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SELECTION OF 5-GHz MODULATION

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Desired Modulation Attributes

- High Data Rate
- Low Frame Overhead
  - Non-Coherent: No PLL Settling
  - Avoid Equalizer Adaptation Time
- Multipath Tolerance
- Low E_B/N_0

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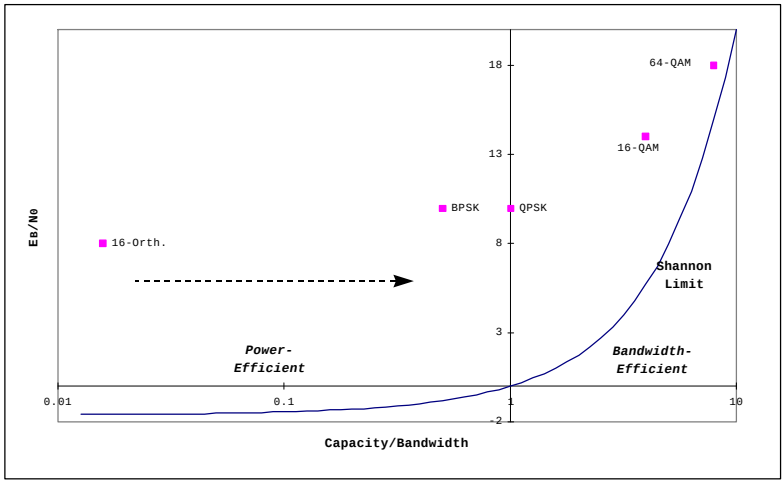
Data Modulation Selection



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Modulation Approaches

- Bandwidth Efficient Modulation
  - Bandwidth = 1/Symbol Rate
  - Complex Amplitude Modulation
  - Constellation Crowded
- Power Efficient Modulation
  - Bandwidth >> 1/Symbol Rate
  - Waveforms Very Different (PM/FM)
  - Constellation Points Spread Out

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Synthesis from Orthogonal Functions

- Traditional Orthogonal Signaling
  - Transmit 1 of M Waveforms
  - Non-Coherent
  - Log_2 M Bits of Information
- Transmit Arbitrary 2 of M Waveforms
  - Log2 M(M-1)/2 Bits of Information
  - 6.9 Bits for M=16
  - Interesting, but Awkward to Encode

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Synthesis from Orthogonal Functions (cont.)

- Structured 2 of M Waveforms
  - 1 of M/2 from 2 SubGroups
  - 2x3=6 Bits for M=16 (Two SubGroups of 8)
- General: Structured 2^K of M Waveforms
  - 1 of $M/2^K$ from 2^K SubGroups
  - Natural Subdivision of Walsh Functions
  - $2^K x Log_2(M/2^K)$ Bits
- Add Another Bit/SubGroup for BiOrthogonal

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Summary of Properties

Modulation	subgroup channels	ES/N0 (dB)	bit/sym /subgroup	bit/ sym	EB/N0 (dB)	Bits/Hz (approx.)		multipath tolerance
1x 1-of-16 BiOrth.	1	13	5	5	6.0	0.156		-1.0
2x 1-of-8 BiOrth.	2	16	4	8	7.0	0.25		-4.0
4x 1-of-4 BiOrth.	4	19	3	12	8.2	0.375		-7.0
8x 1-of-2 BiOrth.	8	22	2	16	10.0	0.5		-10.0
16x DPSK	16	22	1	16	10.0	0.5		-10.0
16x DQPSK	16	27	2	32	11.9	1		-15.0
conventional DPSK		10		1	10	0.5		-10.0
conventional DQPSK		15		2	12	1		-15.0

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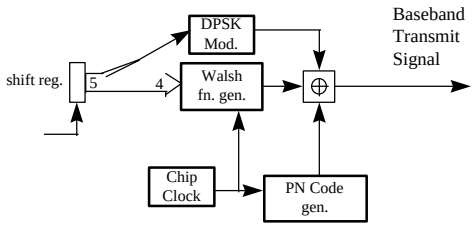
Data Transmission

1 of 16 plus DPSK



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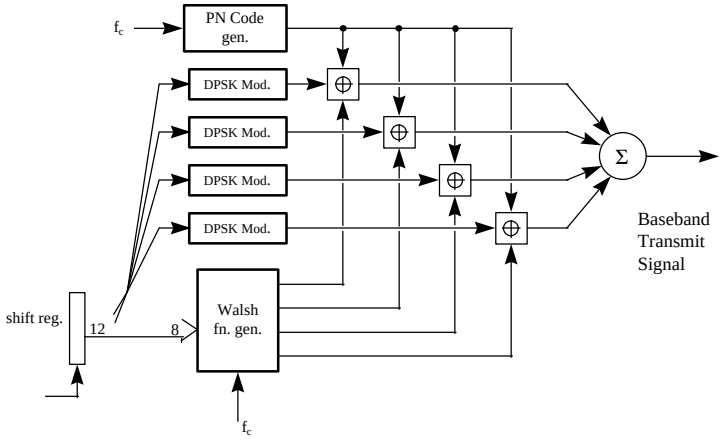
Data Transmission

4 times 1 of 4 plus DPSK



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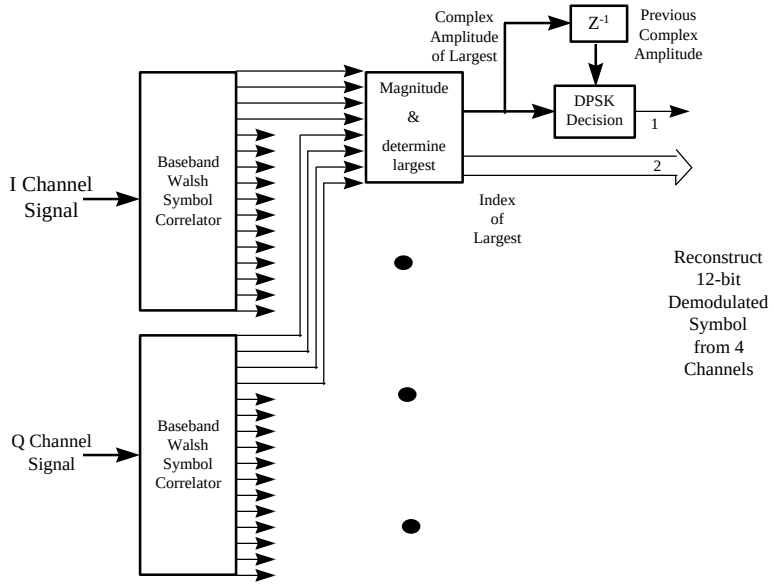
Data Demodulation



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Modulation Summary

- 24 Mbps Data Rate
  - 12 bit/symbol @ 2 Msymbol/s
  - Multipath-Resistant
- 6 Channels in NII Band
  - 48-MHz Null-Null (32 Mchip/s MSK)
- 10-Mbps Fall-Back Mode