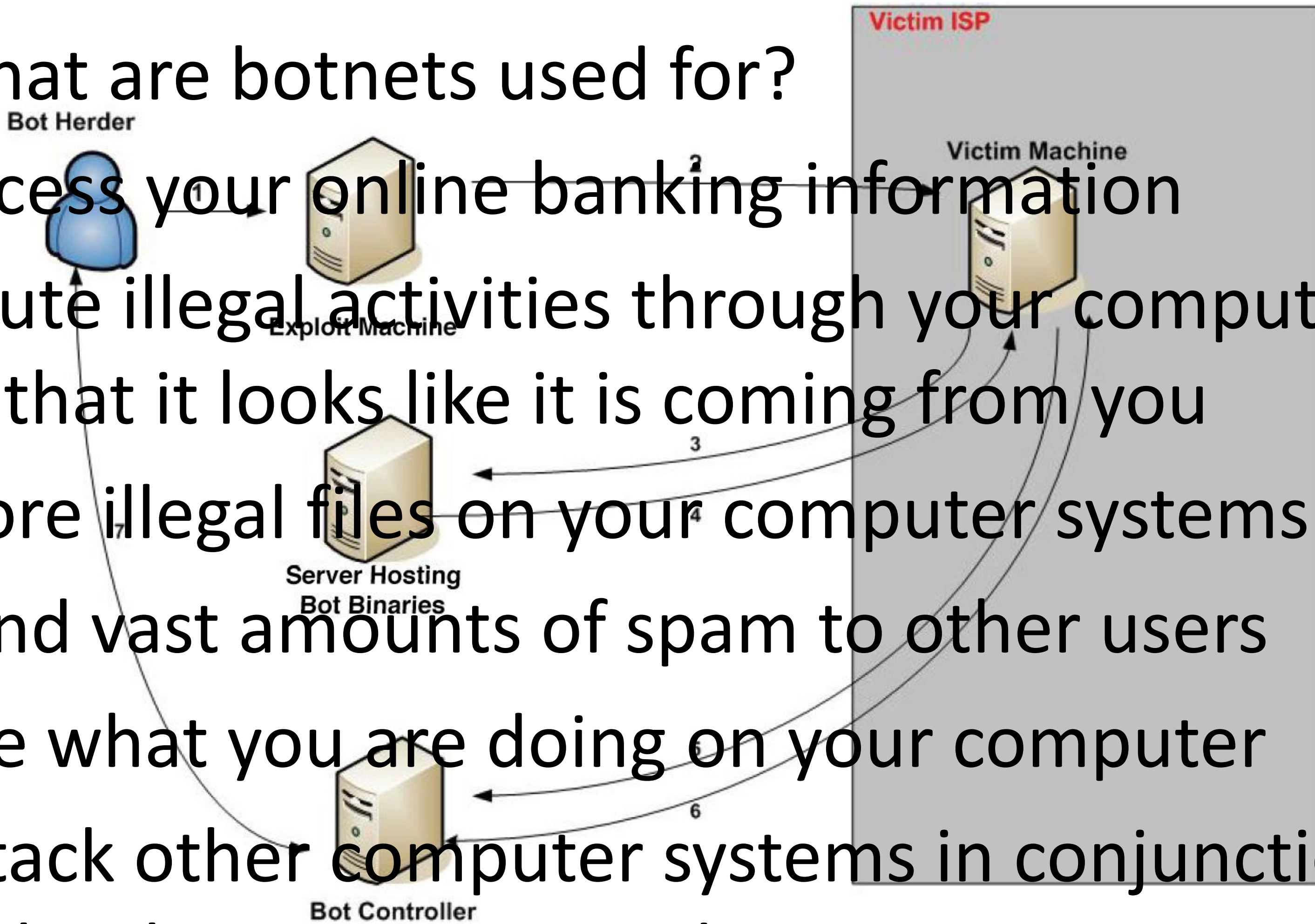
Economic Incentives to Increase Security in the Internet: the Case for Insurance

Marc Lelarge (INRIA-ENS)
Jean Bolot (SPRINT)

IEEE INFOCOM, Rio 2009.

