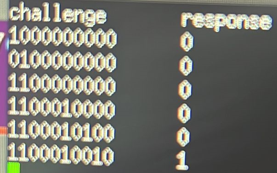
1. **PUF RING OSCILLATOR Design**
   1. We have designed a 64-bit RNG PUF
   2. There are totally 64 ring oscillators.
   3. Each ring oscillators have fixed 7 inverters (inv), but variable feedback buffers (FB)
   4. Feedback buffers (FB) are added on the feedback path to introduce different amount of propagation delay for different ring oscillators to generate variety of frequencies.
   5. We have split 64 ring oscillators into two groups/sets. Group1(1-32) RNG outputs are connected to the mux1, group2(64-33) RNG outputs are connected to the mux2.
   6. Both Mux1 & Mux2 are 32:1. The challenge input **challenge** [9:0] serves as a select input to the mux1 and mux2 to select one out of 32 RNG output as a clock to the counters.
   7. LED6-7 are used to display the comparator results
      1. LED6 will glow if counter1 > counter2
      2. LED7 will glow if counter2 > counter1
      3. Both the LDEs cannot glow for a given trial. Only one will glow
   8. LED4-5 are used to display the state of the counters
      1. LED4 will glow if counter1 reaches the maximum value (2^31)
      2. LED5 will glow if counter2 reaches the maximum value (2^31)



1. **Test steps**
   1. Load the bit file
   2. observe these LEDs
      1. LED0 red --> RNG disabled
      2. LED1 green --> code is alive
      3. LED2 off (it will be on only when btn3 is pressed)
      4. LED3 is green --> system is out of reset (btn0 press will put system in reset)
      5. LED4-LED7 are all off
   3. now it is time to set the challenge inputs
      1. Press btn0 to reset the entire system and start fresh

* The heading message will be printed on the UART terminal as shown below
* 
  + 1. Prese btn2 to increment challenge [4:0] by one & btn3 to increment challenge [9:5].
    2. press btn1 to enable RNG
    3. View the results printed on UART terminal as printed below



* + 1. Repeat (ii) & (iii) any number of times
    2. Press btn0 to start fresh

1. **UART setup**
   1. Install putty
      1. **sudo apt-get install putty**
   2. Make sure the JTAG-USB is connected to the PC
      1. Ty **lusb** command to display all the usb devices connected
   3. Open putty terminal with baud rate of 9600 as follows
      1. **sudo putty /dev/ttyUSB01 -serial -sercfg 9600,8,n,1,N**