

Problem Statement

Attackers can attack several network protocols at the same time, in a coordinated and smart way. Cross-layer attacks can

- cause larger damage to the network
- be more difficult to detect
- create new types of network failures

Defense:

- Single layer defense schemes no longer work
- The defense has to go cross-layer.

MAC Layer Defense against SBW Attack

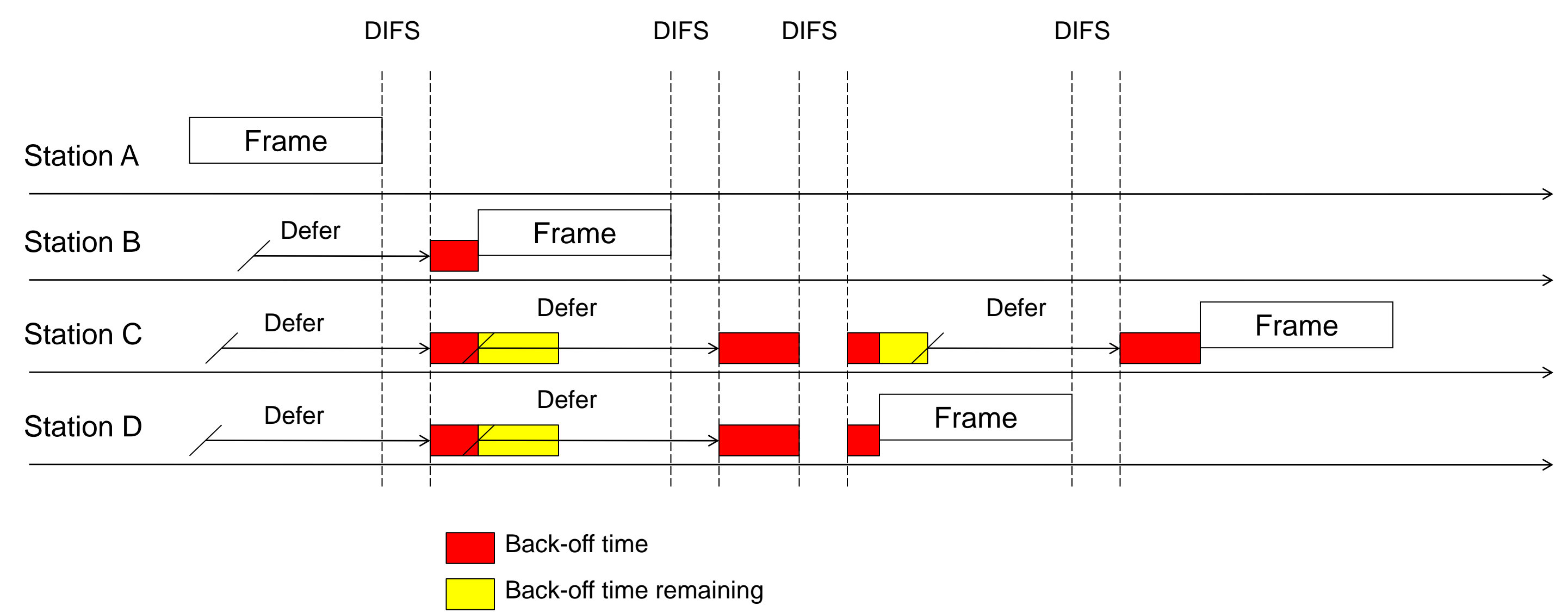


Fig. 3 MAC layer back-off mechanism

Cognitive Radio Networks (CRN)

