Attack analysis

A system model

- The discovery of attacks against a system requires some modelling of the system itself
- The model of the system describes
  - System components
  - System interconnection structure
  - Component vulnerabilities
  - Attacks (simple steps)
- The level of description and of detail obviously depends upon the accuracy we aim to achieve

Modelling an attack - I

- Any attack can be modelled through six attributes

1. Precondition
   - rights on system objects
   - resources
   - competences and info
2. Post condition
   - rights on system objects

3. enabling vulns (component, vulnerabilities)
4. actions to be executed
5. success probability
6. noise

Modelling an attack - II

- The attack post condition is the set of rights the attacker owns if the attack is successful
- The postcondition always include the preconditon (monotone right acquisition)
- The actions to be executed include
  - Human actions
  - Program execution
- Fully automated attack = no human action is required
- Noise = events that enable the detection of the attack

Example -I

- To implement a buffer overflow, one needs
  - To invoke a procedure (rights)
  - To write a parameter that includes the program to be executed (know how)
  - To know the memory map to determine the size of the parameter to overflow the stack (info)
  - Fully automated attack
  - Success probability = depends on controls in the attacked system

Example -II

- If the attack is successful, the injected program is executed as root and it can access any system resource
- The noise of the attack is a function of the checks executed on the attacked system and that make it possible to detect the attack
- The checks influence both the success probability and the noise as they can only discover (log) or also prevent (type -canary) the attack

Attack taxonomies

- Several alternative taxonomies that are focused on just one feature/attribute
  - Enabling vuln
  - The agent that can implement the attack
  - The impact produced by the attack
  - The target component
- All these properties are important but a risk assessment may be focused on other properties or on several of these features

Elementary vs complex attacks

- An elementary attack is the one previoulsy described and characterized by the previous elements
- In a complex system a threat cannot achieve one goal (set of rights) through just one elementary attack
- Elementary attacks have to be composed into a complex one (attack plan, privilege escalation) to increase the rights of the attacker till reaching one of the goals of interest
- Intelligent attackers with a plan of action
- The precondition of each attack in the plan has to be included in the rights the attacker acquires through the previous attacks in the plan (the union of the postconditions of these attack plus any initial rights)

Complex Attacks - I

- Alternative points of view on a complex attack
  - Program (elementary attack = instruction)
  - Planning (steps to achieve a given goal)

- Fundamental difference = coverage
  - In planning or programming we are interested in one program/strategy (optimal or suboptimal) to reach a given goal (consider one robot moving in a space)
  - Several attacks can be selected (several robots simultaneously)
  - An assessment is interested in discovering all the programs/strategies an attacker can implement to achieve a given goal (we have to stop all the robots)

Complex attacks - II

- Elementary attacks are composed to increase the rights of the attackers
- Elementary attacks targeting the same system = increase the attacker rights on the system resources
- Elementary attacks targeting another system = increase the attacker rights by exploiting the trust relation among systems

Complex attack: An example

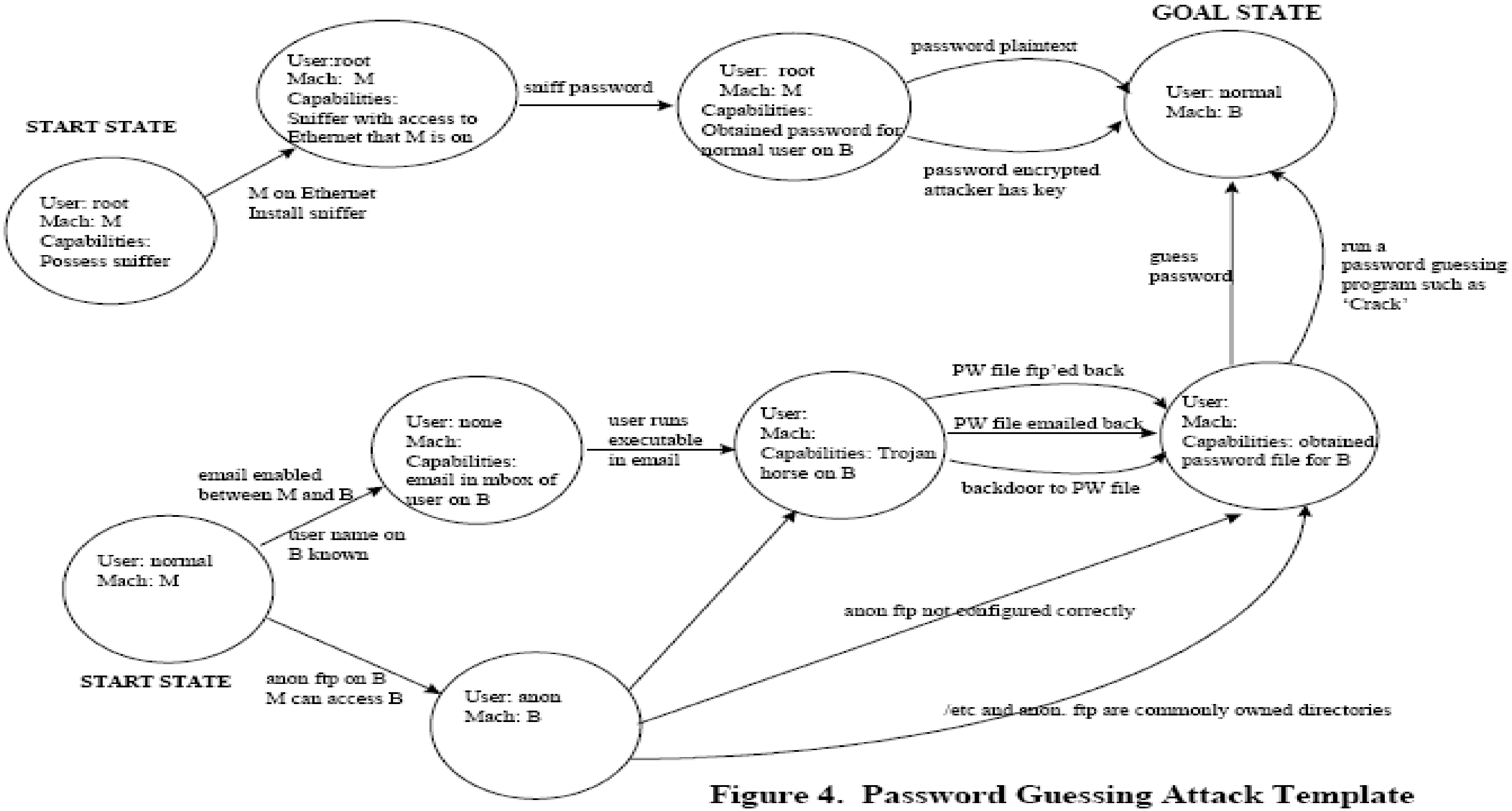


Figure 4. Password Guessing Attack Template

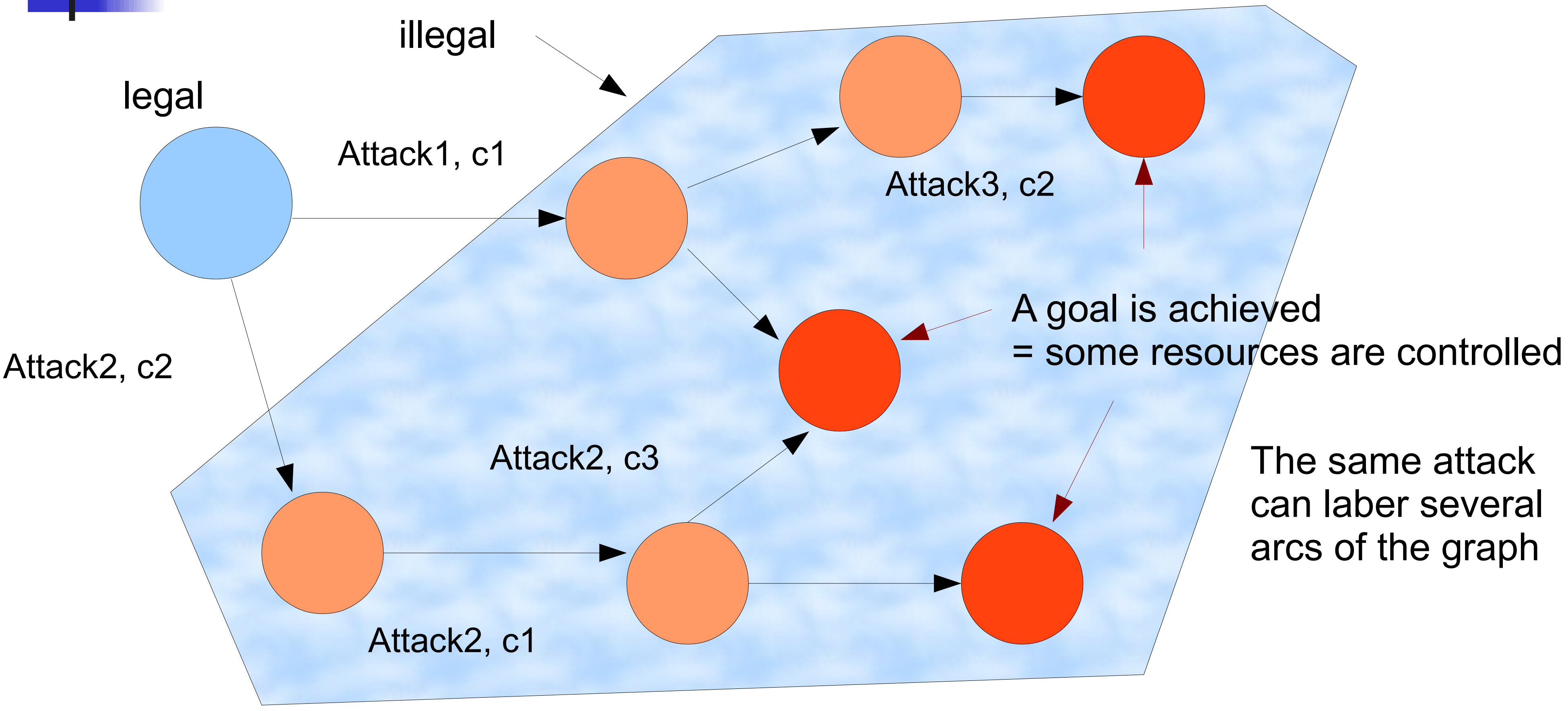
Some other example

C:\Users\fabrizio\Dropbox\1617\BHUSA09-Kortchinsky-Cloudburst-SLIDES.pdf

Attack graph

- It shows how a threat can compose elementary attacks to achieve a given goal
- It is a function of current vulns and of the goals of the attackers
- The graph is acyclic because of the monotone right acquisition process
- It consider the worst case where attacks are successful
- In each state the threat can execute all the attacks that are possible in the previous states

Evolution of a user state



A goal is achieved
= some resources are controlled

The same attack
can laber several
arcs of the graph

Some states are useful only to reach a final state

State= set of rights

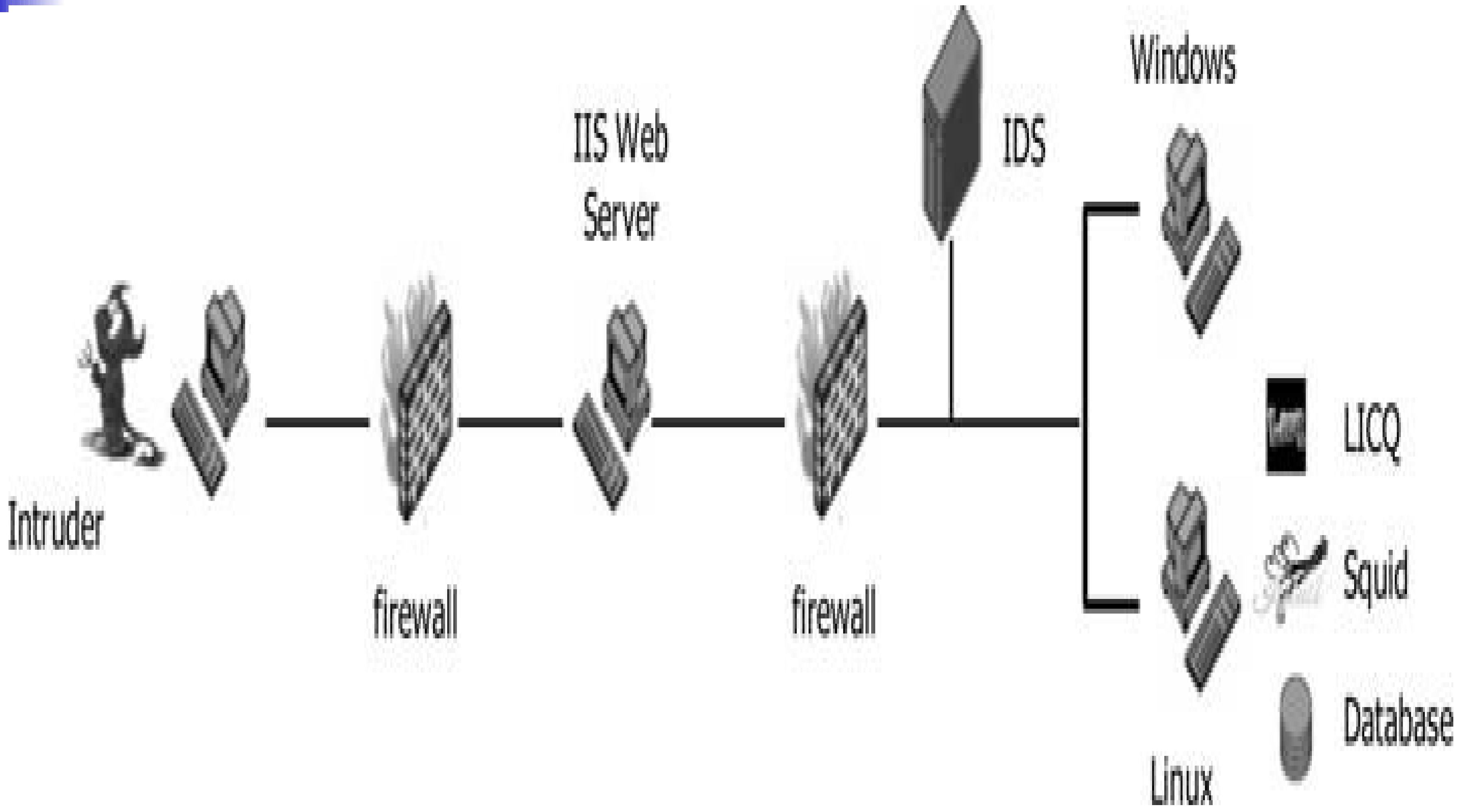
System evolution

- We can draw a graph that represents the evolution of the global system state
- The global system state is the cartesian product of the states of any attacker (user)
- The graph that describes the system evolution may not be acyclic because if a threat implements a DOS this may reduce the rights of other threats

