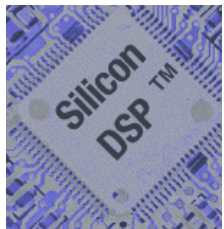


Forward Error Correction (FEC)

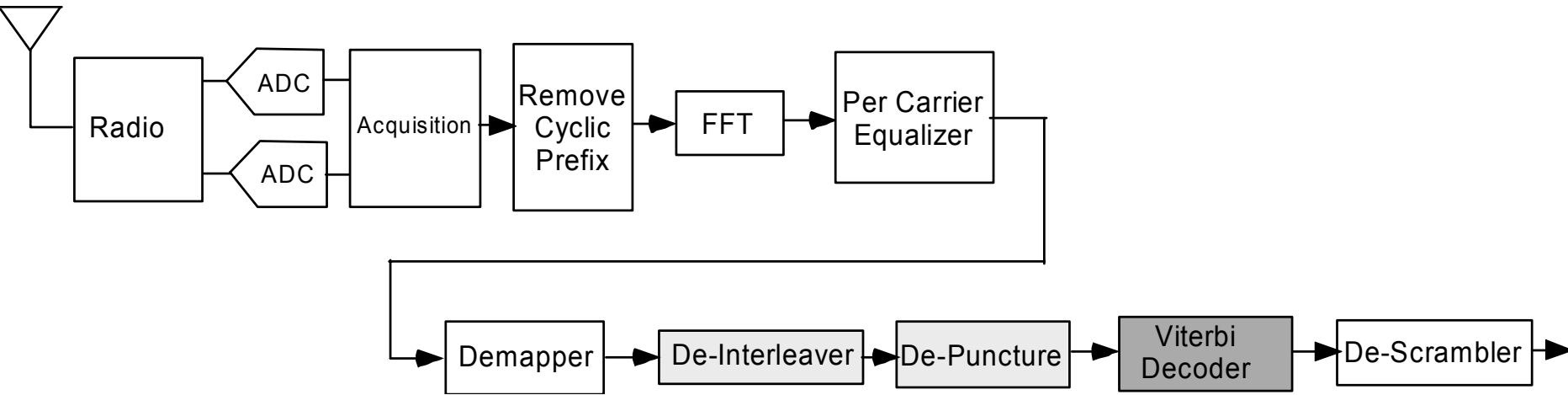
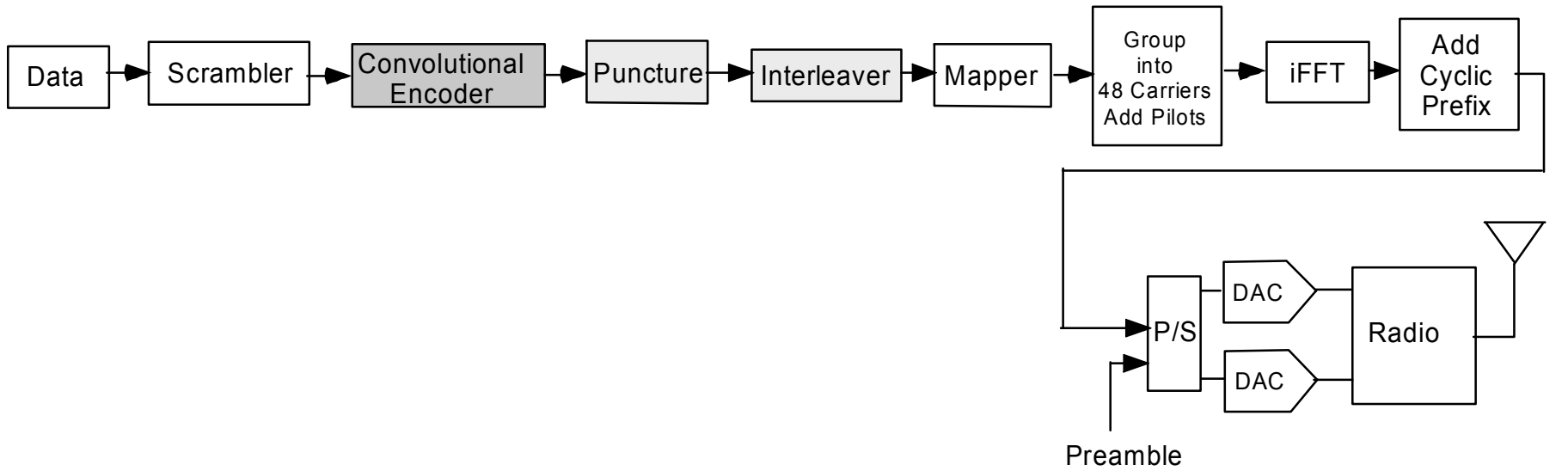
Convolutional Encoder Viterbi Decoder

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Silicon DSP Corporation

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References

Theory and Practice of Error Control Codes, Richard E. Blahut, Addison-Wesley, 1983

