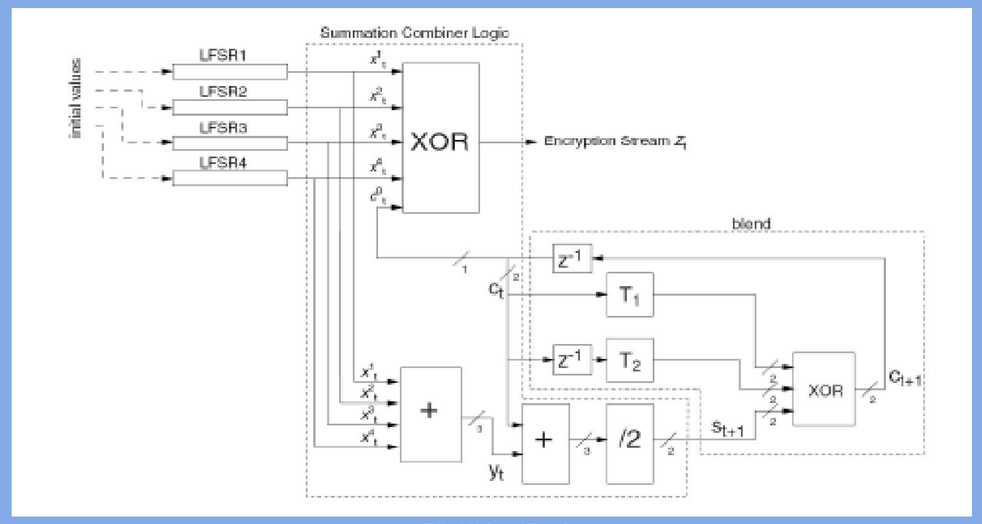
Bluetooth(E0) Cipher



E0 Cipher Design

LFSR Number	LFSR Length	LFSR Feedback Polynomial
1	25	$t^{25} + t^{20} + t^{12} + t^{8} + 1$
2	31	$t^{31} + t^{24} + t^{16} + t^{12} + 1$
3	33	$t^{33} + t^{28} + t^{24} + t^{4} + 1$
4	39	$t^{39} + t^{36} + t^{28} + t^{4} + 1$

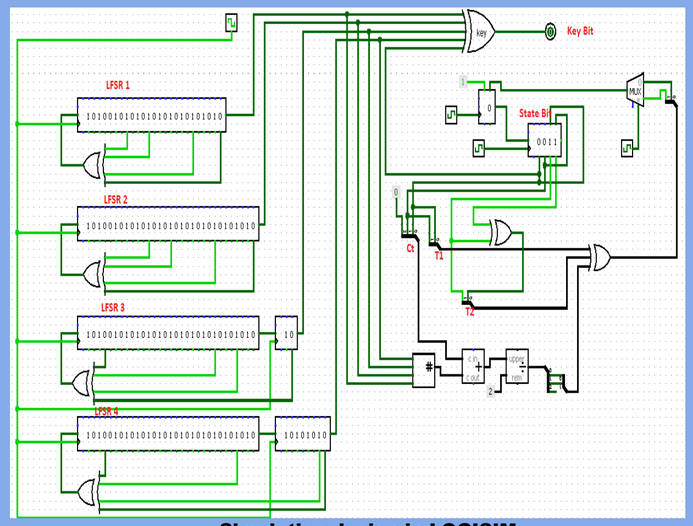
Feedback Polynomial

$$c_{t+1} = \begin{bmatrix} c^0_{t+1} \\ c^1_{t+1} \end{bmatrix} = s_{t+1} \oplus T_1[c_t] \oplus T_2[c_{t-1}]$$

Calculation of State bits

$$T_1 : \quad (x_1, x_0) \mapsto (x_1, x_0),$$
$$T_2 : \quad (x_1, x_0) \mapsto (x_0, x_1 \oplus x_0),$$

Calculation of T1 and T2



Simulation design in LOGISIM

Bluetooth Version	Speed	Compatibility
Bluetooth v1.0 and v1.0B	< 0.7 MBPS	Yes
Bluetooth v1.1	< 0.7 Mbps	Yes
Bluetooth v1.2	0.7 Mbps	No
Bluetooth v2.0 + EDR	2.1 Mbps	No
Bluetooth v2.1 + EDR	24 Mbps	No
Bluetooth v3.0 + HS	24 Mbps	No

Compatibility with Bluetooth Versions

Initializing LFSR's	0.004838 ms
CUDA malloc	243.0138 ms
CPU to GPU copy	0.006840 ms
GPU calculation	0.029884 ms
GPU to CPU copy	4.000000 ms
Total Time for key generation	0.664239 ms

Analysis of execution time in CUDA

```
==3010== Profiling result:
Time(%)      Time     Calls       Avg       Min       Max  Name
 98.38%  658.87us         1  658.87us  658.87us  658.87us  LFSR_SHIFT(int*, int*, int*, int*, int*)
  1.02%  6.8480us         5  1.3690us  1.1520us  1.6320us  [CUDA memcpy DtoH]
  0.60%  4.0000us         5     800ns     736ns     960ns  [CUDA memcpy HtoD]

==3010== API calls:
Time(%)      Time     Calls       Avg       Min       Max  Name
 97.12%  64.846ms         5  12.969ms  6.9340us  64.813ms  cudaMalloc
  1.20%  799.29us        83  9.6290us     711ns  376.60us  cuDeviceGetAttribute
  1.16%  776.87us        10  77.686us  7.1470us  667.87us  cudaMemcpy
  0.19%  127.56us         5  25.512us  5.9390us  94.682us  cudaFree
  0.15%  101.07us         1  101.07us  101.07us  101.07us  cuDeviceTotalMem
  0.13%  86.235us         1  86.235us  86.235us  86.235us  cuDeviceGetName
  0.03%  19.931us         1  19.931us  19.931us  19.931us  cudaLaunch
  0.01%  5.7840us         5  1.1560us     235ns  4.4320us  cudaSetupArgument
  0.01%  4.5910us         2  2.2950us  1.1680us  3.4230us  cuDeviceGetCount
  0.00%  2.3000us         2  1.1500us     987ns  1.3130us  cuDeviceGet
  0.00%  1.2150us         1  1.2150us  1.2150us  1.2150us  cudaConfigureCall
```

