Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Common Coherent and Non-Coherent Modulation Proposal]

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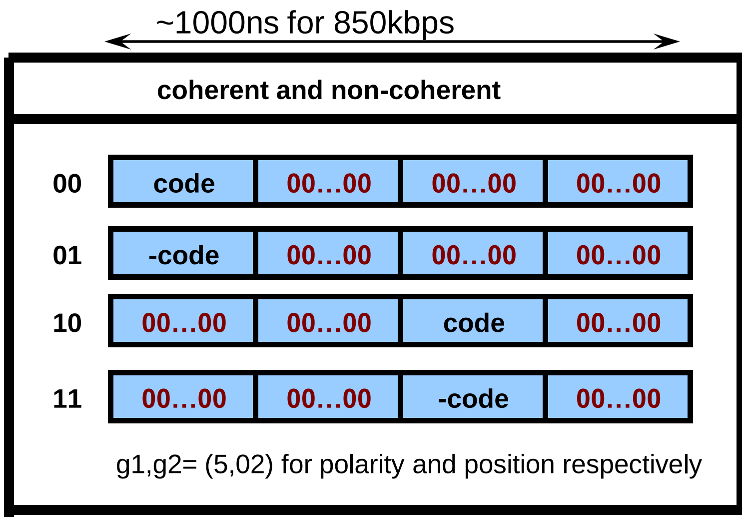
Re: [802.15.6]

Abstract: [Proposes a modulation scheme for BAN]

Purpose: [To promote discussion in 802.15.6.]

802.15.4a Burst Position Modulation



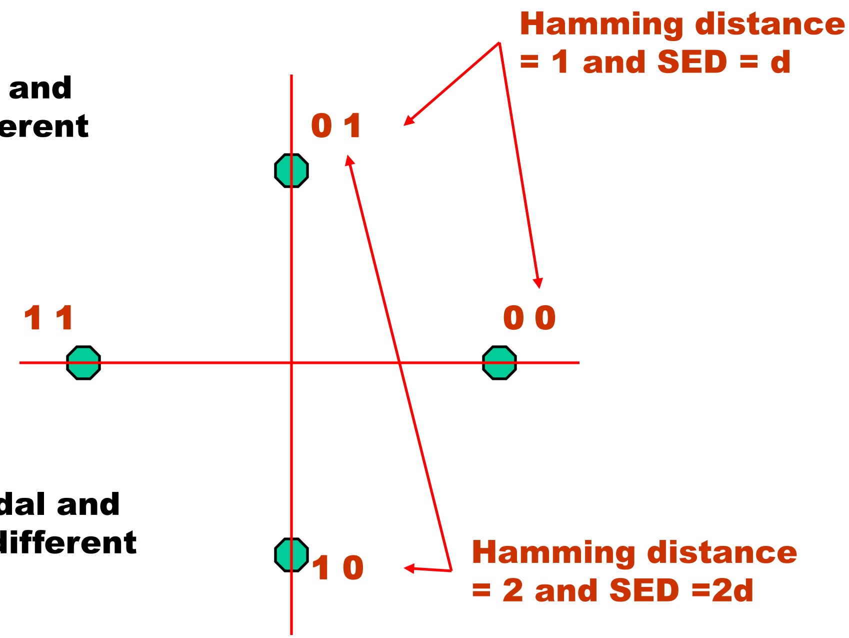
Antipodal 4pt Constellation

bit1	bit0	Symbol Transmitted
0	0	-1 .. 1 .. 0 .. 0
0	1	0 .. 0 .. 1 .. -1
1	0	0 .. 0 .. -1 .. 1
1	1	1 .. -1 .. 0 .. 0