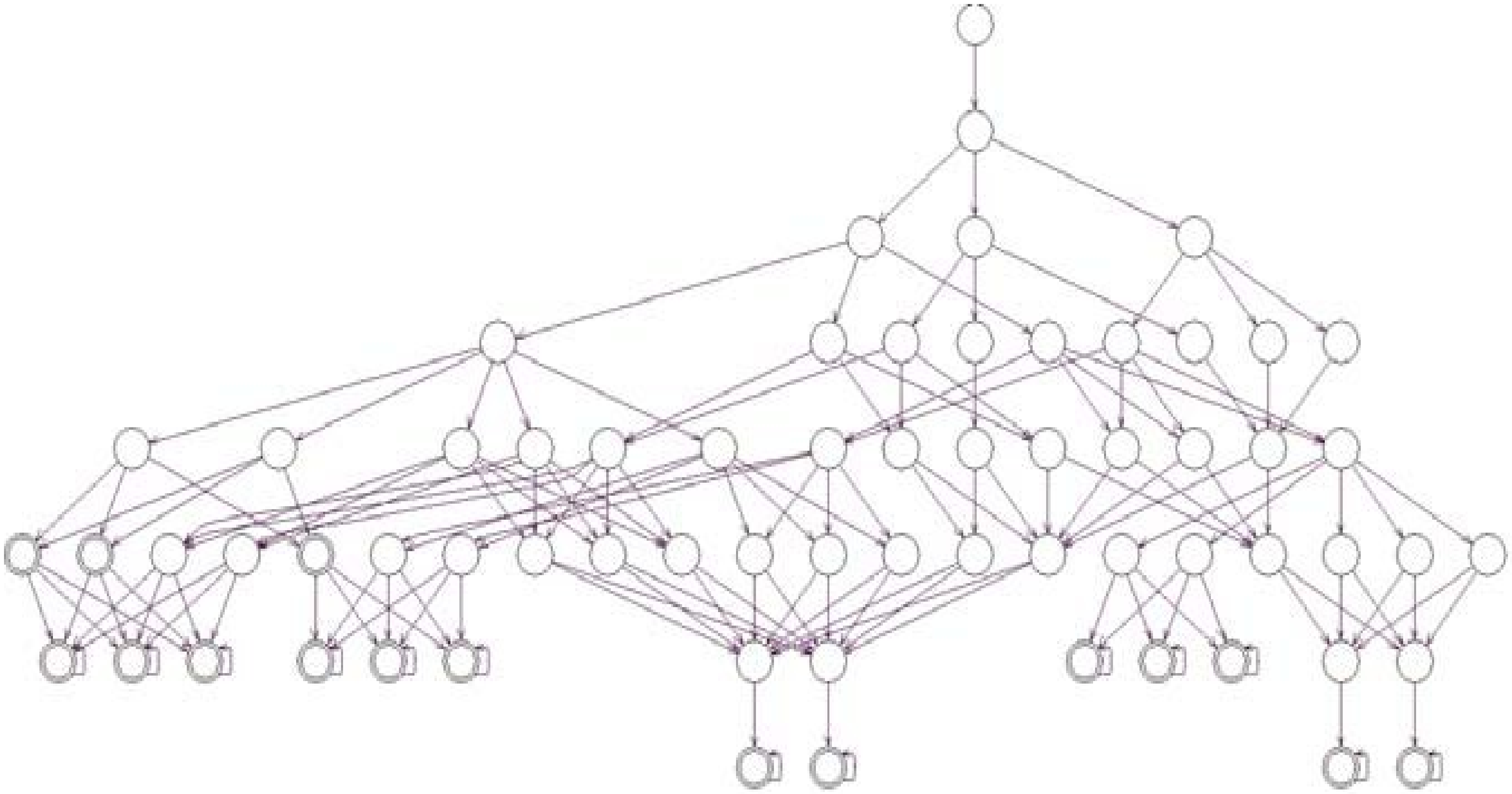
State explosion

- There is a huge number of states that strongly increases the complexity of any analysis
- It is not practical to assume the knowledge of this graph
- Two main reasons for the explosion
  - Several attacks in a plan may commute
  - Distinct attackers can implement their attacks
    - Sequentially
    - In parallel

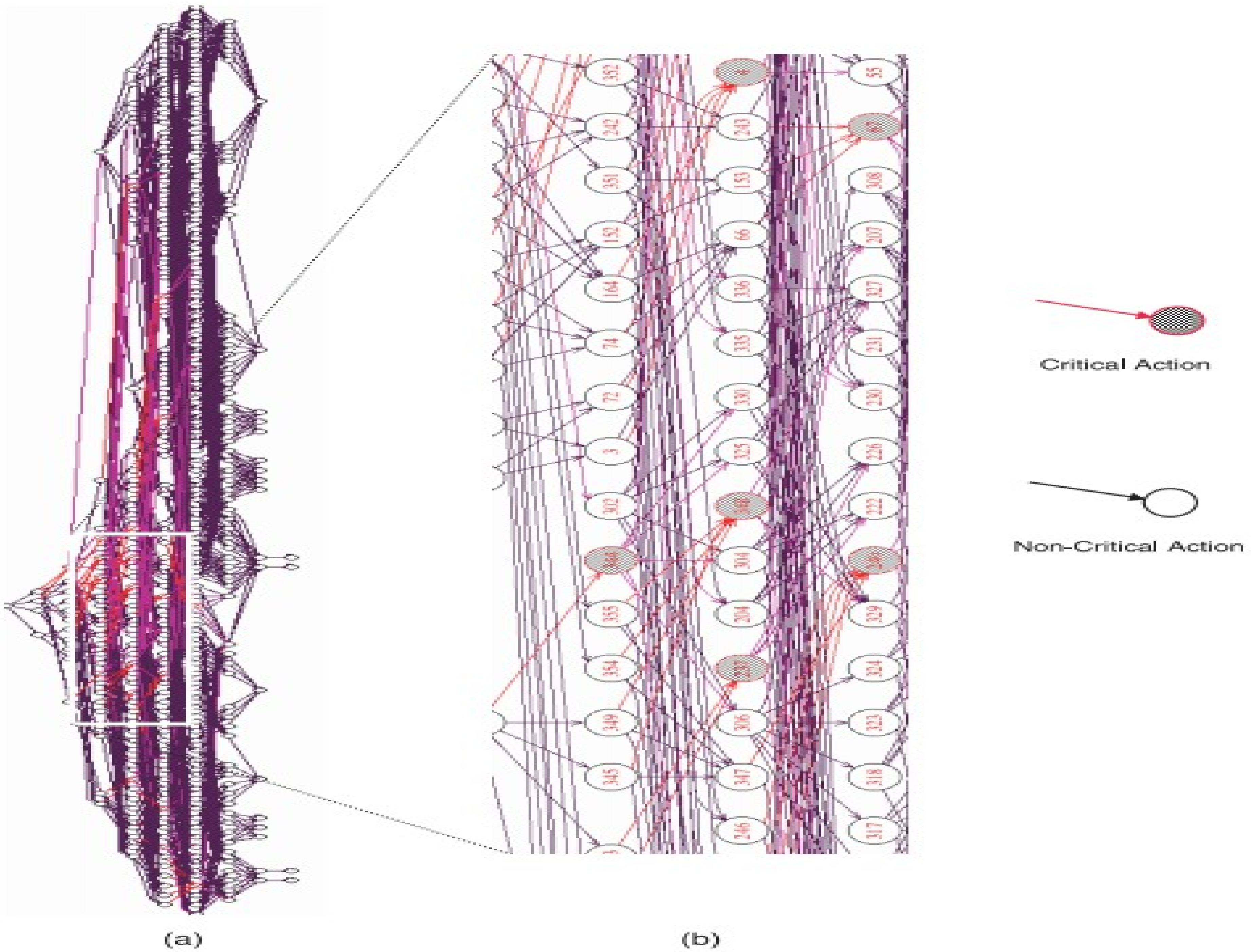
System architecture



Attack Graph



One goal of one user


(a)
(b)
Critical Action
Non-Critical Action

Elementary vs complex attacks

- The problem of discovering elementary attacks is rather different from the discovering of how the attacks can be composed to reach a goal
- The discovery of elementary attacks depends upon both system vulns and on the components of the system that is available
- The composition of elementary attacks may be considered as an instance of a well known optimization problem = how to reach some nodes of a graph

Attack surface

- The system attack surface includes all those elementary attacks that are the starting points of complex attacks, the initial elementary attacks of a complex one
- An elementary attack that is not in the surface can be stopped by preventing the execution of some attacks in the surface
- The ratio r between the number of attacks in the surface and the overall number of attacks in attack plans may be seen as an approximated evaluation on the system security
  - $r \to 1 \Leftrightarrow$ there are several ways to compose the attacks into plans, so the overall security is low
  - $r \to 0 \Leftrightarrow$ by stopping a few attacks in the surface we stop all the plans

Monte Carlo Analysis

- The number of paths/links/nodes of the graph can be strongly reduced by focusing on an attacker behaviour
- Starting from the attack surface, we discover and build only the paths an attacker may select by simulating its behaviour according to its preferences and priorities
- Multiple executions to handle
  - Non determinism in the behaviour
  - Handling of attack failures

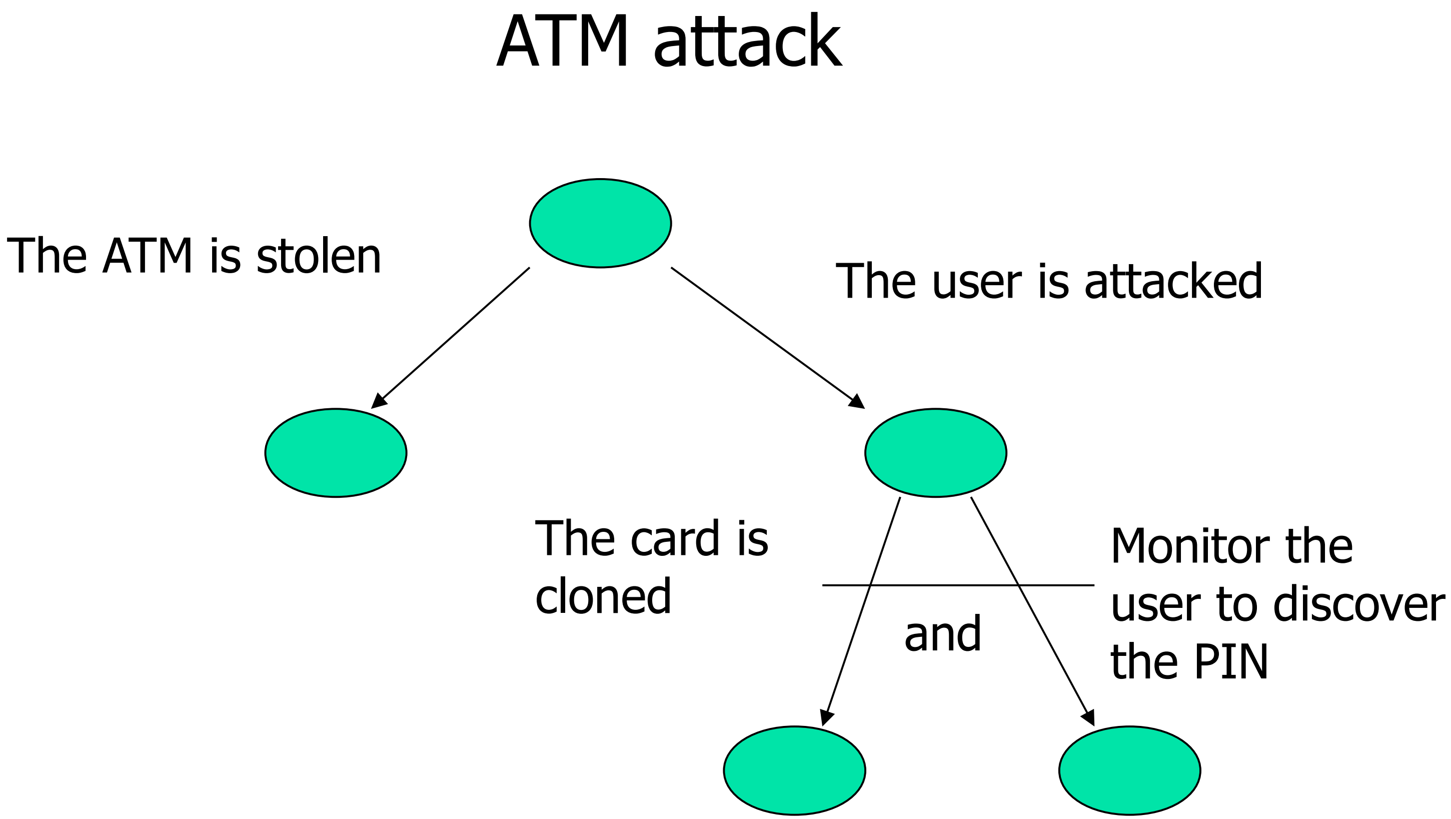
Monte Carlo Analysis

- The approach is based upon the joint executions of the system model and the attacker one
- The joint execution builds a subset version of the attacker attack graph
- The accuracy of the subset depends upon the accuracy of
  - System model
  - Attacker model

Attack Tree Analysis – I

- A top down approach to discover how a complex attacks can be implemented
- A complex attack is decomposed into simpler attacks
- The top down procedure stops when its frontier include elementary attacks only
- Two alternative decompositions
  - AND = all the attacks are required
  - OR = just one of the attacks is required

Attack Tree Analysis - II



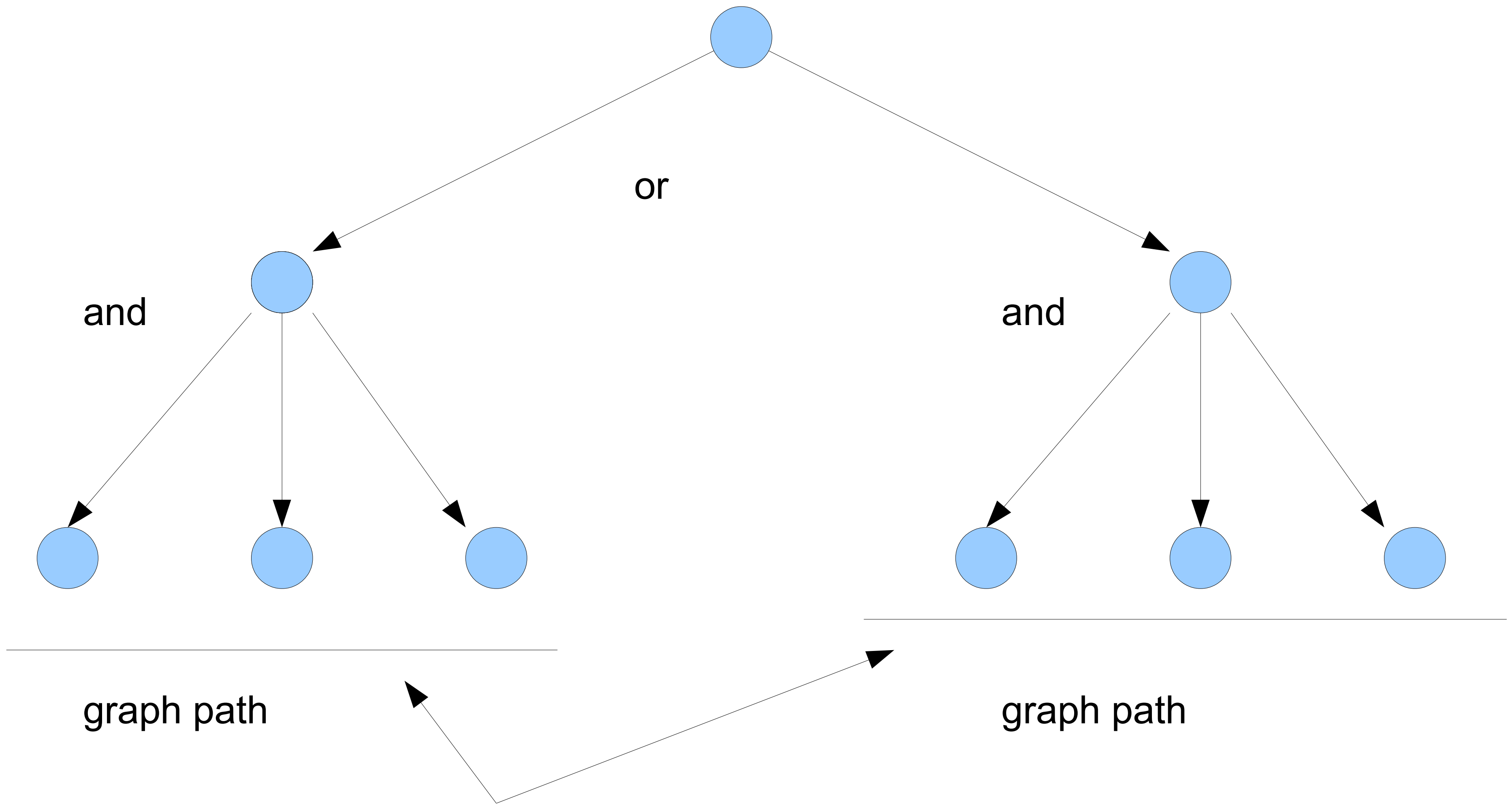
Attack Tree Analysis -III

- Thinking of a tree may be misleading because elementary attacks may be shared among subtrees
- How to discover problems shared among subtrees?
- A model based on a finite state automata may simplify the recognition of equivalent states and, hence, of common problems
- States = set of access rights that have been acquired
- Automata = attack graph

