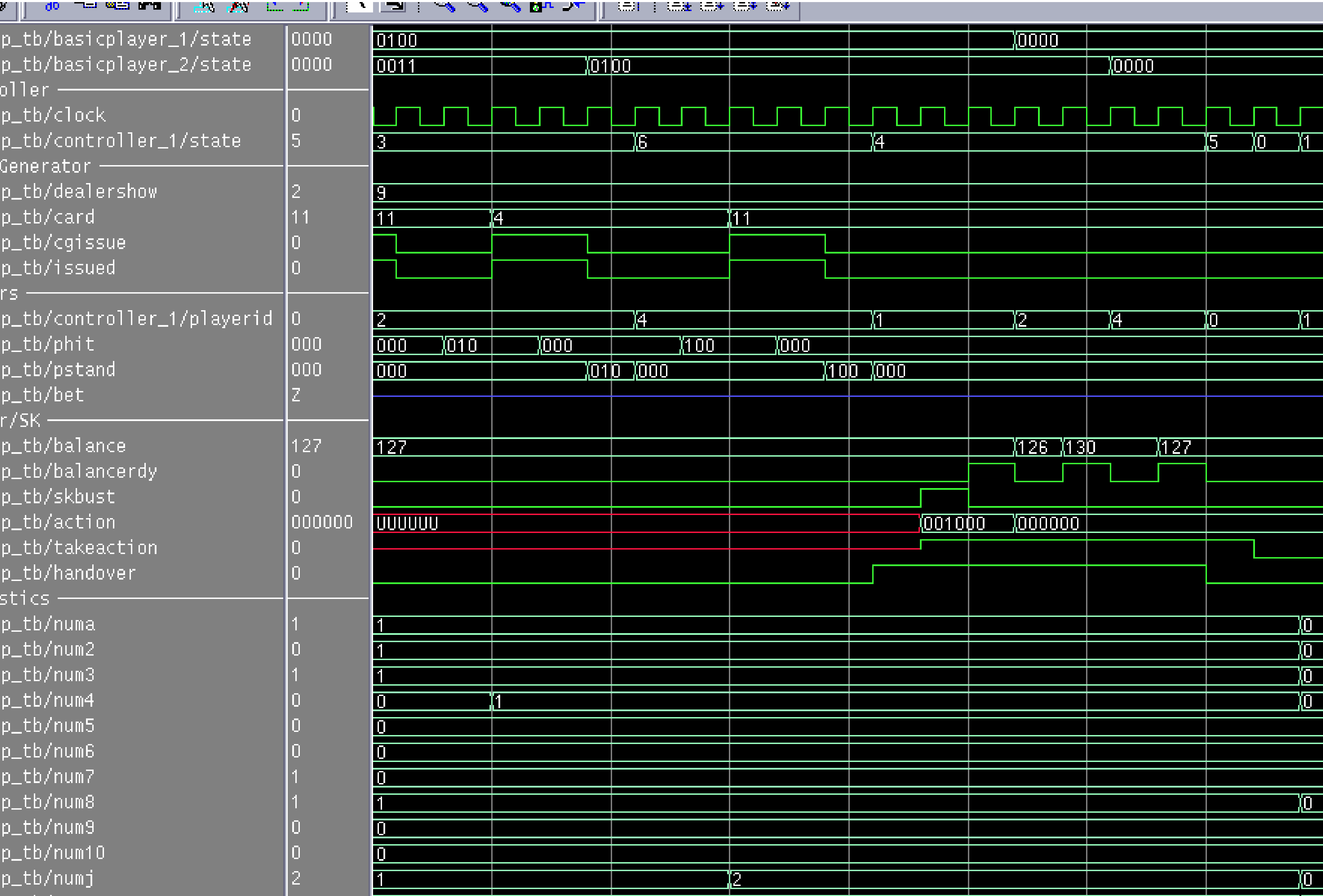


/top_tb/basicplayer_1/state	0000
/top_tb/basicplayer_2/state	0000
Controller	
/top_tb/clock	0
/top_tb/controller_1/state	5
Card Generator	
/top_tb/dealershow	2
/top_tb/card	11
/top_tb/cgissue	0
/top_tb/issued	0
Players	
/top_tb/controller_1/playerid	0
/top_tb/phit	000
/top_tb/pstand	000
/top_tb/bet	Z
Banker/SK	
/top_tb/balance	127
/top_tb/balancerdy	0
/top_tb/skbust	0
/top_tb/action	000000
/top_tb/takeaction	0
/top_tb/handover	0
Statistics	
/top_tb/numa	1
/top_tb/num2	0
/top_tb/num3	1
/top_tb/num4	0
/top_tb/num5	0
/top_tb/num6	0
/top_tb/num7	1
/top_tb/num8	1

Simulation 0.8-1us



Simulation 1-1.8us



p_tb/basicplayer_1/state	0000
p_tb/basicplayer_2/state	0000
oller	
p_tb/clock	0
p_tb/controller_1/state	5
Generator	
p_tb/dealershow	2
p_tb/card	11
p_tb/cgissue	0
p_tb/issued	0
rs	
p_tb/controller_1/playerid	0
p_tb/phit	000
p_tb/pstand	000
p_tb/bet	Z
r/SK	
p_tb/balance	127
p_tb/balancerdy	0
p_tb/skbust	0
p_tb/action	000000
p_tb/takeaction	0
p_tb/handover	0
stics	
p_tb/numa	1
p_tb/num2	0
p_tb/num3	1
p_tb/num4	0
p_tb/num5	0
p_tb/num6	0
p_tb/num7	1
p_tb/num8	1
p_tb/num9	0
p_tb/num10	0
p_tb/numj	2

