Covert Communications in a Dynamic Interference Environment

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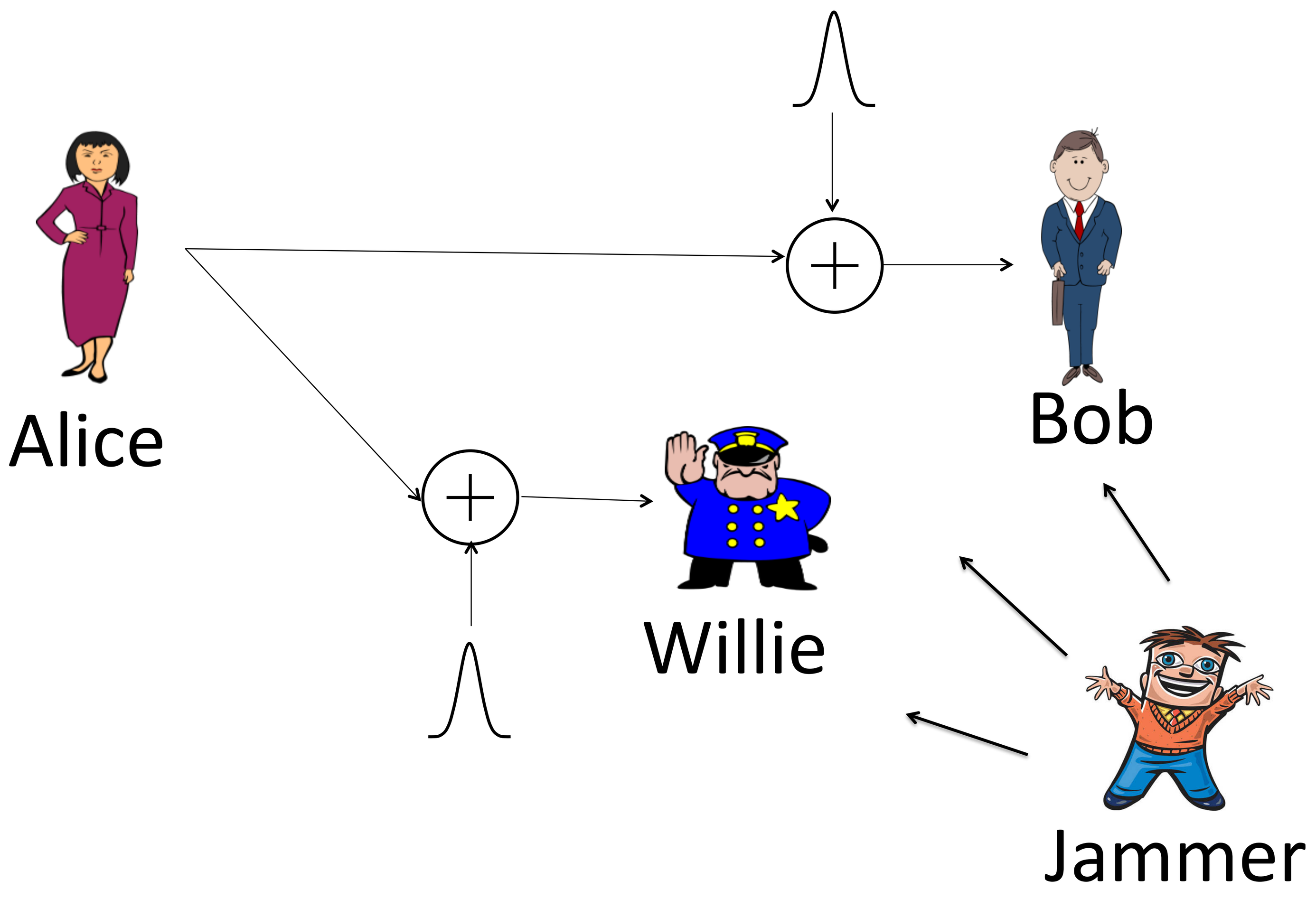
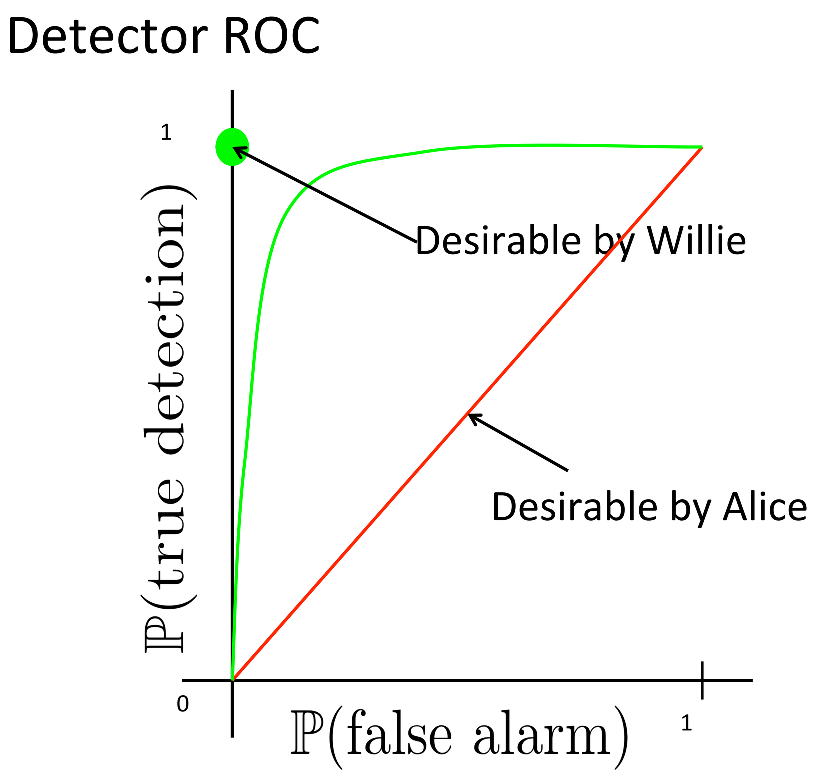
Introduction