Attack tree vs graph (automata)

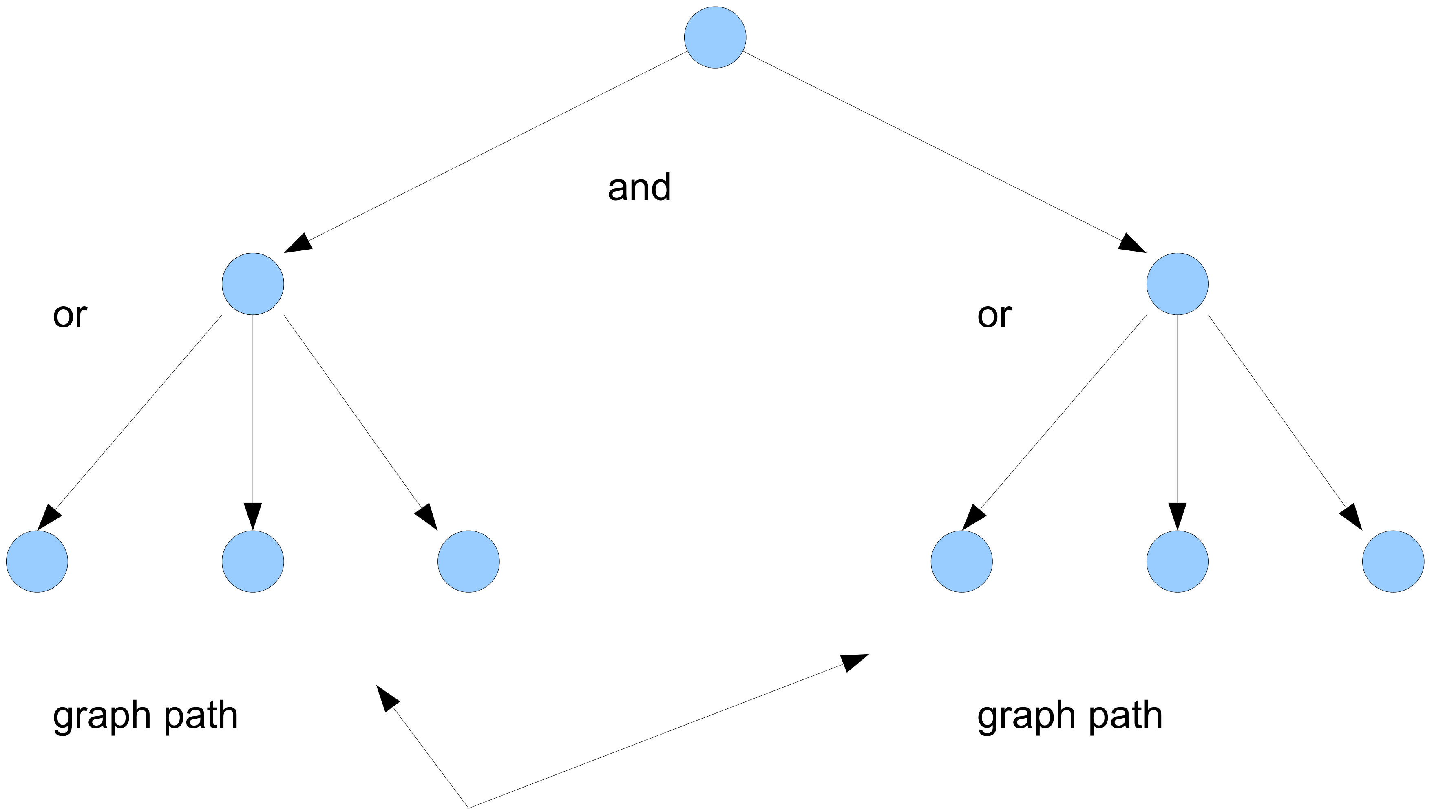
- The attacks in an AND relation in the tree belongs to the same path of the graph
- An OR nodes implies that several paths can be defined and do exist in the graph
- A tree represents one or more complex attacks
  - Consider the subtree rooted in the root of the tree
  - This subtree includes all the sons of an AND node and one son of an OR node
  - The complex attack composes all the leaves (elementary attacks) of the subtree

Attack tree vs graph



Two complex attacks that are represented as two paths

Attack tree vs graph

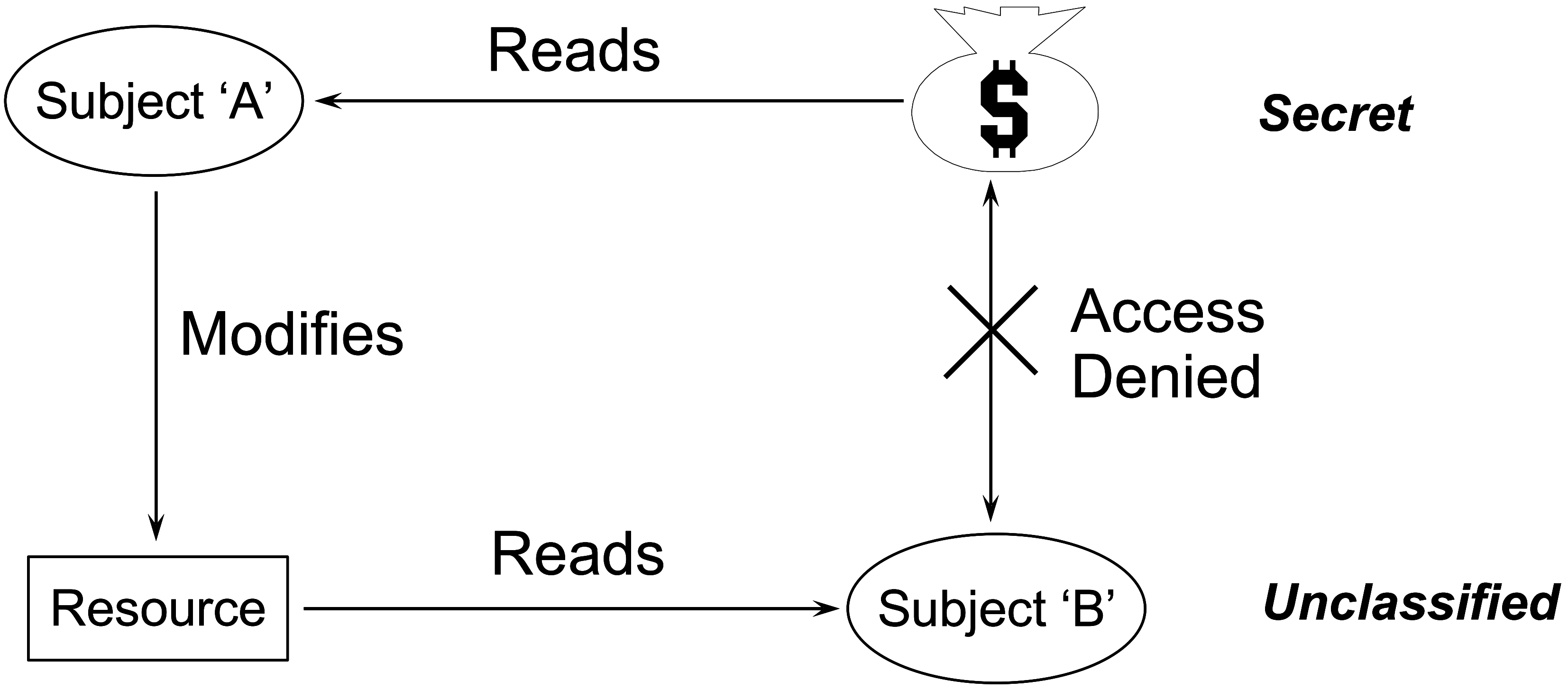


Nine complex attacks that include one descendant of each or node

A simple taxonomy of elementary attacks

1. Buffer/stack/heap overflow
2. Exchanged information is illegaly read (sniffing)
3. Some of the legal messages of a legal user are repeated (replay attack)
4. Interface operations are invoked in an unexpected order (interface attack)
5. Interception and manipulation of information exchanged between two entities (man-in-the-middle)
6. Information flows are diverted
7. Time-to-use Time-to-check (Race condition)
8. XSS (cross site scripting)
9. Covert channel
10. Impersonating
    - A user
    - A machine (IP spoofing, DNS spoofing, Cache poisoning)
    - A connection (connection stealing/insertion)

Covert Channel


Reads

Subject ‘A’

$

Secret

Modifies

Access Denied

Reads

Resource

Subject ‘B’

Unclassified

Cryptographic attacks

A dedicated taxonomy

a) Brute force attack

b) Differential cryptanalysis

c) Linear cryptanalysis

d) Meet-in-the-middle attack

e) Chosen-ciphertext attack

f) Chosen-plaintext attack

g) Ciphertext-only attack

h) Known-plaintext attack

i) Power analysis

j) Timing attack

k) Man-in-the-middle attack

Attacks against the TCB

- **bypassing**
- **tampering**
- **direct attack (by exploiting vulns in TCB)**
- **misused**

Complex attacks and countermeasures

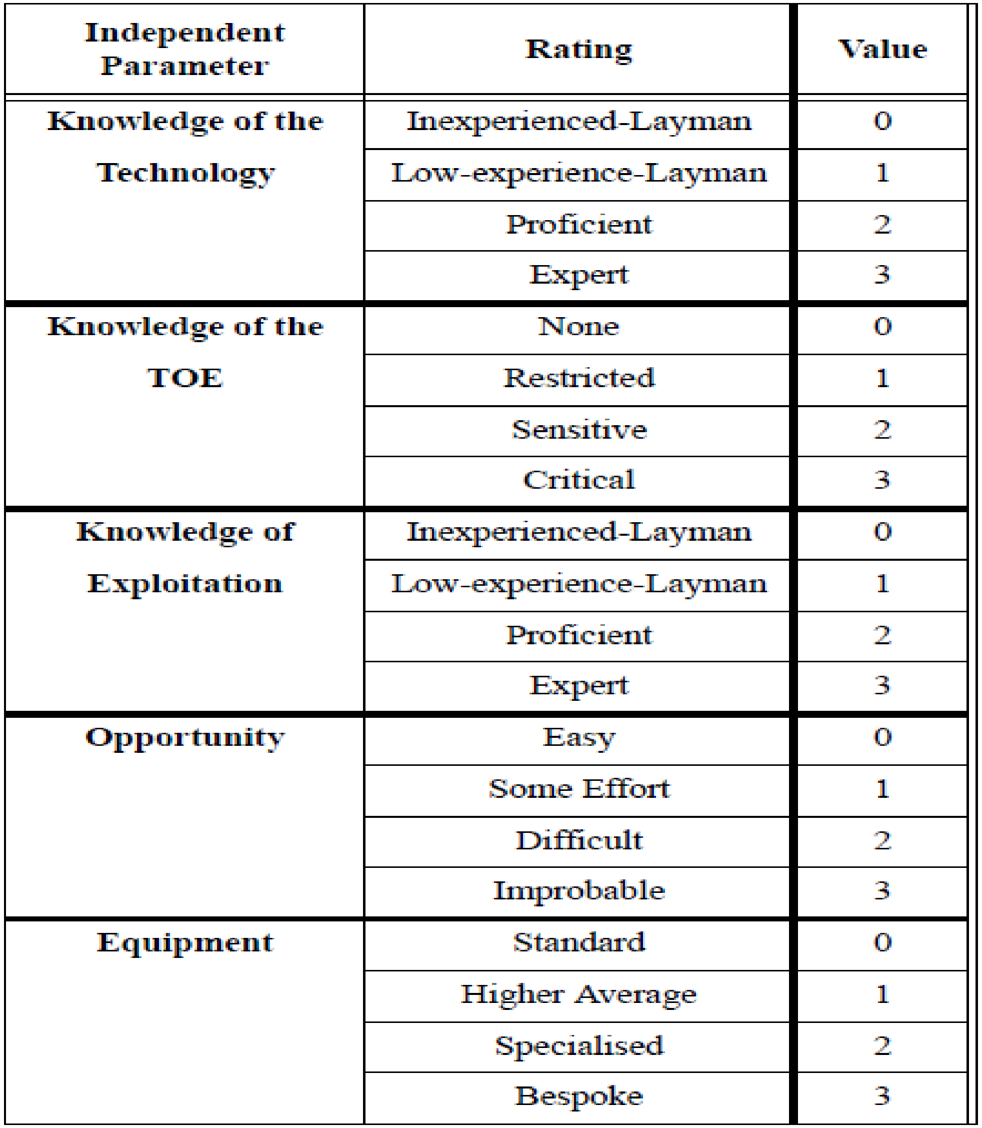
- We stop a complex attack by stopping any of its elementary attacks
- If an elementary attack is shared among several complex ones, all are stopped.
- Cut set of an attack graph = a set of arcs (= of elementary attacks) such that no goal can be reached if they are cut (if the attacks are stopped)
- A cut set includes at least one elementary attack for each complex one that enables a threat to reach one goal (you have to discover all the complex attacks)
- Shared attacks are the key to cost effectiveness

Selecting the countermeasures

- Several cut sets may exist, each with a distinct cost
- Cost effective solutions stop
  - the most shared elementary attacks
  - attacks with cheapest countermeasures
- Betweeness = how many paths to a goal shares an arc that corresponds to the same attack

How dangerous is an attack?

The danger of an attack decreases as the value Increases



Independent Parameter	Rating	Value
Knowledge of the Technology	Inexperienced-Layman	0
	Low-experience-Layman	1
	Proficient	2
	Expert	3
Knowledge of the TOE	None	0
	Restricted	1
	Sensitive	2
	Critical	3
Knowledge of Exploitation	Inexperienced-Layman	0
	Low-experience-Layman	1
	Proficient	2
	Expert	3
Opportunity	Easy	0
	Some Effort	1
	Difficult	2
	Improbable	3
Equipment	Standard	0
	Higher Average	1
	Specialised	2
	Bespoke	3

How dangerous?