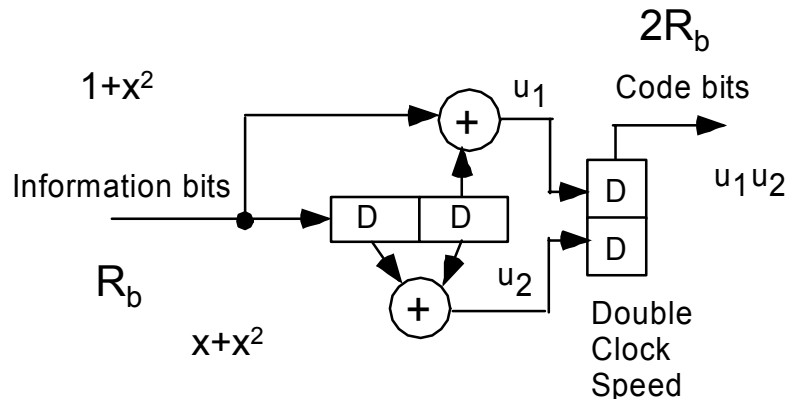
Error-Control Coding for Data Networks, Irving S. Reed, Xuemin Chen, Springer, 2003

A tutorial on Convolutional Coding with Viterbi Decoding, Chip Fleming, 1999-2006,
<http://home.netcom.com/~chip.f/viterbi/tutorial.html>

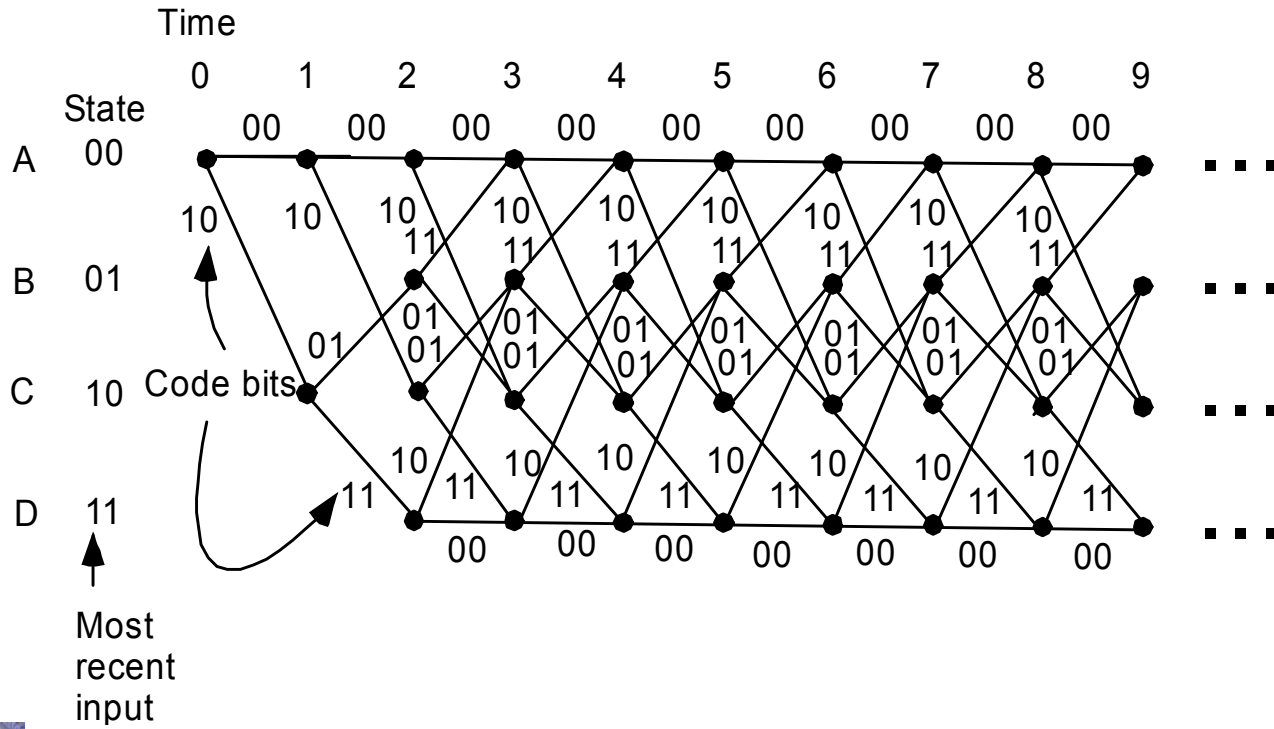
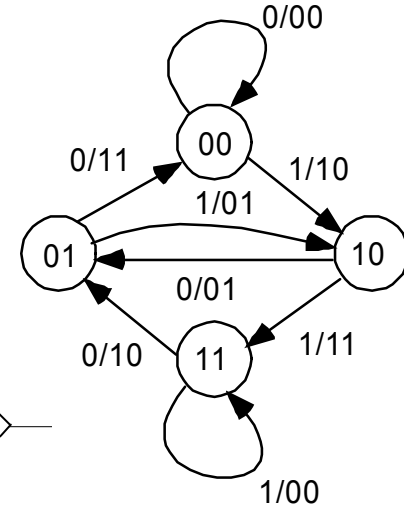
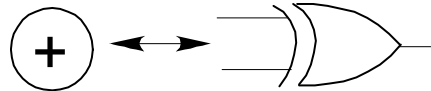
Digital Communications, Bernard Sklar, Second Edition, Prentice Hall, 2001