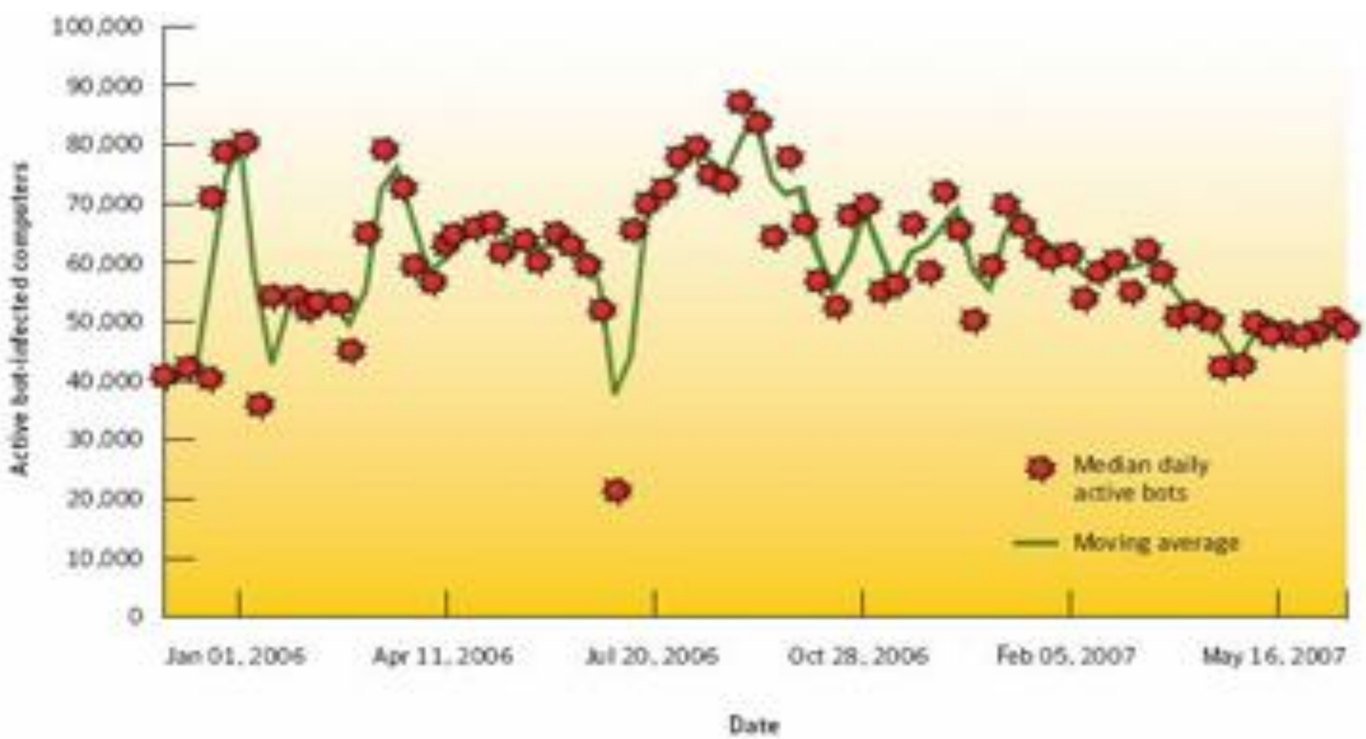
Bot Networks

- What are botnets used for?
- Access your online banking information
- Route illegal activities through your computer so that it looks like it is coming from you
- Store illegal files on your computer systems
- Send vast amounts of spam to other users
- See what you are doing on your computer
- Attack other computer systems in conjunction with other compromised systems…