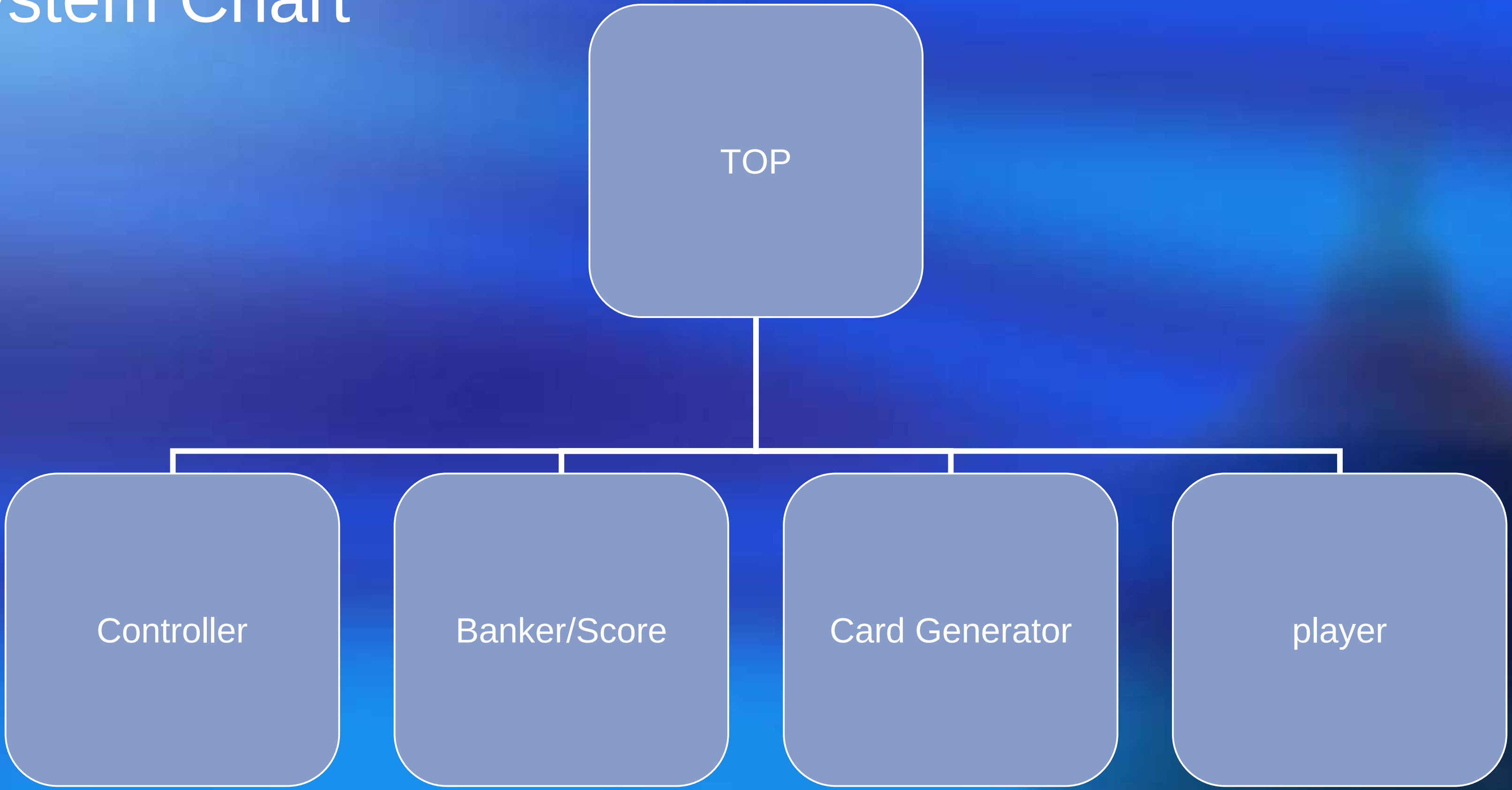
Black Jack

Improvement of PLAYER group

ECE 552 Spring 2005

Overview of BJ

- System Chart



TOP

Controller

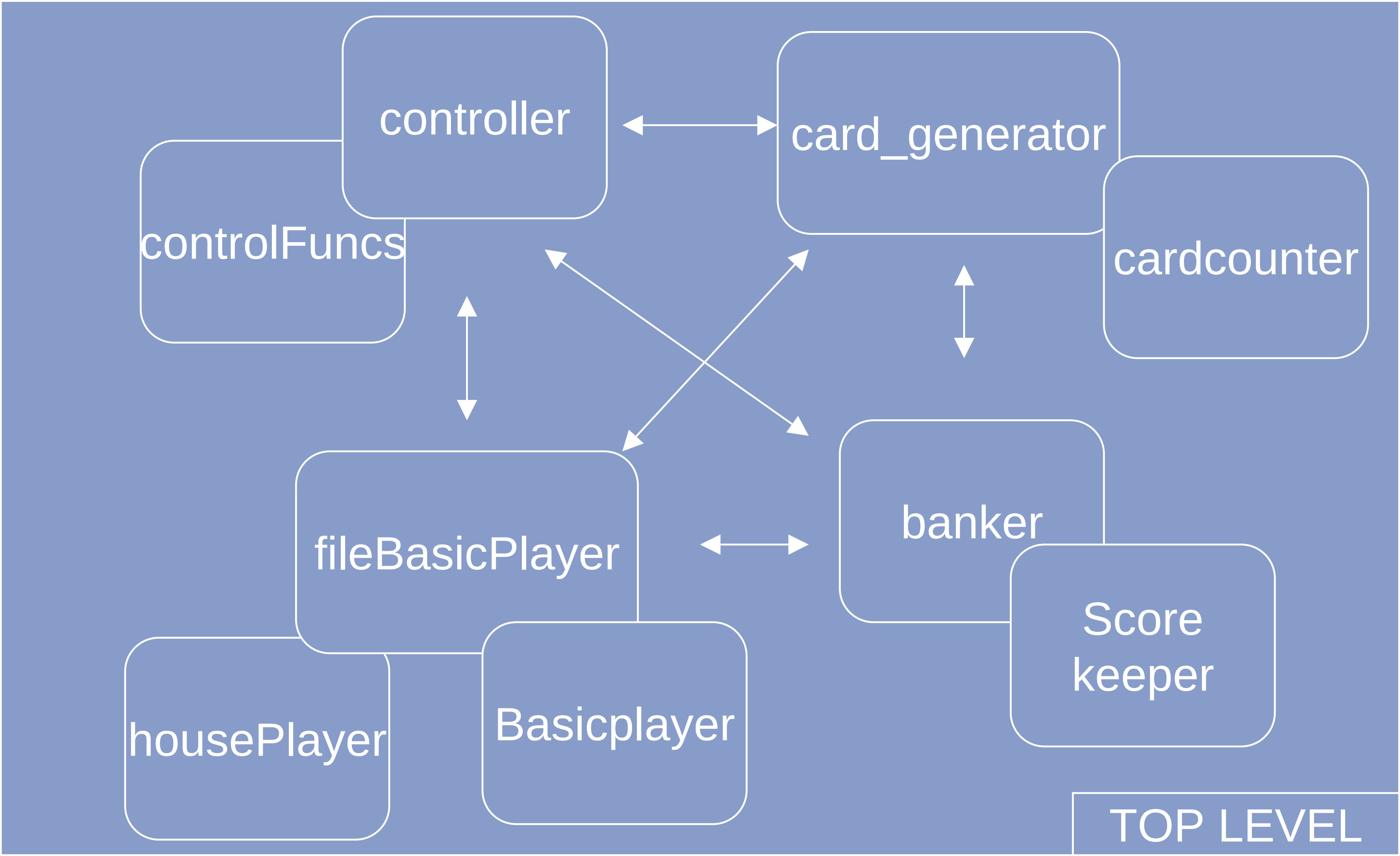
Banker/Score

Card Generator

player

Submodule

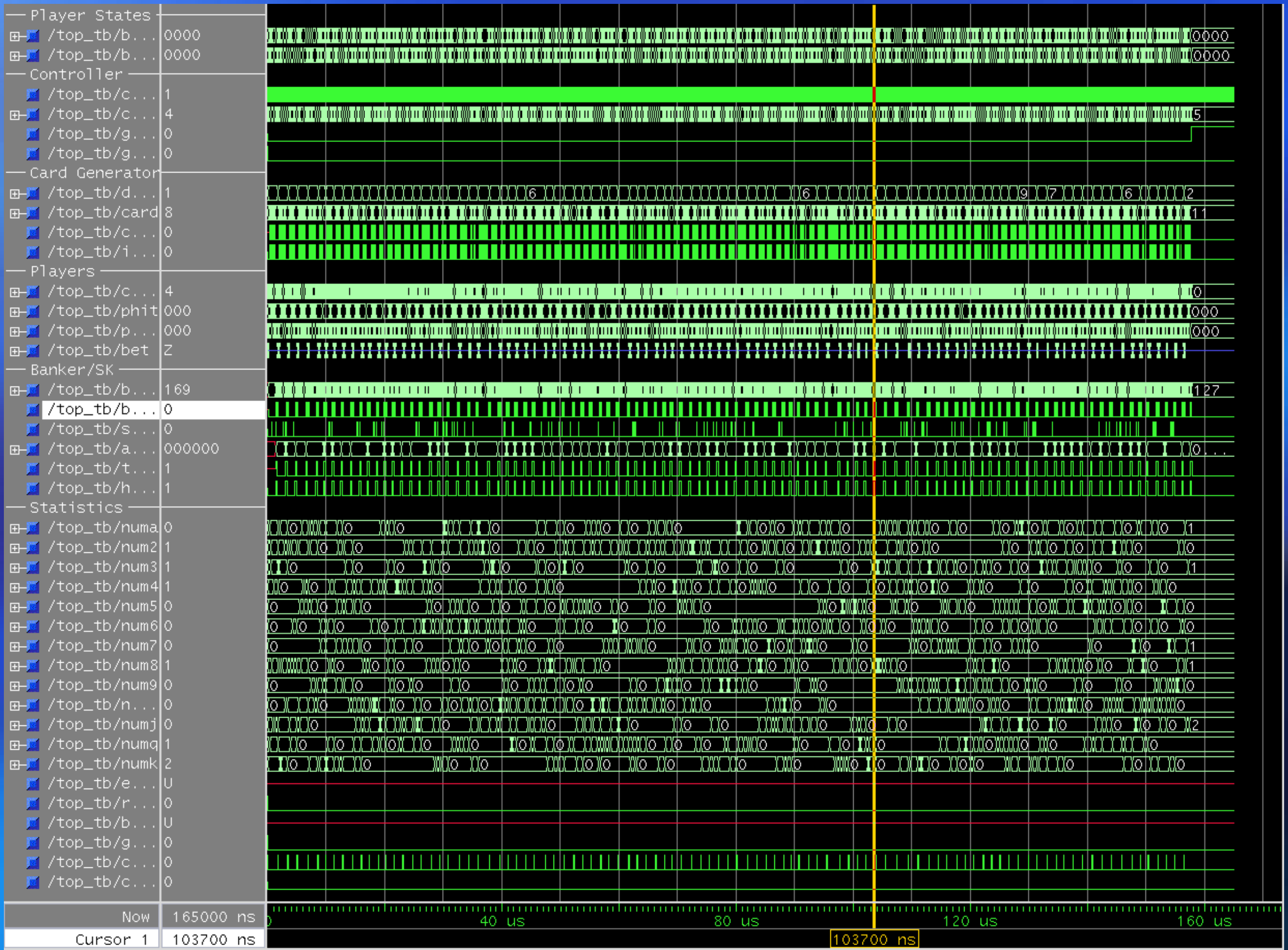
- Divided into 9 submodule



Simulation

1. Using the BJ.do file to do the simulation, and run for 165000ns.

2. Two basic player and one house player was in game.



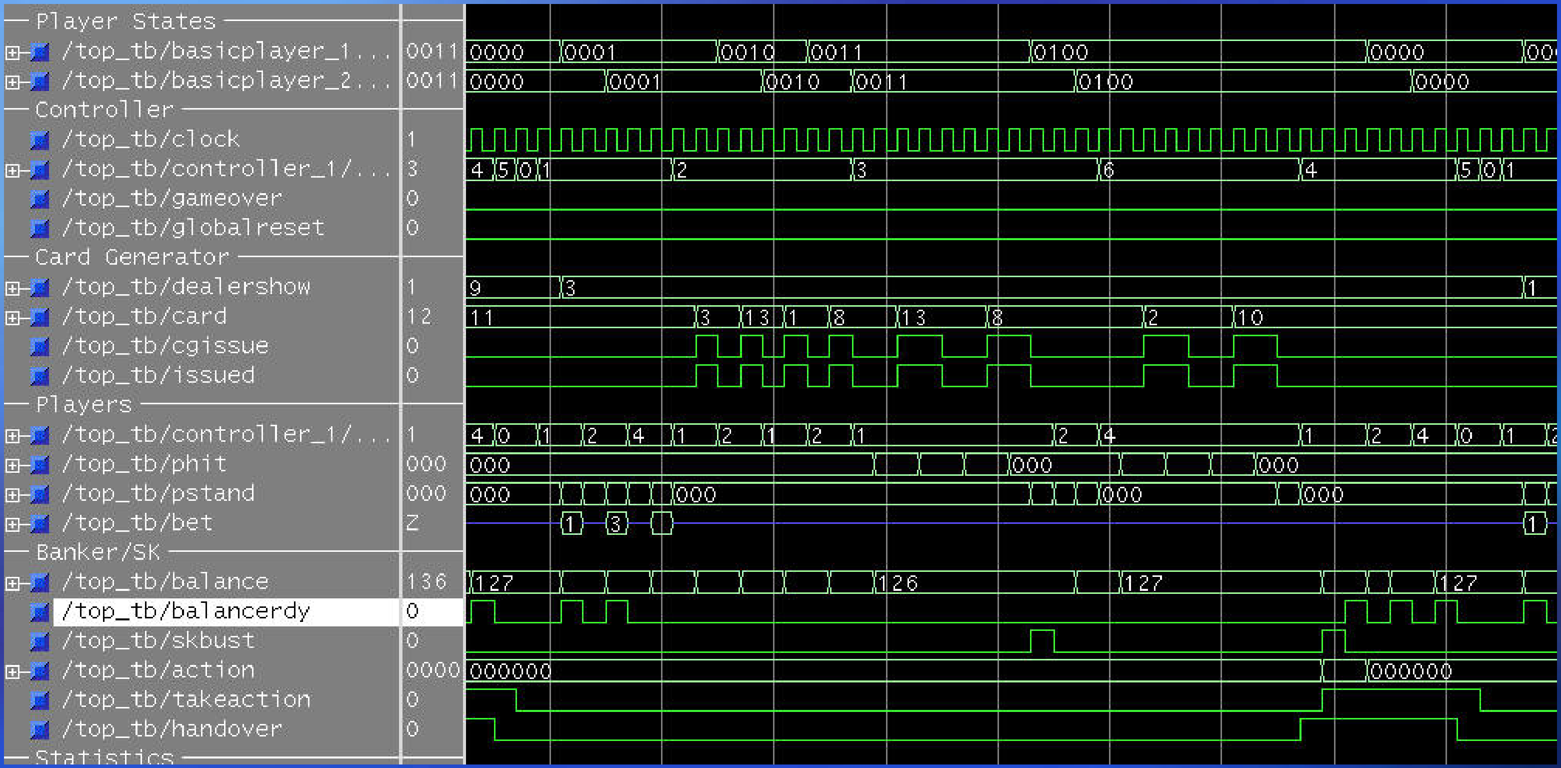
Basic function

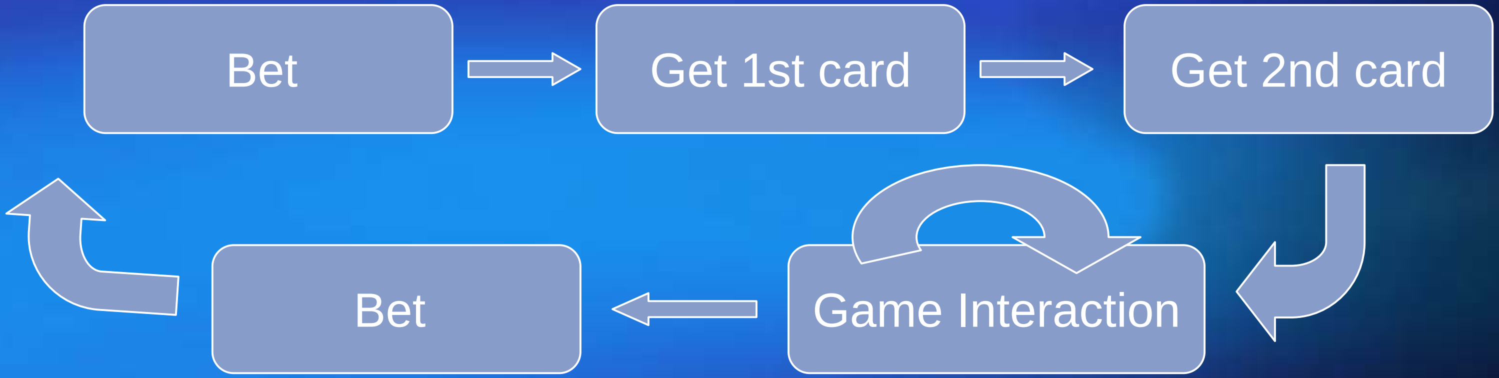
- Two player and dealer
- Fixed value for each player
- Cardgenerator try to use uniform distribution to generate each card
- Use 4 new decks for each hand
- Dealer obey the soft 17 rule

Possible Improvement

- Maybe more effective way to make card generator.
- Add more actions to player for more fun

Player’s action in a hand





Bet

Get 1st card

Get 2nd card

Game Interaction

Bet

Basic function for player

- Fixed bet value
- Only STAND and HIT available
- Simple strategy based on the same as dealer – hit until total greater than 16
- Actions independent from dealer’s card and former hands

Goal

- Try to find a better strategy depend on the show card
- Maybe bet intelligently based on the previous result

Thanks.

