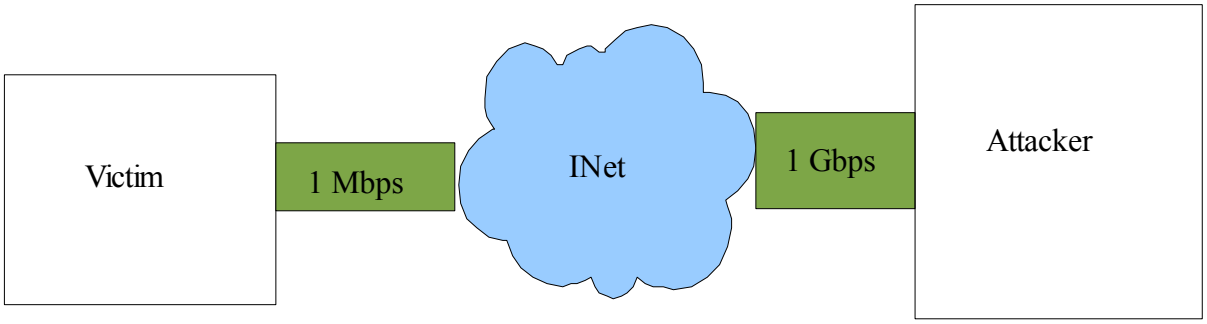
DENIAL OF SERVICE ATTACKS (Lecture on 4/17/07)

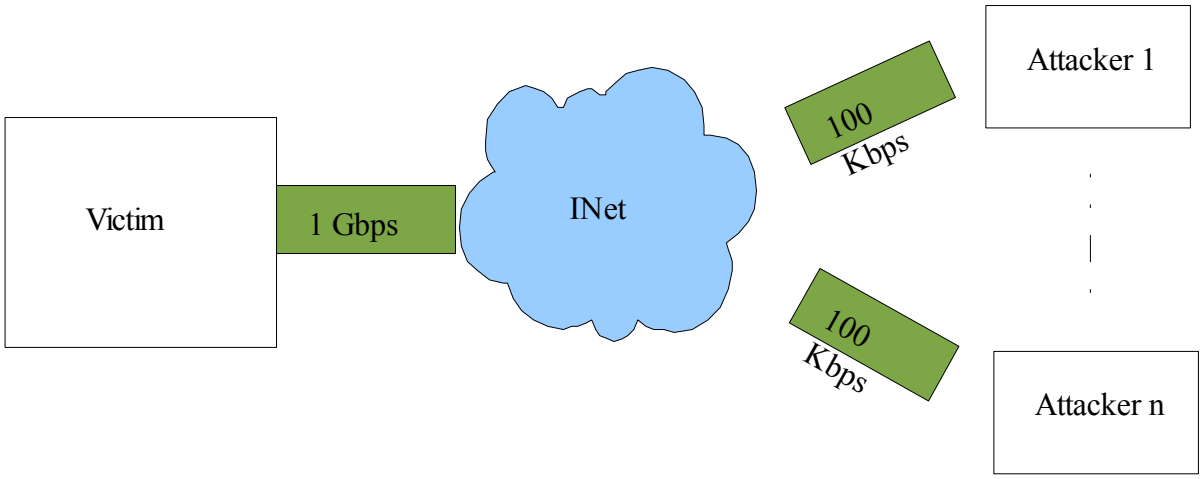
- Crashing Program
- Resource Exhaustion
  - Network Bandwidth
  - Memory
  - OS Resources (File Descriptors)
  - Disk
  - CPU

Some Network DoS attacks:



The attacker floods the victim with requests that overwhelm the victim's b/w resource

When victim has greater b/w than the attacker

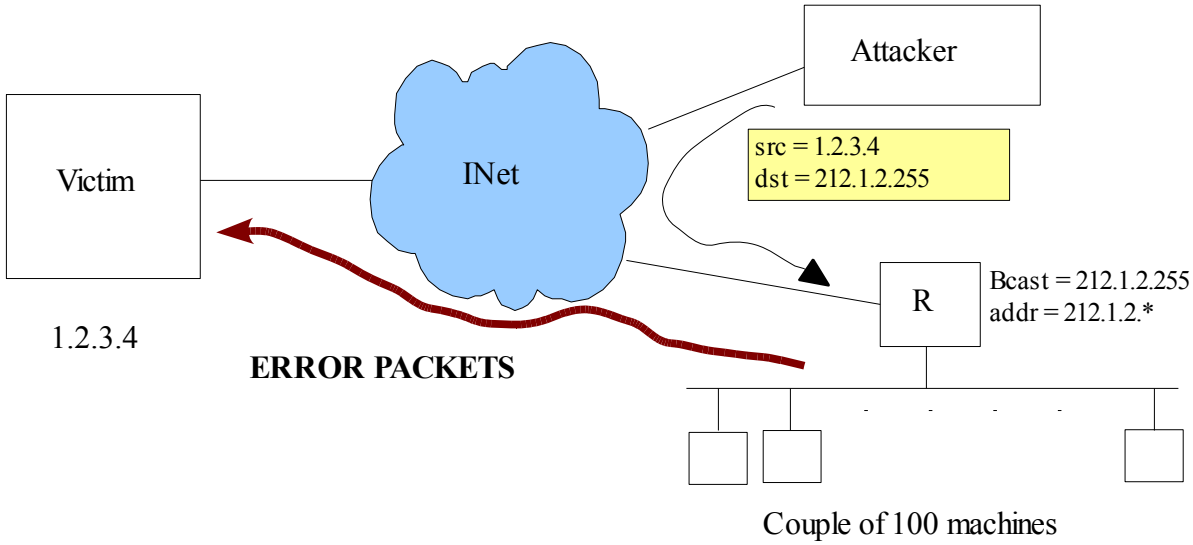


The attacker machines (also called zombies, bots or slaves) are obtained by exploiting some vulnerability and spreading worms