- The model assumes that the 5 coordinates are orthogonal, eg independent
- This maps each attack into a point in a 5 dimension space
  - Technology competence
  - Info on the target system
  - Attack experience
  - Probability of opportunity
  - Devices

Danger decreases with the distance from the origin of the space

Danger of automatic attacks

- Original features of ICT security are
  - Fully automated attacks = fully programmable attacks
  - Automatic tools to implement attacks (execute the program)
- The existence of tools that implement the attacks
  - Simplify the implementation of attacks
  - Strongly enlarge the pool of potential attackes

⇒ The potential impact of a vulnerability

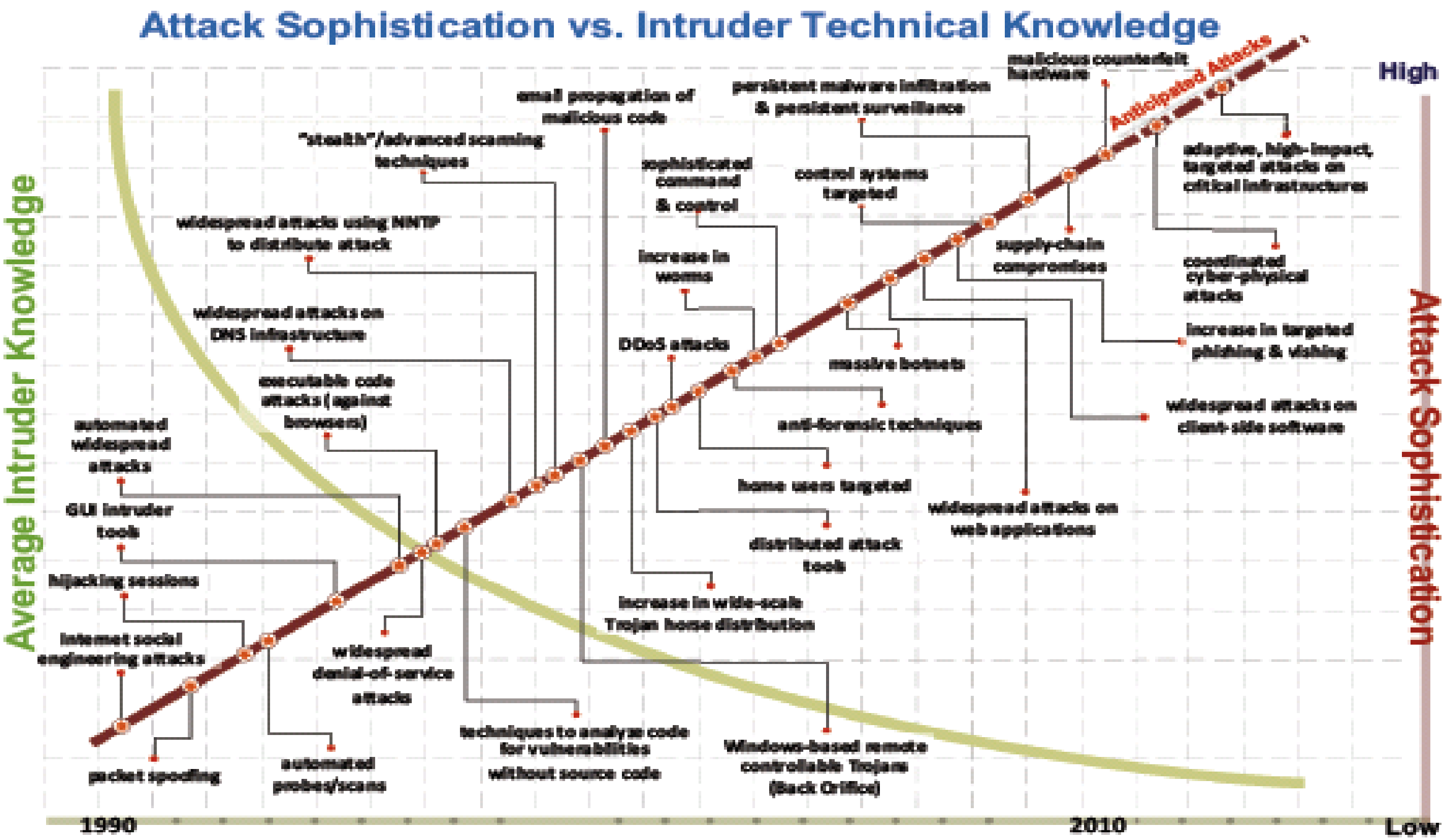
⇒ The probability that an attack is implemented

The danger strongly depends upon the feasibility of automating an attack

Fully automated attacks

- Exploit = the program that exploit the vulnerability to implement the attack tp control some components
  = an instance for each distinct system
- All the instances of a standard component
  - Are affected by the same vulns
  - Can be attacked by the same exploit
- Fully automated attack= no further actions, information, abilities are required besides the ability of running the exploit
- In the previous evaluation, the first 3 dimensions are equal to zero and the fifth one is outside the control of the defender
- Currently, several exploit databases are available that store exploit that can be tested against a system

Fully automated attacks



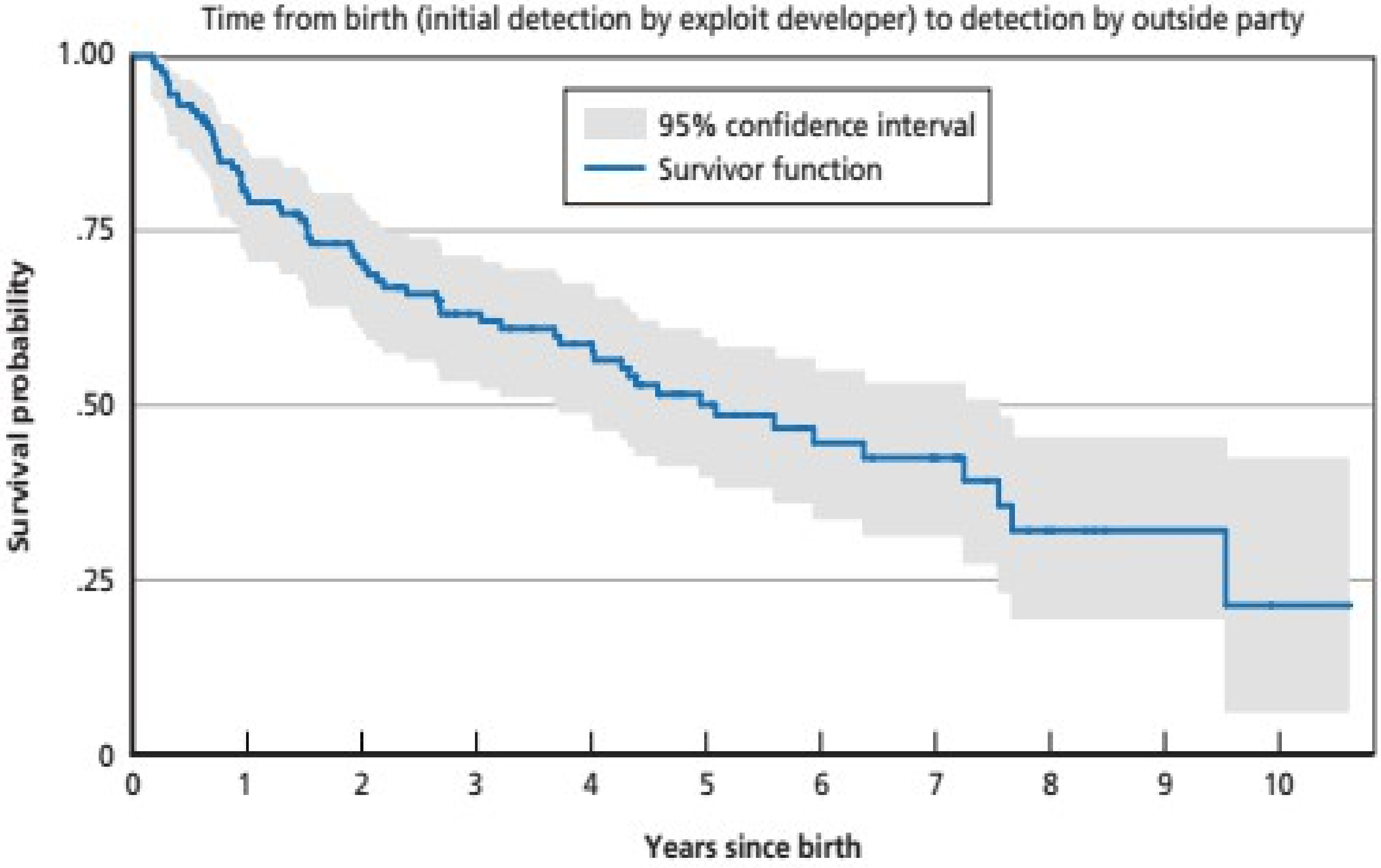
Fully automated attacks

- The functions show how really dangerous attacks may be implemented through tools that are distributed and accessed through the web
- It is more and more critical the window of exposure = the time interval between
  - The time an exploit is pubblicly available
  - The vuln is removed from the system

⇔ even a complex organization has to apply the patches to remove a vuln in a very short time

(good point to remember with the next slide)

Average life of 0-days



Fully automated attacks: an example

```
Thu Feb 24 09:45:47    HTTP request from 202.109.114.209: POST /_vti_bin/_vti_aut/fp30reg.dll
Thu Feb 24 09:45:54    possible overflow attempt via HTTP from 202.109.114.209 (request line is 65552 bytes
long)
Thu Feb 24 09:45:54    HTTP bogus request from 202.109.114.209: SEARCH
/□HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH
HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH...
```

```
Thu Feb 24 15:48:21    possible overflow attempt via HTTP from 81.30.200.55 (request line is 65552 bytes long)
Thu Feb 24 15:48:21    HTTP bogus request from 81.30.200.55: SEARCH
/□HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH
HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH...
Thu Feb 24 15:48:23    HTTP request from 81.30.200.55: POST /_vti_bin/_vti_aut/fp30reg.dll
```

```
Thu Feb 24 15:57:37    possible overflow attempt via HTTP from 218.43.229.149 (request line is 65552 bytes
long)
Thu Feb 24 15:57:37    HTTP bogus request from 218.43.229.149: SEARCH
/□HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH
HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH...
Thu Feb 24 15:57:41    HTTP request from 218.43.229.149: POST /_vti_bin/_vti_aut/fp30reg.dll
```

```
Thu Feb 24 16:00:34    HTTP request from 61.54.219.101: GET /default.ida?
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXX%u9090%u685...
```

Three attacks in two seconds

The ICT zoo (malware)

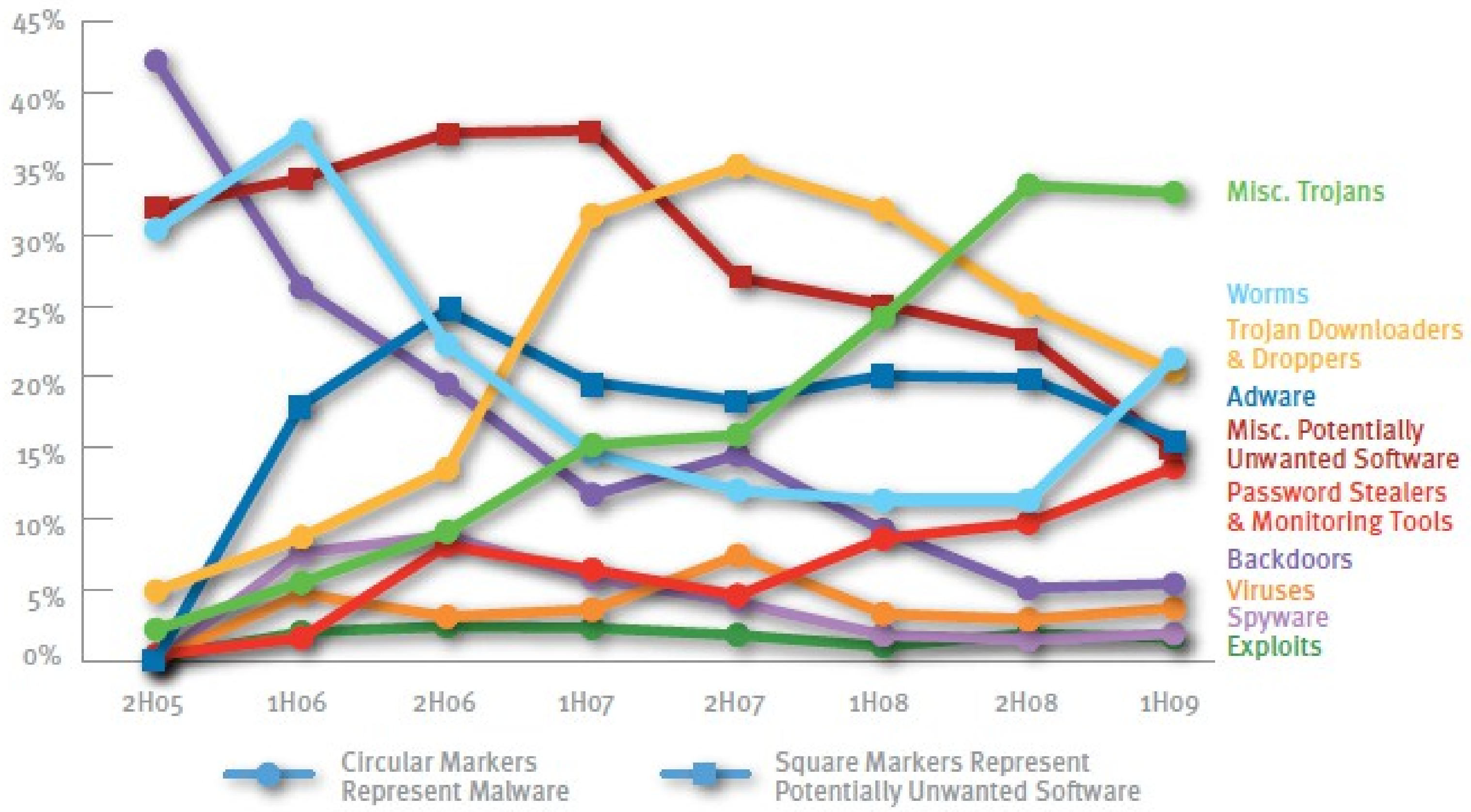
- Virus
- Worm
- Trojan Horse
- Hybrid
- Autonomous Hybrid

Most important problem

In the future

Some statistics

FIGURE 10. Computers cleaned by threat category, in percentages, 2H05–1H09



Virus

- A program that
  - Hides itself in other program or data
  - It is transmitted together with such a program or such data (parasite)
  - Can be activated at a prefined time
  - The behaviour is fully dependent upon the programmer of the virus
- Currently USB keys and devices are the main diffusion mechanisms

Fully automated and mobile attacks

- Worms and virus implements automated attacks and can replicate on other nodes
- Worm=an autonomous program that after successfully attacking another node, creates on this node
  - An instance of the code to attack (infect) other nodes
  - A payload (send spam, steal/update/modify node info)
  - Connect to a C&C and download the payload
  - Domain flux
- The worm attacks any node the infected one can reach
- Genetic diversity is important but multiple versions of a worm may exist

Sapphire/Slammer worm

- 376 byte in one UDP packet
- It exploits a vuln in the SQL server
- An infect node can infect from 100 to 10000 further node in one second
  - The number of infected nodes doubles in 8.5 seconds
  - ≈ 100 times faster than previous worms
- In 10 minutes it has infected 90% of nodes that may have been infected =
  worm attacks will be successful
- More than 75.000 infected nodes