Antipodal and 2 bits different

Antipodal and 2 bits different

Orthogonal and 1 bit different



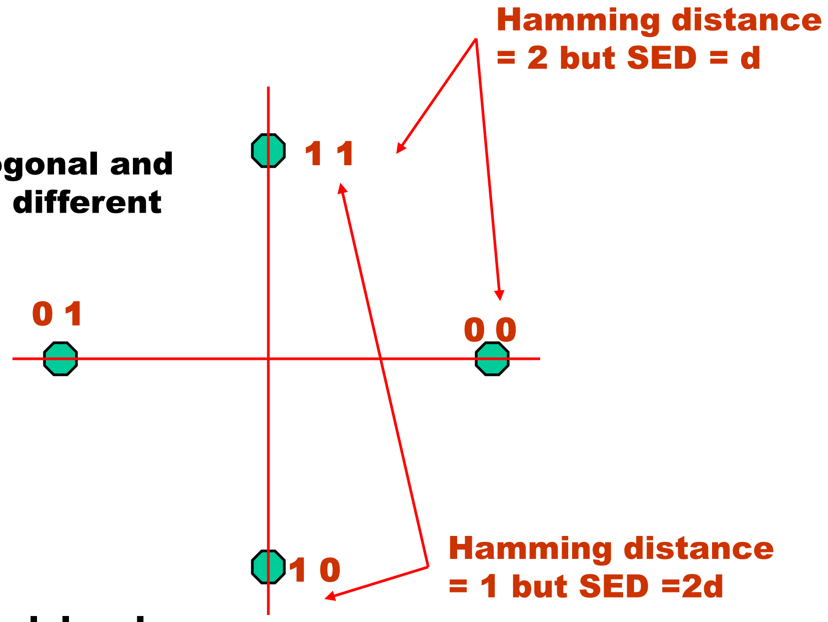
SED = Squared Euclidean Distance

Non-Antipodal 4 pt Constellation

bit1	bit0	Symbol Transmitted
0	0	-1 .. 1 .. 0 .. 0
0	1	1 .. -1 .. 0 .. 0
1	0	0 .. 0 .. -1 .. 1
1	1	0 .. 0 .. 1 .. -1