BLACKJACK GAME
ECE 552

THE PLAYER

Gaurav

BLACKJACK PLAYERS

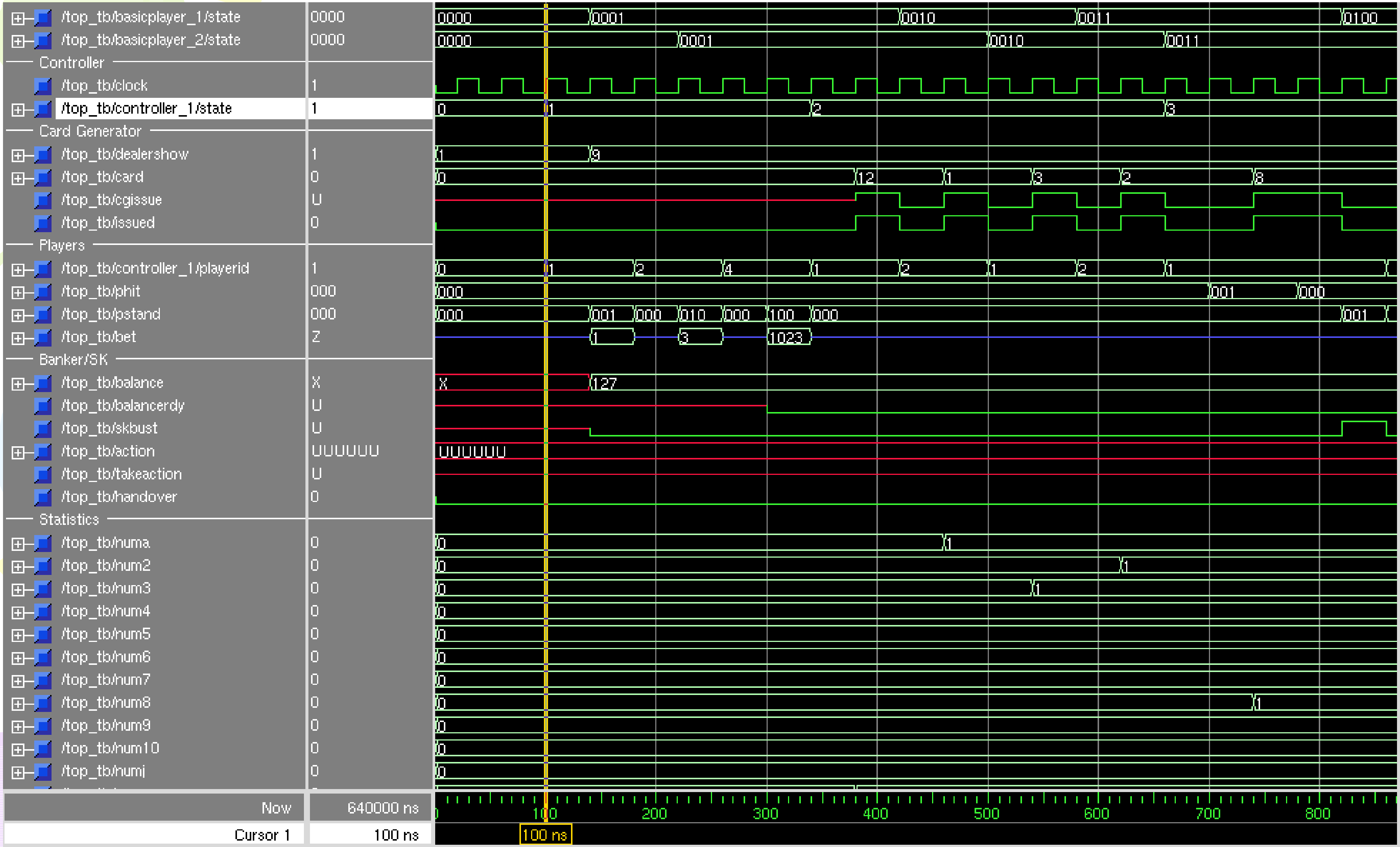
- HOUSE PLAYER
  - DEALER
  - HAS UNLIMITED CHIPS (1024)
  - FIRST CARD DEALT IMMEDIATELY AFTER RESET = ‘0’
  - SECOND CARD DEALT ON HIS TURN
  - BET PLACED – ALWAYS ‘0’ CHIPS
  - COMPETES WITH ALL THE PLAYERS

BLACKJACK PLAYERS CONTD...

- BASIC PLAYER
  - HAS LIMITED CHIPS (128)
  - FIRST AND SECOND CARDS DEALT IN CONSECUTIVE PLAYER MODES
  - ABILITY TO "*HIT*" OR "*STAND*" ACCORDING TO PLAYER STRATEGY
  - BET PLACED – ALWAYS 1 CHIP
  - COMPETES ONLY WITH THE DEALER

PLAYER STATES

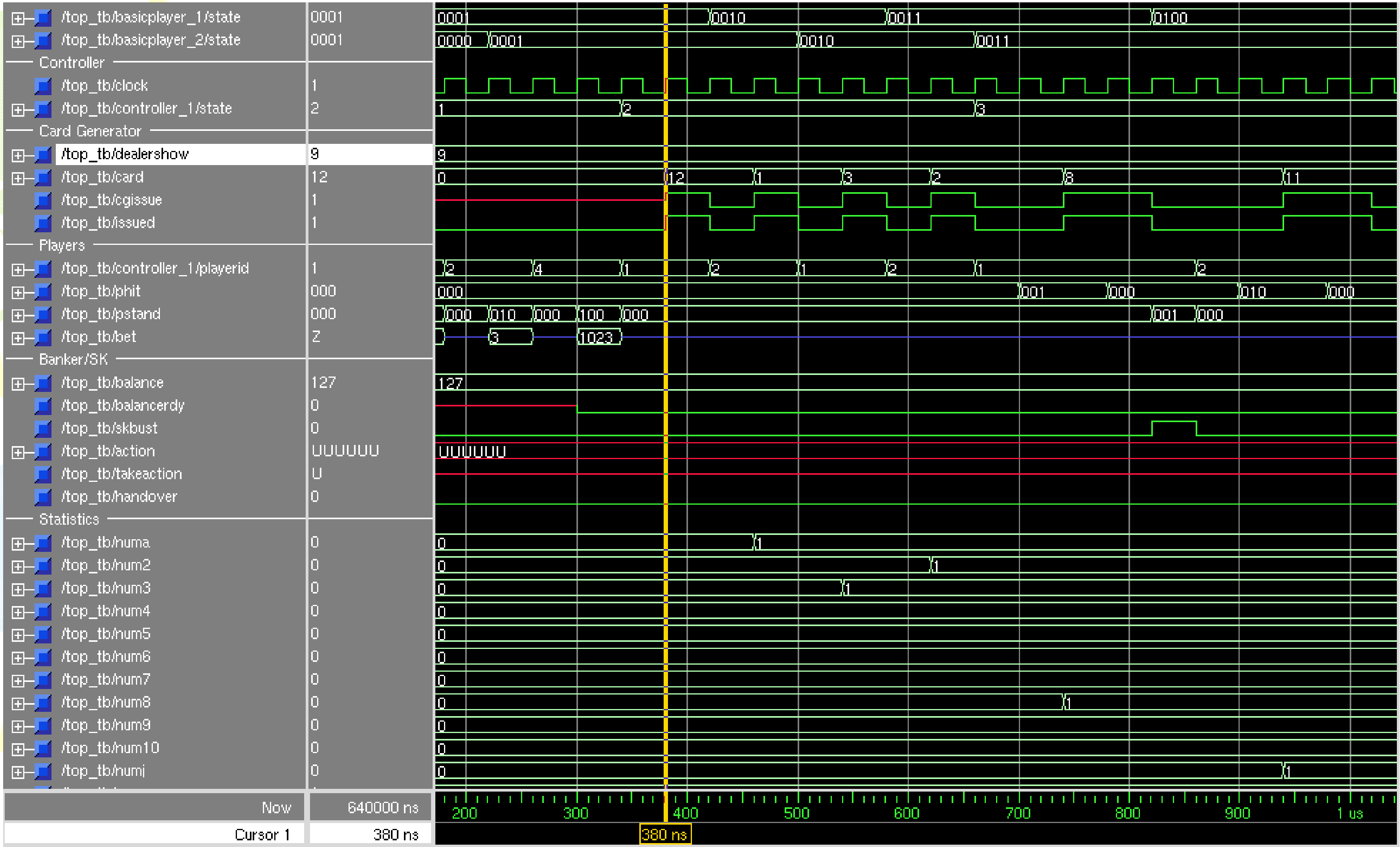
- STATE 1: BET MODE
  - *state=“0000”*
  - House player bets 0
  - Basic player bets 1 chip. (myBet <= “0000000001”).
  - Both players have stand signal high



```
/top_tb/basicplayer_1/state      0000
/top_tb/basicplayer_2/state      0000
Controller
/top_tb/clock                    1
/top_tb/controller_1/state       1
Card Generator
/top_tb/dealershow               1
/top_tb/card                     0
/top_tb/cgissue                  U
/top_tb/issued                   0
Players
/top_tb/controller_1/playerid    1
/top_tb/phit                     000
/top_tb/pstand                   000
/top_tb/bet                      Z
Banker/SK
/top_tb/balance                  X
/top_tb/balancerdy               U
/top_tb/skbust                   U
/top_tb/action                   UUUUUU
/top_tb/takeaction               U
/top_tb/handover                 0
Statistics
/top_tb/numa                     0
/top_tb/num2                     0
/top_tb/num3                     0
/top_tb/num4                     0
/top_tb/num5                     0
/top_tb/num6                     0
/top_tb/num7                     0
/top_tb/num8                     0
/top_tb/num9                     0
/top_tb/num10                    0
/top_tb/numj                     0
                           Now   640000 ns
                      Cursor 1   100 ns
```

PLAYER STATES contd...

