Constrained Adaptive Jamming and Anti-Jamming

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Self-Tuned, Inference-Based, Real-Time Jamming

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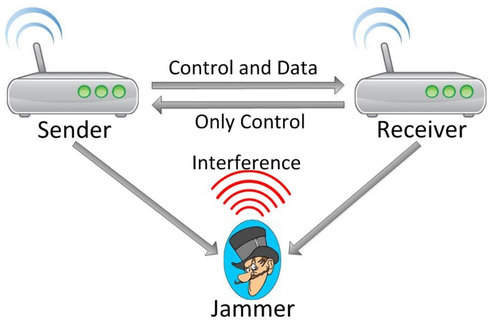
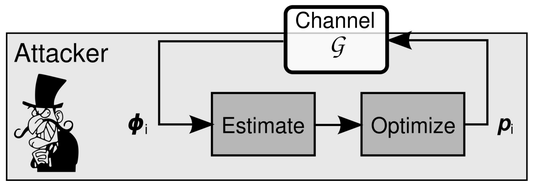
Problem Overview



Goal: To understand the jamming threat we aim to extend the jamming attack space by exploring how low energy, hard to detect, and high impact a jammer can be mounted if an attacker listens and attacks. To do this we introduce Self-Tuned, Inference-based, Real-time jamming or STIR-jamming



STIR-jamming remodels the communication system as a control system with a discrete plant G which maps jamming parameters to observed performance. In this model the attacker:

- Observes the communication system
- Refine a channel model based on observation
- Optimize its attack with the refined channel model
- Repeat

Attack Formulation

mSTIR-Jamming Attack

Given: $\phi_k, \mathcal{S}, \widehat{\mathcal{G}}_k, \boldsymbol{p}_k$

Find error: $\epsilon_k = \text{error}(\phi_k, \widehat{\mathcal{G}}_k, \boldsymbol{p}_k)$

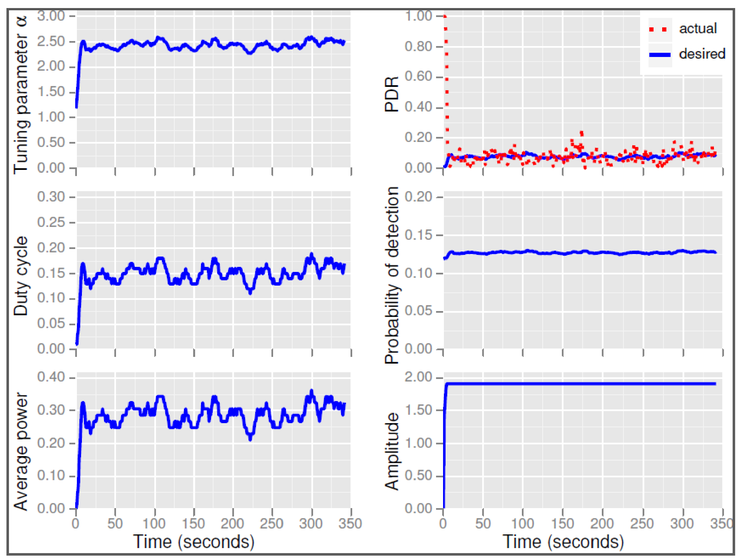
Estimate: $\widehat{\mathcal{G}}_{k+1} = \text{update}(\widehat{\mathcal{G}}_k, \epsilon_k)$

Optimize: $\boldsymbol{p}_{k+1} = \arg\max_{\boldsymbol{p}} \ \mu(\mathcal{S}, \boldsymbol{p}, \widehat{\mathcal{G}}_{k+1})$ s.t. $\boldsymbol{p}_{min} \leq \boldsymbol{p} \leq \boldsymbol{p}_{max}$

We implement a model-based version or the mSTIR-jamming algorithm as below:

- Given a model $\widehat{\mathcal{G}}_k$ and jamming parameter estimates p_k find the error ϵ_k from the observations Φ_k
- Update your model $\widehat{\mathcal{G}}_{k+1}$ given your error ϵ_k
- Optimize the jamming parameter p_{k+1} given $\widehat{\mathcal{G}}_{k+1}$
- Repeat