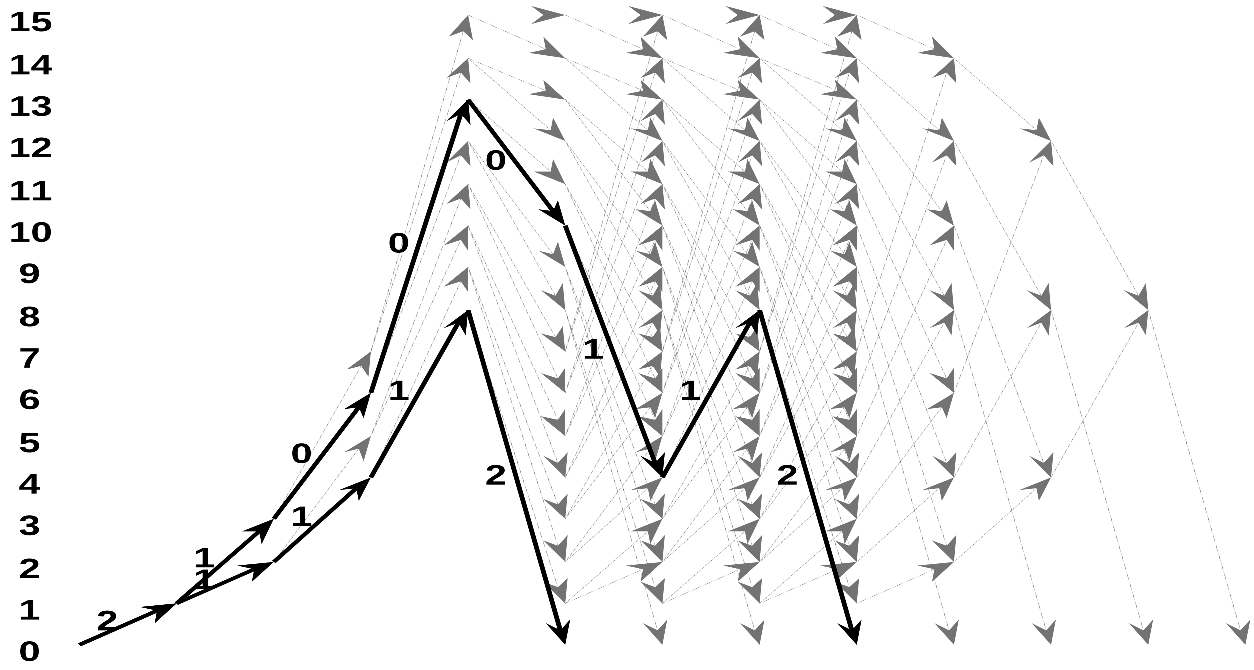
Orthogonal and 2 bits different

Antipodal and 1 bit different



SED = Squared Euclidean Distance

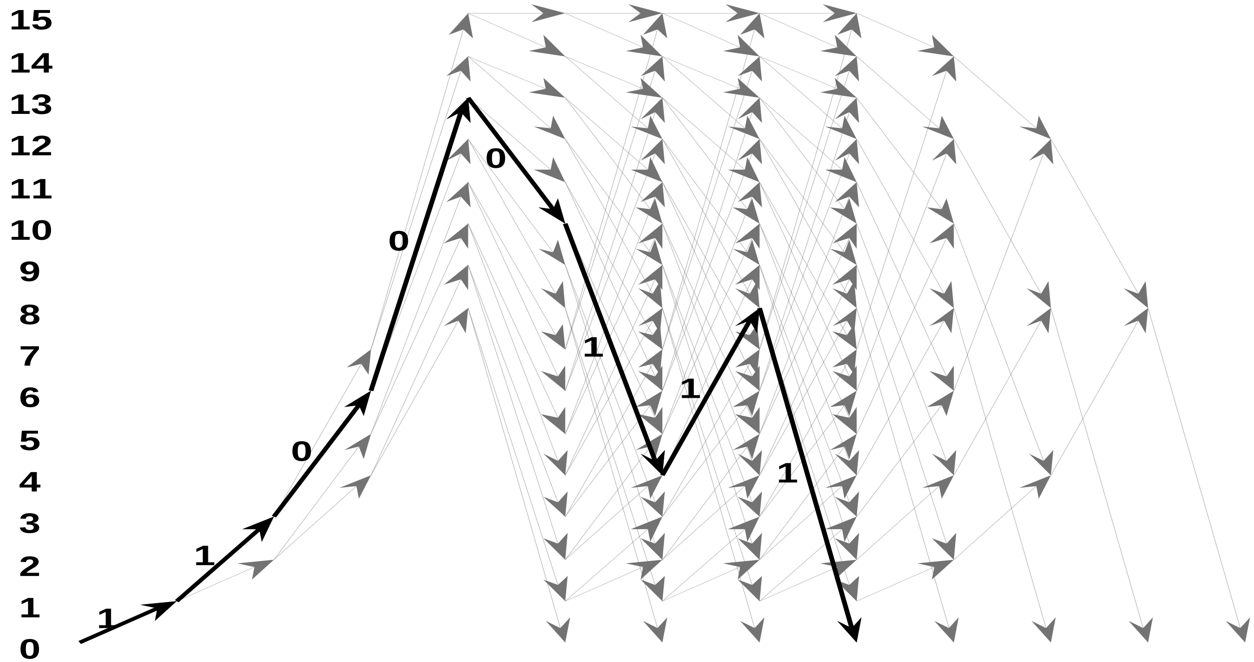
Trellis Diagram, Optimum antipodal conv. code with K=5, g1=35, g2=23



d_{free} = 7, with 2 parallel pathways

This is the way this code is supposed to work!