- STATE 2: <u>CARD 1 DEALT</u>
  - *state="0001"*
  - If card is issued on the bus update card total.
    - If card is an ace, total = 11 and number of aces = 1
    - Else, total = total + card (card < 10)
    - Or total = total + 10 (card = 10/ J/ K/ Q)
  - In case of *House Player*
    - Total = dealershow
    - *dealershow* signal from controller displays dealer's card value.



```
/top_tb/basicplayer_1/state      0001
/top_tb/basicplayer_2/state      0001
Controller
/top_tb/clock                    1
/top_tb/controller_1/state       2
Card Generator
/top_tb/dealershow               9
/top_tb/card                     12
/top_tb/cgissue                  1
/top_tb/issued                   1
Players
/top_tb/controller_1/playerid    1
/top_tb/phit                     000
/top_tb/pstand                   000
/top_tb/bet                      Z
Banker/SK
/top_tb/balance                  127
/top_tb/balancerdy               0
/top_tb/skbust                   0
/top_tb/action                   UUUUUU
/top_tb/takeaction               U
/top_tb/handover                 0
Statistics
/top_tb/numa                     0
/top_tb/num2                     0
/top_tb/num3                     0
/top_tb/num4                     0
/top_tb/num5                     0
/top_tb/num6                     0
/top_tb/num7                     0
/top_tb/num8                     0
/top_tb/num9                     0
/top_tb/num10                    0
/top_tb/numj                     0
                         Now     640000 ns
                    Cursor 1     380 ns
```

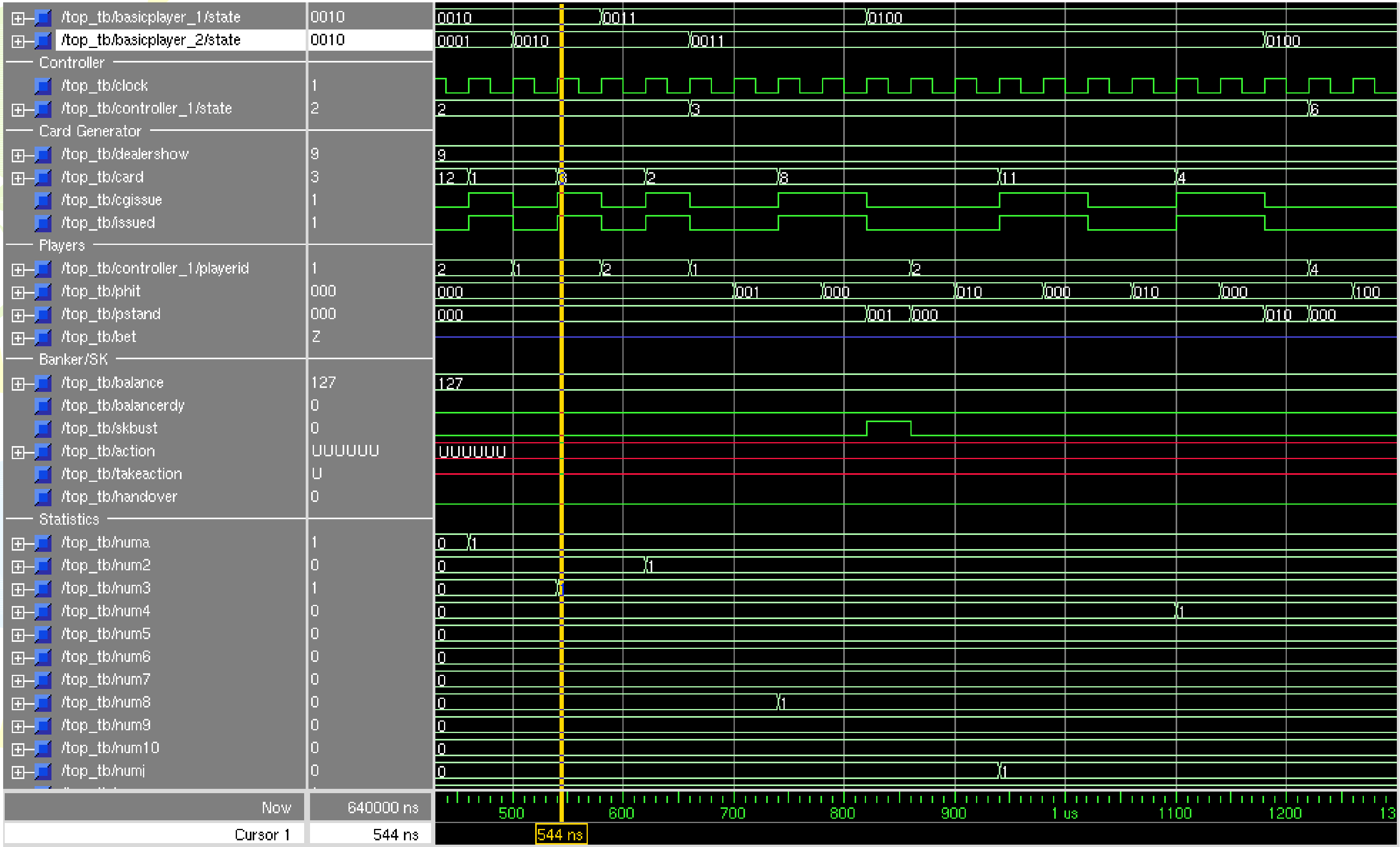
Player 1 = 12

Player 2 = 3

Dealer = 9

PLAYER STATES contd...

- STATE 3: CARD 2 DEALT
  - *state="0010"*
  - For Players it is same as STATE 2.
  - In case of *House Player*
    - If card is issued on the bus update card total.
    - If card is an ace and number of aces = 1 then increment total by 1 else increment total by 11 and increment number of aces by 1.
    - Else, total = total + card (card < 10)
    - Or total = total + 10 (card = 10/ J/ K/ Q)



```
/top_tb/basicplayer_1/state      0010
/top_tb/basicplayer_2/state      0010
Controller
/top_tb/clock                    1
/top_tb/controller_1/state       2
Card Generator
/top_tb/dealershow               9
/top_tb/card                     3
/top_tb/cgissue                  1
/top_tb/issued                   1
Players
/top_tb/controller_1/playerid    1
/top_tb/phit                     000
/top_tb/pstand                   000
/top_tb/bet                      Z
Banker/SK
/top_tb/balance                  127
/top_tb/balancerdy               0
/top_tb/skbust                   0
/top_tb/action                   UUUUUU
/top_tb/takeaction               U
/top_tb/handover                 0
Statistics
/top_tb/huma                     1
/top_tb/num2                     0
/top_tb/num3                     1
/top_tb/num4                     0
/top_tb/num5                     0
/top_tb/num6                     0
/top_tb/num7                     0
/top_tb/num8                     0
/top_tb/num9                     0
/top_tb/num10                    0
/top_tb/humj                     0
Now                              640000 ns
Cursor 1                         544 ns
```

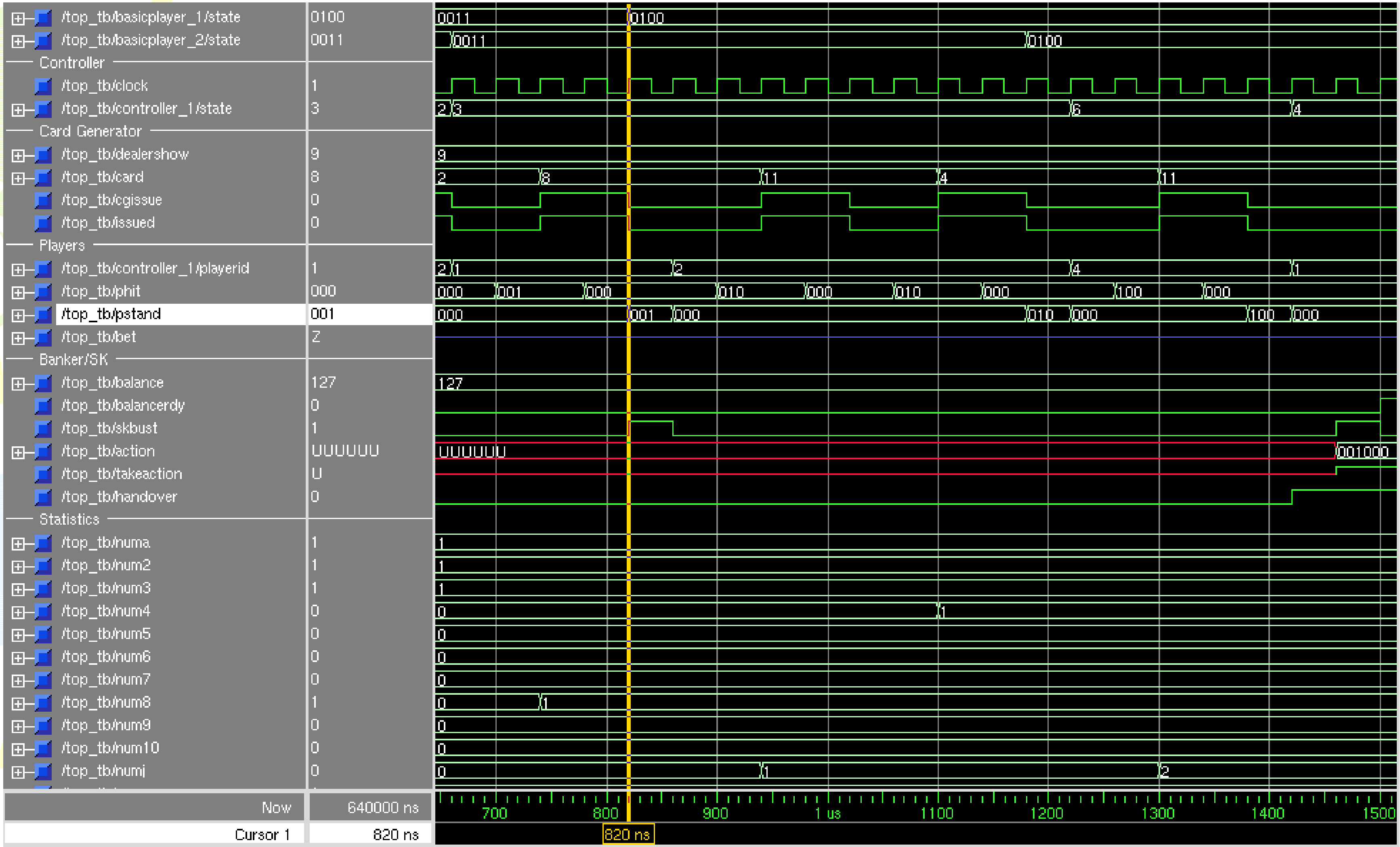
Player 1 = 8

Player 2 = 11

Dealer = 11

PLAYER STATES contd...

