Prioritizing Intrusion Analysis Using Dempster-Shafer Theory

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PROBLEM

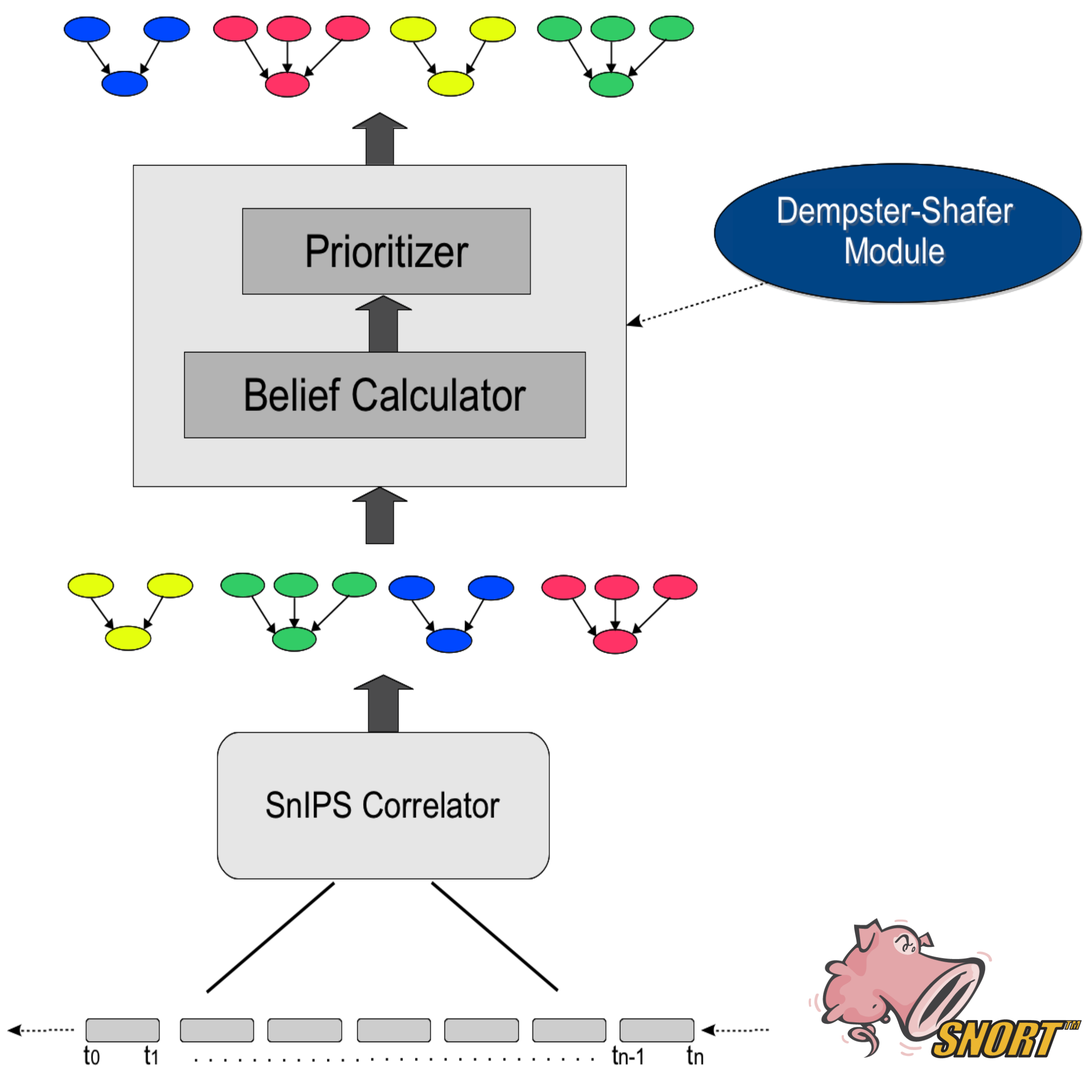
High False positive rate in IDS alerts

SOLUTION

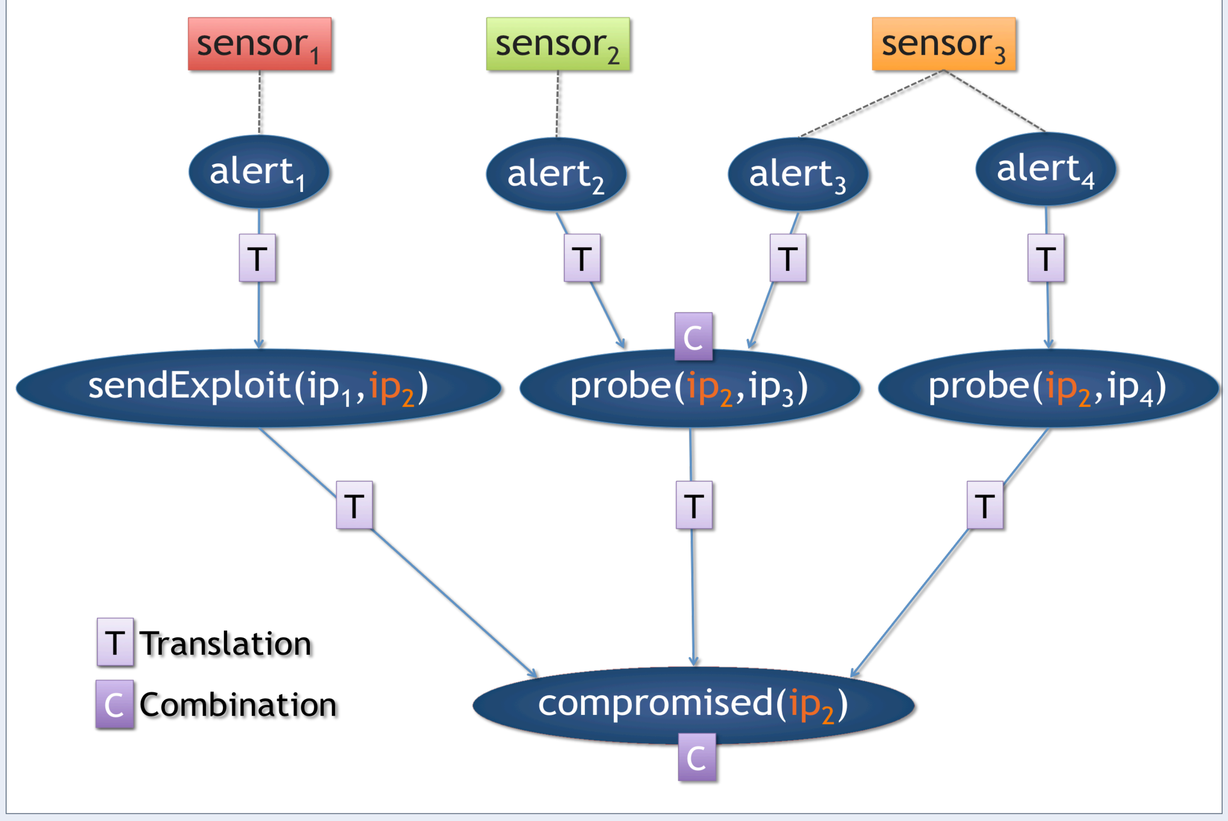
Using DS to prioritize IDS alerts

- Using unknown to capture uncertainty
- Accounting for lack of independence among alerts
- Efficient algorithm

SYSTEM ARCHITECTURE



BELIEF CALCULATION OVERVIEW



BELIEF CALCULATION METHODS

DS Translation Process

$alert_2$		maps to	$probe(ip_2,ip_3)$	
element	bpa		element	bpa
{trustworthy}	0.33	→	{true}	0.33
{non-trustworthy}	0.67	→	{true, false}	0.67