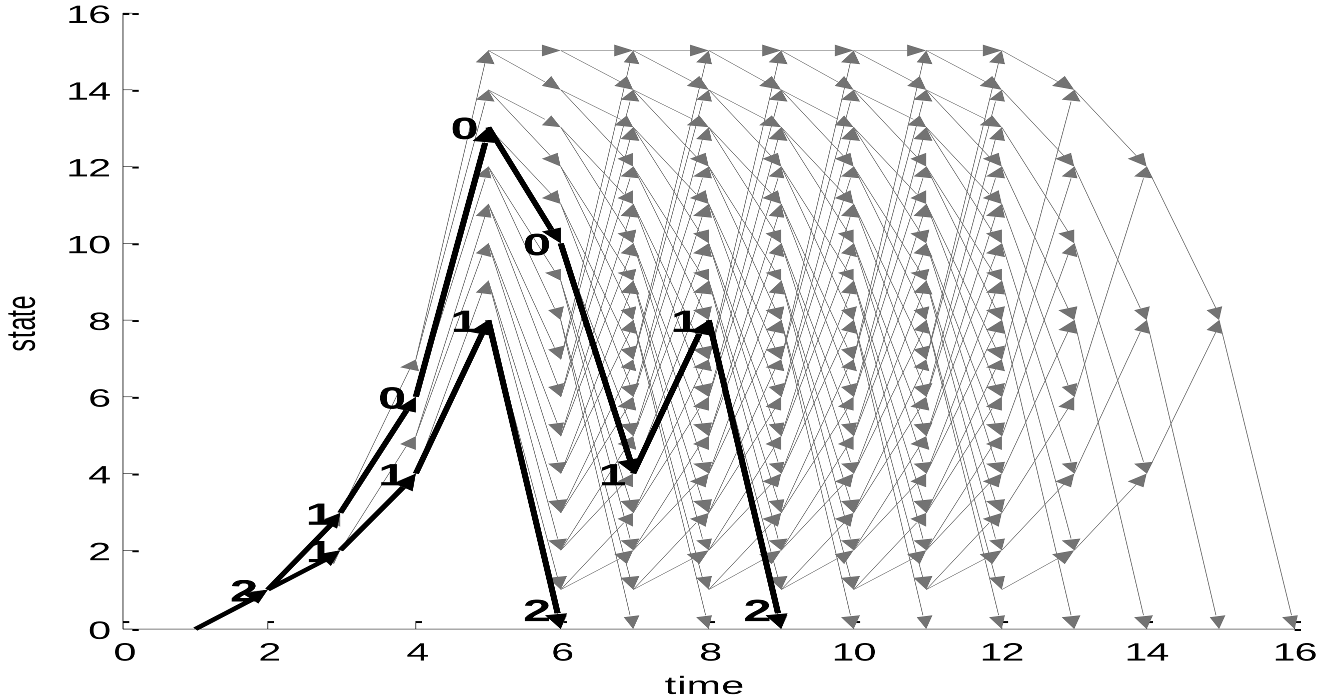
Trellis Diagram, Non-Antipodal
K=5, g1=35, g2=23



d_{free} = 5, 1 pathway

This is how it actually works with the PPM/BPSK constellation!

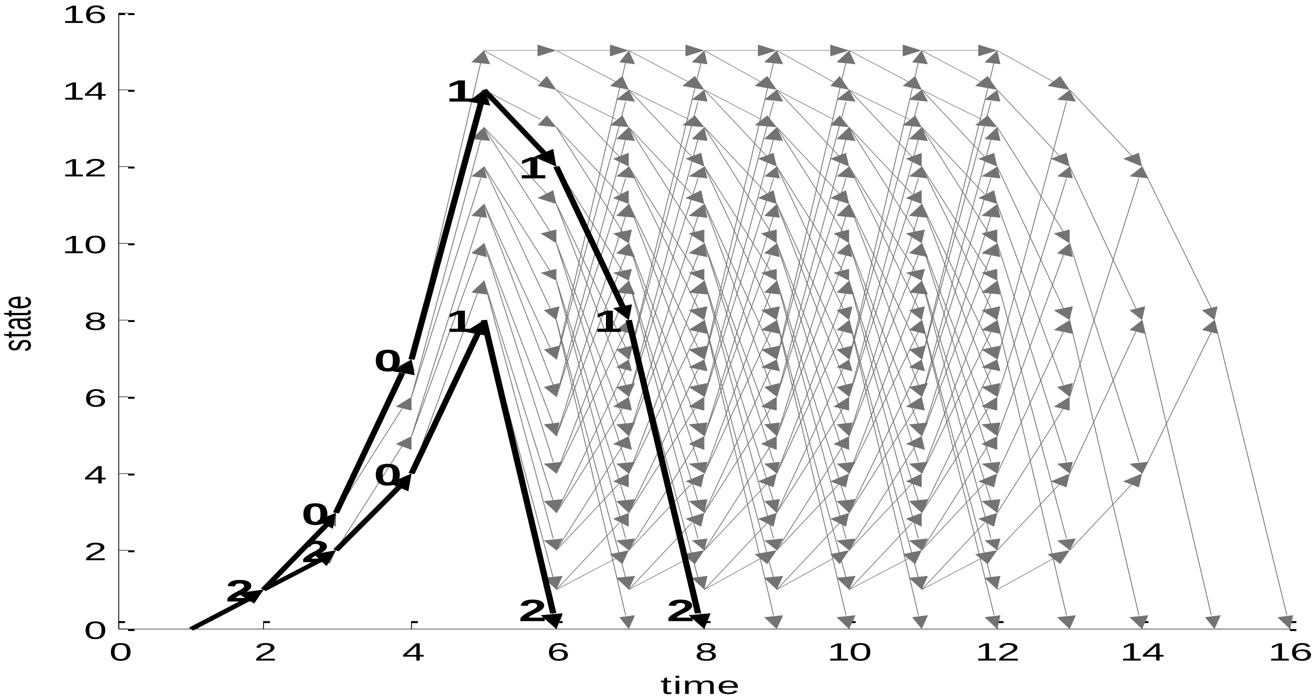
Trellis Diagram, Non-Antipodal K=5, g1=35, g2=16