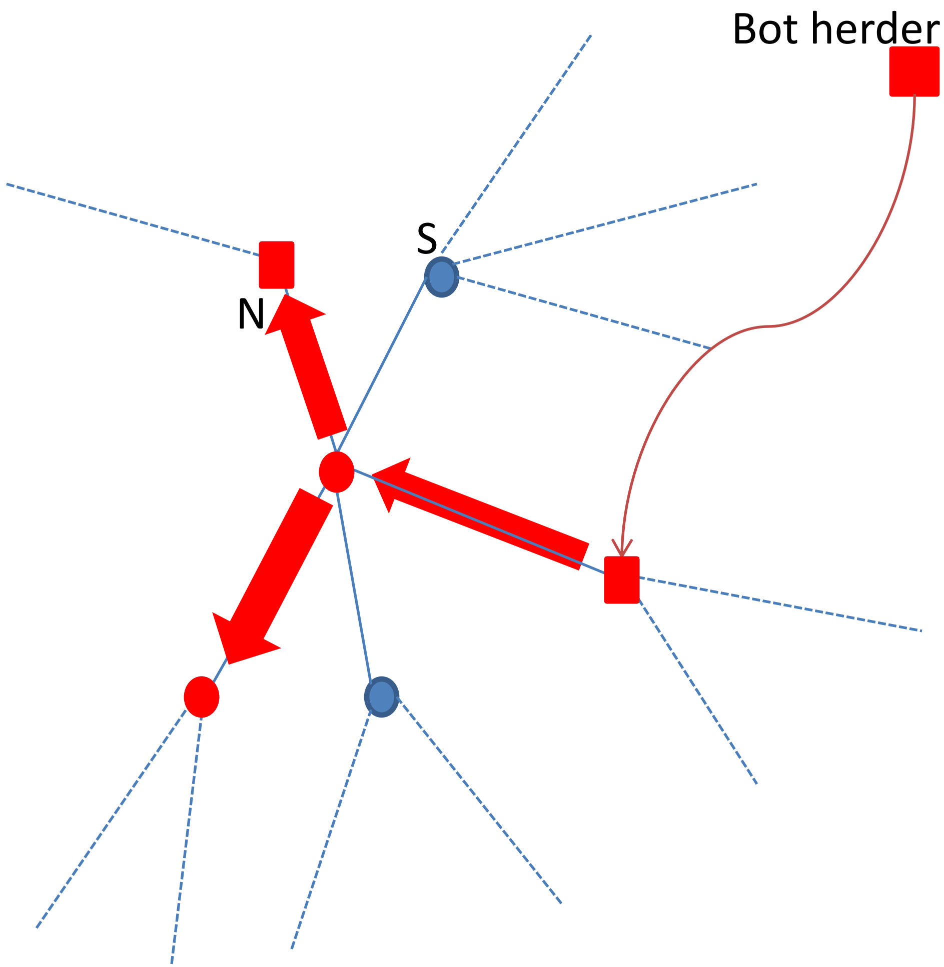


Symantec Internet Security Threat Report

Symantec observed: an average of 61,940 active bot-infected computers per day (...)
and 5,060,187 distinct bot-infected computers (over a period of one semester).



(1) Epidemic Model



- Bot herder directly infects agents N with probability p.
- Each neighbor is contaminated with a probability of contagion depending on its state.

(1) Economic Model for the agents

- Each agent faces a potential loss ℓ.
- Investment in security has a fixed cost c and reduces the probability of loss.
- Binary choice:
  - in state N, the probability of loss is p^N.
  - in state S, the probability of loss is $p^S < p^N$.
- Optimal strategy is S if

$$p^S u[w-\ell-c]+(1-p^S)u[w-c] >$$
$$p^N u[w-\ell]+(1-p^N)u[w]$$

(1) Solving a market failure?

- Epidemic risk model allows to compute price of anarchy: agents under-invest in all cases!

  Free rider problem and/or Critical mass problem.