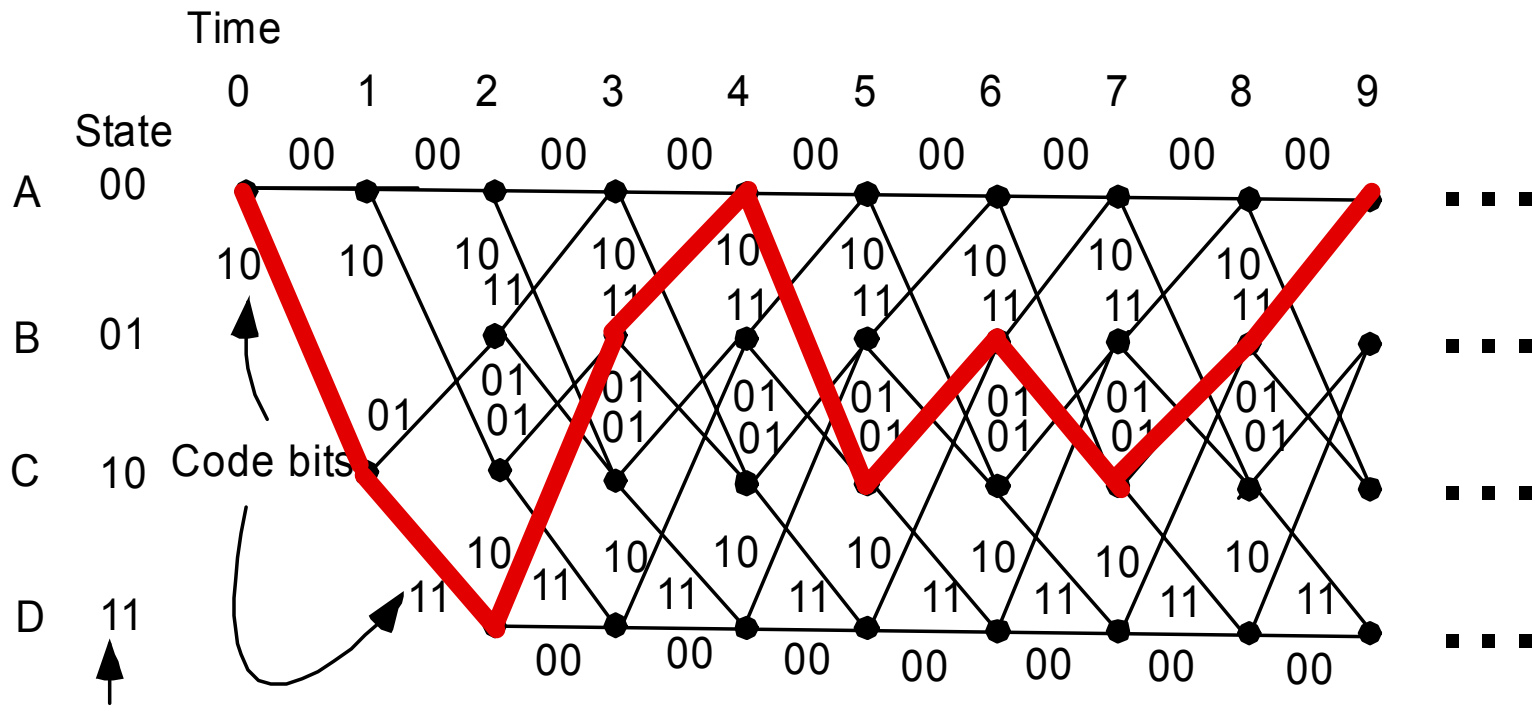


Convolutional Encoder



Rate 1/2





Input Stream 110010100

Output Stream 10 11 10 11 10 01 01 01 11



