Attack Trees: What Are They?

- A way of thinking and describing security of systems and subsystems.
- A way of building an automatic database that describes the security of a system.
- A way of capturing expertise, and reusing it.
- A way of making decisions about how to improve security, or the effects of a new attack on security.

Attack Trees: How Do They Work?

- Represent the attacks and countermeasures as a tree structure.
- Root node is the goal of the attack.
  - In any complex system, there are several root nodes, each representing a different goal.
- Leaf nodes are attacks.

Boolean Node Values

- Once a tree is created, different values can be assigned to the leaf nodes.
- The simplest of these values are boolean: possible vs. impossible, for example.

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Other Boolean Node Values

- Any Boolean value can be codified in the leaf nodes and then used to prune the tree.
  - Easy and not easy.
  - Expensive and not expensive.
  - Intrusive and non-intrusive.
  - Legal and illegal.
  - Special equipment required and not required.

Combining Node Values

- Each node can have several values: Boolean and continuous.
- Can be used to make statements about attacks.
- For example:
  - Cheapest low-risk attack
  - Most likely non-intrusive attack
  - Best low-skilled attack
  - Cheapest attack with the highest probability of success

Tree Construction

- Step 0) Identify goals. Each goal is a separate attack tree.
- Step 1) Identify attack against goals; repeat as necessary.
- Step 2) Existing attack trees can be plugged in as appropriate.
- In general, once you have a library of general attack trees, you can create a specific tree out of these reusable components after the first couple of levels.

Using an Attack Tree to Determine the Vulnerability of a System Against an Attack

- After building an attack tree, an analyst can look at the value of the root node to see if the system goal is vulnerable to attack.
- For example, the presence of a possible Boolean value or an attacker's cost below a certain threshold.
- The analyst can also determine if the system is vulnerable to a particular type of attack.
  - Password guessing attacks, legal attacks, unskilled attacks, etc.

Using an Attack Tree to List the Security Assumptions of a System

- The attack tree can also be used to provide a comprehensive list of the assumptions of a security system.
  - For example, the security of this system assumes that no one can successfully bribe the president of our corporation.

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Using an Attack Tree to Compare and Rank Attacks

- In a similar manner, different attack (or defense) scenarios can be compared and ranked (based on their respective root node values) in order of most likely to succeed.

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What Else? (cont.)

- Attack trees can compare:
  - Effects of various countermeasures.
  - Security of different products.
- Attack trees can show:
  - What assumptions security is based on.
  - What happens when those assumptions are broken.
  - How to best use a security budget.

Scalability

- Attack trees become part of larger attack trees.
  - Attack tree against safe is part of a larger attack tree, whose goal is to read a document.
  - Attack tree against PGP is part of a larger attack tree, whose goal is to read a particular file.
- You can read the results of an attack tree without understanding its details.

Scalability (cont.)

- Changes at lower levels automatically propagate.
  - A new attack against PGP automatically affects the security of any tree that has PGP as a component.
  - A new attack against an encryption algorithm likewise propagates up.
- Subtrees are reusable components.
  - The PGP tree works everywhere PGP is used.

Conclusions

- In many systems, applying security measures is like sticking a tall spike in the ground and hoping that the enemy runs right into it.
- Attack trees are a methodology to ensure that security is a broad palisade.
- Attack trees are a rigorous way to think about security.
- Attack trees work.