Wireless Inference-based Notification (WIN) without Packet Decoding

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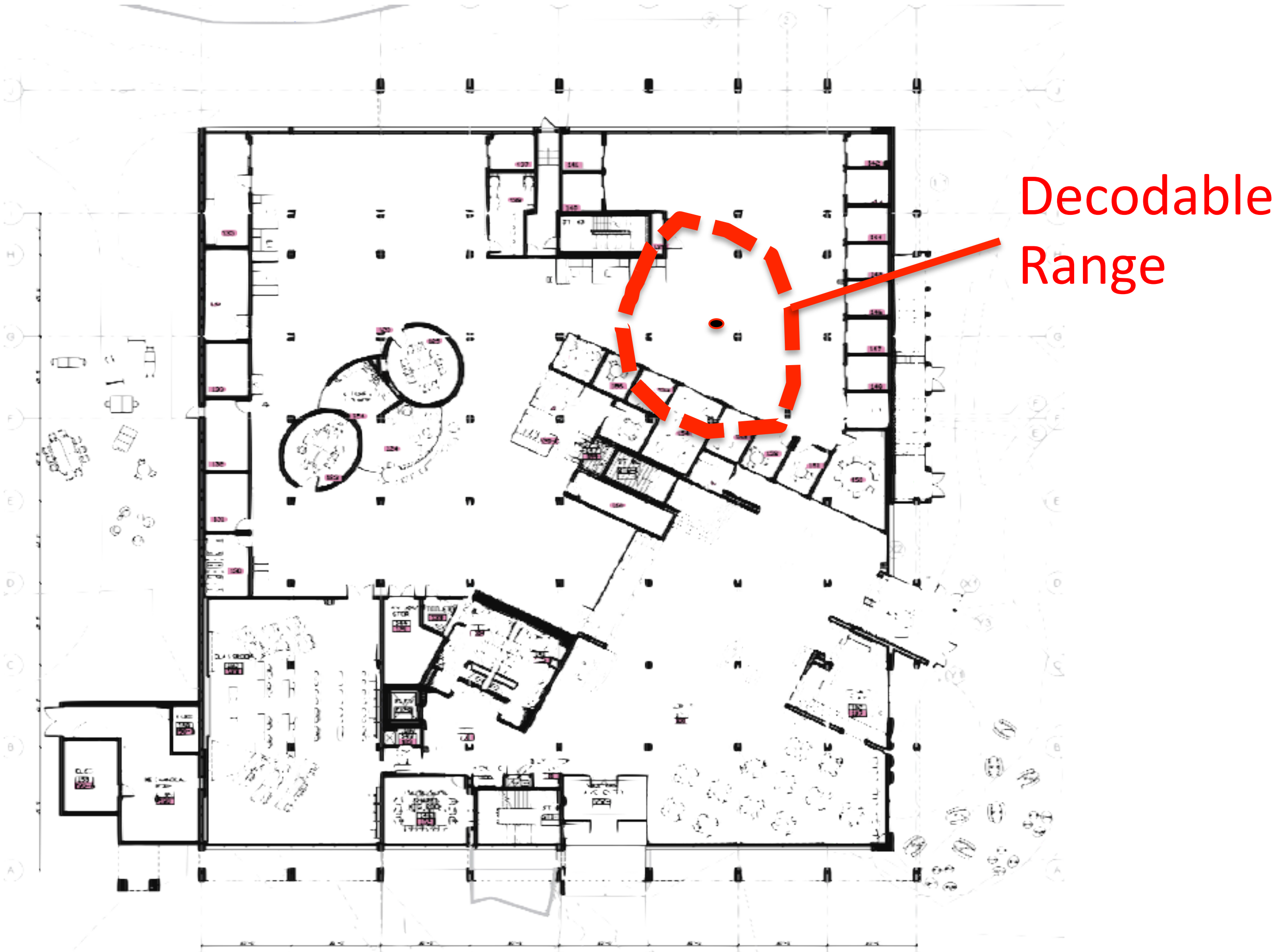
Motivation: We want larger transmission range