- STATE 4: GAME INTERACTION
  - *state="0011"*
  - Player Strategy
    - If total is above 16
      - If total is above 21 – adjust the number of aces and make ace value = 1
      - Else stand
    - If total is not above 16, hit and increment total until total is above 16.



```
/top_tb/basicplayer_1/state      0100
/top_tb/basicplayer_2/state      0011
Controller
/top_tb/clock                    1
/top_tb/controller_1/state       3
Card Generator
/top_tb/dealershow               9
/top_tb/card                     8
/top_tb/cgissue                  0
/top_tb/issued                   0
Players
/top_tb/controller_1/playerid    1
/top_tb/phit                     000
/top_tb/pstand                   001
/top_tb/bet                      Z
Banker/SK
/top_tb/balance                  127
/top_tb/balancerdy               0
/top_tb/skbust                   1
/top_tb/action                   UUUUUU
/top_tb/takeaction               U
/top_tb/handover                 0
Statistics
/top_tb/numa                     1
/top_tb/num2                     1
/top_tb/num3                     1
/top_tb/num4                     0
/top_tb/num5                     0
/top_tb/num6                     0
/top_tb/num7                     0
/top_tb/num8                     1
/top_tb/num9                     0
/top_tb/num10                    0
/top_tb/numj                     0
                    Now          640000 ns
               Cursor 1          820 ns
```

Player 1 hits and gets card = 8

Then deactivates hit signal and stands.

PLAYER STATES contd...

- STATE 5: END OF HAND
  - *state=“0100”*
  - Player
    - If balance is ready (balanceRdy from Banker) Player updates his balance.
    - Else waits for the balanceRdy signal to go high.
    - Player in has Stand signal ON.
  - Similar for House Player

PLAYER STATES contd...

- STATE 6: IDLE
  - Player
    - All shared buses on high impedance.

Some Suggestions

- Logic Modification
  - The second card to the House Player should be dealt along with the other players for a fair game. (rather than dealing it after the players play their hand)
  - Suggestion: To hide the card, the card may be generated and kept as a separate signal accessible only to the card generator and house player (may be also scorekeeper).

- House Player code errors
  - In case of an ace, adds 10 instead of 11 to the total.
  - In state 1: bet mode, bets 1024 instead of 0. (*doesn’t make any difference!*)

THANK YOU.

BLACKJACK (Controller module)

Presented by:

Karthik,Ikram,Priya & Tushti

ECE 552 | Spring’05

Role of the Controller:

- Notification of the start of a new hand
- Cycles through players and makes them place their bets
- Controls the assignment of cards to the players & the dealer
- Activates the Scorekeeper & the banker after all players have played

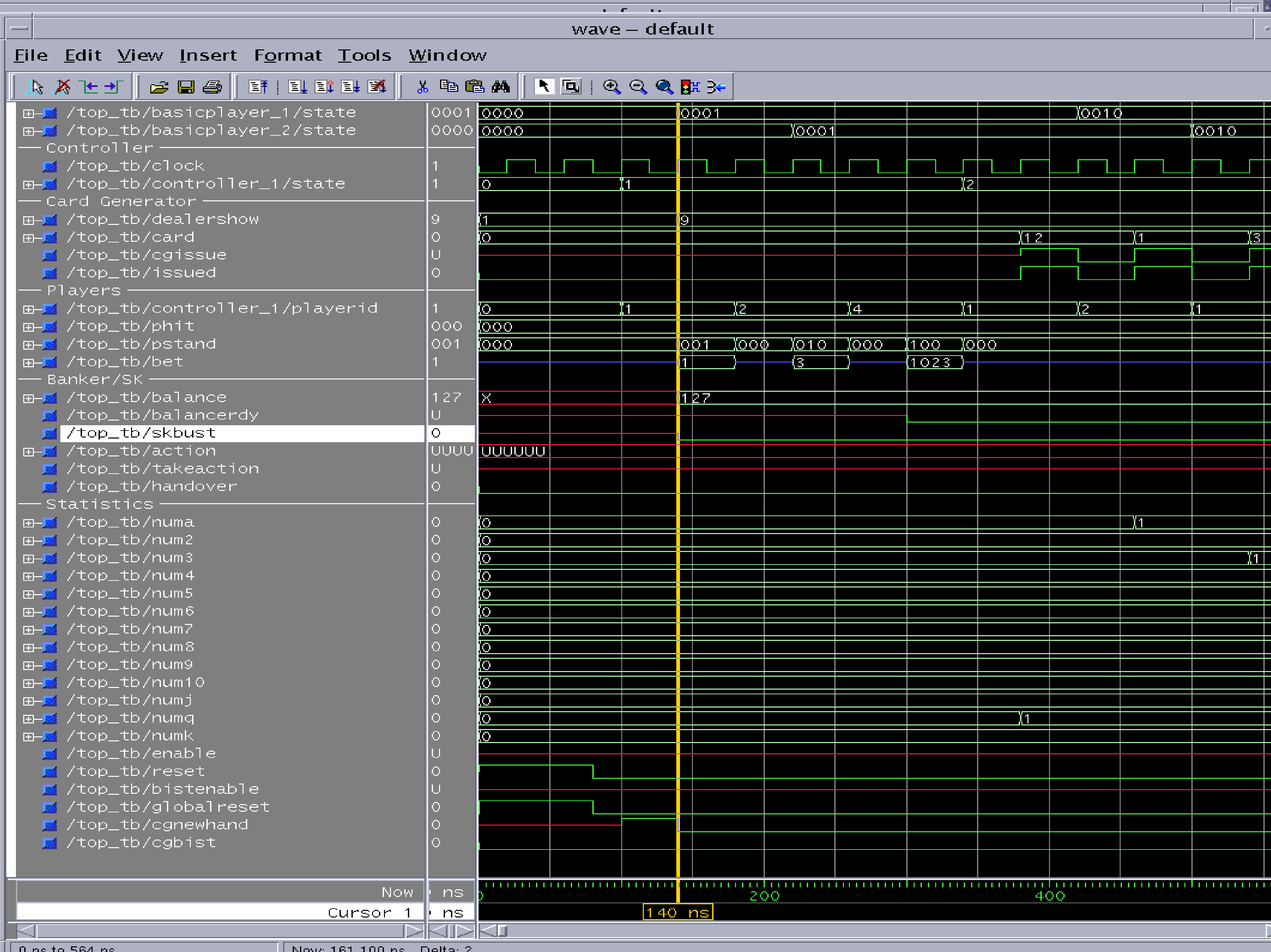
State “0000” and “0001”

State “0000”

cgNewHand <= ‘1’ : this signifies the start of a new hand

State “0001”

All the players place their respective bets



/top_tb/basicplayer_1/state	0001
/top_tb/basicplayer_2/state	0000
Controller	
/top_tb/clock	1
/top_tb/controller_1/state	1
Card Generator	
/top_tb/dealershow	9
/top_tb/card	0
/top_tb/cgissue	U
/top_tb/issued	0
Players	
/top_tb/controller_1/playerid	1
/top_tb/phit	000
/top_tb/pstand	001
/top_tb/bet	1
Banker/SK	
/top_tb/balance	127
/top_tb/balancerdy	U
/top_tb/skbust	0
/top_tb/action	UUUU
/top_tb/takeaction	U
/top_tb/handover	0
Statistics	
/top_tb/numa	0
/top_tb/num2	0
/top_tb/num3	0
/top_tb/num4	0
/top_tb/num5	0
/top_tb/num6	0
/top_tb/num7	0
/top_tb/num8	0
/top_tb/num9	0
/top_tb/num10	0
/top_tb/numj	0
/top_tb/numq	0
/top_tb/numk	0
/top_tb/enable	U
/top_tb/reset	0
/top_tb/bistenable	U
/top_tb/globalreset	0
/top_tb/cgnewhand	0
/top_tb/cgbist	0

Now · ns
Cursor 1 · ns

0 ns to 564 ns
Now: 161,100 ns   Delta: 2

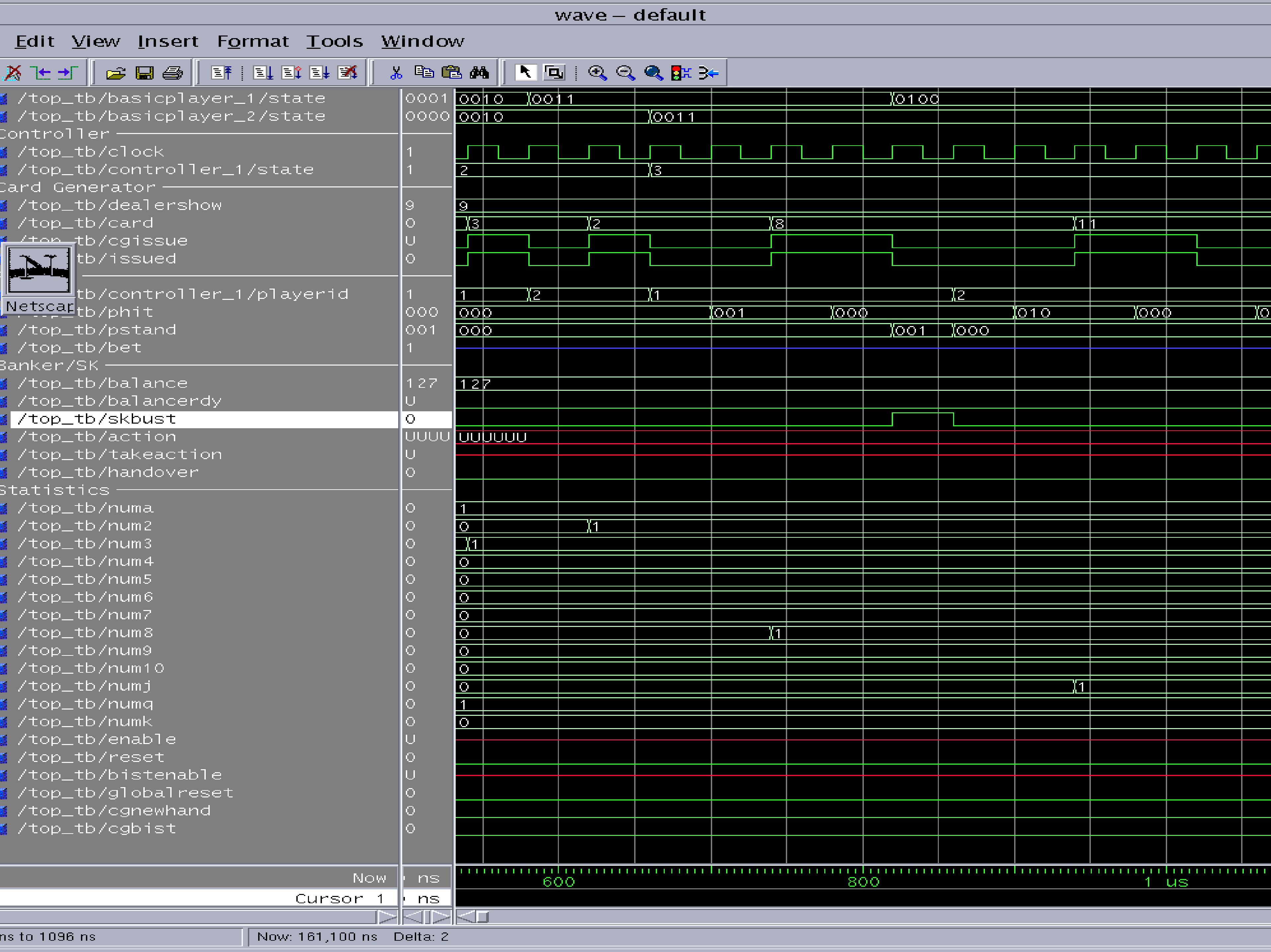
State “0010”