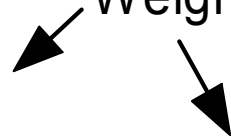
Error Correction and d_{\min}

$C1=1010111011$

$C2=1011001001$

$C1+C2=0001110010$

Weight=4



Hamming Distance=4

C

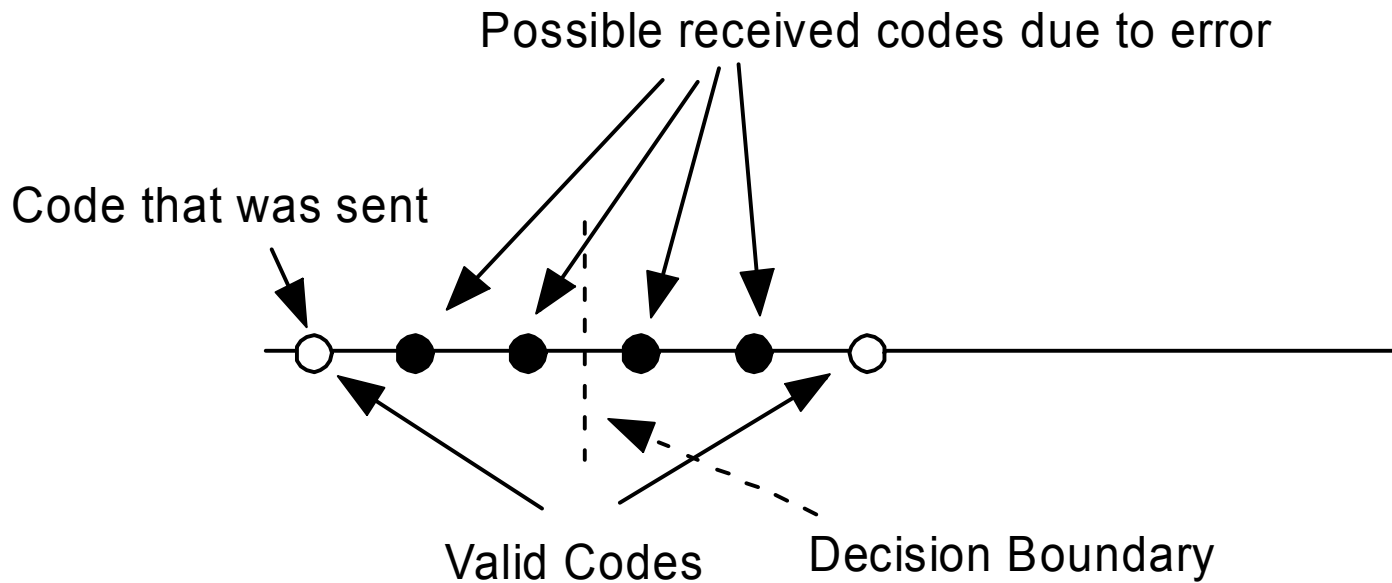