NOTE: More attacker machines => harder to distinguish attacker

An 'Old School' attack – *SMURF*

In all the bandwidth DoS attacks the attacker needs to somehow escalate its bandwidth to beat the victim (if the attacker doesn't have sufficient b/w). SMURF was an old trick that no longer works thanks to good network administration policies which do not allow broadcast packets from hosts outside the LAN.

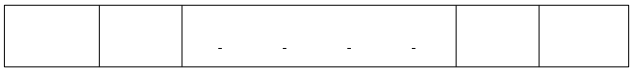


SMURF attack: Gives 200 times bandwidth !

CPU DoS

- Algorithmic Complexity Attacks

  Example: Hash Table



  i = hash(x)

  append(hashtable[i], x)

  - hash function is typically fixed and public
  - easy for an attacker to find collisions

    Attack:

    1. Choose many inputs $x_1, x_2, ..., x_n$ that all hash to 0.
    2. Interact with the server to cause it to insert $x_1, x_2, ..., x_n$ into its hash table
    3. Force the server to do "H.T. Lookups".

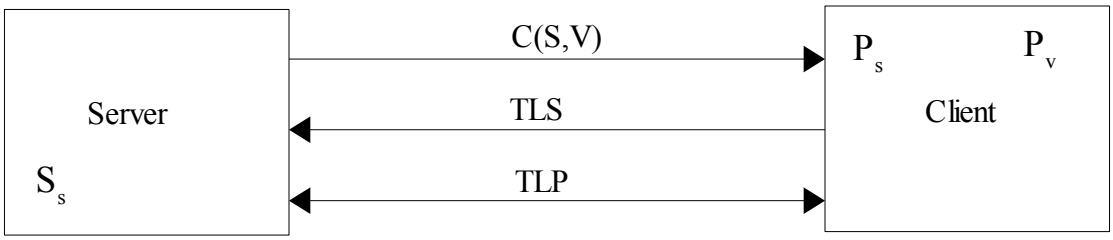
       Idea is to bridge the gap between average case complexity and the worst case complexity.

  A similar attack can be devised for binary trees (making them unbalanced)

  Solution: Use a randomized hash function (that takes a random seed upon initialization).

[READ Universal Hash Functions]

TLS/SSL (CPU DoS)

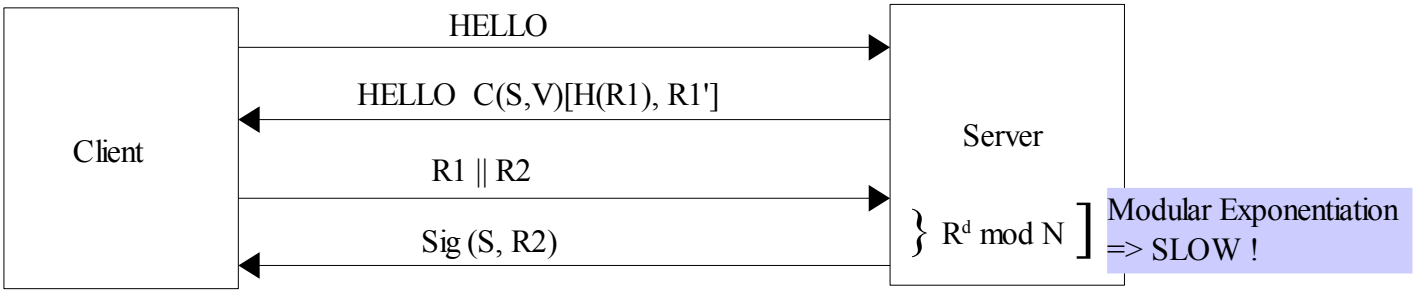


v : Could be a third party such as Verisign

C(S,V) : Certificate of the server

TLS Guarantees:

- Secrecy
- Authenticity
- Server Identity



Client:

1. Verify Certificate and find R1
2. Send R1 and R2 (a new random number for signature verification)
3. Verify signature

R1' is the first few bits (say 64) of R1.

- Modular Exponentiation in software
- Typical Desktop ≈ 100 modular exponentiations per sec
- Couple of 100 challenges (R2s) and server slows down a lot.

NOTE: R1 is optional (for backward compatibility)

CLIENT PUZZLES

Problems:

- Doesn't distinguish real from attacks
- Must be configured per system
- Discriminate against slow clients

With puzzles the attacker needs to have at least as much MIPS as the server for launching an attack.