Sapphire/Slammer worm …

- In 10 minutes it has infected 90% of nodes that may have been infected =
  worm attacks will be successful
- Not sure this is a “good” feature
- It creates a lot of “noise” that strongly simplifies attack detection
- “Stealth worm” = slow attack, low amount of noise, difficult detection

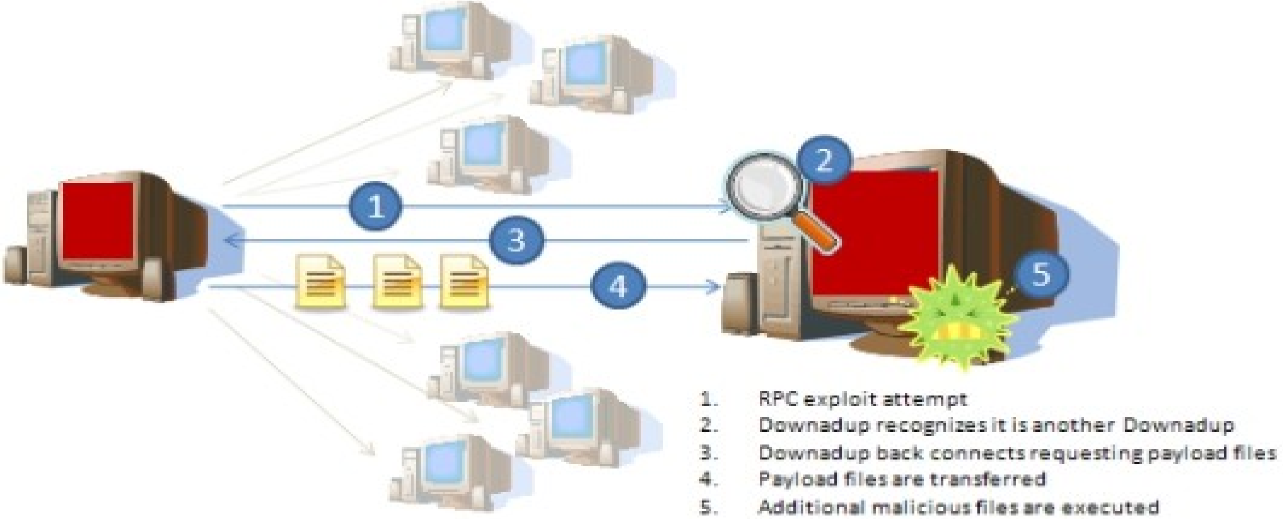
Conficker: an hybrid

- Can attack:

  Windows 2000, Windows XP, Windows Vista, Windows Server 2003, Windows Server 2008, e Windows Server 2008 R2 Beta

- Hybrid as it can exploit: USB device, share and email
- 9 milions system attacked (e.g. English defence dept, french air army, hospitals) in jan. 2009
- 30% of nodes is currently vulnerable
- It can download updates, 5 versions

Conficker vs p2p



1. RPC exploit attempt
2. Downadup recognizes it is another Downadup
3. Downadup back connects requesting payload files
4. Payload files are transferred
5. Additional malicious files are executed

- Let us assume that an infected node is attacked
- The infected node
  - understands that the attacker is a peer (is infected)
  - connects to the attacker and downloads any update

Conficker

- It implements Domain flux by generating alternative domains and nodes in these domains to download the updates
- Input/output connessions are encrypted
- Payload = information collection + creation of a botnet
- Botnet= overlay network including the nodes that have been attacked and controlled by the worm creator rather than by the legal owner

An important point

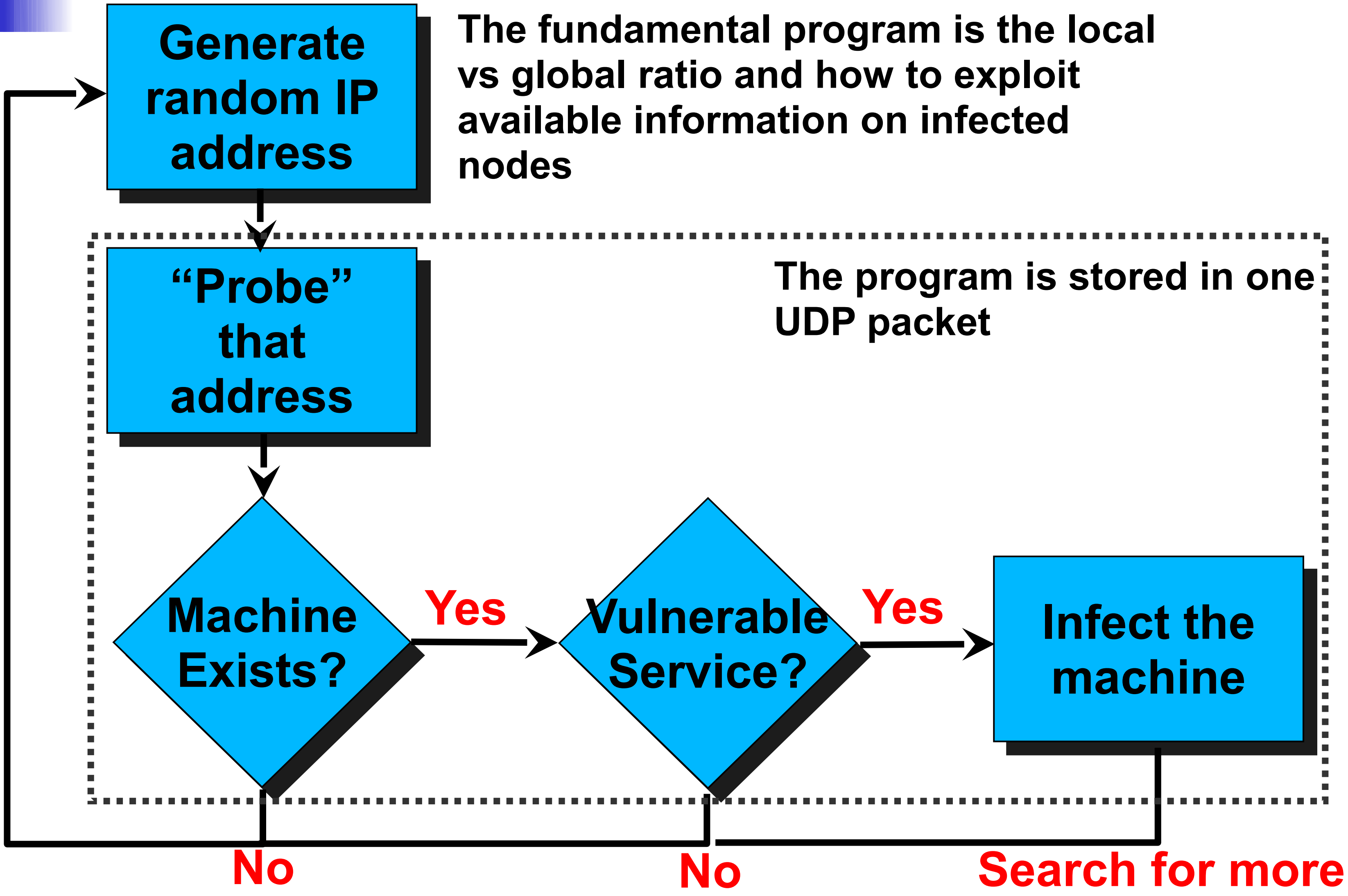
“Whereas a missile comes with a return address, a computer virus generally does not.”

Deterrence and Dissuasion in Cyberspace, J.Ney

The general structure of a worm

The fundamental program is the local vs global ratio and how to exploit available information on infected nodes

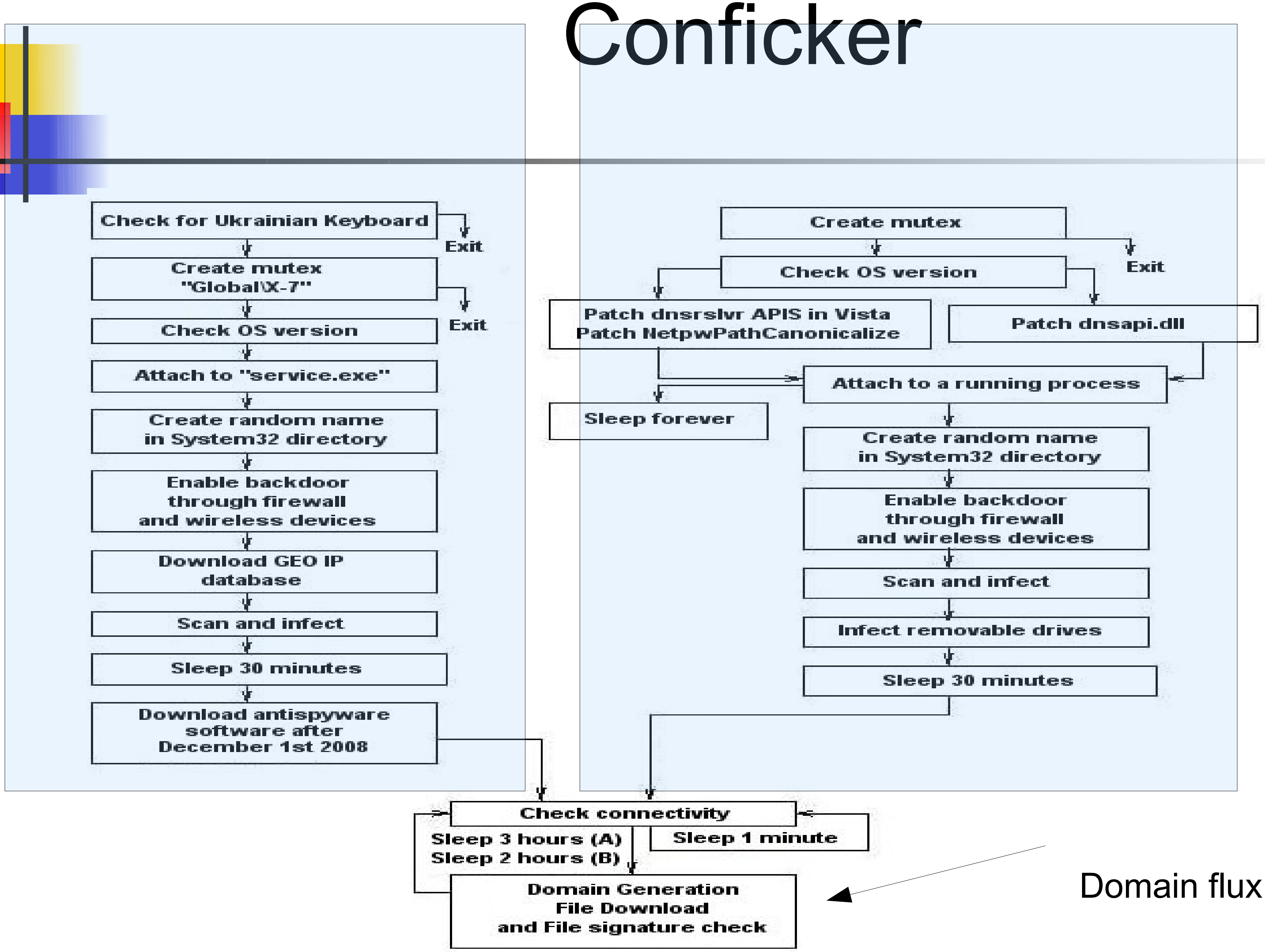
The program is stored in one UDP packet



Conficker

Version A

Version B



Check for Ukrainian Keyboard

Exit

Create mutex "Global\X-7"

Exit

Check OS version

Attach to "service.exe"

Create random name in System32 directory

Enable backdoor through firewall and wireless devices

Download GEO IP database

Scan and infect

Sleep 30 minutes

Download antispyware software after December 1st 2008

Create mutex

Exit

Check OS version

Patch dnsrslvr APIS in Vista
Patch NetpwPathCanonicalize

Patch dnsapi.dll

Attach to a running process

Sleep forever

Create random name in System32 directory

Enable backdoor through firewall and wireless devices

Scan and infect

Infect removable drives

Sleep 30 minutes

Check connectivity

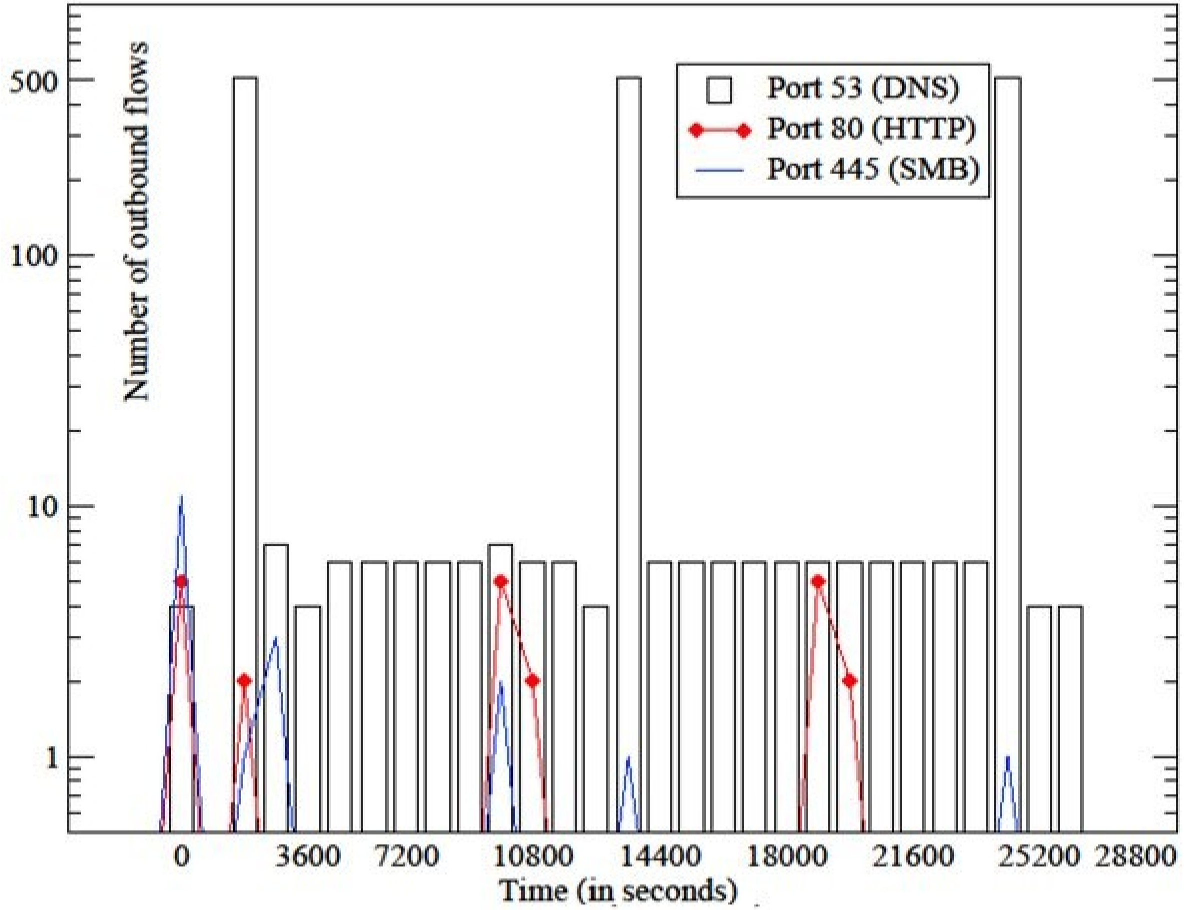
Sleep 3 hours (A)
Sleep 2 hours (B)