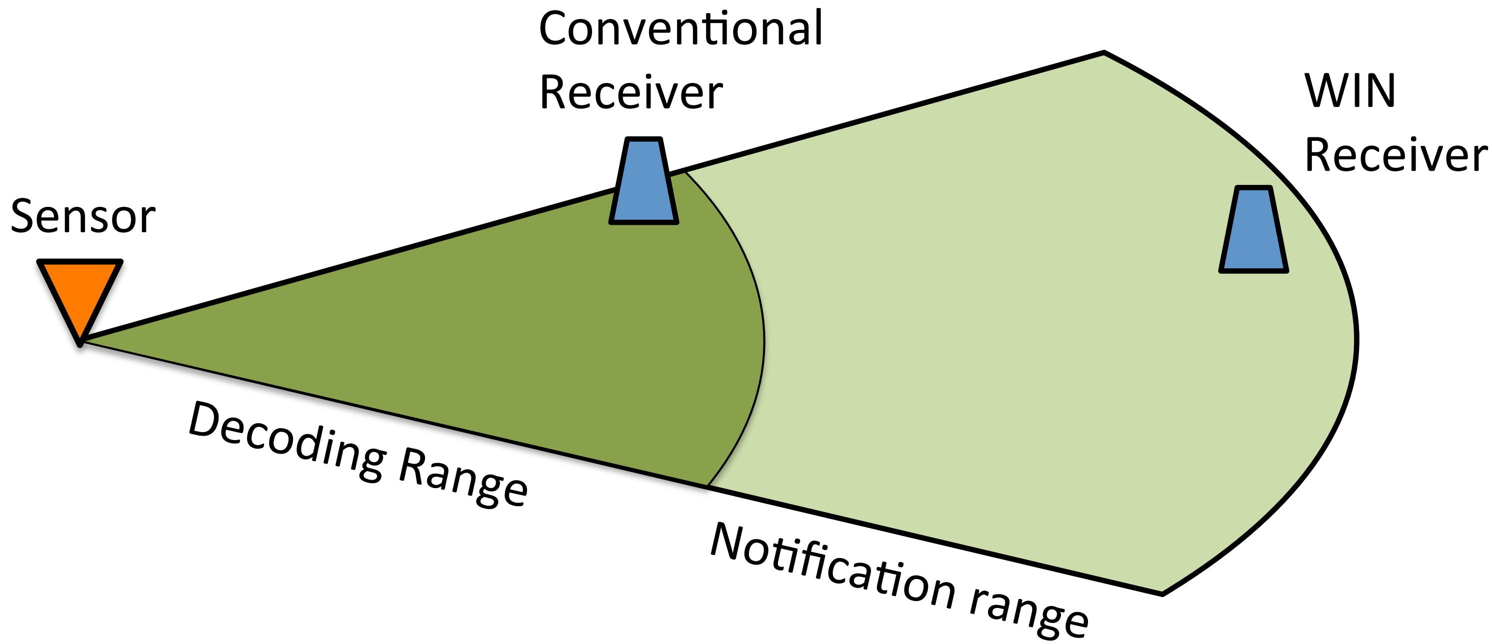
We couldn't determine the state of out-of-range sensors

Conventional Notification with Packet Decoding

No prior information is assumed about the packet or the arrival pattern

Proposed Inference-based Notification (WIN)

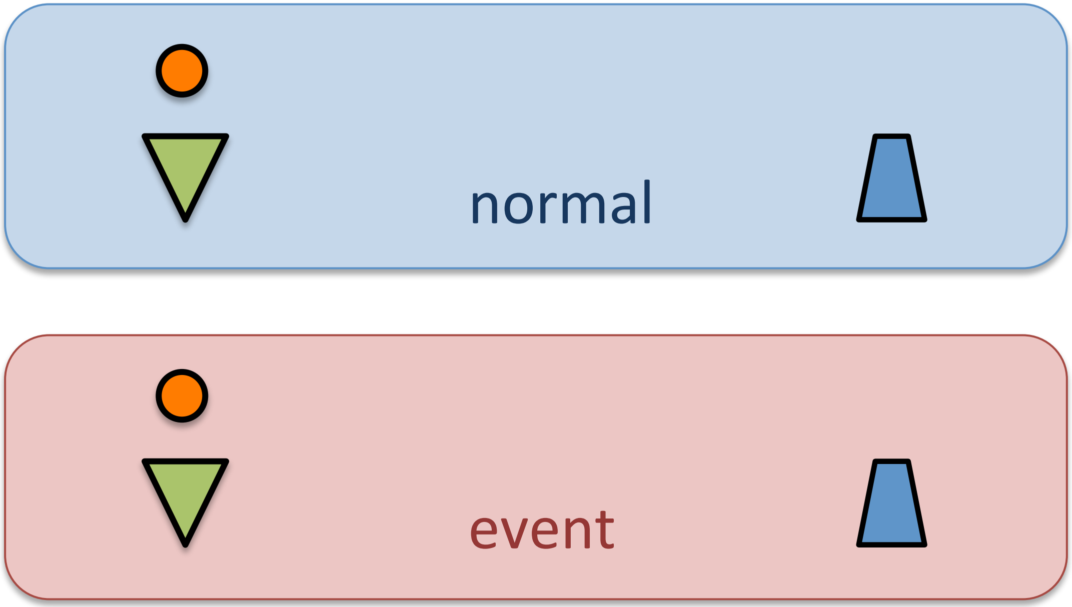
Infer the intended message by observing packets and their arrival pattern instead of decoding packets