d_{free} = 7, 2 parallel pathways

This is a better code with the PPM/BPSK constellation!

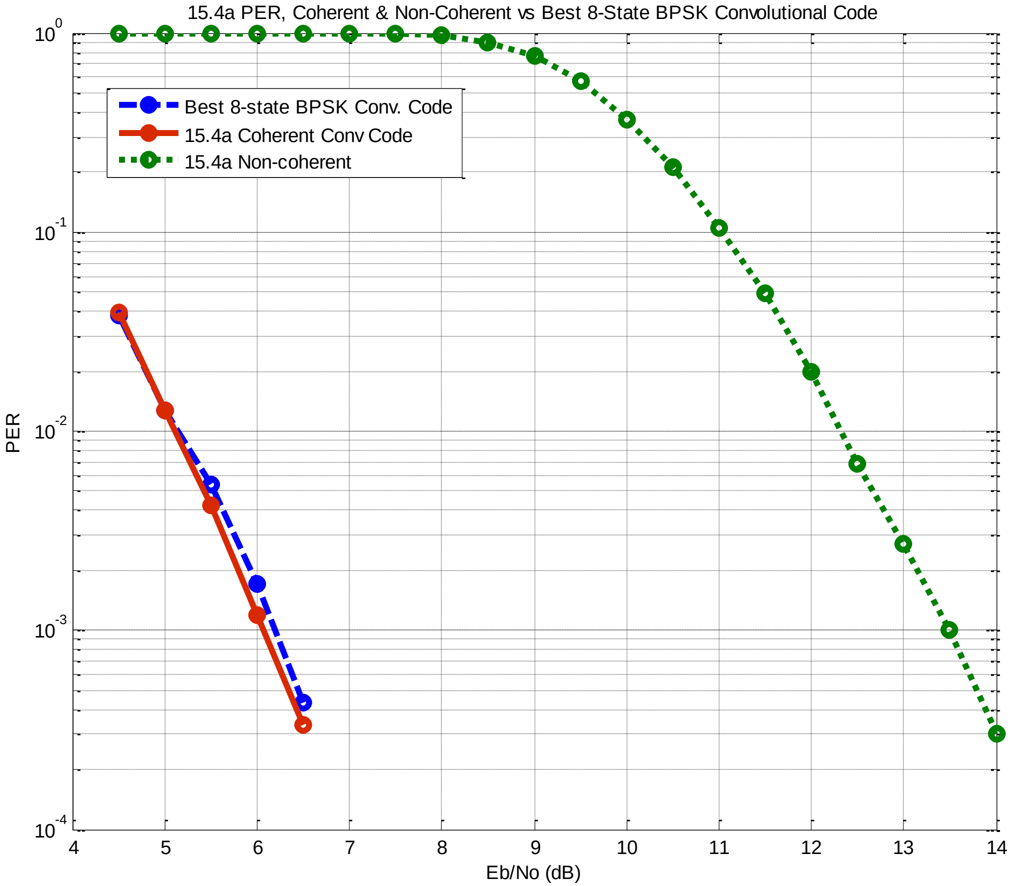
Trellis Diagram, Non-Antipodal K=5, g1=33, g2=02



d_{free} = 7, 2 parallel pathways

This is just as good too and its systematic!