All the players(excluding the dealer) get their initial 2 cards

Player 1 gets: 12,3

Player 2 gets: 1,2

Dealer gets his open card : 9



```
/top_tb/basicplayer_1/state        0001   0010  0011  0100
/top_tb/basicplayer_2/state        0000   0010  0011
Controller
/top_tb/clock                      1
/top_tb/controller_1/state         1      2  3
Card Generator
/top_tb/dealershow                 9      9
/top_tb/card                       0      3  2  8  11
/top_tb/cgissue                    U
tb/issued                          0
tb/controller_1/playerid           1      1  2  1  2
tb/phit                            000    000  001  000  010  000  0
/top_tb/pstand                     001    000  001  000
/top_tb/bet                        1
Banker/SK
/top_tb/balance                    127    127
/top_tb/balancerdy                 U
/top_tb/skbust                     0
/top_tb/action                     UUUU   UUUUUU
/top_tb/takeaction                 U
/top_tb/handover                   0
Statistics
/top_tb/numa                       0      1
/top_tb/num2                       0      0  1
/top_tb/num3                       0      1
/top_tb/num4                       0      0
/top_tb/num5                       0      0
/top_tb/num6                       0      0
/top_tb/num7                       0      0
/top_tb/num8                       0      0  1
/top_tb/num9                       0      0
/top_tb/num10                      0      0
/top_tb/numj                       0      0  1
/top_tb/numq                       0      1
/top_tb/numk                       0      0
/top_tb/enable                     U
/top_tb/reset                      0
/top_tb/bistenable                 U
/top_tb/globalreset                0
/top_tb/cgnewhand                  0
/top_tb/cgbist                     0
                             Now   ns
                        Cursor 1   ns
ns to 1096 ns     Now: 161,100 ns   Delta: 2
```

State “0011”

All the players (excluding the dealer) either ‘hit’ or ‘stand’

So they get their remaining cards until they ‘stand’

Final cards for:

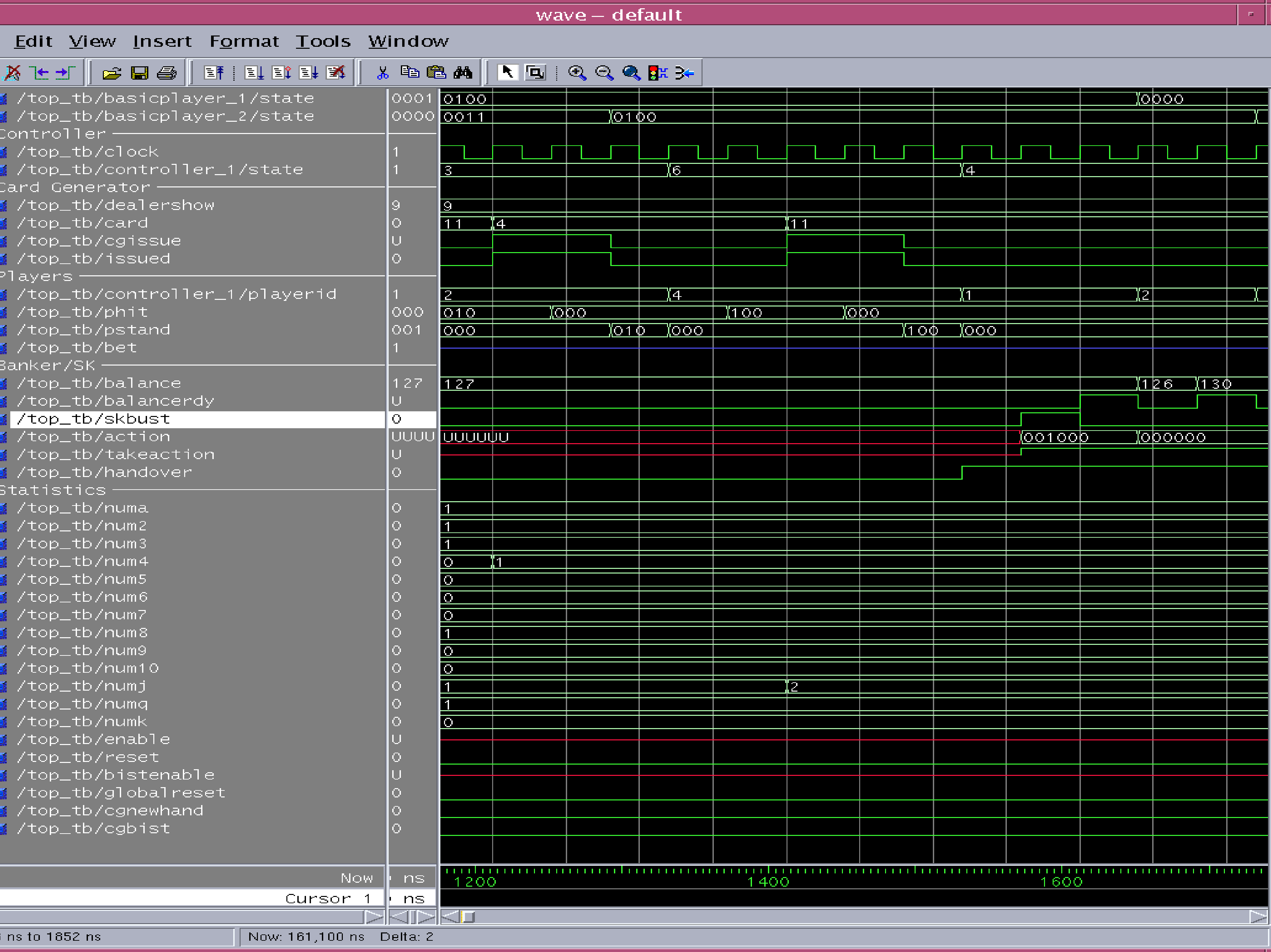
Player1 : 12,3,8

Player2 : 1,2,11,4

State “0110”

Dealing with the Dealer:

- Here the dealer gets his cards until he ‘stands’
- Final cards with the dealer: 9,11



```
/top_tb/basicplayer_1/state      0001
/top_tb/basicplayer_2/state      0000
Controller
/top_tb/clock                    1
/top_tb/controller_1/state       1
Card Generator
/top_tb/dealershow               9
/top_tb/card                     0
/top_tb/cgissue                  U
/top_tb/issued                   0
Players
/top_tb/controller_1/playerid    1
/top_tb/phit                     000
/top_tb/pstand                   001
/top_tb/bet                      1
Banker/SK
/top_tb/balance                  127
/top_tb/balancerdy               U
/top_tb/skbust                   0
/top_tb/action                   UUUU
/top_tb/takeaction               U
/top_tb/handover                 0
Statistics
/top_tb/numa                     0
/top_tb/num2                     0
/top_tb/num3                     0
/top_tb/num4                     0
/top_tb/num5                     0
/top_tb/num6                     0
/top_tb/num7                     0
/top_tb/num8                     0
/top_tb/num9                     0
/top_tb/num10                    0
/top_tb/numj                     0
/top_tb/numq                     0
/top_tb/numk                     0
/top_tb/enable                   U
/top_tb/reset                    0
/top_tb/bistenable               U
/top_tb/globalreset              0
/top_tb/cgnewhand                0
/top_tb/cgbist                   0
```

ns to 1852 ns   Now: 161,100 ns   Delta: 2

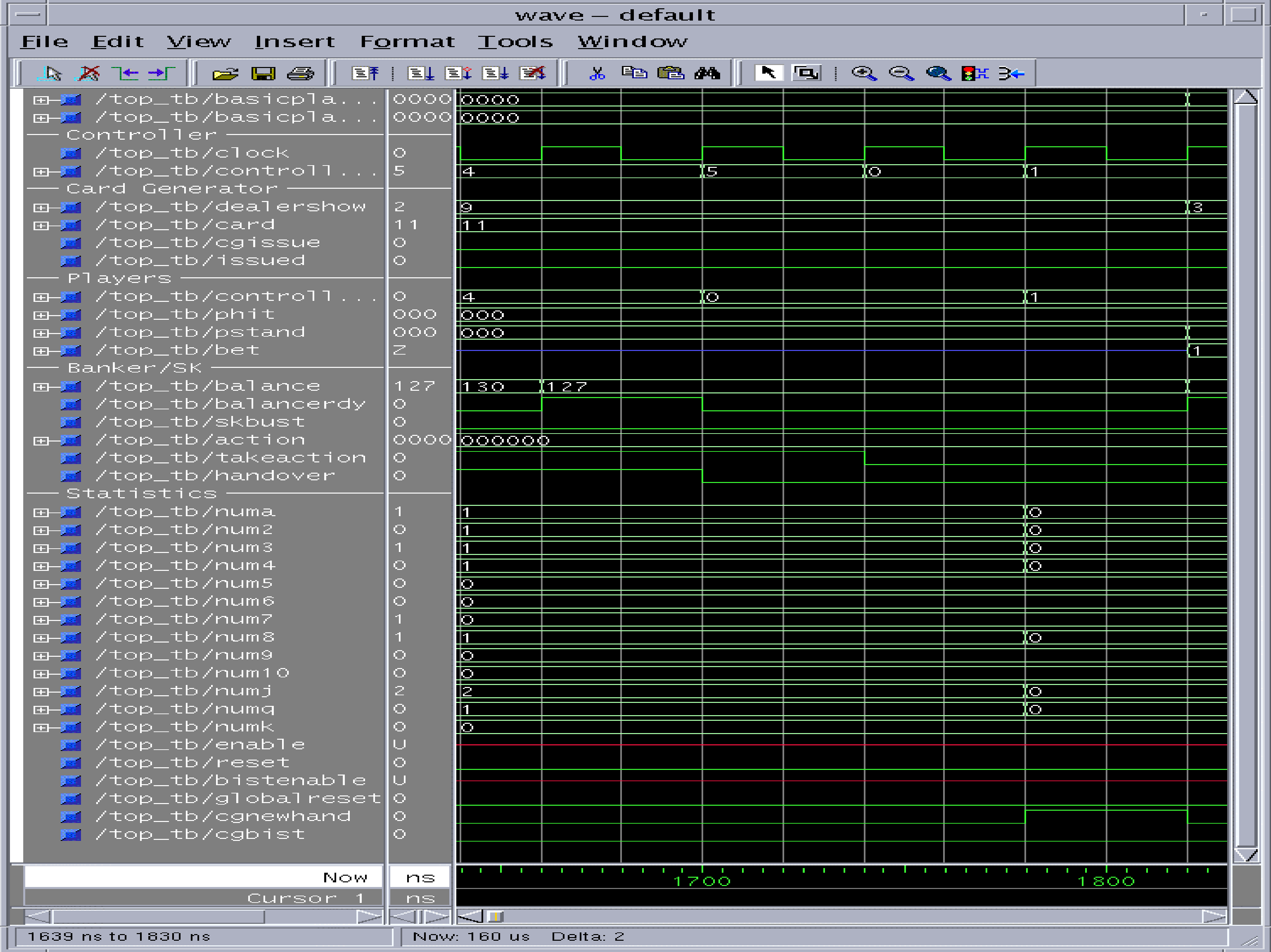
State “0100” and “0101”

