Improving Sensor Network Immunity under Worm Attacks: a Software Diversity Approach

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Motivation

- Internet worms replicate themselves to infect and propagate among as many computers as possible in a very short time, by exploiting e.g. buffer-overflow vulnerabilities

- Is worm attack possible in sensor networks? Yes

  -Simple hardware architecture and OSes provide little protection

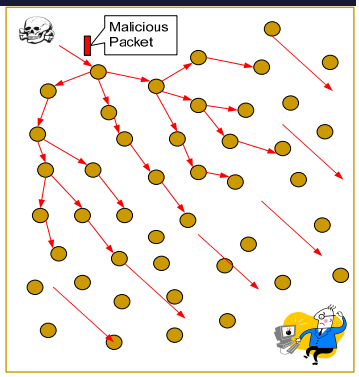
  -Sensors in the same network have homogeneous hardware and software

Sensor Worm

- Crafted messages that exploits software vulnerabilities of sensors, causing sensors to crash or taking control of sensors

- Worst case:

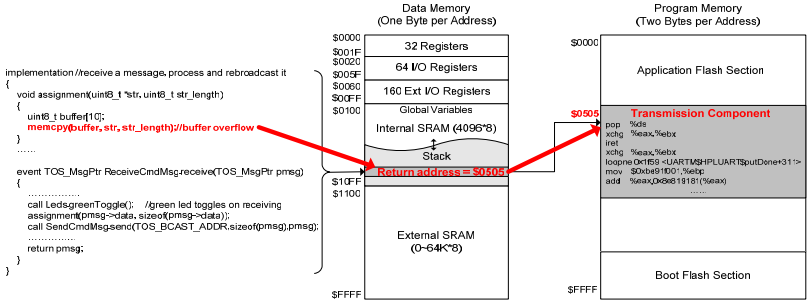
  - A single message to compromise the entire network



Contribution I

- We illustrate the feasibility of launching sensor worms through *trial experiments* on Mica2 motes

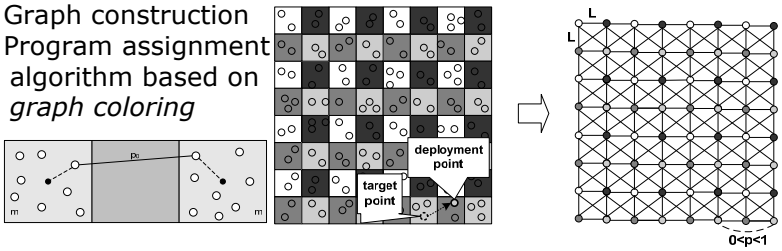
  - Buffer overflow may result in transfer of program flow to transmission component & propagation of malicious packets



Contribution II

- In the spirit of survivability through heterogeneity philosophy, we explore *software diversity* for sensor worm defense

  - Graph construction
  - Program assignment algorithm based on *graph coloring*



- Impact of sensor deployment error: deployment points are modeled by *two-dimensional normal distribution* with target points as mean

Probability that two nodes from neighboring cells with the same color are connected

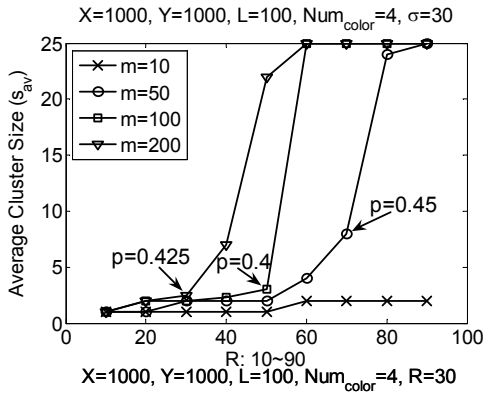
$$p_0 = \int_{x=0}^{X}\int_{y=0}^{Y} \frac{p_{n2}}{2\pi\sigma^2} e^{-[(x-x_1)^2+(y-y_1)^2]/2\sigma^2}\,dxdy$$

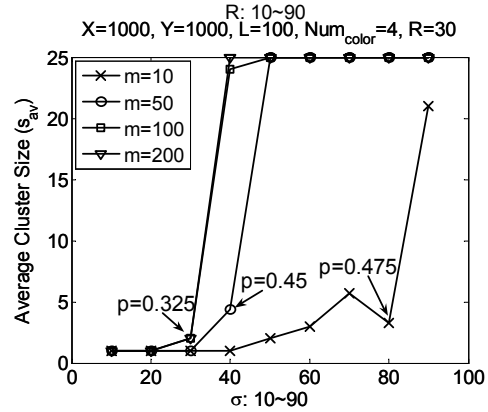
Probability that two neighboring cells with same color are connected

$$p = 1-(1-p_0)^m$$

Performance Evaluation

- Average cluster size based on *percolation theory*





- Compare worm containment with other schemes