$C_1 C_2 C_3 \dots C_n$

$(C-C)$

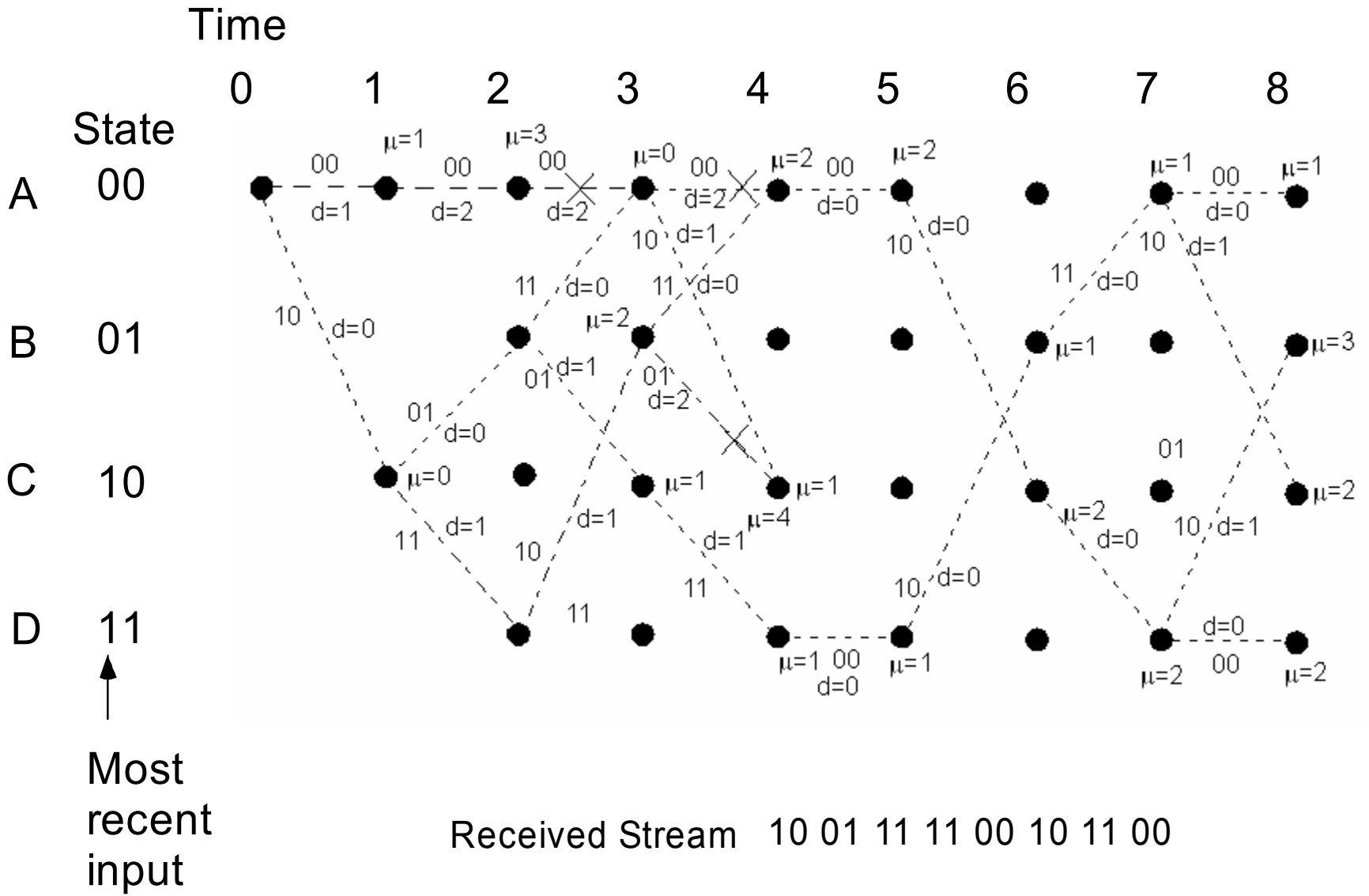
$(C_1-C) (C_2-C) \dots (C_n-C)$

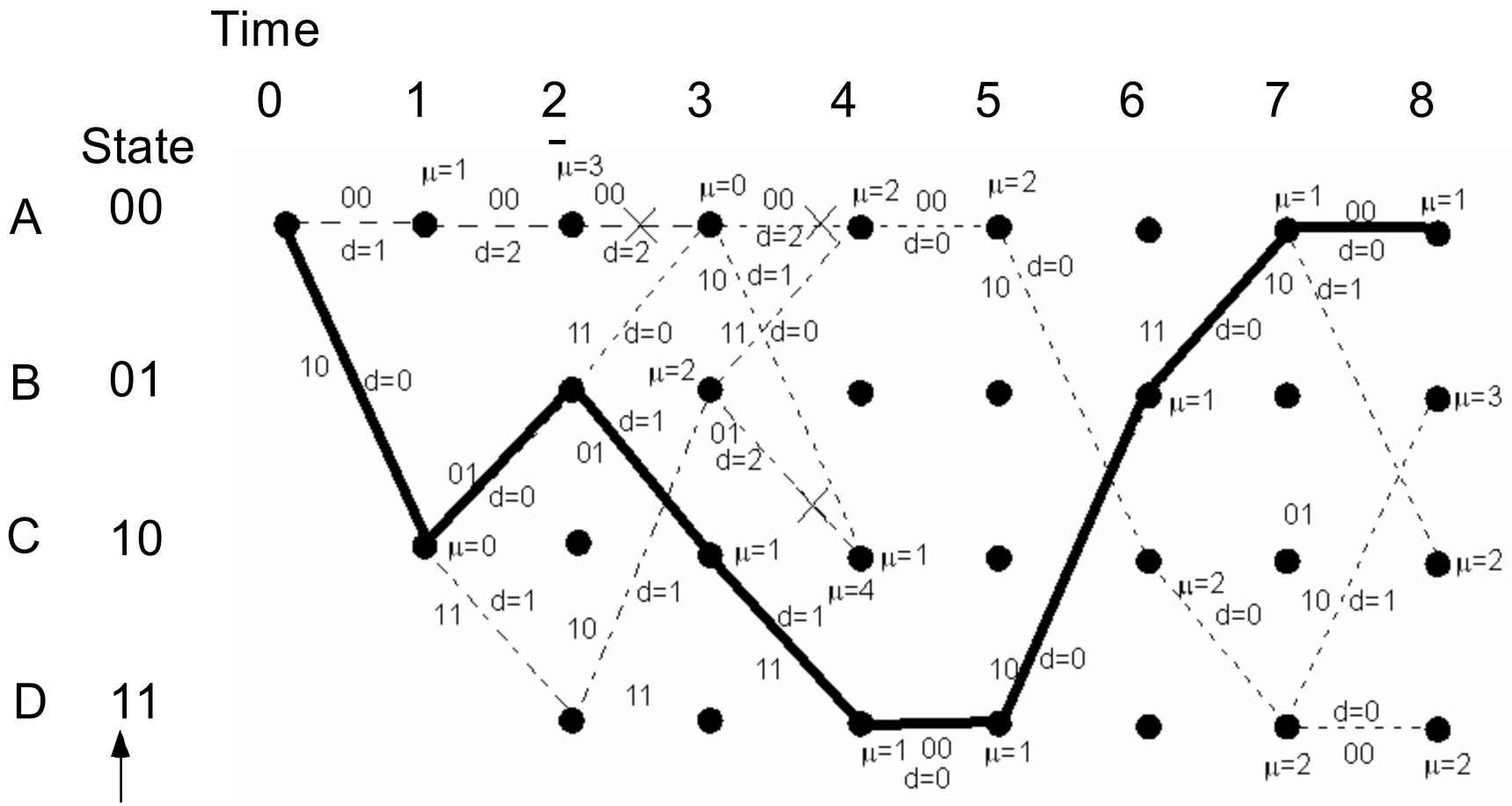