Sleep 1 minute

Domain Generation
File Download
and File signature check

Domain flux

Conficker

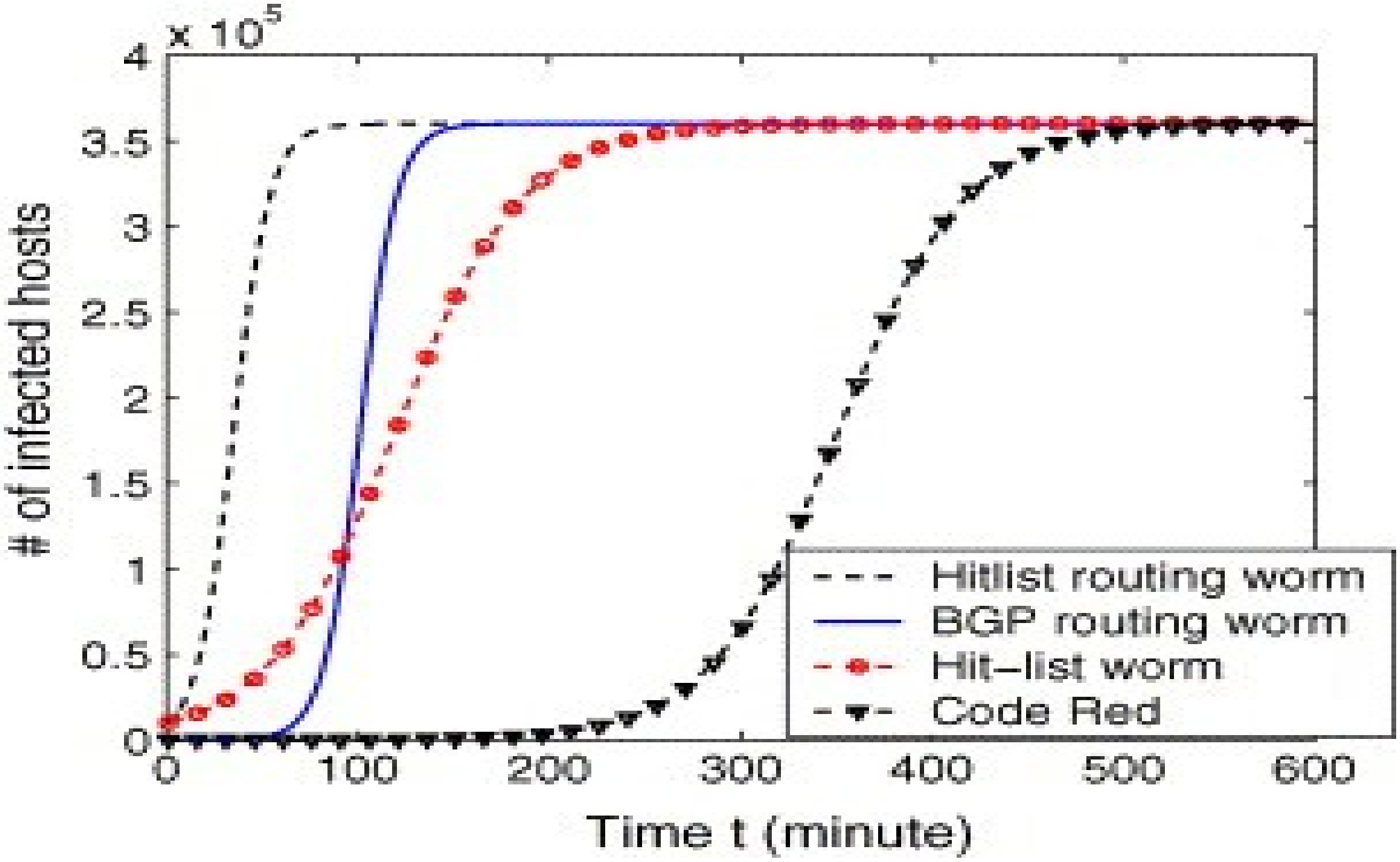


Generation of IP addresses in an infected nodes

Address generation

- Two disjoint subsets
  - Local (high density) = subnet of the infected node
  - Global (low density)
- Density = the probability that a random address belonging to the set corresponds to a real node
- If the ratio of local vs global addresses is too low the worm may be detected and removed before spreading, eg infecting other nodes
- If the percentage is too large, then after infecting all nodes resources are wasted because one node may be infected several times
- Even low changes in the ratio may be very critical, non linear effects

The influence of the ratio



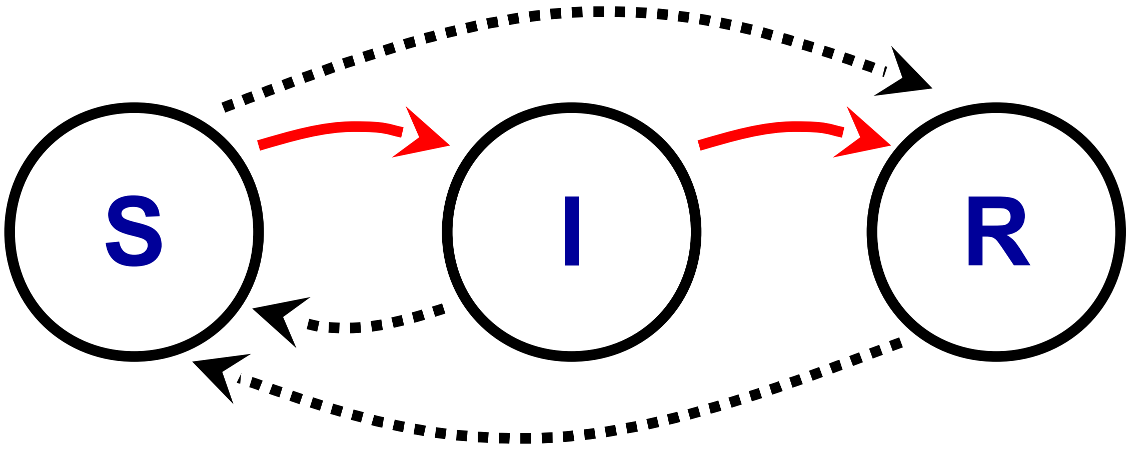
A detection model

- Some proposals aim to detect infected nodes by their anomalous behavior
- High rate of failed connections
- Two thresholds can be introduced
  - Distance on the scanned hosts
  - Frequency of the scanning
- Further features to discover worms
  - New host contacted
  - Unused addresses used

A theoretical spreading model

- Let us discuss a theoretical model to study the spreading of a worm
- The model is epidemiological = it has been defined to evaluate the number of people infected overtime
    - because of a contagious illness
    - in a closed population
    - fully connected population

A finite state model of individual to study the spreading



Model states

- susceptible = Host that may be infected
- Infected = Infected host
- Recovered = Host that cannot be infected

Typical transition sequences (red arrows)

- The host runs the software that is vulnerable (potential).
- The worm has exploited the vuln and successfully attacked the node (infected).
- The infection is detected and the system reconfigured (recovered).

A set of diff equations

Classic epidemiology

- [Kermack and McKendrick, 1927]
- Alll the nodes follows the red paths in the automata (P tlo I, I to R)

$$\frac{\mathrm{d}s}{\mathrm{d}t} = -\beta s i$$

$$\frac{\mathrm{d}i}{\mathrm{d}t} = \beta s i - \gamma i$$

$$\frac{\mathrm{d}r}{\mathrm{d}t} = \gamma i$$

s = potentially infected

i = infected

r = recovered

Beta = *infection rate*

Gamma = recovery rate

Gamma may be neglected in the case of worms because the time to spread is very litte

Kermack and McKendrick model

- β is a function of
  - The function to generate the IP addresses
  - The number of the system affected by the vulns
  - It increase with the virulence
  - The model assume that a node can infected any other node =
    complete connection and no defence
- γ should not be neglected anytime
  - The spreading is rather slow
  - There are some automatic components to detect and remove the infected nodes

Epidemiological threshold

$R_0 = \beta s / \gamma$

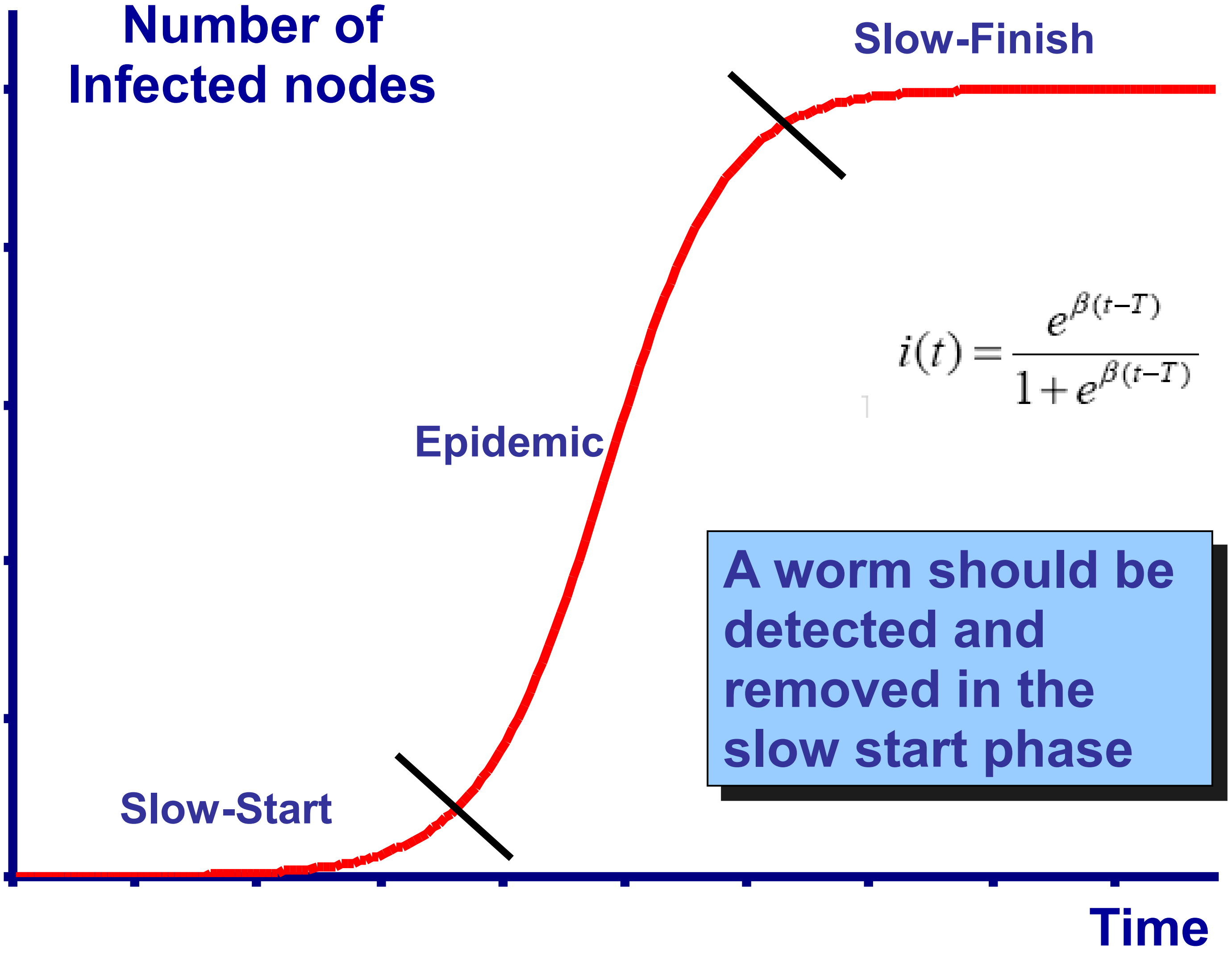
- s= percentage of nodes that may be infected
- It is the average number of nodes infected by an infected node
- If $R_0 > 1$ the worm spreads, otherwise it will be defeated

Solution of the system of diff equations

- No exact solution can be computed
- Anytime the initial number of infected may be neglected (I(0)≅0) then

$$I(t+\Delta t) = I(t) + \rho c S(t)\frac{I(t)}{N}\Delta t - I(t)\gamma\Delta t + o(\Delta t).$$

Solution = logistic function



$$i(t) = \frac{e^{\beta(t-T)}}{1+e^{\beta(t-T)}}$$

A worm should be detected and removed in the slow start phase

A model that consider patching

$dS(t)/dt = -\beta\, S(t)I(t) - dQ(t)/dt$

$dR(t)/dt = \gamma I(t)$

$dQ(t)/dt = \mu S(t)J(t)$ patched

$dJ(t)/dt = I(t)+R(t)$

$S(t) + I(t) + R(t) + Q(t) = N$

There are two reasons why a node is no longer susceptible

1. It has been infected
2. It has been patched

The number of patched nodes is proportional to the susceptible and of infected ones

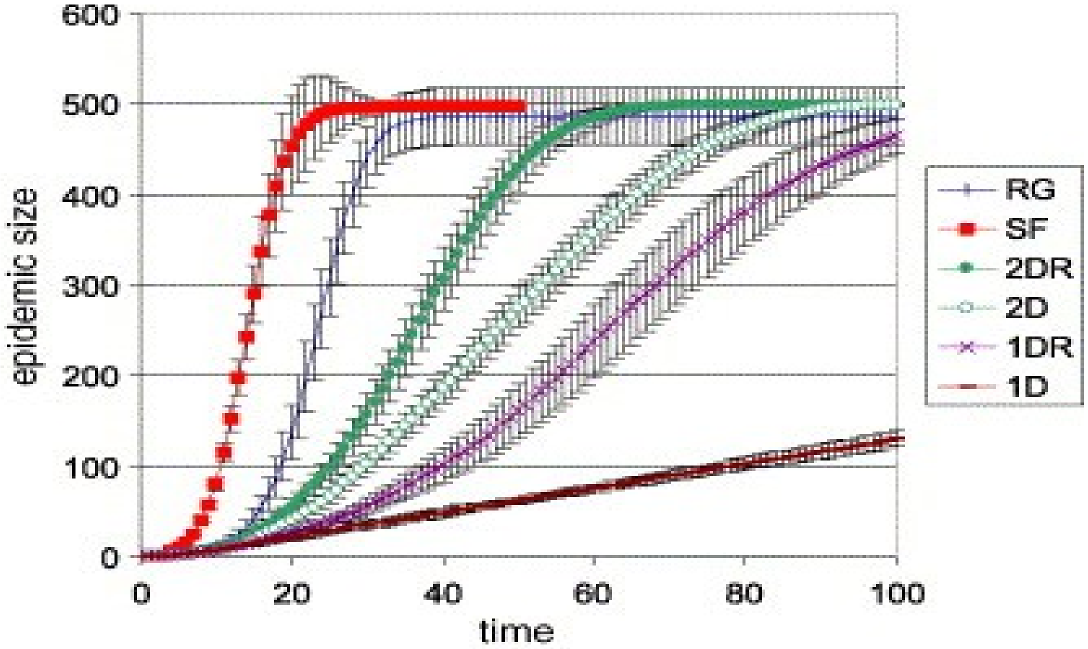
Further interesting models

- Let suppose that there is a partial connection among nodes (scale free, small world, …)
- Initially some nodes are infected
- We would like to know
  - How the connection structure influences the spreading and the parameter R_0
  - How patching (=vaccination) influences the spreading
  - Alternative vaccination strategies
- Several topologies may be be considered to discover how they influence the spreading