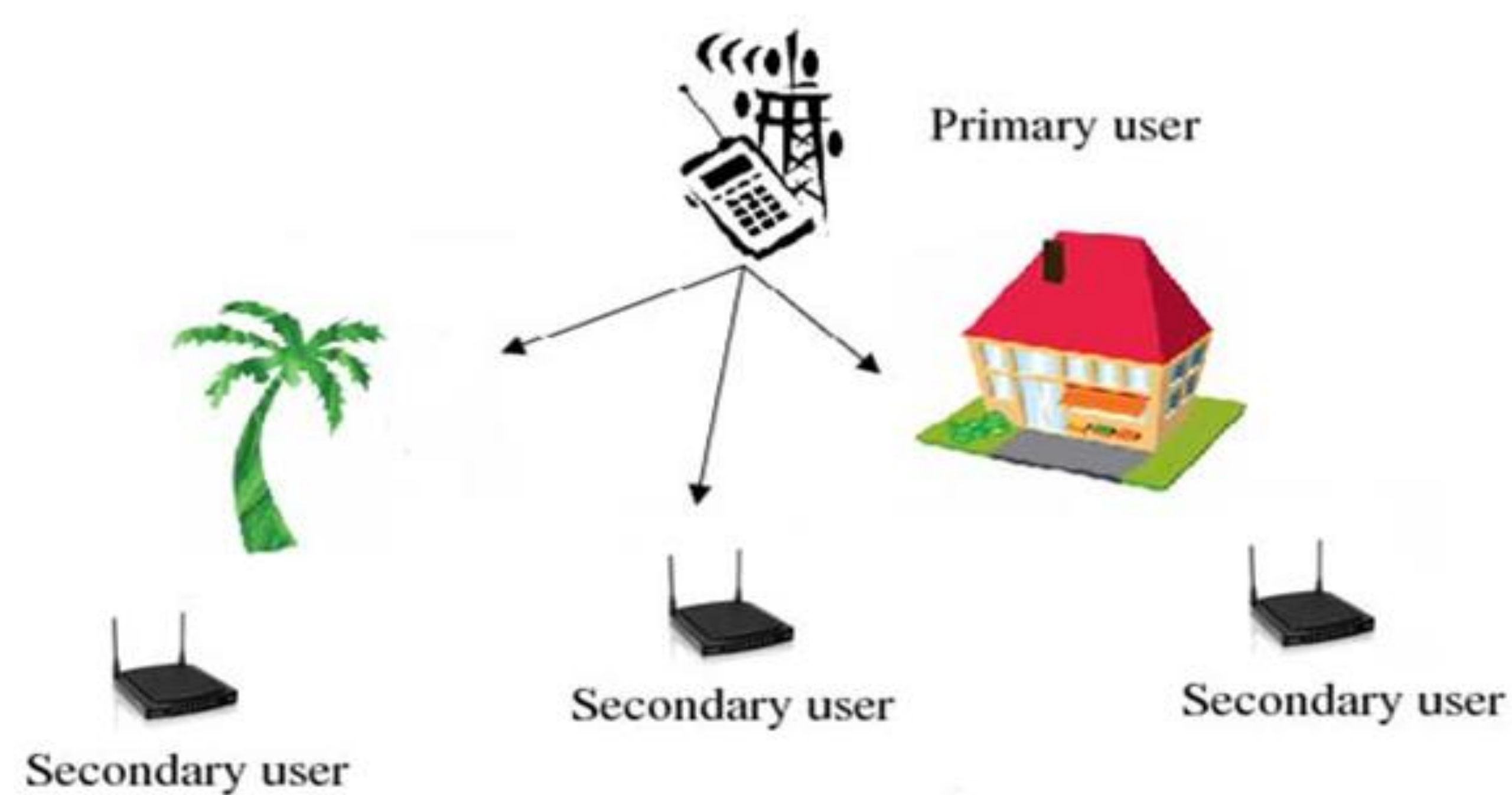


Fig. 1 Collaborative Spectrum Sensing

Defense Scheme

- Deduce the distribution of back-off window size
- Observe the actual back-off window size
- Evaluate the difference of the two distributions

Cross Layer Attack

- Conduct RFSD attack with probability P_1 in PHY layer
- Conduct SBW attack with probability P_2 in MAC layer
- There exists an optimal P_1 and P_2 so that single layer defense can not detect the malicious user

