FaceTrust: Collaborative Unwanted Traffic Mitigation Using Social Networks

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Motivation

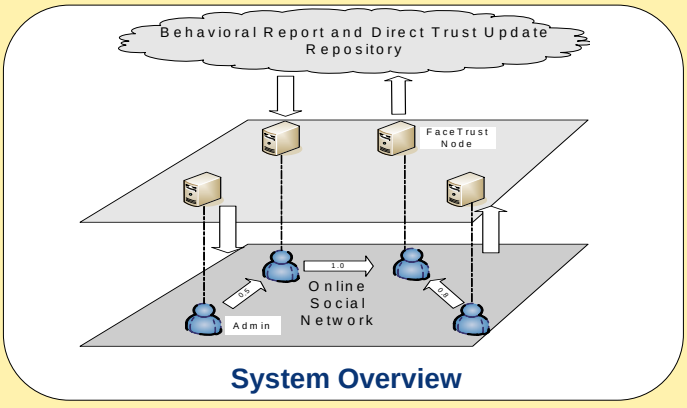
Rapid and Reliable Suppression of Unwanted Traffic

Current unwanted traffic mitigation techniques rely heavily on centralized, non-collaborative infrastructures with limited coverage and slow response times e.g.:

- **SpamHaus, Dshield, TrustedSource, SiteAdvisor:** IP or site reputations for spam and malicious code
- **CounterMalice, EarlyBird**: network-layer worm detection/ containment
- **Software Vendors:** Security patches for vulnerable systems

However, threats spread too fast and are hard to identify!

- A TCP flash worm could infect 1 million nodes under 4 secs [Staniford WORM 04]
- Many spam bots appear low volume if observed at any single domain [Ramachandran SIGCOMM 06]



System Overview

Prior Approaches and Our Goal

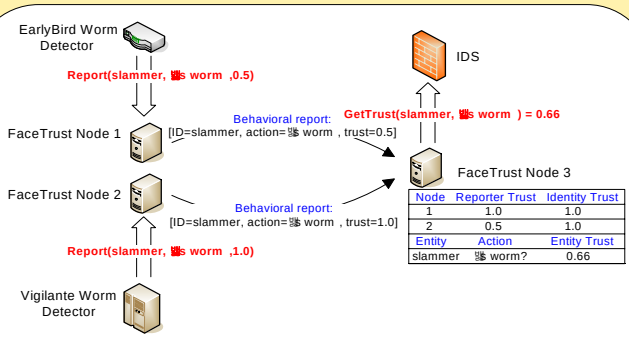
- **ALPACAS:** Collaborative spam filtering. Assumes correctness of spam reports
- **Vigilante, Sweeper, NetShield, [Weaver Security 04]**: Collaborative worm detection, early warning and containment. Assume all nodes can verify reports, or that all nodes are trustworthy

Our goal :

- A *Collaborative Trust Management System for Internet Entities*, e.g. IP address, packet signature, email signature etc
- Applications determine with a quantifiable certainty whether an entity is performing a specific malicious *action*, e.g. ``is a spam bot''

Challenges:

- Fake *reports* regarding the *behavior* of entities
- Fake *updates* regarding the *trustworthiness* of *reporters*
- Sybil attack



FaceTrust Operation Example

Trustworthy Behavioral Reports

Reporter Trust:

- Any two socially acquainted FaceTrust nodes i,j initialize the *direct trust* d_{ij} between their devices to a social trust $2\ [0.0,1.0]$.
- Any two nodes i,j able to verify each other's *behavioral reports*, update d_{ij} based on similarity $s_{ij}\ 2\ [0.0,1.0]$ between their reports

$$d^{k+1}_{ij} = \alpha * d^{k}_{ij} + (1-\alpha) * s_{ij}$$

- Node k retrieves d_{ij} to build the *reporter trust graph* $T(V_k,E_k)$.
- For each node $j\ 2\ V_k$ of which node k considers the behavioral reports, k analyzes T to compute the transitive *reporter trust* t_{kj}.

For every path p from k to j: $t_{kj} = max_p\ (\Pi_{u\ !\ w\ 2\ p}\ d_{uw})$

Identity Trust. OSN Providers as Certification Authorities:
OSN providers analyze the social graph using a SybilLimit-like algorithm to derive the probability I_j that a node j is a Sybil

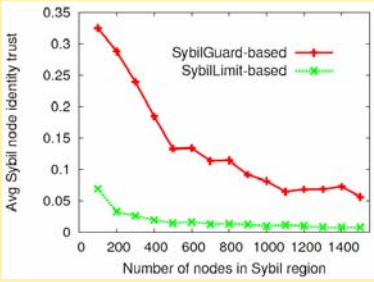
$$t_{kj}\ \tilde{A}\ t_{kj}\ £\ I_j$$

Entity Trust:

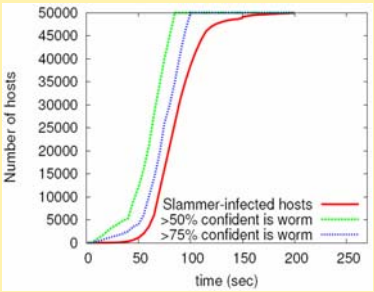
- For the same entity e and the same action a, node k may receive multiple behavioral reports from nodes $j\ 2\ V_k$, with trust c_j.

$$GetTrust_k(e,a) = \frac{\Sigma_{j\in V_k}\ t_{kj}\ c_j(e,a)}{\Sigma_{j\in V_k}\ t_{kj}}$$

Evaluation



- Facebook 50K node sample.
- Sybil region forms a random graph with avg degree 14. A single attack edge to the honest region.
- Average **honest** node identity trust is **~0.9**
- **Identity trust of Sybil nodes decreases substantially with their number**



- 2000 honest worm reporters
- 500 dishonest worm reporters
- $|V| = 1000$
- Social trust random in [0.0, 1.0].
- SQL Slammer Worm dynamics from [Moore S&P 03].
- SimPy-based discrete-event simulator.
- **Nodes conclude that slammer is worm faster than worm spreads**

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