Scale free

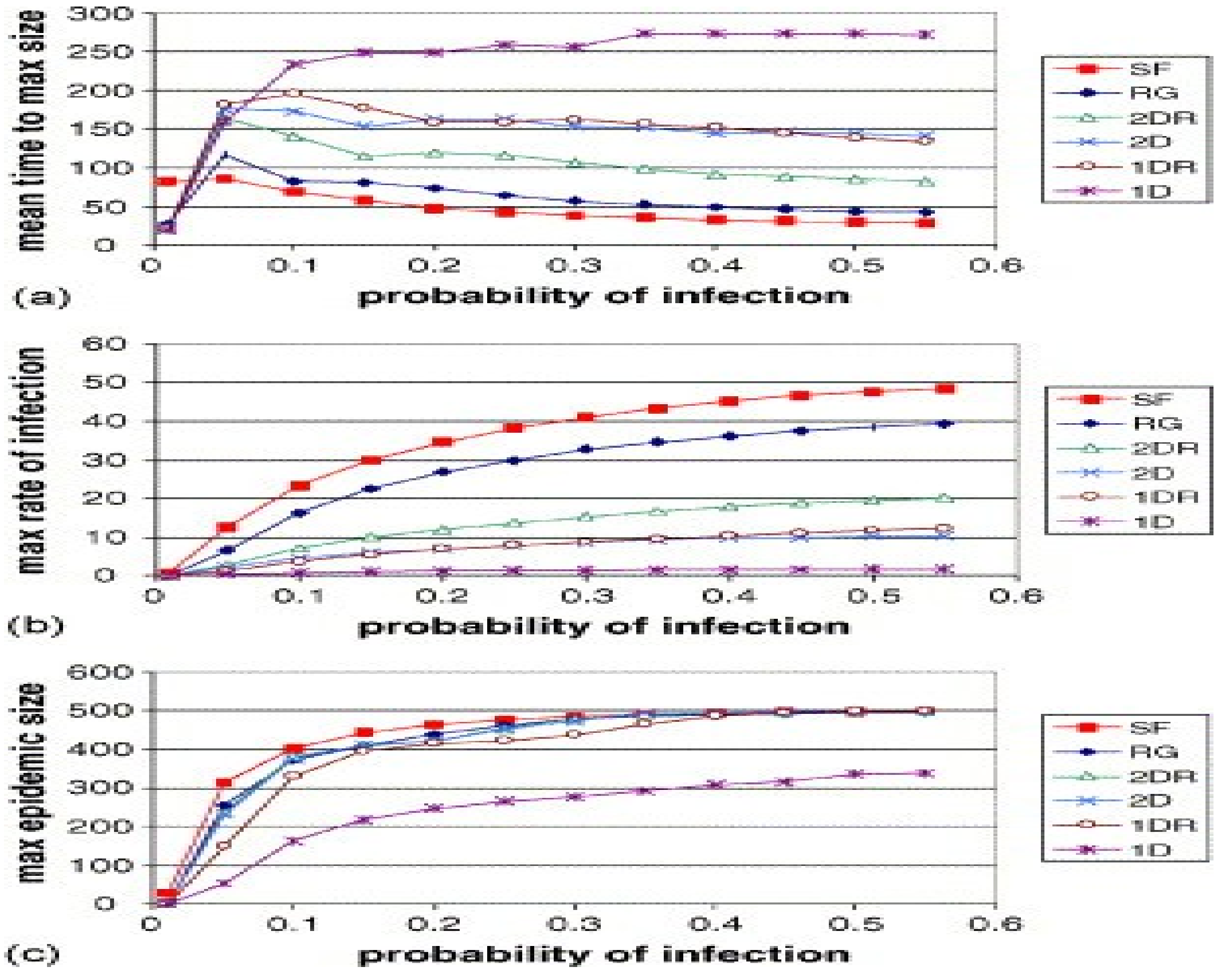
- Scale free
  - When a connection is created, nodes with a larger number of connections are preferred
  - The rich becomes richer
  - There are some network hubs with an exponential increase in the number of their connections
- Very robust with respect to random node attacks, highly fragile with respect to intelligent attacks

Interconnection Topology



RG=random, SF=scale free, 2D= two dimensions lattice,
1D= one dimension lattice 2DR= two dimensions lattice rewired ,
1DR= one dimension rewired

Other interesting values



Average time to max infected

Max infection rate

Number of infected

Computing a worm β

Alpha

$$\beta = \frac{C}{N} \times \frac{\alpha}{\tau}$$

Tau

$$i(t) = \frac{e^{\beta(t-T)}}{1+e^{\beta(t-T)}}$$

C = 1 (a random machine is selected)

C= N (an infected machine is always selected)

N = 2^{32} (size of IP address)

Alpha = number of nodes tested in parallel

Tau =average time for testing a machine

Code red

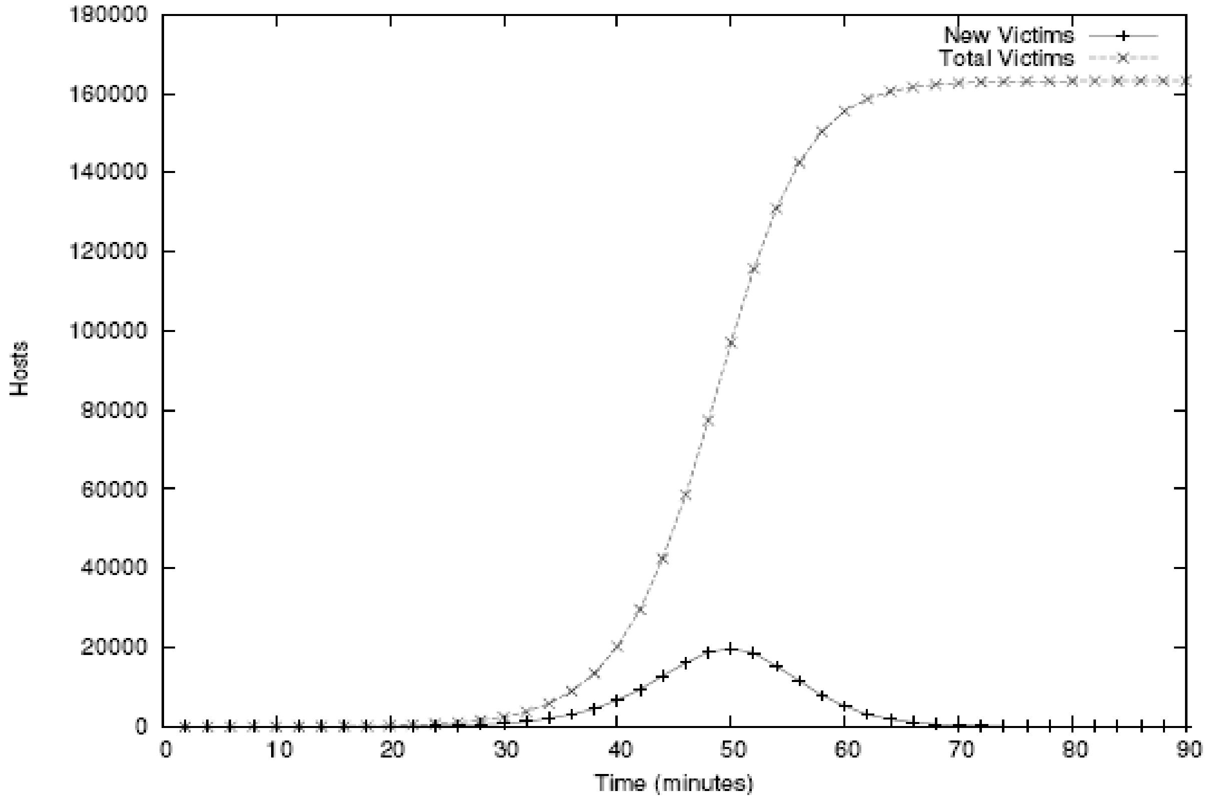
***Tau* = 19 seconds**

***Alpha* = 100**

$$\beta = \frac{1}{2^{32}} \times \frac{100}{19} = 1.23 \times 10^{-9}$$

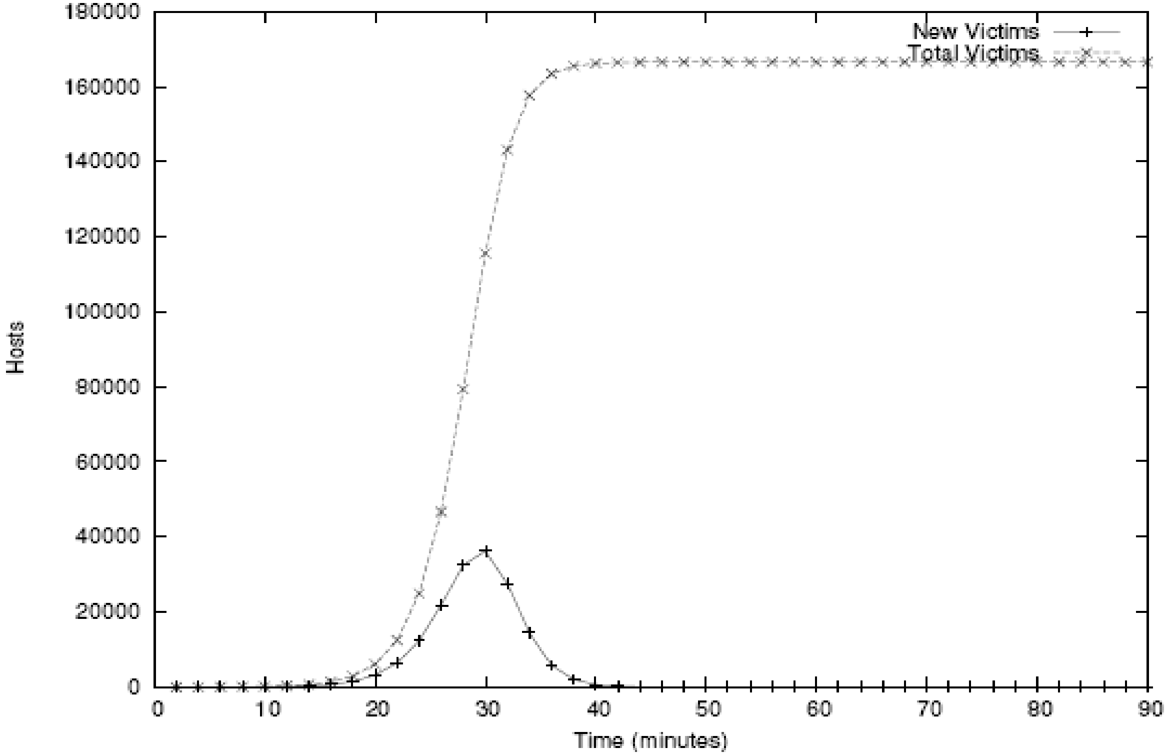
Good approximation

Spreading - I



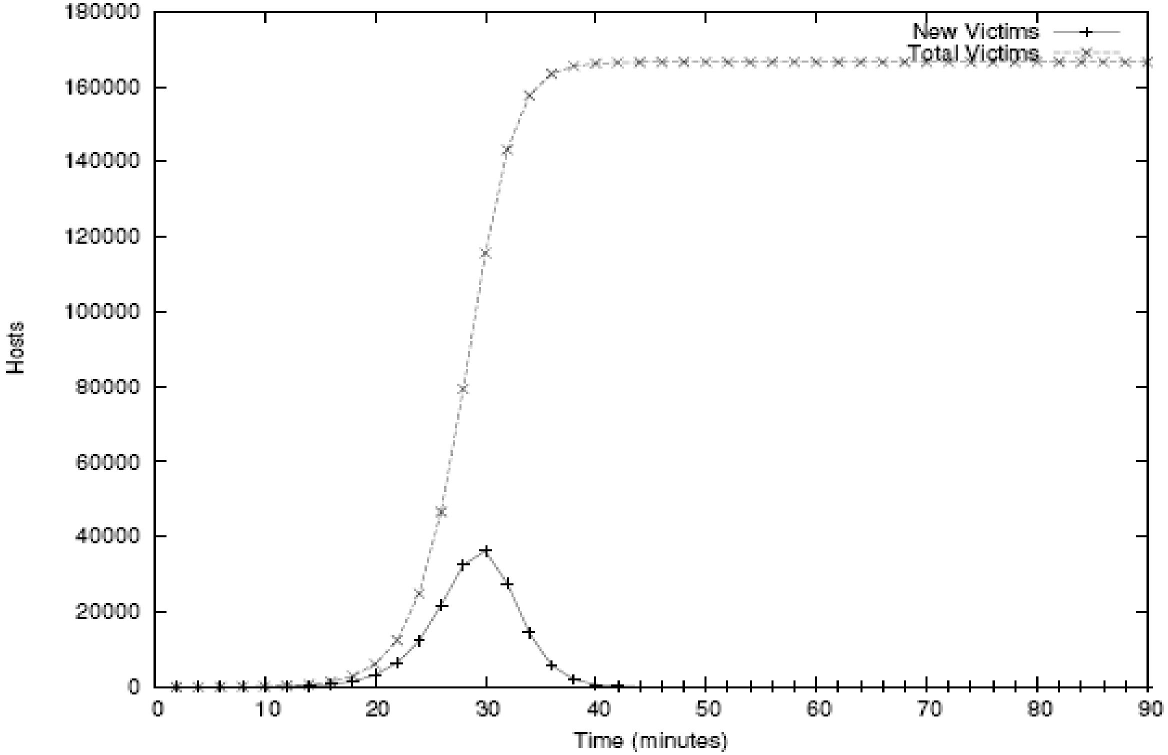
10 parallel threads and conflicts on nodes to be infected are neglected

Spreading - II



Optimization of the time out to detect that no node has the IP address that has been generated

Spreading - II



Optimization of the time out to detect that no node has the IP address that has been generated

