Cognitive Radios:
AI Challenges on the Physical and MAC Layers

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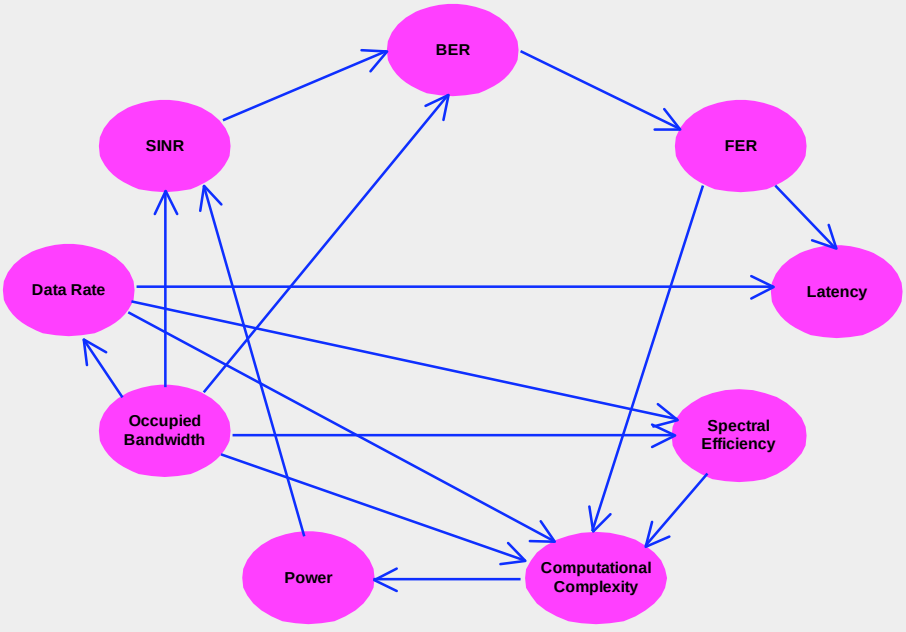

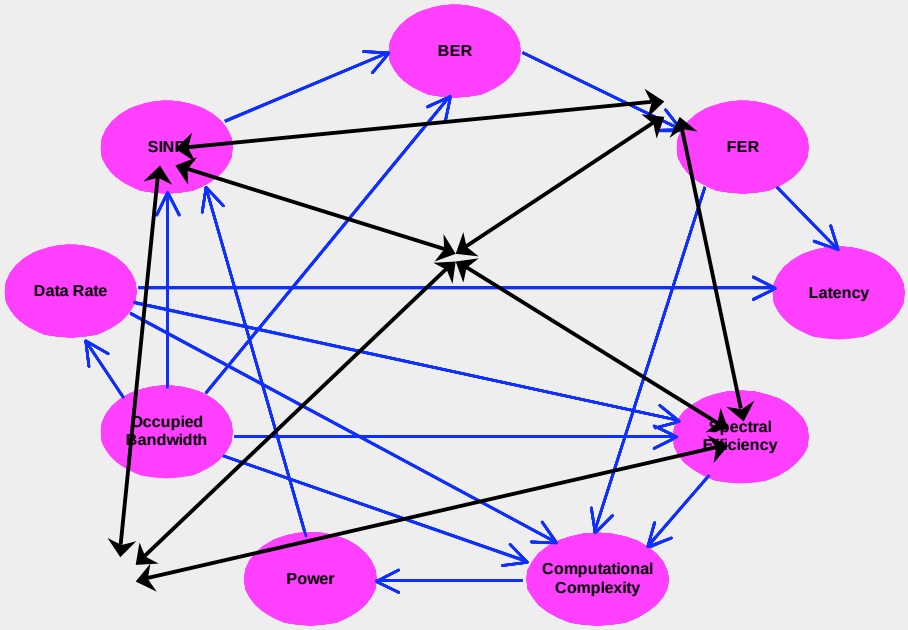

Objective Functions - BER

BPSK (AWGN)

$$P_e = Q\left(\sqrt{rT_0 B\frac{2C}{N}}\right)$$

Non-AWGN

$$P_e = \int_0^{\infty} P_{AWGN}(x)\,p(x)\,dx$$

M-PSK (AWGN)

$$P_e = \frac{2}{\log_2 M}\left\{Q\left[\sqrt{T_0 B}\sin\left(\frac{\pi}{M}\right)\sqrt{r\frac{2C}{N}}\right]\right\}$$

M-QAM AWGN

$$P_e = \left(\frac{4}{\log_2 M}\right)\left(\frac{\sqrt{M}-1}{\sqrt{M}}\right)\left\{Q\left[\sqrt{\frac{3rT_0 B}{(M-1)}\frac{C}{N}}\right]\right\}$$

Symbol	Meaning
C	Carrier Power
N	Noise Power
B	Bandwidth
T_0	Symbol Period ($1/R_s$)
R_s	Symbol Rate
M	Modulation order
r	Coding rate
p(x)	pdf non-AWGN channel

Objective Functions

Spectral Efficiency

$$S_{eff} = \frac{k}{k(1+\alpha)}$$

SINR

$$SINR = \frac{T_0 C}{N + \sum_i I_i}$$

Occupied Bandwidth

$$B = R_s k(1+\alpha)$$

Frame Error Rate

$$FER \le \sum_{m=t+1}^{n_{FEC}} \binom{n}{m} P_e^{\,m} (1-p)^{n-m}$$

Data Rate

$$R_b = R_s k \left(\frac{k_{FEC}}{n_{FEC}}\right)\left(\frac{T_{Tx}}{T_{Tx}+T_{Rx}}\right)\left(\frac{L}{L_{\max}}\right)$$

Symbol Glossary

Symbol	Meaning
C	Carrier Power
N	Noise Power
B	Bandwidth
T_0	Symbol Period ($1/R_s$)
R_s	Symbol Rate
M	Modulation order
k	Number of bits per symbol ($\log_2(M)$)
α	Pulse shape filter roll-off factor
T_{Tx} / T_{Rx}	Amount of time to transmit / receive in a TDD system
L / L_{max}	Number of bytes / maximum bytes in a packet
r	Coding rate = k_{FEC}/n_{FEC}
k_{FEC} / n_{FEC}	Number of message / codeword bits in a block of coding
t	Number of correctible errors in a block code
N	Constraint length of convolutional code
τ	Terminating time of convolutional code

National Institute of Justice
The Research, Development, and Evaluation Agency of the U.S. Department of Justice

This project is supported by Award No. 2005-IJ-CX-K017 awarded by the National Institute of Justice, Office of Justice Programs, US Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this publication/program/exhibition are those of the author(s) and do not necessarily reflect the views of the Department of Justice.

National Science Foundation
WHERE DISCOVERIES BEGIN

This material is based upon work supported by the National Science Foundation under Grants No. 9983463, DGE-9987586, and CNS-0519959. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).

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