State “0100”

Results stage: control goes to the scorekeeper to decide the winner

State “0101”

Gameover stage : Displays the final amount of chips won by each player



/top_tb/basicpla...	0000
/top_tb/basicpla...	0000
Controller	
/top_tb/clock	0
/top_tb/controll...	5
Card Generator	
/top_tb/dealershow	2
/top_tb/card	11
/top_tb/cgissue	0
/top_tb/issued	0
Players	
/top_tb/controll...	0
/top_tb/phit	000
/top_tb/pstand	000
/top_tb/bet	Z
Banker/SK	
/top_tb/balance	127
/top_tb/balancerdy	0
/top_tb/skbust	0
/top_tb/action	0000
/top_tb/takeaction	0
/top_tb/handover	0
Statistics	
/top_tb/numa	1
/top_tb/num2	0
/top_tb/num3	1
/top_tb/num4	0
/top_tb/num5	0
/top_tb/num6	0
/top_tb/num7	1
/top_tb/num8	1
/top_tb/num9	0
/top_tb/num10	0
/top_tb/numj	2
/top_tb/numq	0
/top_tb/numk	0
/top_tb/enable	U
/top_tb/reset	0
/top_tb/bistenable	U
/top_tb/globalreset	0
/top_tb/cgnewhand	0
/top_tb/cgbist	0
Now	ns
Cursor 1	ns

1639 ns to 1830 ns

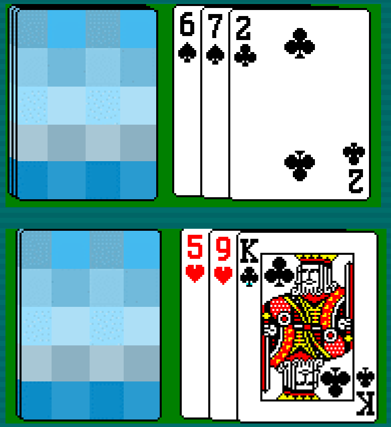
Now: 160 us   Delta: 2

Probable errors:

- ‘Action’ vector needs to be only (n-1)*2 bits for ‘n’ players.
- Ace being counted as 10 by the house player.

THANK YOU !!!!!