The sender could be repetitively sending the same “status=ok” packet just to notify receiver

"Everything is normal"

Packet arrival patterns could also be recurring



What happens if we allow the receiver to learn?

+ What's the benefit?
+ How can we achieve that?

Smart Receiver

Make decisions based on "experience"

Comparing decoding based on received packet sequence and the proposed WIN approach

Conventional decoding :
find closest codeword (MLE)

$$p(x \mid D) \propto p(D \mid x)$$

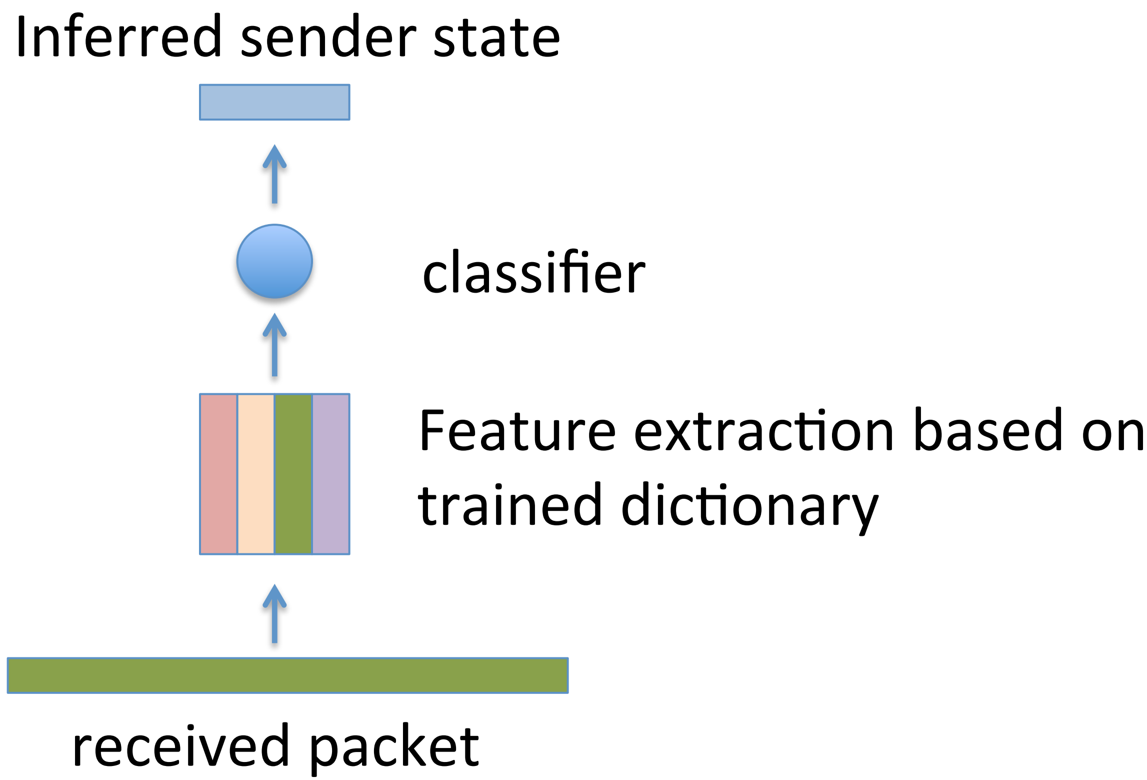
WIN approach :
find codeword with highest posterior probability

$$p(x \mid D) = p(D \mid x)\, \mathbf{p(x)}$$

Learned probability of recurring packet arrival patterns

Single layer model:

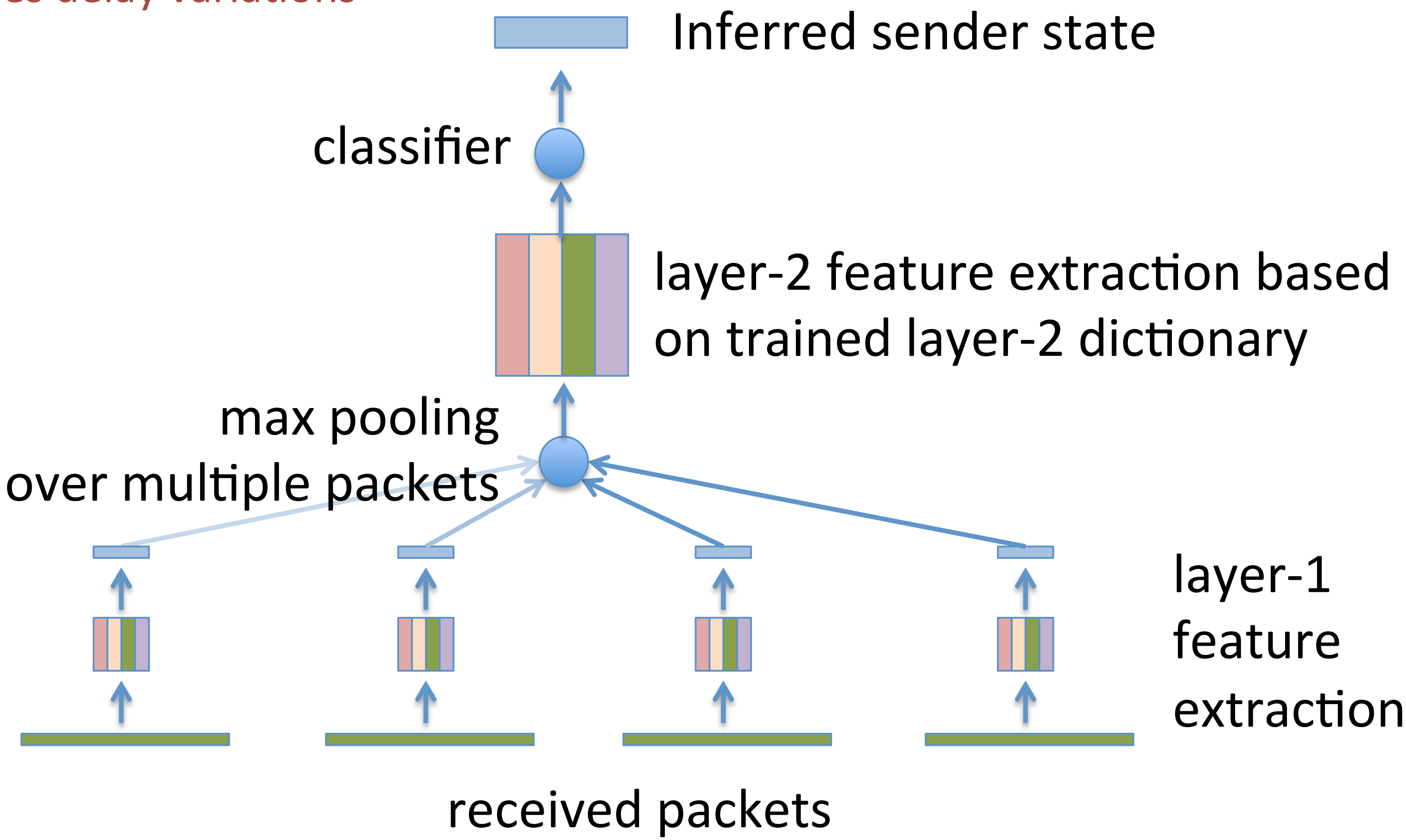
Inference based on single received packet