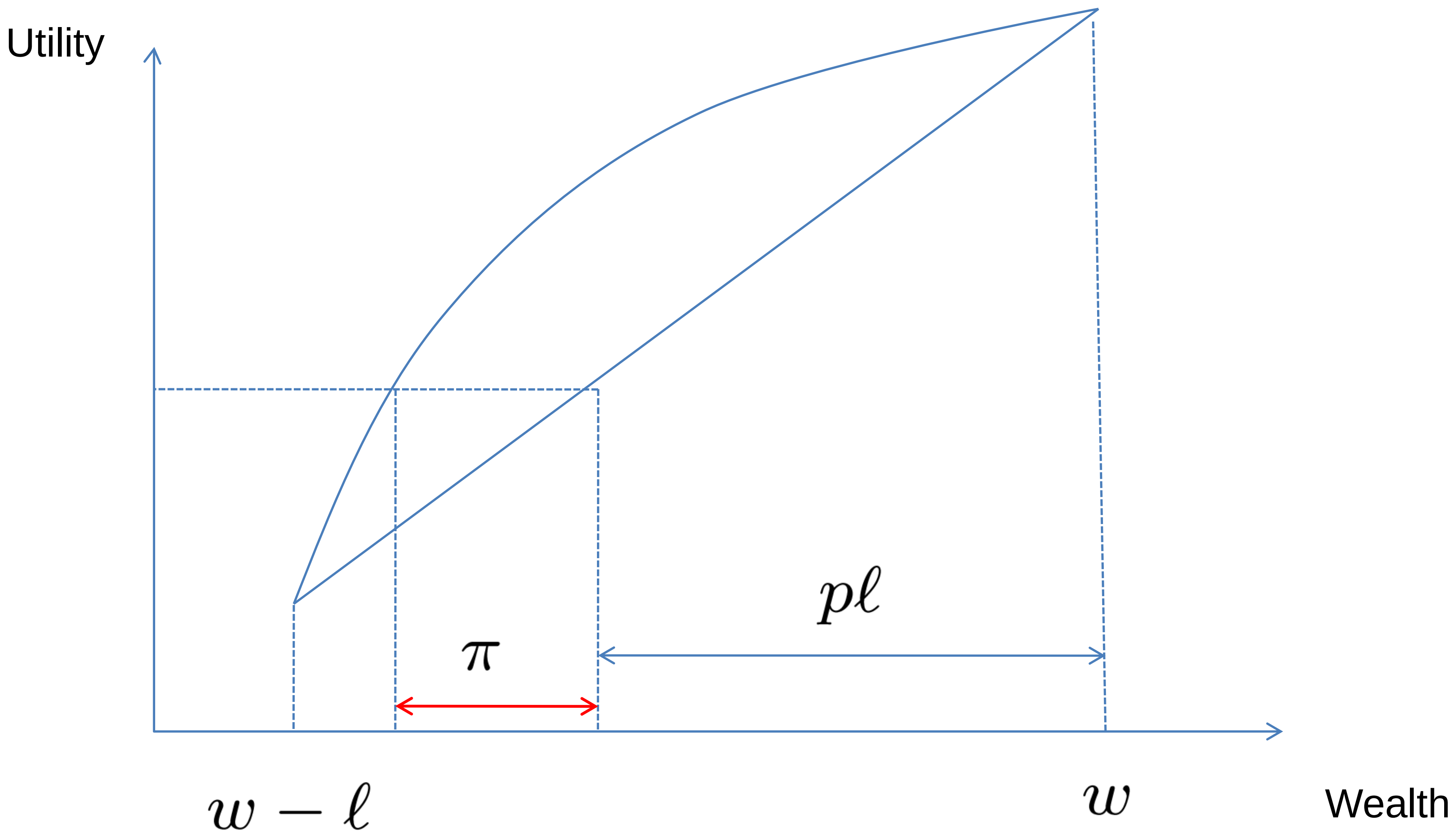
Varian (02), Kunreuther & Heal (03), L & B (08)

- Designing incentives for user behavior.
- Internalizing network externalities through cyber-insurance?

(2) A framework to study insurance

- Principal-Agent Model: the Principal (Insurer) proposes the contract and the Agent just has to accept or reject the contract.
- The Principal is risk-neutral (can diversify the risks) and the Agent exhibits risk-aversion.
- An insurance contract is a couple of a premium and a benefit: insurer offers a contract (p[S],b[S]) to agents in state S and (p[S]+x,b[S]-y) to agents in state N.

(2) Example: Full coverage



(2) Optimal risk sharing under asymmetric information

- Asymmetric information : adverse selection and moral hazard.
- If the insurer observes the level of protection of the agent: optimal risk sharing requires that the insurer perfectly ensures the agent.
- If the insurer cannot observe the level of protection of the agent, trade-off between risk sharing and incentives.

(3) Analysis of two cases

(i) No moral hazard and full coverage.

$b[s]=\ell-p[s]$; $x=y>0$.

(ii) Moral hazard and any contract.

$x=y=0$.

Results:

- In cases (i) and (ii), insurance is not an incentive for protection (competitive insurance market or monopolistic insurer).

(3) Insurance as a good incentive

- If there is no moral hazard, there exists t such that in a competitive insurance market where the premium loading is forced to exceed t, then insurance is an incentive to protection.
- Implementing a tax for individuals not investing in protection could enable an insurance market.
- If there is no moral hazard, a 'social insurer' is a good incentive.

To take away:

- Improving technical defenses is not enough! We need to find the proper economic incentives to deploy them.
- Moral hazard problem is a barrier for insurance and requires technical solutions: monitoring, estimating damages, security metrics.
- How to evolve the Internet to help insurers do a better job?