ECE 552 Spring 2005
Blackjack Project: Card Generator Group

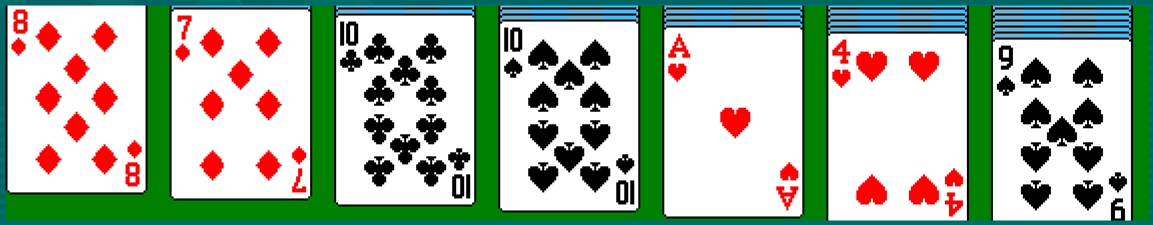


Ronnie Chai

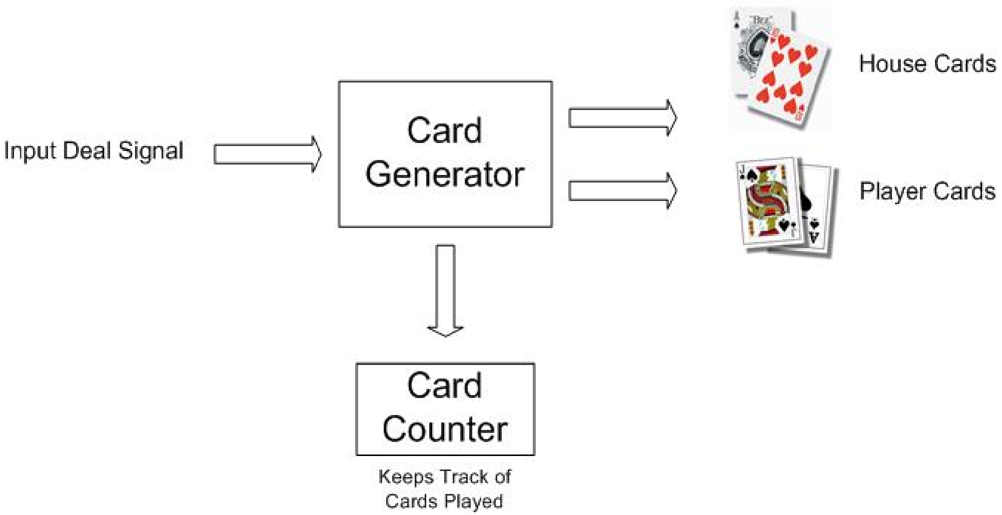
Eric Cardwell

Nathan Dennis

Pradeep Chimakurthy



Block Diagrams of How it Works



Input Deal Signal

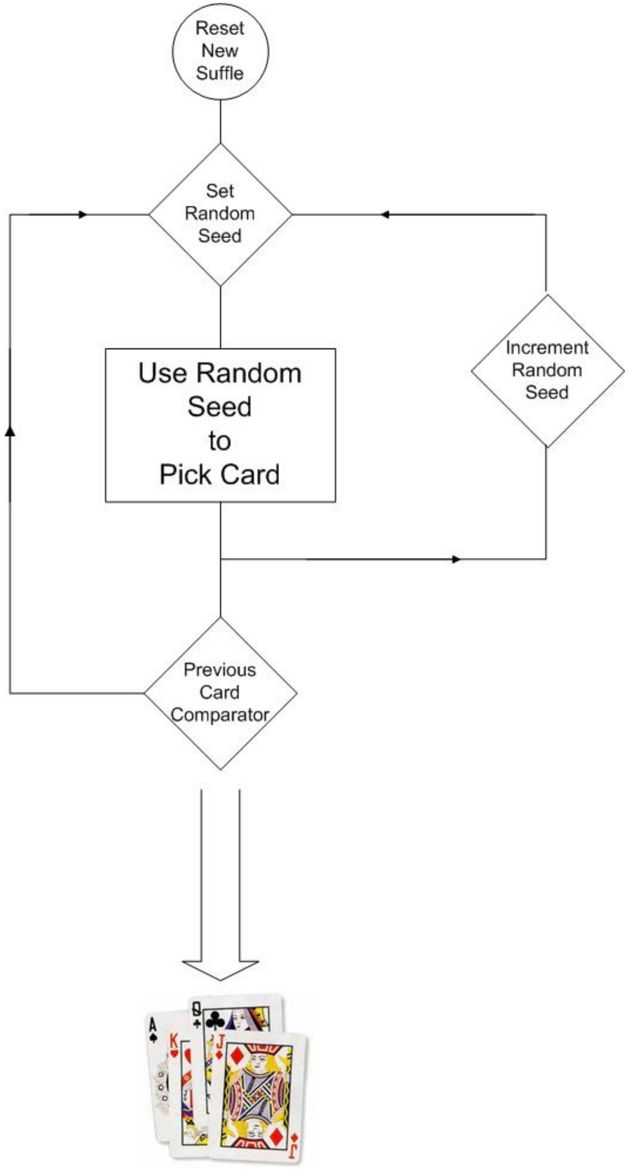
Card Generator

House Cards

Player Cards

Card Counter

Keeps Track of Cards Played



Reset New Suffle

Set Random Seed

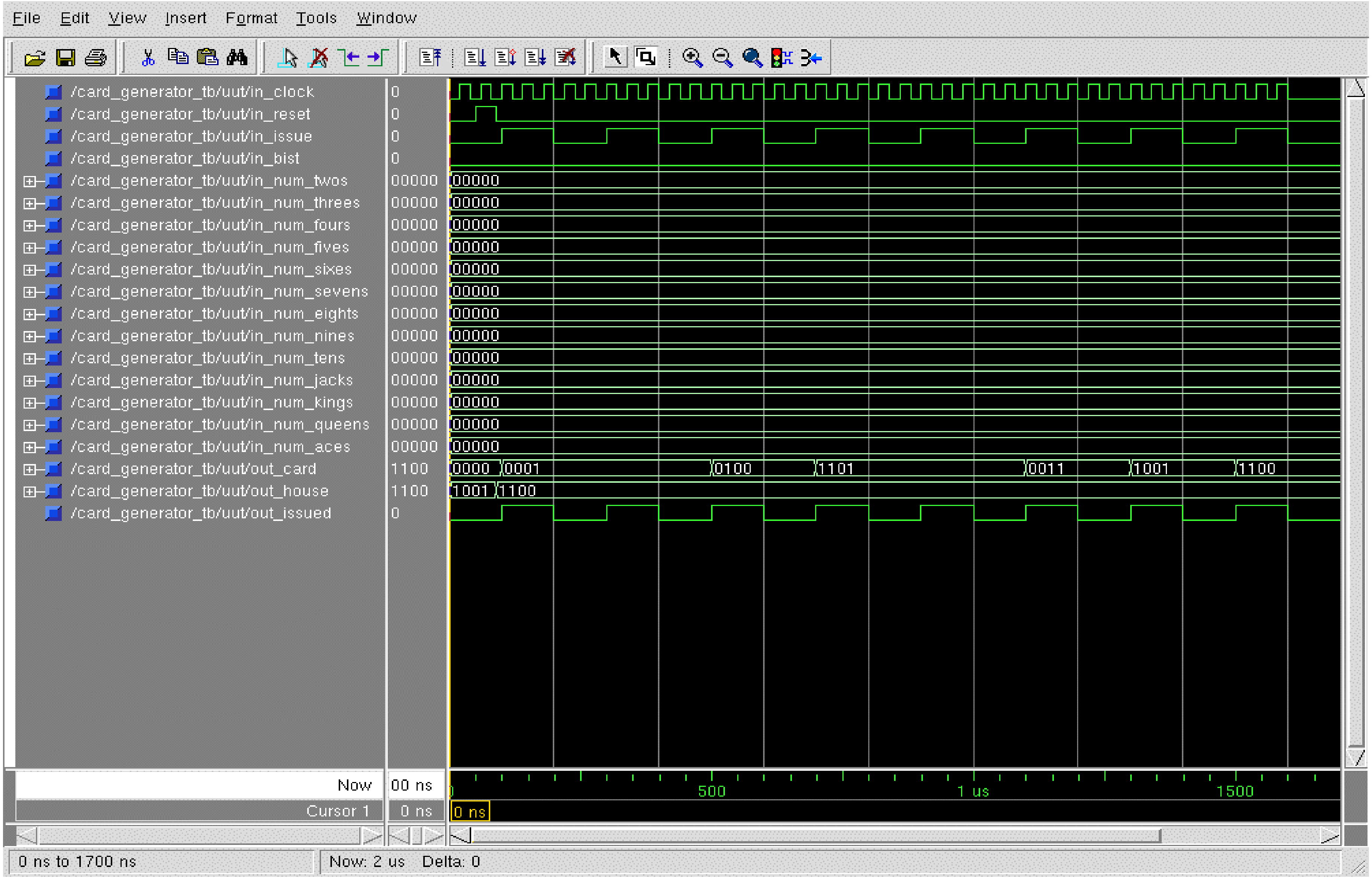
Use Random Seed to Pick Card

Increment Random Seed

Previous Card Comparator

Cards get Dealt

Card Generator Test Bench

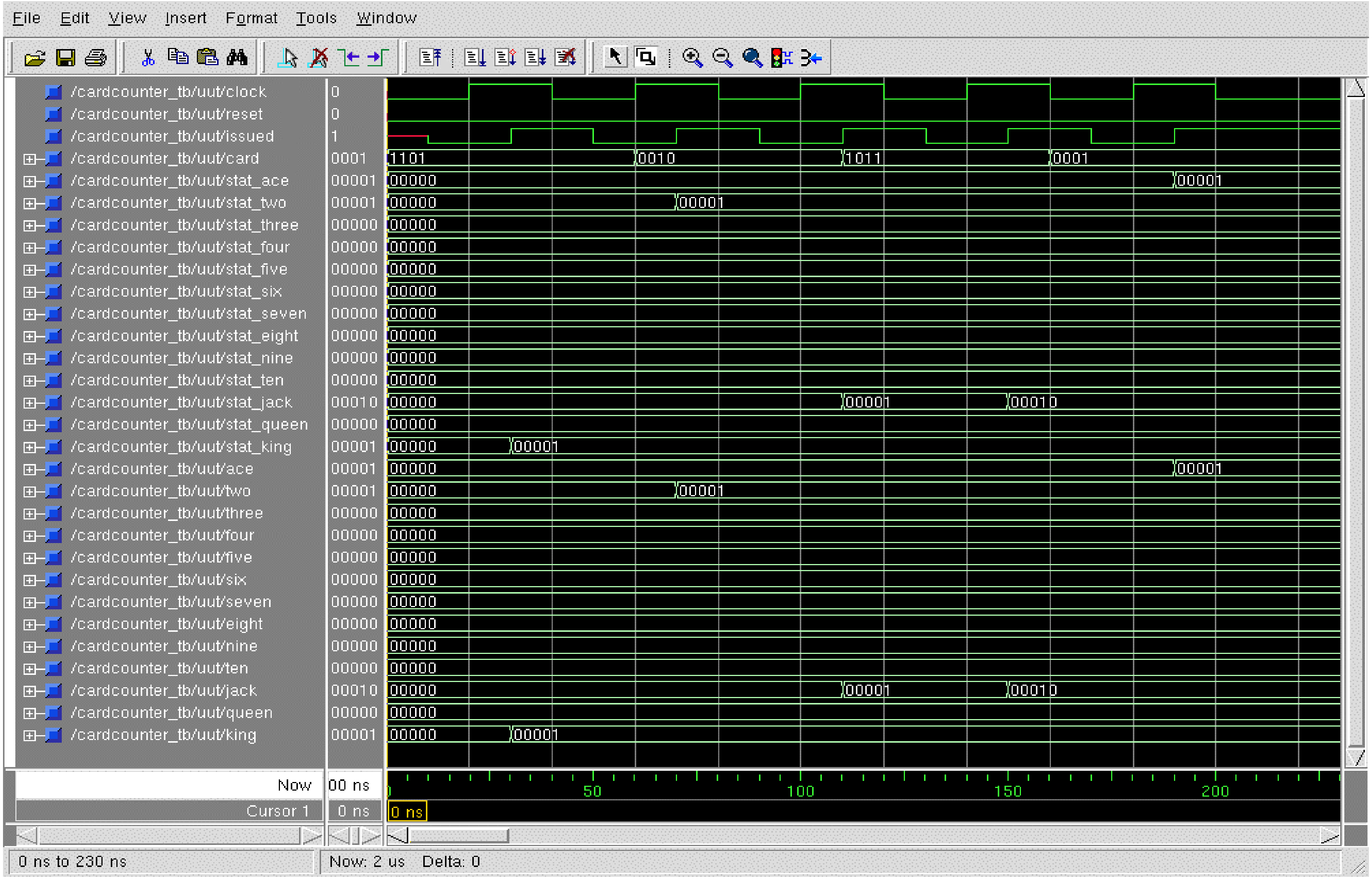


```
/card_generator_tb/uut/in_clock         0
/card_generator_tb/uut/in_reset         0
/card_generator_tb/uut/in_issue         0
/card_generator_tb/uut/in_bist          0
/card_generator_tb/uut/in_num_twos      00000
/card_generator_tb/uut/in_num_threes    00000
/card_generator_tb/uut/in_num_fours     00000
/card_generator_tb/uut/in_num_fives     00000
/card_generator_tb/uut/in_num_sixes     00000
/card_generator_tb/uut/in_num_sevens    00000
/card_generator_tb/uut/in_num_eights    00000
/card_generator_tb/uut/in_num_nines     00000
/card_generator_tb/uut/in_num_tens      00000
/card_generator_tb/uut/in_num_jacks     00000
/card_generator_tb/uut/in_num_kings     00000
/card_generator_tb/uut/in_num_queens    00000
/card_generator_tb/uut/in_num_aces      00000
/card_generator_tb/uut/out_card         1100
/card_generator_tb/uut/out_house        1100
/card_generator_tb/uut/out_issued       0

                                  Now   00 ns
                             Cursor 1   0 ns     0 ns

0 ns to 1700 ns          Now: 2 us   Delta: 0
```

Card Counter Test Bench



/cardcounter_tb/uut/clock	0
/cardcounter_tb/uut/reset	0
/cardcounter_tb/uut/issued	1
/cardcounter_tb/uut/card	0001
/cardcounter_tb/uut/stat_ace	00001
/cardcounter_tb/uut/stat_two	00001
/cardcounter_tb/uut/stat_three	00000
/cardcounter_tb/uut/stat_four	00000
/cardcounter_tb/uut/stat_five	00000
/cardcounter_tb/uut/stat_six	00000
/cardcounter_tb/uut/stat_seven	00000
/cardcounter_tb/uut/stat_eight	00000
/cardcounter_tb/uut/stat_nine	00000
/cardcounter_tb/uut/stat_ten	00000
/cardcounter_tb/uut/stat_jack	00010
/cardcounter_tb/uut/stat_queen	00000
/cardcounter_tb/uut/stat_king	00001
/cardcounter_tb/uut/ace	00001
/cardcounter_tb/uut/two	00001
/cardcounter_tb/uut/three	00000
/cardcounter_tb/uut/four	00000
/cardcounter_tb/uut/five	00000
/cardcounter_tb/uut/six	00000
/cardcounter_tb/uut/seven	00000
/cardcounter_tb/uut/eight	00000
/cardcounter_tb/uut/nine	00000
/cardcounter_tb/uut/ten	00000
/cardcounter_tb/uut/jack	00010
/cardcounter_tb/uut/queen	00000
/cardcounter_tb/uut/king	00001

Now 00 ns

Cursor 1 0 ns 0 ns

0 ns to 230 ns

Now: 2 us Delta: 0

Problems Identified

- First card for dealer does not increment card counter as out_issued flag not set.

- Card Sequence correction can be problematic based on random seed and sequence

```
    if( card > 12 ) then
                      card := (14 - card) + sequence;
```

When a card generated has upper 4 bits 1111 and sequence is 0 ,

```
         taking the card := card + 1; generates a card that has value 0.
```

- Logic to ensure that card generated does not exceed pack is faulty.

```
           if( sum_of_played = 16 ) then
                      if( tmp_card = "1100 (Queen)" ) then
           tmp_card := (others=>'0');--did not consider card value ‘0’ in  switch case
                      else
                          tmp_card := tmp_card + 1;
                                           end if;
```

- Initialization of signals which is problematic with synthesis tools.

Code Improvements

Why?

- Synthesis problems
- Randomness of card generation
- Accounting cards between games

How?

- Introduce reset
- Use memory cell stacks.
- Shuffle deck after 2 decks or 104 cards are dealt.

Test Bench Improvements

Why?

- Coverage for card_generator.vhd is only 75%
- Coverage for cardcounter.vhd is only 68.8%
- Coverage should be at least 95%

How?

- Increase the duration of signals in both test benches
- Look for other combinations of input

ECE 552 Black Jack Presentation

Score Keeper & Banker

Score Keeper:

Robert Greenwell
Derek Ziemian

Score Keeper – What Does It Do?

- Receives information from the Controller pertaining to
  - Which player is currently on turn
  - When and what card that player has received
  - When all players are standing (hand)

- This information is used to compile a score based on
  - How many cards a player has
  - And the value of said cards
    - A value of 21 with 2 cards = Blackjack
    - A value of 21 = Win (unless BJ or tie)
    - If there is no Blackjack or 21, the hands are compared to see who wins and if there is a tie

- Next, information is sent to the Banker
  - A signal telling the Banker the score is final
  - And a matrix containing each players stats (Blackjack, Win, Tie, or Lose)

Score Keeper – The Code

- While the code for the Score Keeper was for most the part functional, there were several areas for improvement
  - The code was poorly commented. Comments have been added to the code as necessary to understand its flow
  - There was a large amount of unused code in the program (such as unutilized loops and variables), and this code has been removed as deemed fit
  - An internal vector (HP_BJ) was not being reset, and if tripped, would cause the score to be incorrectly reported to the Banker in any subsequent hands. This error has been corrected

Score Keeper – Test Bench

- There where issues found with the preexisting Test Bench for the Score Keeper
  - Only a very simplistic simulation was conducted by the existing Test Bench
  - A new Test Bench was created to provide for more rigorous simulations
    - Added additional vectors to test the functionality of a larger portion of the code
    - Added the ability to simulate 6 Players instead of only 3

Banker:

Steven Bunch
Lanie Britton
Chris Beall

Banker Code Tasks - What Does It Do?

- Initializes each player’s bank account to 127
  - Then manipulates an individual’s account
  - Tracks bets wagered
  - Subtracts or adds money in an account due to wins or losses
- Monitors the score keeper for the end of the game to be reported
  - Monitors for either 100 hands played, or
  - If a player has reached the max bank allowed, or
  - If a player is out of money
- Lets the controller know that the game has ended
  - A signal out indicates that the controller should end the game or playing session

Banker – The Code

- As with the majority of the Black Jack code, the Banker code was poorly commented
- Although generally functional, many signals in the code were unused
- Other sections of the code might also be determined to be unused, but will require modification of the testbench

Modifications/Suggestions

- The code was commented for ease of reuse
- Bulky unused code was removed
- The testbench will need to be modified
  - Ensure Functionality
  - Ensure Code Coverage