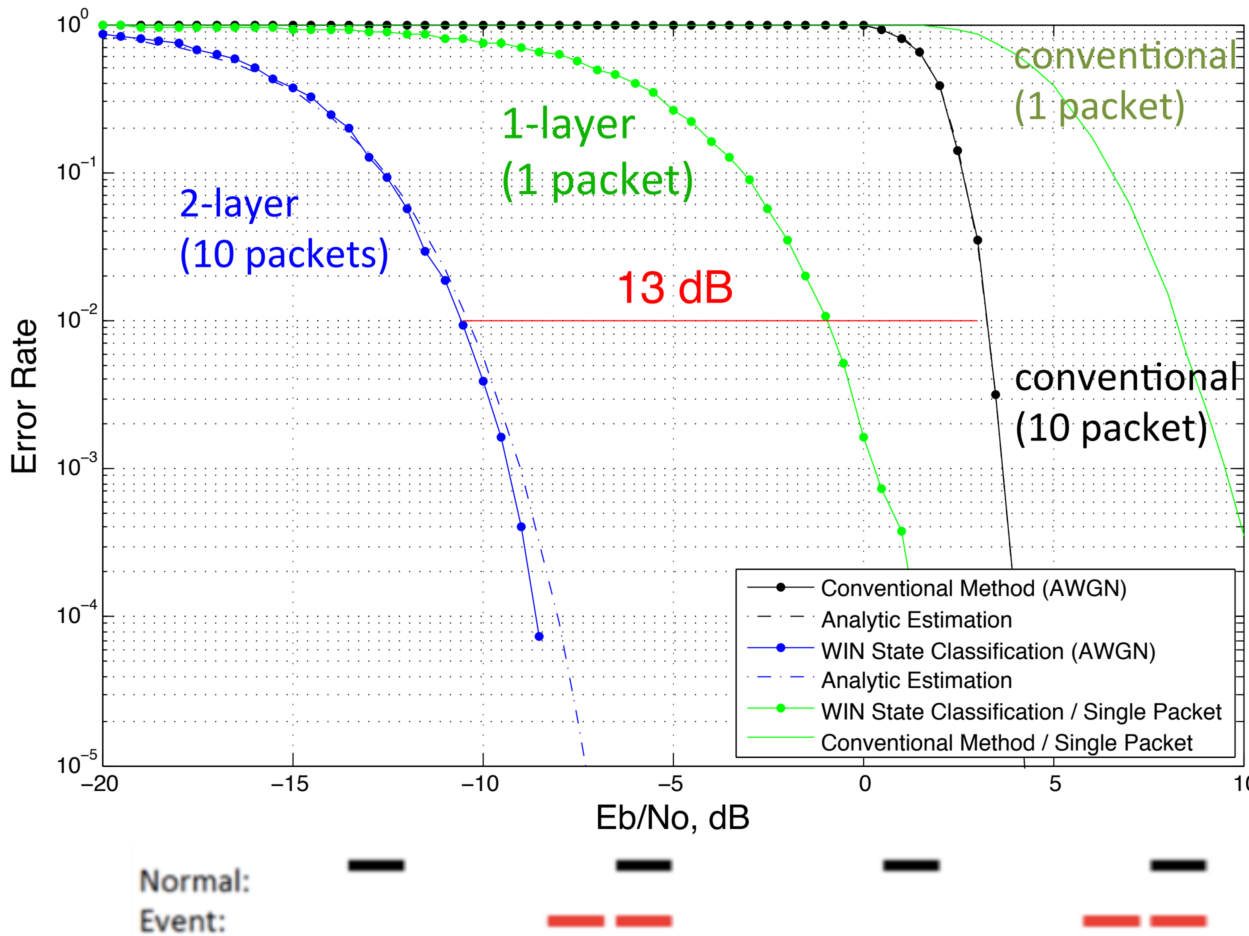
Two layer model:

Inference based on multiple received packets

1. Examines larger number of packets
2. Inspects arrival patterns of multiple packets
3. Handles delay variations



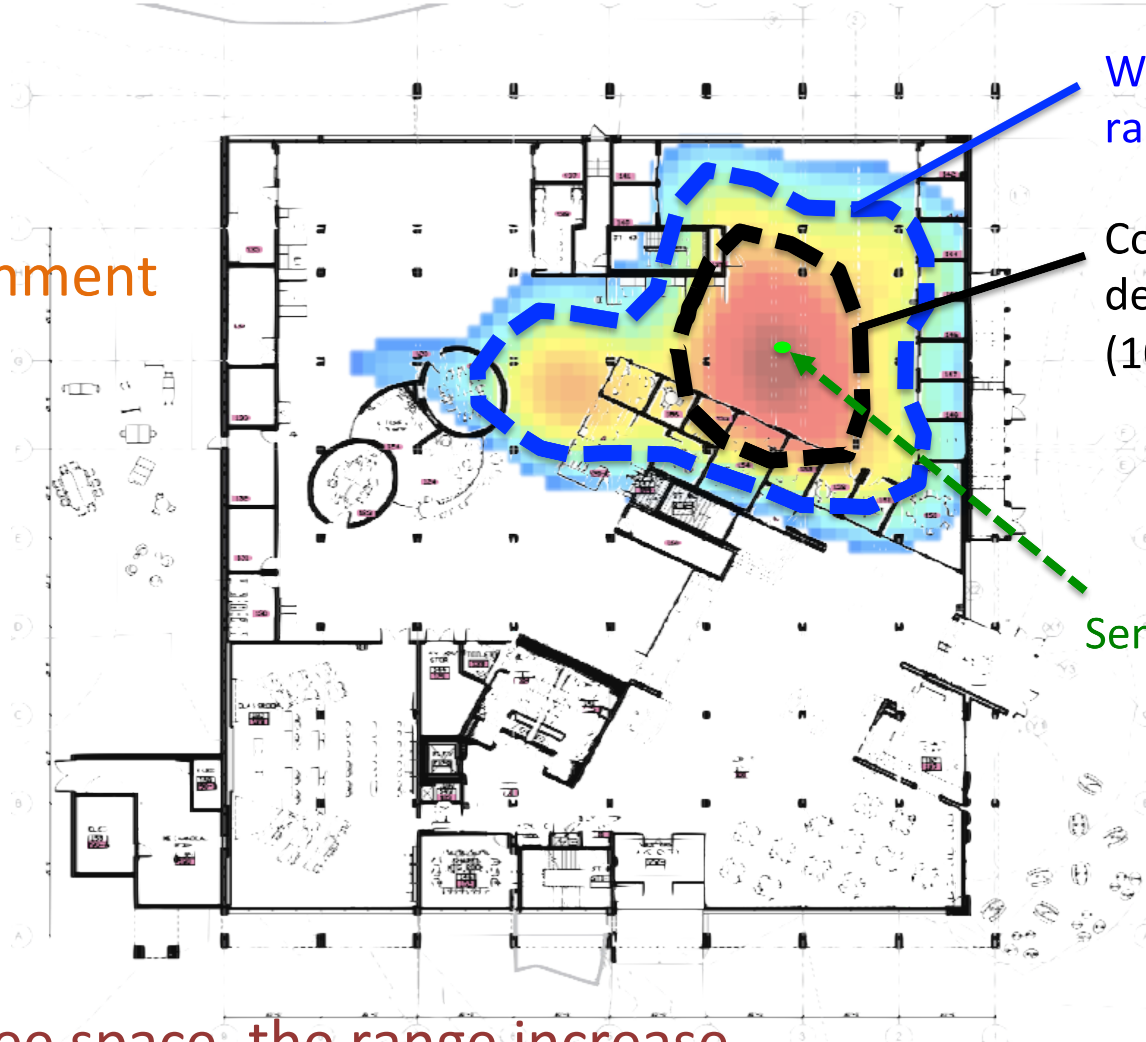
Simulated Performance Gain



1. Sender has 3 states : {inactive, active, event}
2. AWGN channel

Increased sensor reporting range based on measured SNR

Case 1:
A real indoor office environment



Case 2: For free space, the range increase corresponding to 13 dB SNR gain is much larger (4X)

Summary

1. Receivers can utilize prior information on packet arrival patterns to infer sender state instead of trying to decode packets

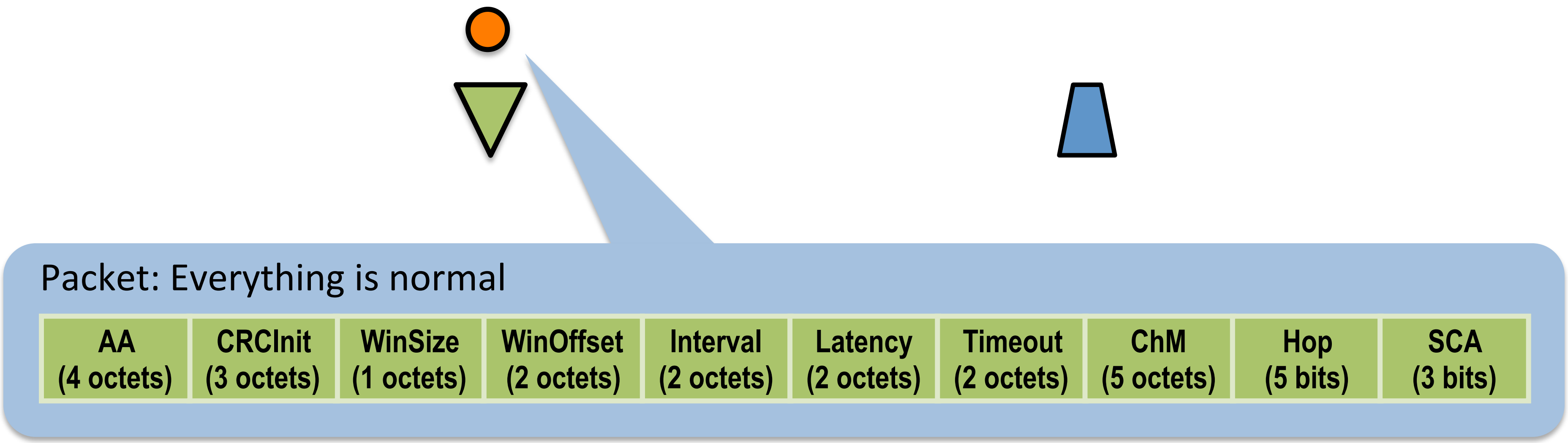
2. We can achieve large gains in receiver SNR by using a 2-layer inference model