Error Correction



$$2t+1 = d_{\min}$$





Most recent input

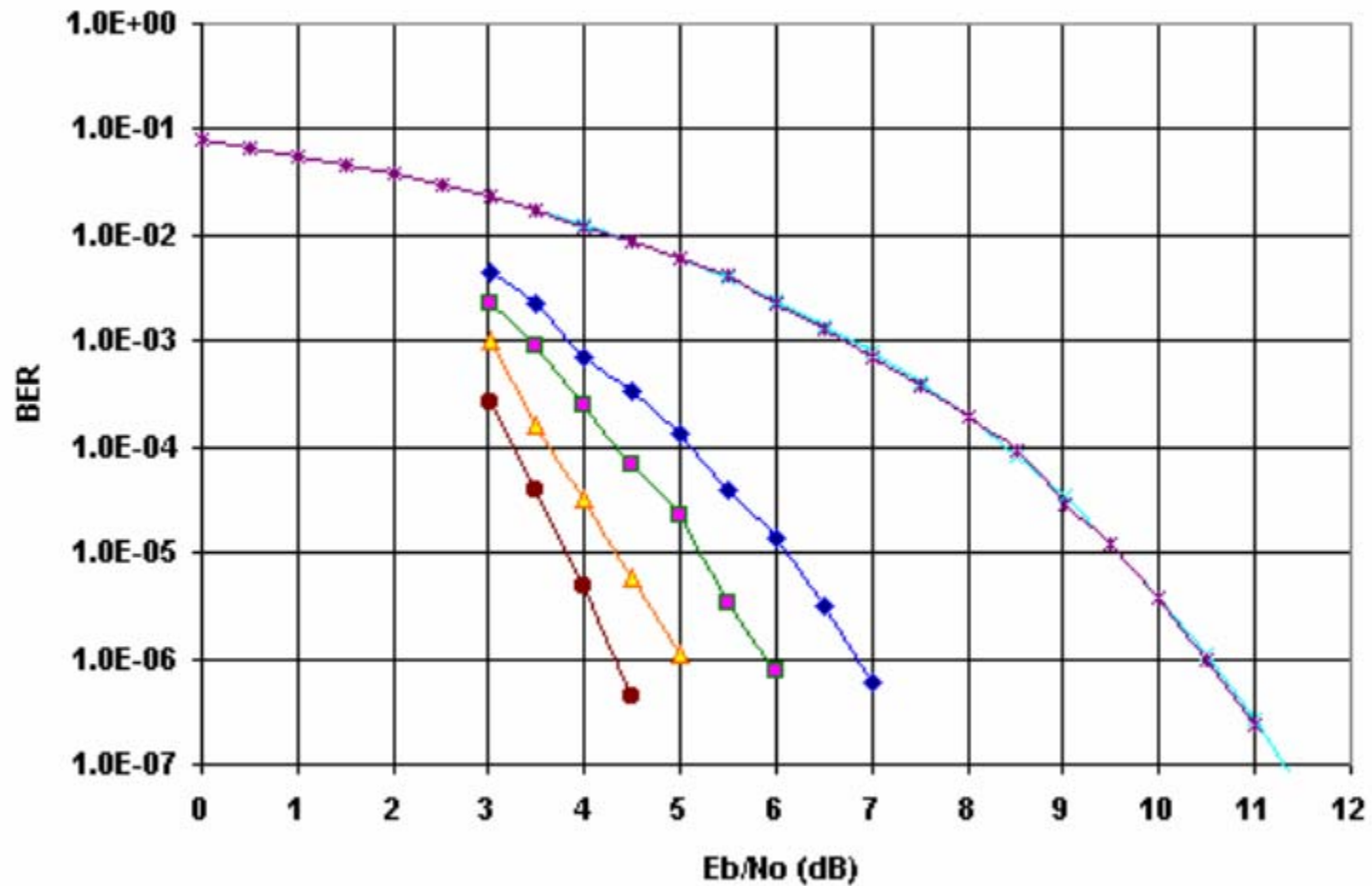
Received Stream 10 01 11 11 00 10 11 00

Decoded Stream 10 01 01 11 00 10 11 00