Much of security research is devoted to keeping the adversary from *intercepting* the message. Here, we consider covert signaling, which keeps the adversary (Willie) from even *detecting* the signal's existence.



Covertness Criterion [1]



A system is *covert* if $P_{FA}+P_{MD} > 1-\varepsilon$ for any $\varepsilon > 0$ for an optimal Willie.

Prior Work

Without a jammer (AWGN) [1]: Alice can send O(sqrt(n)) bits (and no more) in n channel uses reliably and covertly.

With M-block dynamic fading or a time-varying jammer [4,5]: Alice can send O(n) bits in n channel uses reliably and covertly.

Why? Willie is confused about the background environment and thus cannot detect Alice.

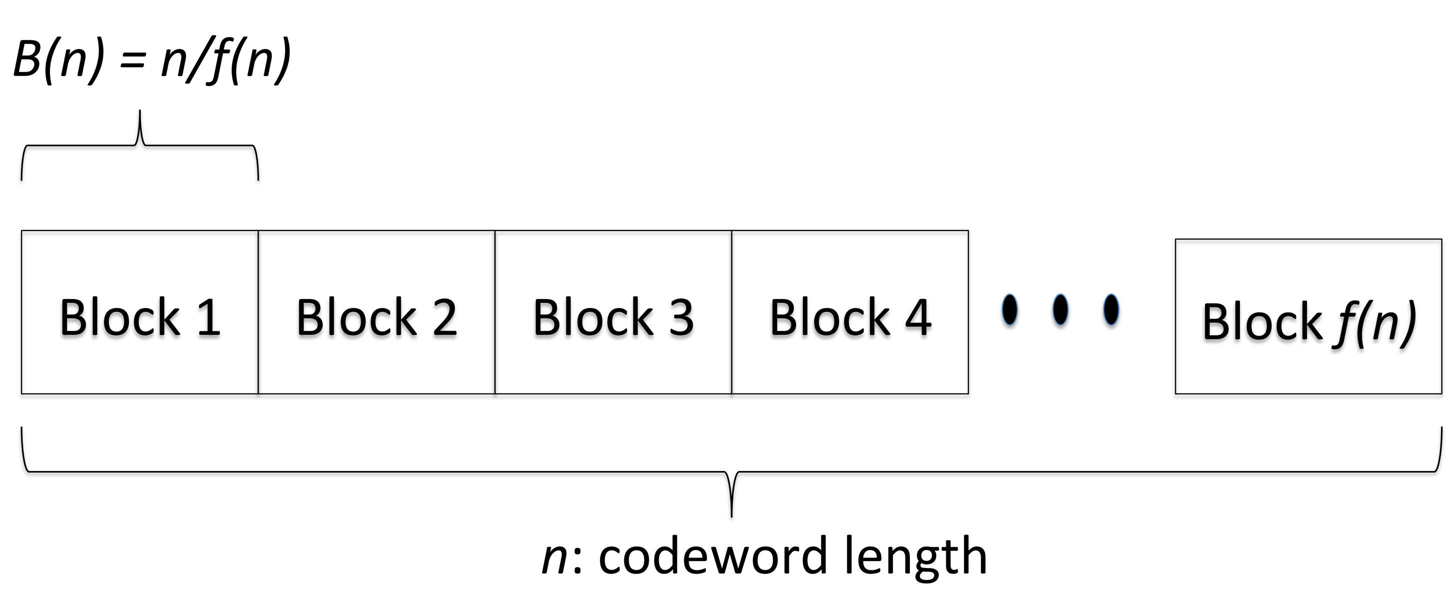
So, a dynamic background helps Alice to avoid detection by Willie, but:

Too Slow [6]: Willie is able to estimate the background reliably, and thus keep Alice to O(sqrt(n)) bits.

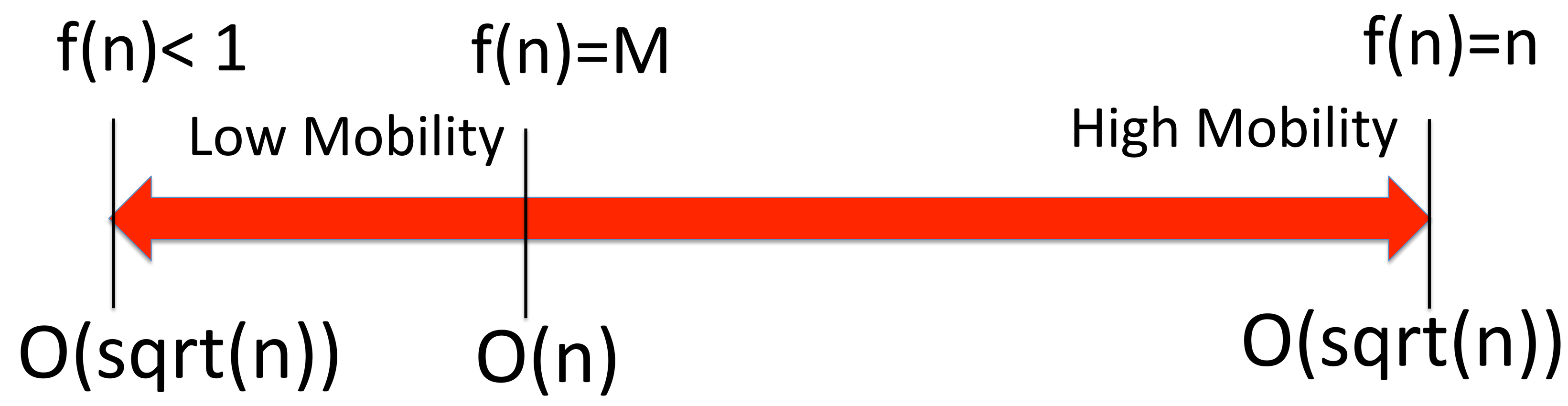
Too Fast [1, below]: Willie is able to "average out" the fading, and thus keep Alice to O(sqrt(n)) bits.

Block Fading Model

f(n): number of fading blocks per codeword of length n



Goal



Neither high nor low mobility is favorable.

Goal: Find the covert throughput for f(n) between f(n)=M and f(n) = n.

Results

Theorem 1 (converse): The throughput is no more than O(n/sqrt(f(n))).

Proof: Tedious Chebyshev bounding of the performance of a (sub-optimal) power detector at Willie.

Theorem 2 (achievability): The (optimal) throughput is at least O(n log f(n) / f(n)).

Comment:

+ Tight for small f(n).
+ Very loose at f(n) = n.

Note the gap between the achievability and converse.

Theorem 3 (achievability, Willie can only employ a power det): When Willie employs a power detector, a throughput of O(n / sqrt(f(n))) can be achieved.

Conclusion

Dynamics: A dynamic background can help Alice hide her signal from the Warden Willie, but the rate of variation matters **– neither too fast nor too slow is effective**.

Results: We have derived lower and upper bounds on the throughput of covert communications as a function of the rate of background variation.

References

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[6] D. Goeckel, B. Bash, S. Guha, and D. Towsley, ``Covert Communications when the Warden Does Not Know the Background Noise Power,'' IEEE Communication Letters, Vol. 20: pp. 236-239, February 2016.

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