Coherent vs Non-Coherent AWGN PER



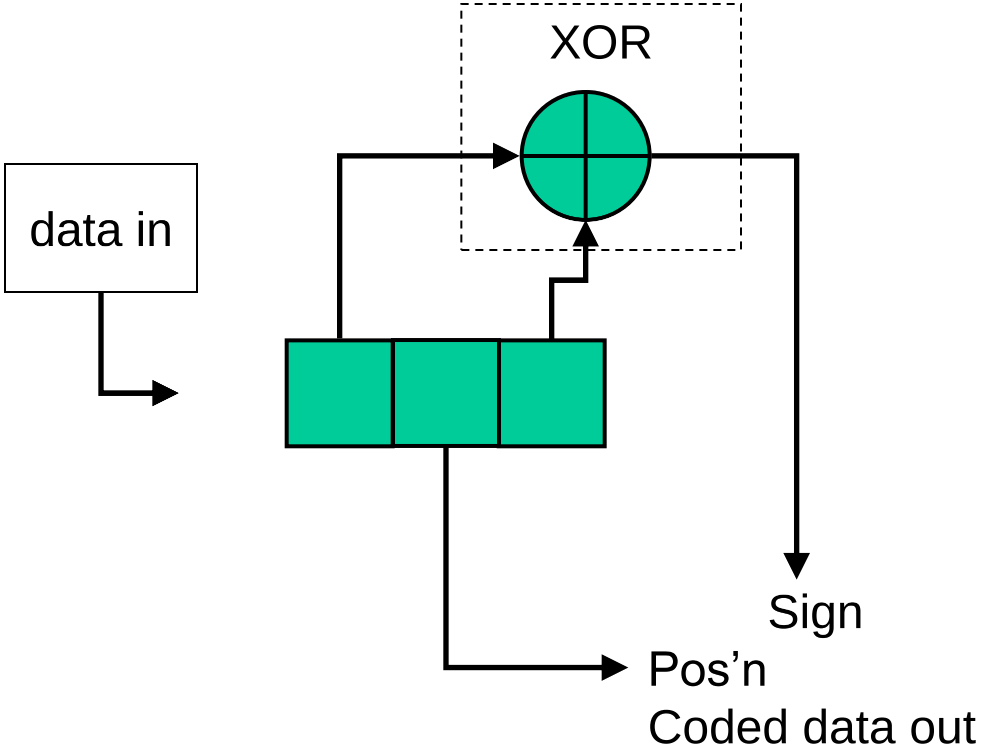
At 1Mbps required Eb/No of 12dB means shorter non-coherent range.

Range increases as bit rate decreases. 7m for 1Mbps => 50m for 20kbps

802.15.4a Convolution code

Pos'n	Sign	Symbol Transmitted
0	0	-1 .. 1 .. 0 .. 0
0	1	1 .. -1 .. 0 .. 0
1	0	0 .. 0 .. -1 .. 1
1	1	0 .. 0 .. 1 .. -1

Note: Can recover ***Pos'n*** bit with non-coherent receiver architecture.



Exact code composition TBD

Figure 7. Convolutional code. Rate ½ code, K=3, Generators (5,2), g1=101, g2=010

Summary

- Combined PPM and BPSK for both coherent and non-coherent modulation at all PRFs.
- K=3 convolutional code with octal generators (5,2) for polarity and position respectively
- Small Viterbi Decoder ~3k gates
  - <0.1mm^2 in 90nm CMOS

Advantages

- Non-coherent can decode also
  - Don’t need a common lower performance mode to accomodate non-coherent receiver
- No Price to Pay for Coherent
  - Optimal AWGN BER performance for coherent architecture
- Coherent may turn off its Viterbi decoder
  - systematic code makes this easy
  - If signal good enough, (lose ~8dBs)
  - lower power consumption