Future Work

We can view WIN as a beginning of a new class of low-power coding methods based on packet arrival patterns learned by receiver

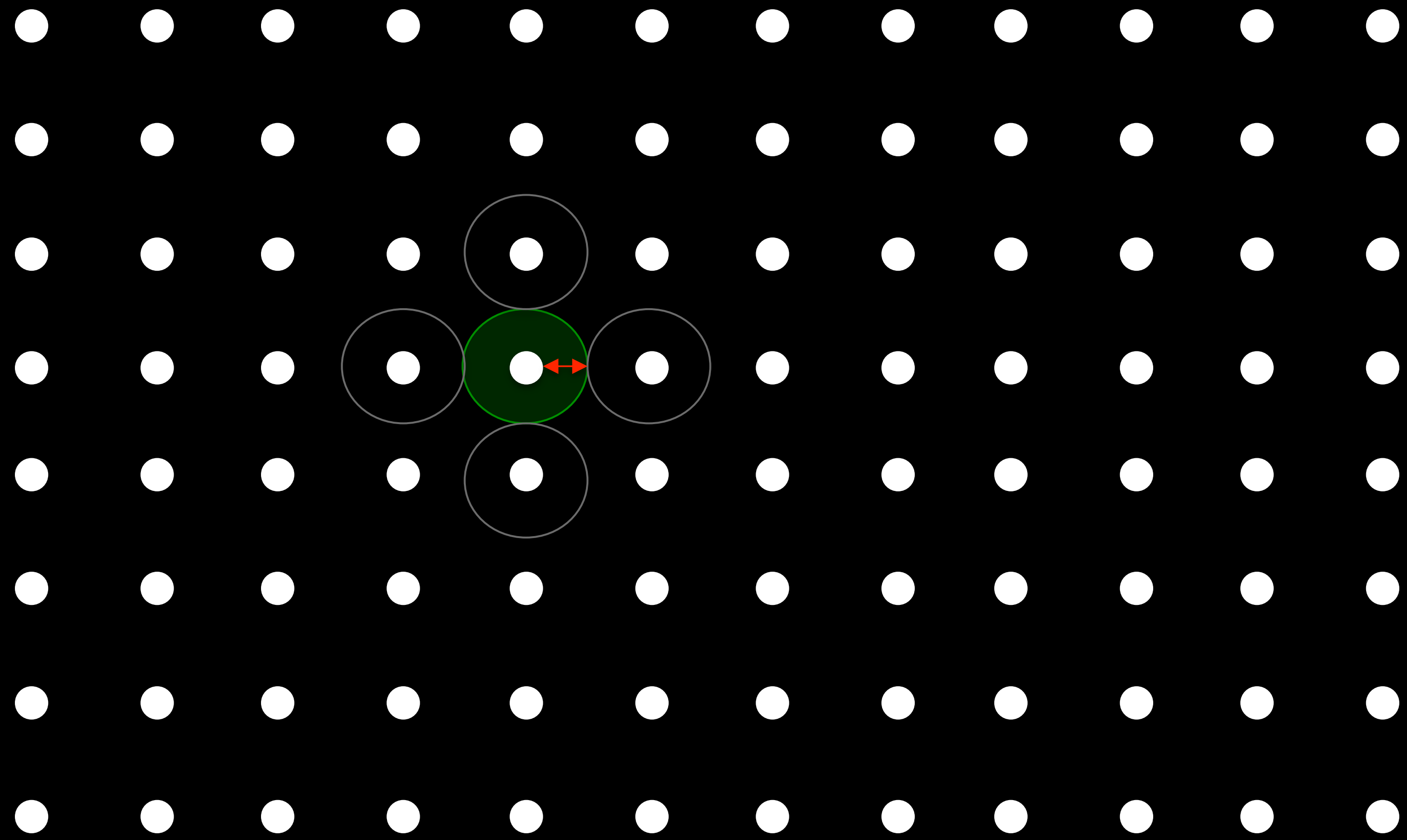
Thank You!