Cross Layer Defense

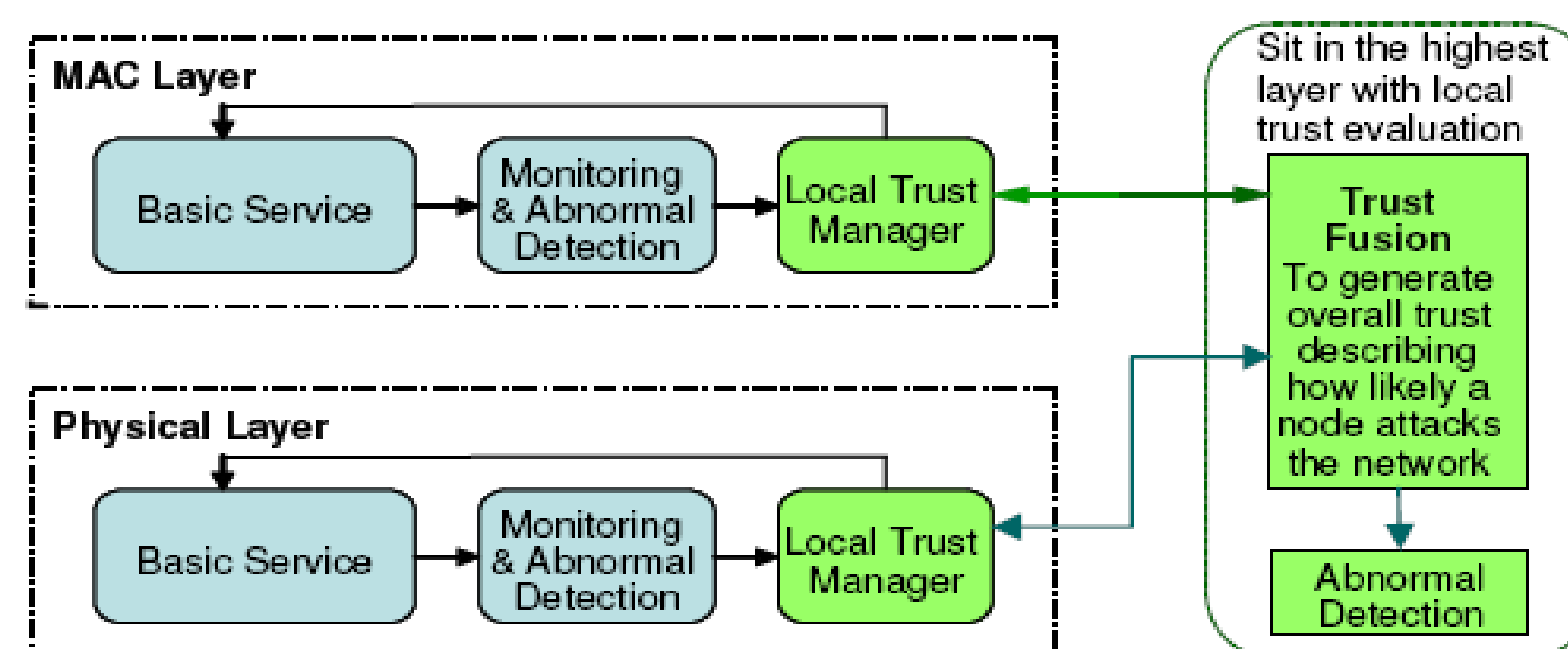


Fig. 4 Cross Layer Defense Framework

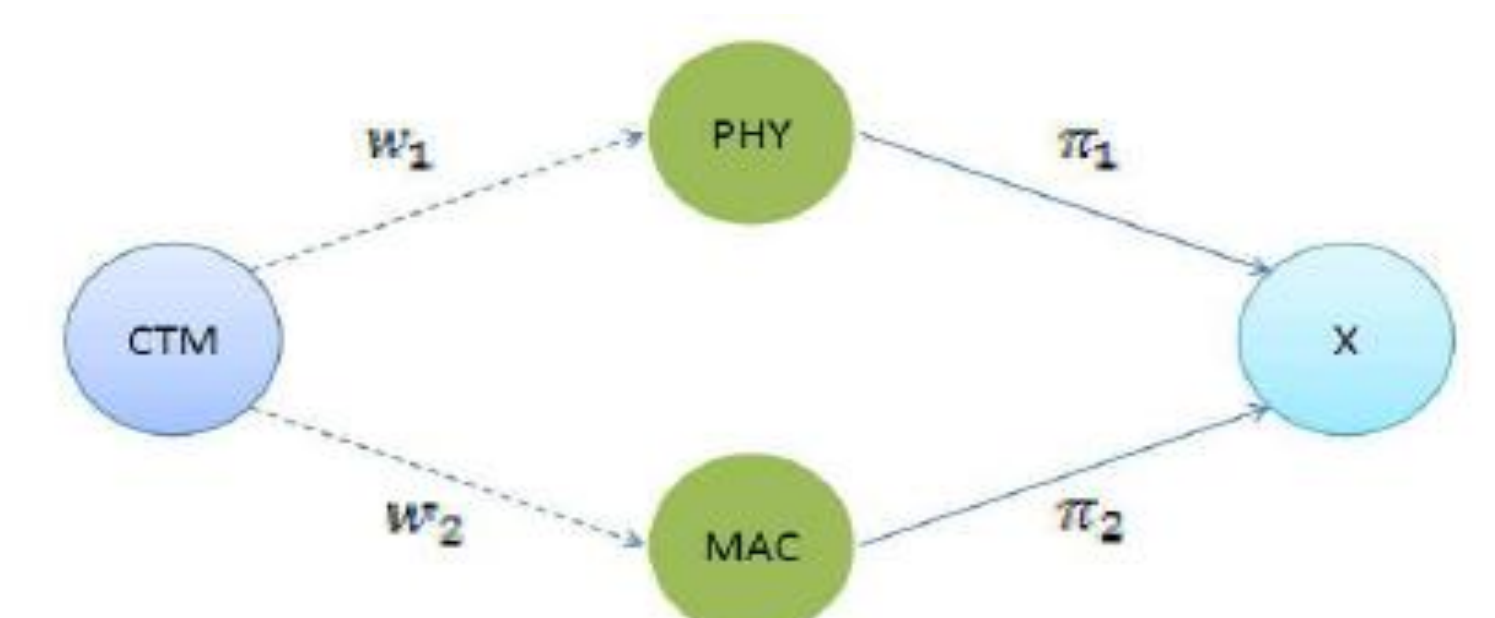


Fig. 5 Multipath Trust Combining

Single Layer Attacks in CRN

	Attacks in Cognitive radio Networks	Damage:	
		RCU: Reduce Channel Utilization	IPU: Interference to Primary User
Physical Layer	Primary User Emulation (PUE)	X	
	Reporting False Sensing Data – False Alarm (RFSD-FA)	X	
	Reporting False Sensing Data – False Alarm (RFSD-MD)		X
MAC Layer	Common Control Channel Denial of Service (CCCDoS)	X	
	Small Back-off Window (SBW)	X	
Network Layer	Routing towards Primary User (RPU)		X
Layers Above	Traditional Attacks	Depends	Depends

Fig. 2 Attacks in Cognitive Radio Networks

Physical Layer Defense against RFSD Attack

- Step 1: For node j , perform Neyman-Pearson test using reports from other $(N-1)$ nodes to detect presence of primary user.
- Step 2: Based on test result of step 1, perform Neyman-Pearson test 2 to see if node j is lying or not.
- Step 3: Determine the physical layer trust value Based on the binary observations of the node behavior (lying or not).