DS Combination Process

Standard

$$m_{1,2}(h) = \frac{1}{1-K} \cdot \sum_{h_1 \cap h_2 = h} m_1(h_1) \cdot m_2(h_2) \qquad K = \sum_{h_1 \cap h_2 = \{\}} m_1(h_1) \cdot m_2(h_2)$$

Customized

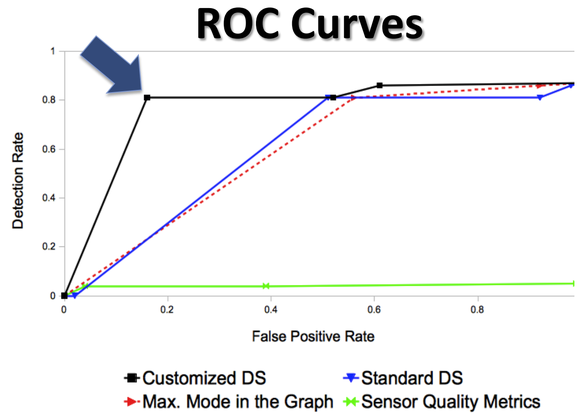
$$m_{1,2}(h) = \sum_{h_1 \cap h_2 = h} \psi[h_1, h_2]$$

$$\psi[t,t] = r_1 \cdot m_1(t) + (1-r_1) \cdot m_1(t) \cdot m_2(t)$$
$$\psi[t,\theta] = (1-r_1) \cdot m_1(t) \cdot m_2(\theta)$$
$$\psi[\theta,t] = (1-r_2) \cdot m_1(\theta) \cdot m_2(t)$$
$$\psi[\theta,\theta] = r_1 \cdot m_2(\theta) + (1-r_1) \cdot m_1(\theta) \cdot m_2(\theta)$$

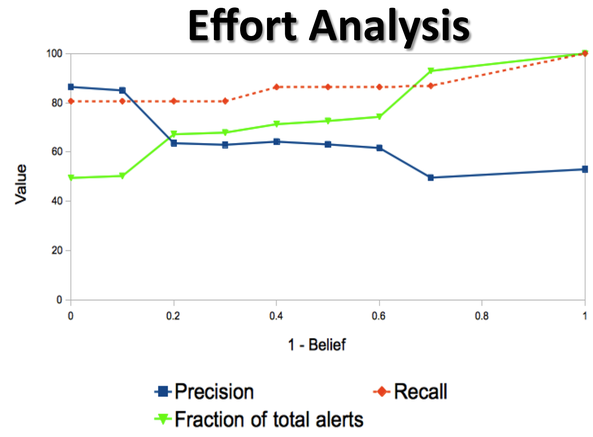
r_i : estimated overlapping factor

EVALUATION

ROC Curves

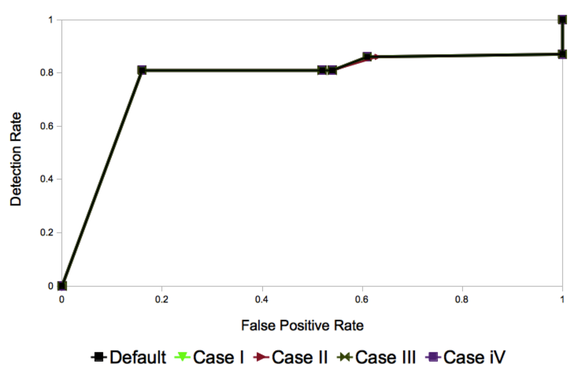


Effort Analysis



Figures are for MIT LL99 training dataset

Sensitivity Analysis



Tags	Metrics	
unlikely	0.01	10% ↓
possible	0.33	10% ↓
likely	0.66	10% ↓
probable	0.99	10%

REFERENCES

- Loai Zomlot, Sathya Chandran, Kui Luo, Xinming Ou, and S. Raj Rajagopalan. Prioritizing intrusion analysis using Dempster-Shafer theory. In the 4th ACM Workshop on Artificial Intelligence and Security (AISec), 2011.
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