Decoded Message 10111000

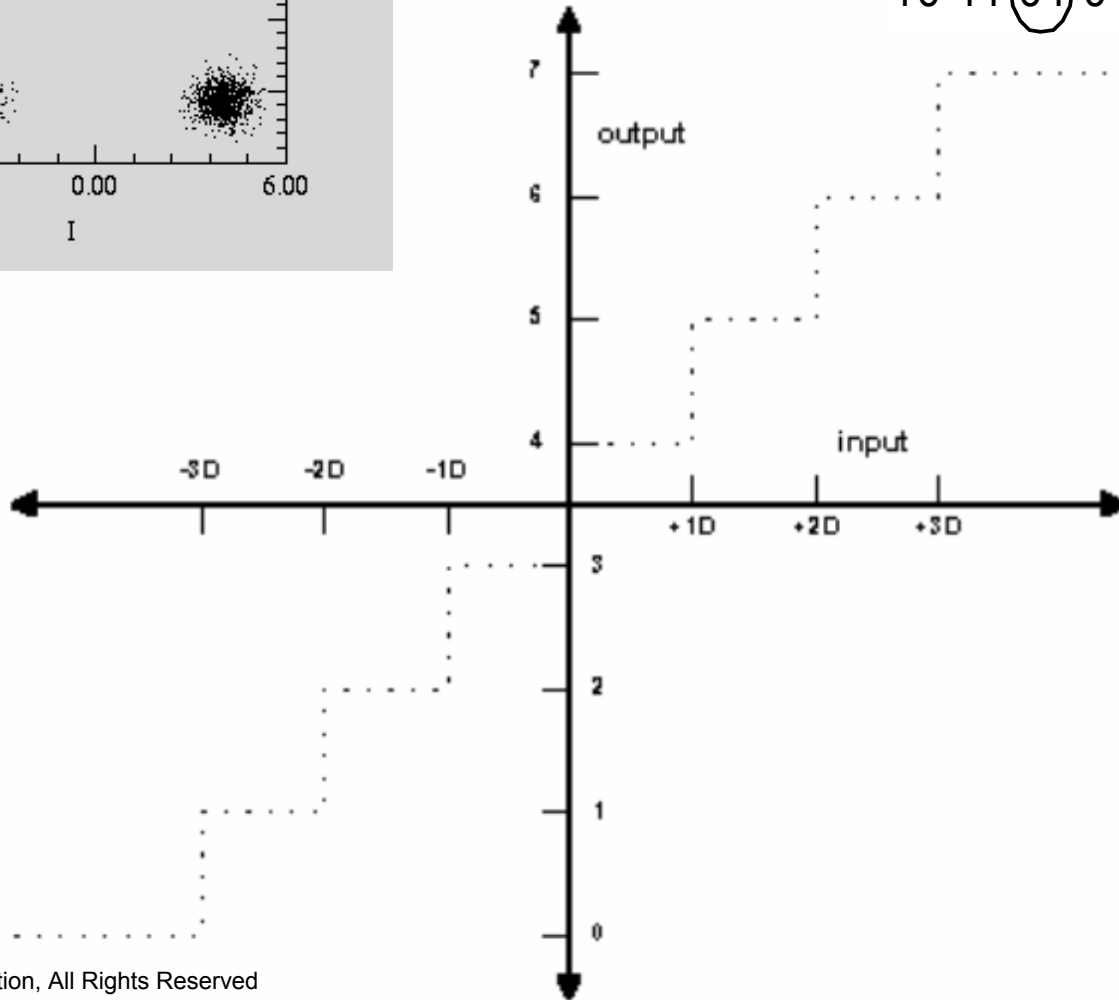
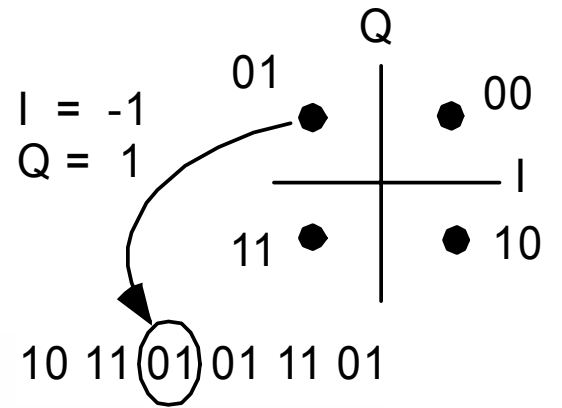
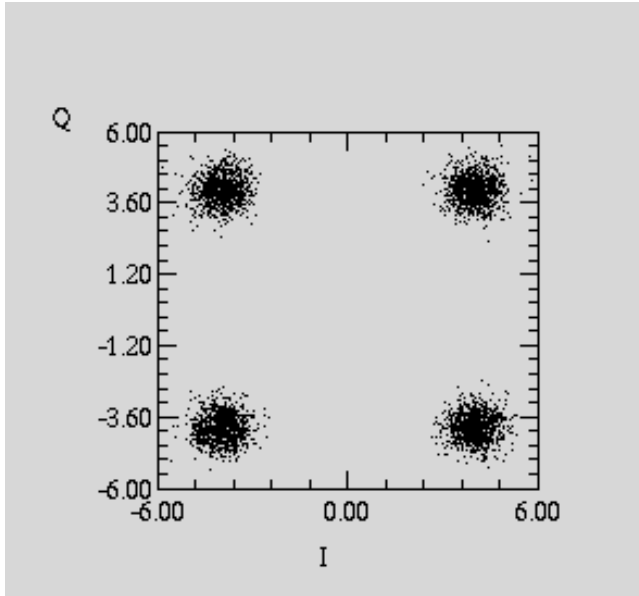