Simulation Results

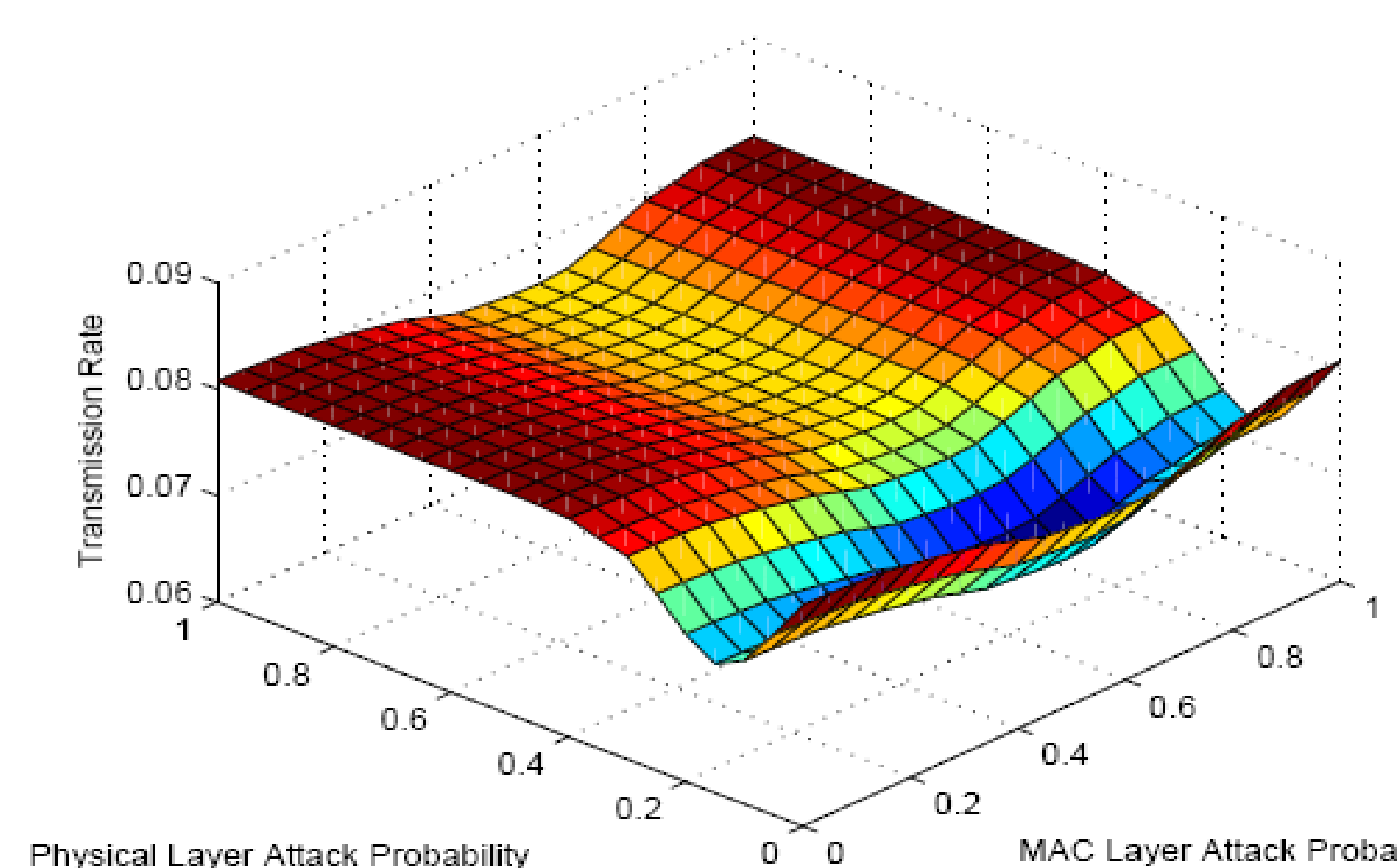


Fig. 6 Cross Layer Attack, Single Layer Defense

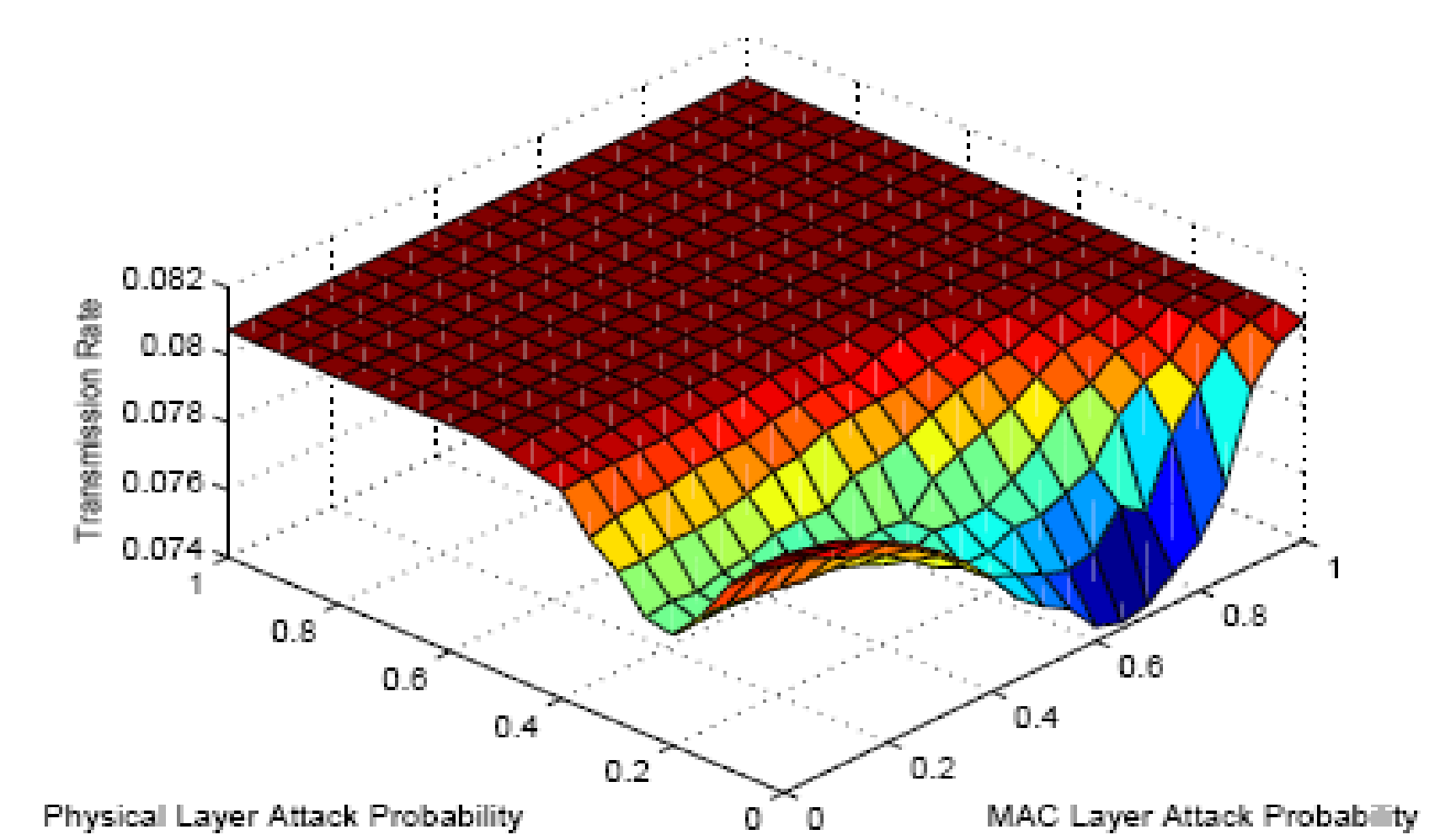


Fig. 7 Cross Layer Attack, Cross Layer Defense

Impact

- Demonstrated the damage of cross-layer attacks;
- Effectively secured cognitive radio networks;
- Proposed a generic cross layer defense framework that can be applied to many other networks.