This is not a question about how we should design smaller packets. Sender still needs to send out those information.



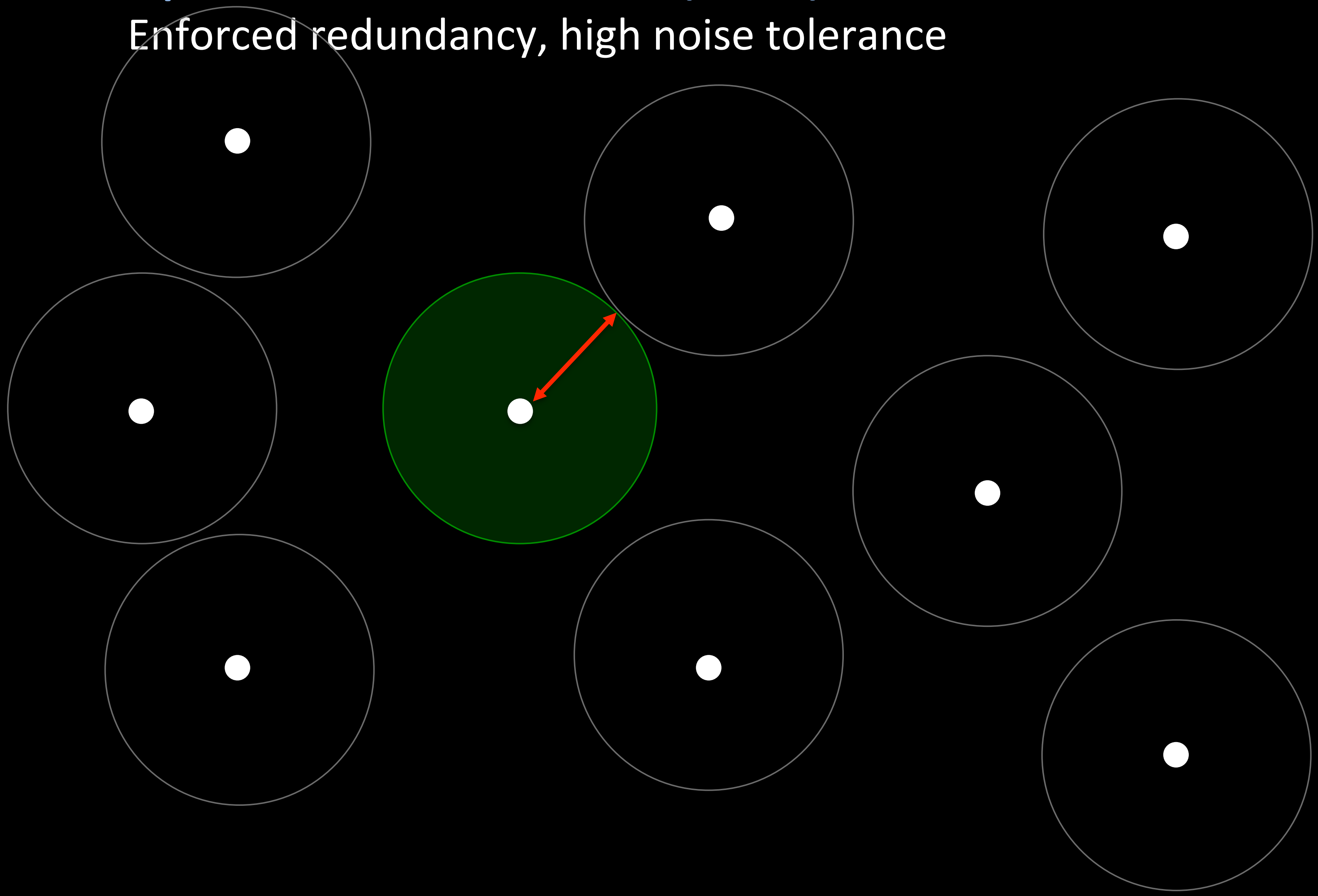
Dense Codewords

Low redundancy, low noise tolerance



Sparse Codewords (ECC)

Enforced redundancy, high noise tolerance



Prior-aware Approach

Learning signal pattern further increases noise tolerance