Simulation Results for Rate 1/2 Convolutional Coding with Viterbi Decoding on an AWGN Channel with Various Convolutional Code Constraint Lengths



—◆— Simulated BER, $K=3$ —■— Simulated BER, $K=5$ —▲— Simulated BER, $K=7$
—●— Simulated BER, $K=9$ —*— Theoretical Uncoded BER —*— Simulated Uncoded BER

Soft Decisions



Ref: Chip Fleming



Soft Decision Gain

- Soft Decision Viterbi Decoding has about 3 dB gain over hard decision (all references).
- The gain diminishes after number of bits >4. Most gain from 3 to 5 bits.
- Reported Gains of 5-6 dB in 16 and 64 QAM



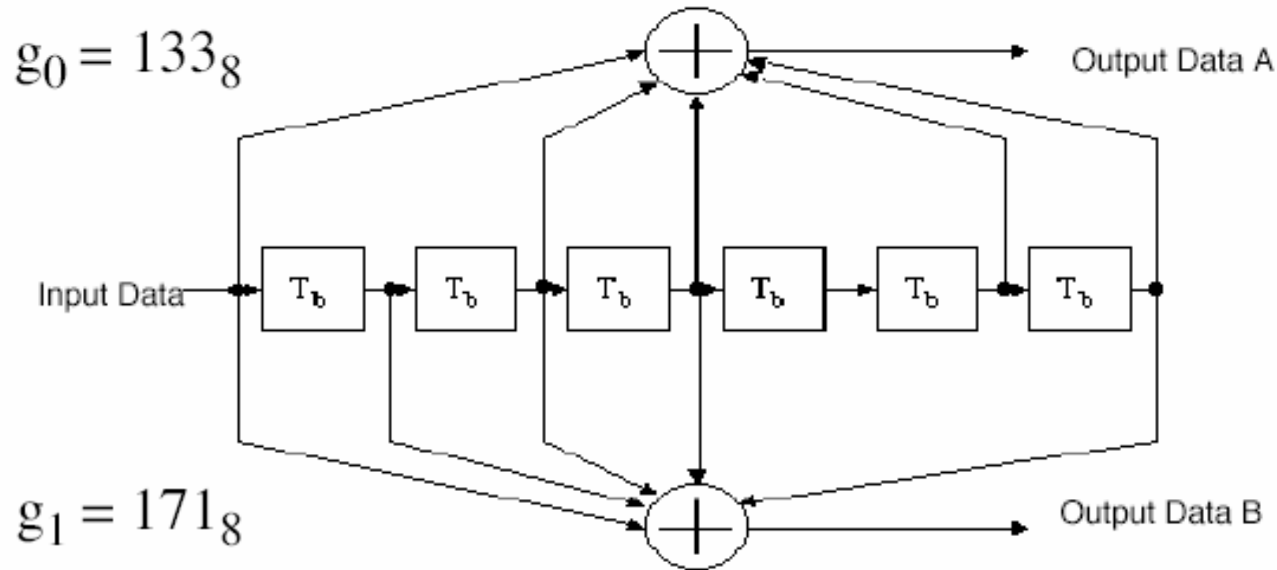
Soft Decision Demapper Reference

Filippo Tosato, Paola Bisaglia, "Simplified Soft-Output Demapper for Binary Interleaved COFDM with Application to HIPERLAN/2, HP Laboratories Bristol, October 10th, 2001

IEEE 802.11a Convolutional Encoder

$$1+x^2+x^3+x^5+x^6$$

$$g_0 = 133_g$$



$$g_1 = 171_g$$

$$1+x+x^2+x^3+x^6$$

Constraint Length K equal to $7=6+1$

A Output First Then B

- Traceback length 48 for non-punctured and 96 for punctured (Xilinx)

For hard-decision input the Viterbi decoder's smallest accumulated error metric in the final state indicates how many channel symbol errors occurred.

Traceback depth $K \times 5$ more if puncturing used. Example 60.

Flush K bits.