Implementation Results



- Initial attack implemented with random jamming on 802.15.4 architecture
- Implemented in SDR (USRP2)
- System observations given by the receiver to the jammer with a 10% error
- Measured Actual PDR
- Calculated
  - Average Power
  - Jamming Duty Cycle
  - Jamming Amplitude
  - Estimated Probability of Detection
- Tuning Parameter quickly stabalizes

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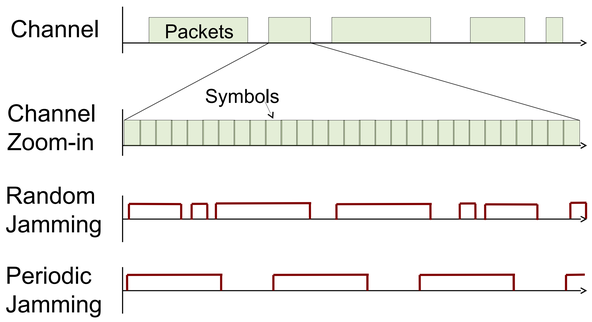
Adaptive Filtering Selection for Efficient Anti-Jamming

Bruce DeBruhl and Patrick Tague

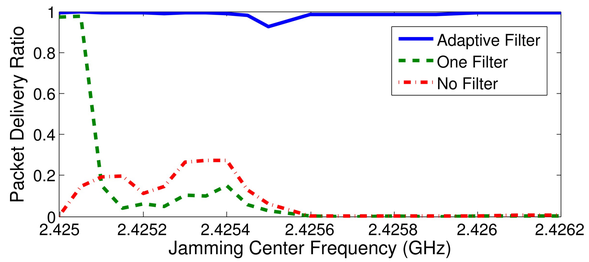
Problem Overview

•*Short Form Periodic Jammers* (SFPJ) aim to deny a wireless channel by alternating between emitting noise and sleeping at speeds on the magnitude of symbol time



SFPJ can *reduce attack cost by over 90%* compared to constant jamming, making it a highly effective attack

- We have shown [DeBruhl and Tague ICCCN'11] that filtering can eliminate short form periodic jamming
- We have also shown [DeBruhl and Tague PECCS'12] that a single filter is insufficient



Problem: To eliminate the effect of SFPJ with a single filter, the center frequency of the jammer must be known

Goal

Develop a technique which mitigates the effects of short form periodic jamming while making no assumptions about its center frequency

Design Strategies

Ideally, our technique will:

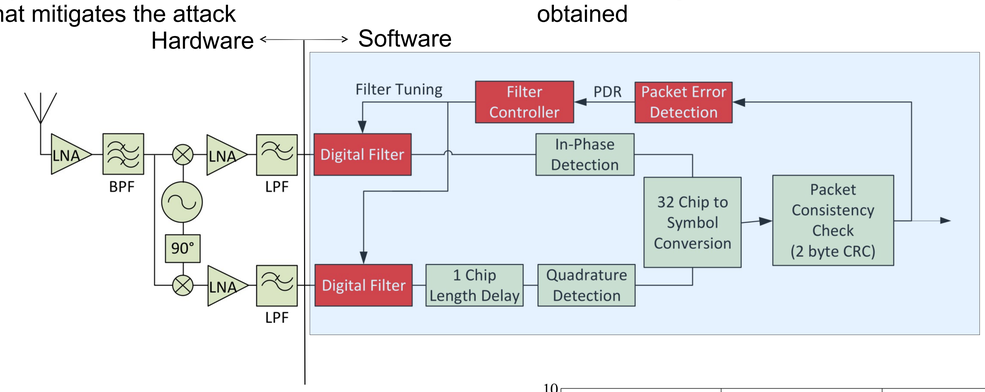
- **Quickly Adapt** to changing jamming strategy
- Not effect performance in benign scenarios
- Be Implemented in **Low Cost Software**

Design & Implementation

- Define a set of filters F such that:
  - Any filter in F is able to be used without decreasing the PDR of the legitimate receiver
  - For any attack frequency fa their must be a filter in F that mitigates the attack

To select a filter the receiver will:

- Use existing detection techniques [Xu, et al. Mobihoc'05] to activate filter search
- Search through filters until a reasonable PDR ratio is obtained



Hand Tuned Filters

- If filter widths are too narrow, it is too hard to find the right filter
- If filter widths are too wide, interferes with DSSS