Spreading - III

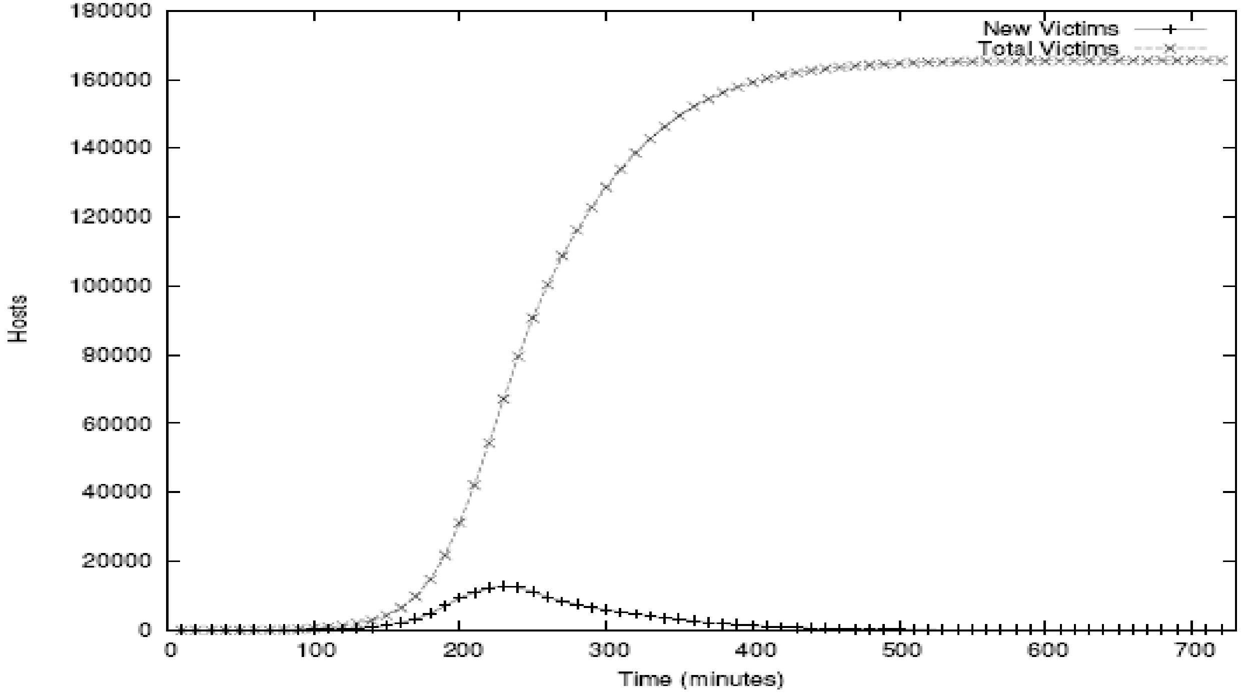


Figure 7: Local preference propagation

Local bias in the generation

Spreading - IV

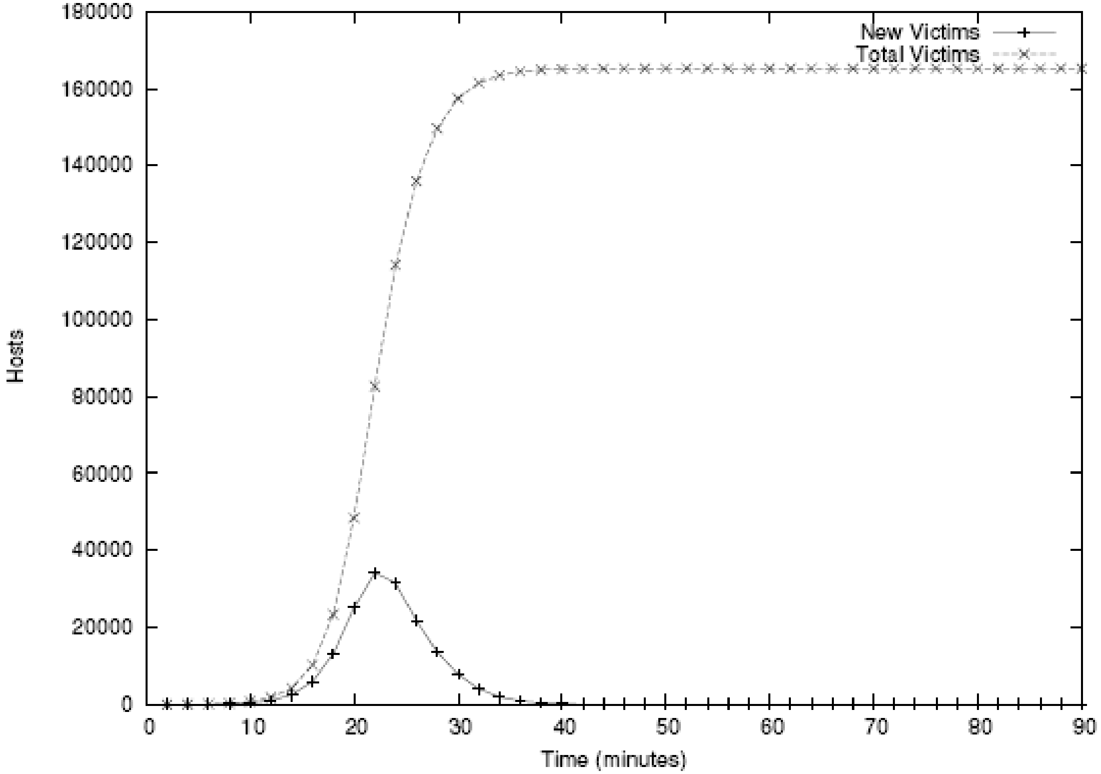
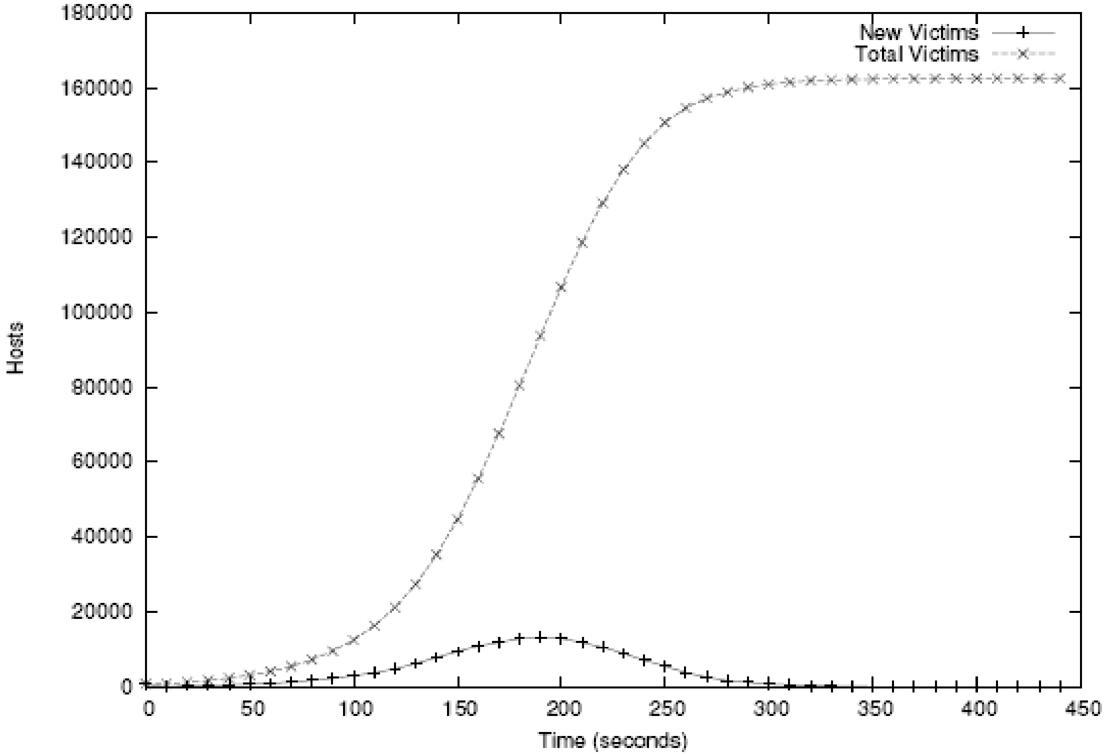


Figure 8: Local preference with multi-threading and short timeouts

Spreading - V



- prescan to find better subspaces to generate IP addresses and with a large number of susceptible nodes
- Infected nodes are remembered and neglected
- multithread

Local vs global

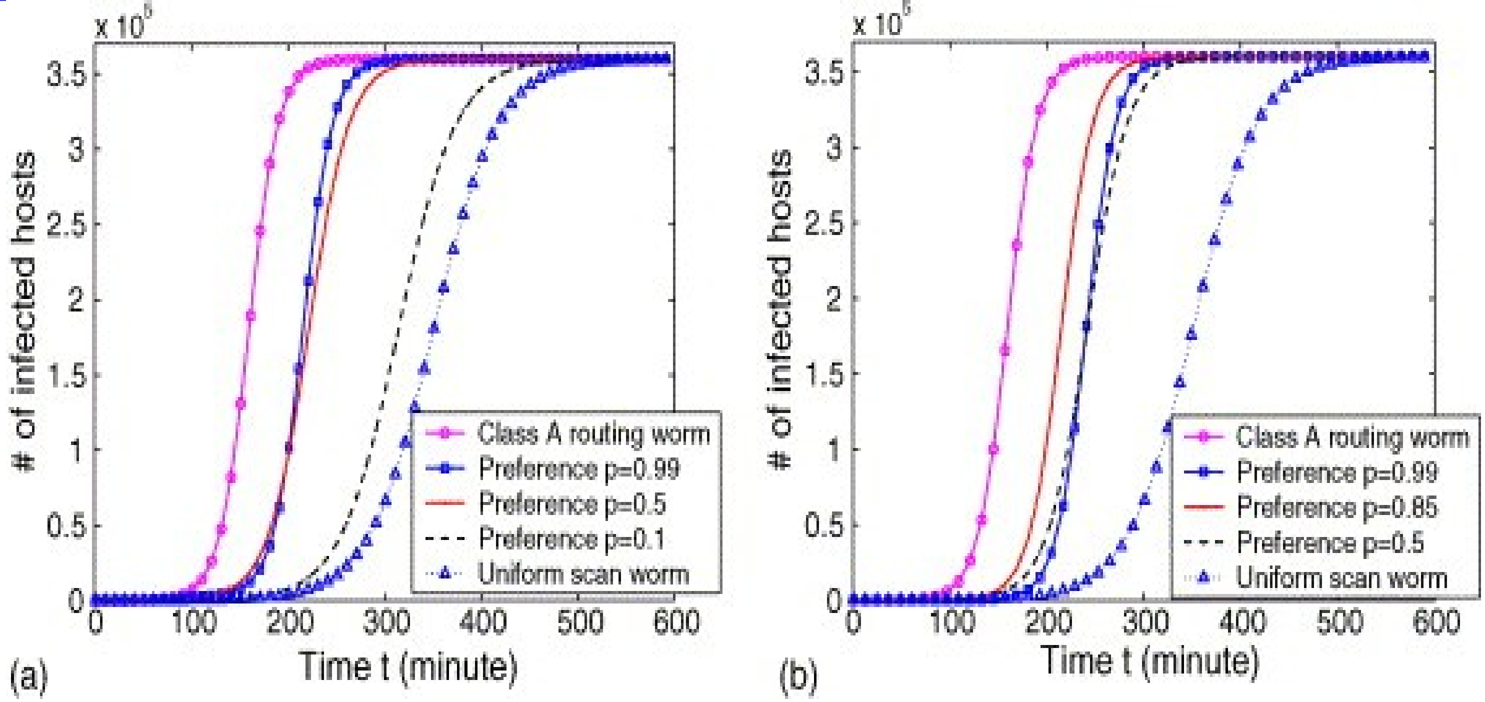
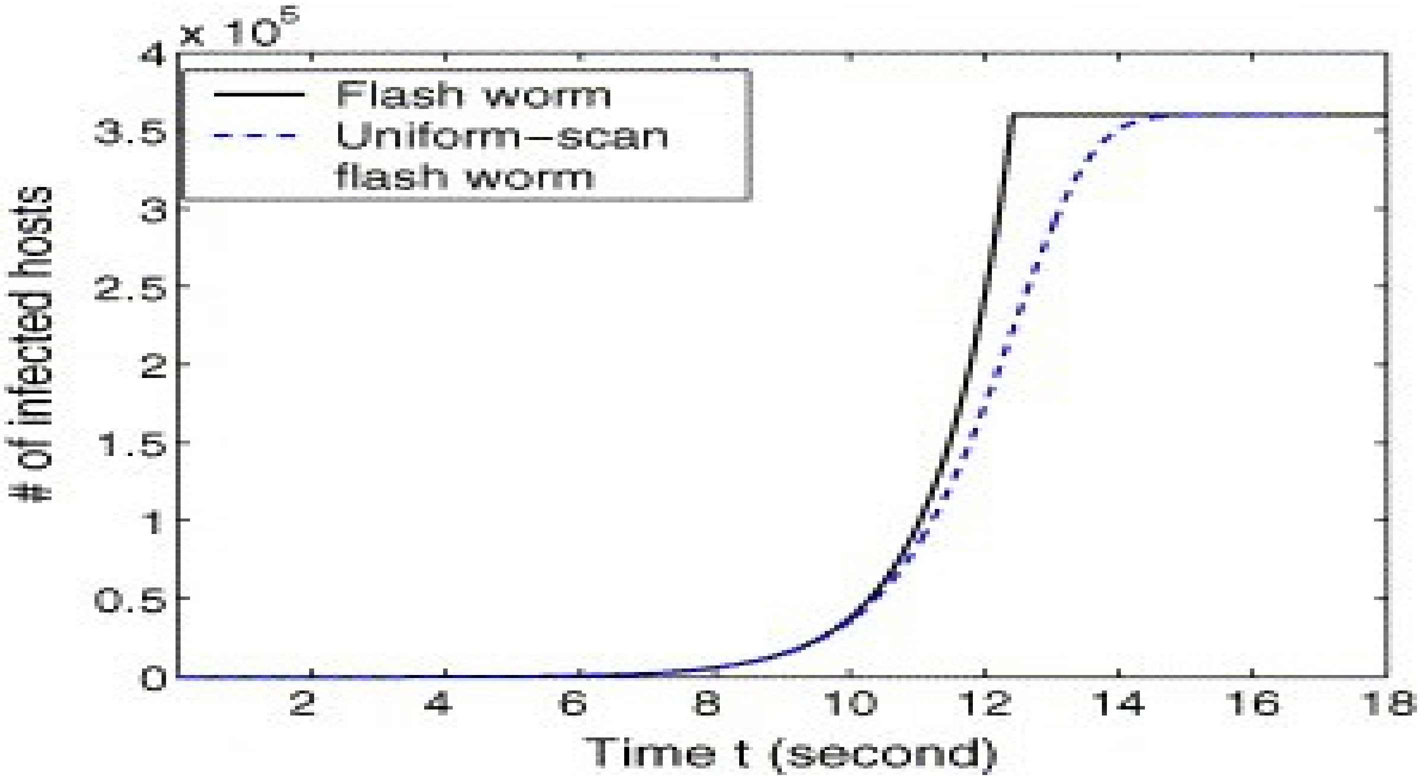


Fig. 5. Comparison of Code Red, a /8 routing worm, a local preference worm with different preference probabilities p.

(a) Local preference scan on “/8” network level (K=256, m=116).

(b) Local preference scan on “/16” network level (K=65,536, m=29,696).

Extreme optimization



The time scale has changed

Which address space?

- Some worms consider IP addresses
  - ⇒ Any node can infect any other nodes
  - ⇒ The addresses that are generated depend upon the adopted function and not upon the interconnection
- Some worms consider logical addresses, ie the email addresses
  - ⇒ A node can infect only nodes it already knowns
  - ⇒ The interconnection structure that has to be considered is the logical one

Trojan horse

- A program that has a different goal from the expected one
- Its main goal is to implement a backdoor to enable illegal accesses to the system
- Malware

Hybrid

- Most malware current integrates all the previous behavior
- Software with an opportunistic approach to spread to other nodes
  - Usb
  - Share
  - Mail
  - Attack
  - ....

Autonomous Hybrid

- They can transmit themselves to other nodes without exploiting the node resources
- Even if the node does not exchange email, it can
  - Trasmit email from the node
  - Hide in the mail

Symantec Global Internet Security Threat Report 2009

in 2008, there were six trojans in the top 10 new malicious code families detected. ***Three of the six trojans include a back door component and one includes a virus component.***
The remaining four families consist of worms,
one has a back door component and one has a virus component.

The previous edition of the Report noted that the prevalence of trojans is indicative of multistage attacks.
A multistage attack typically involves an initial compromise,followed by the installation of an additional piece of malicious code, such as a trojan that downloads and installs adware. As was the case in 2007, during this reporting period, five of the top 10 new malicious code families that were identified download additional threats.