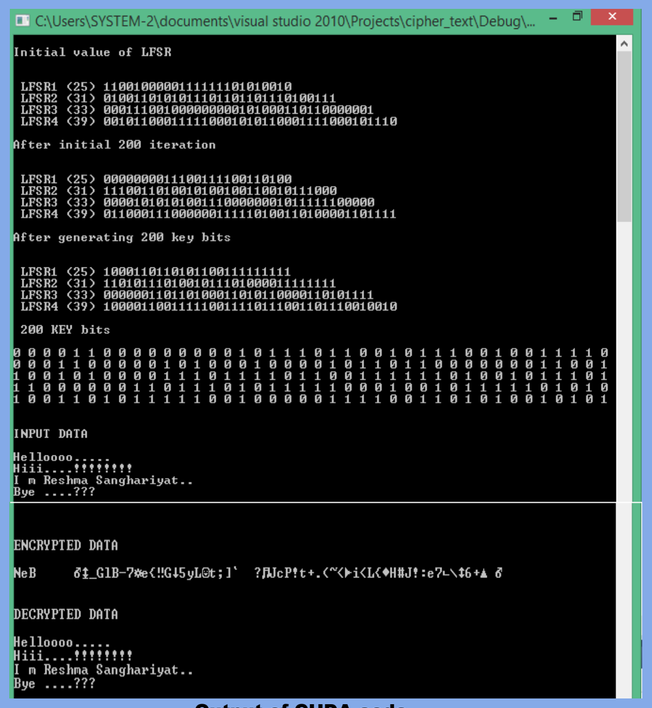
Profiling Result

CUDA	C
0.664 ms	32 ms

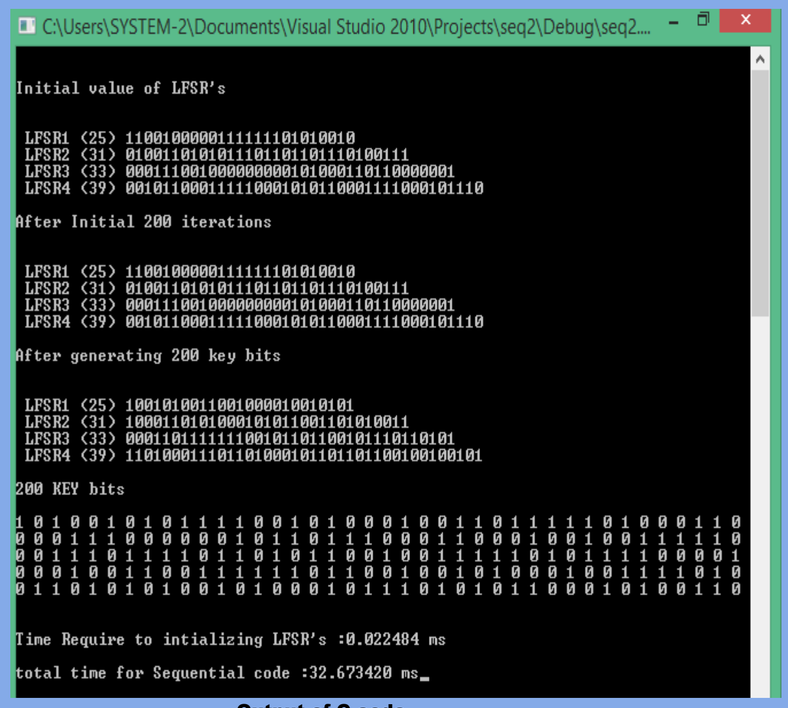
Execution time for 200 bits

CUDA	C
0.333 Mbps	0.0062 Mbps

Communication Speed



Output of CUDA code



Output of C code

Conclusion

In real time application of Bluetooth Communication, communication speed is 0.7 to 2.1 Mbps. Whereas in CUDA we will get communication speed is 0.33 Mbps which is very less compare to actual Bluetooth communication. Here, we conclude that we can replace lower version of Bluetooth communication hardware with our software code (CUDA code).

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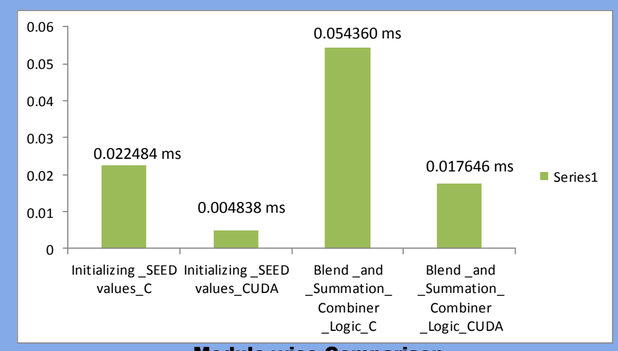

Module wise Comparison