Accountability and Freedom

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Real-World Security

- It's about risk, locks, and **deterrence**.
  - Risk management: cost of security < expected loss
    - Perfect security costs way too much
  - Locks good enough that bad guys break in rarely
  - Bad guys get caught and punished enough to be **deterred**, so police / courts must be good enough.
  - Can recover from damage at an acceptable cost.
- Internet security similar, but **little accountability**
  - Can't identify the bad guys, so can't deter them

How Much Security

- Security is costly—buy only what you need
  - You pay mainly in inconvenience
  - If there's no punishment, you pay a lot
- People *do* behave this way
- We don't *tell* them this—a big mistake
- *The best is the enemy of the good*
  - Perfect security is the worst enemy of real security
- **Feasible security**
  - Costs less than the value it protects
  - Simple enough for users to manage
  - Simple enough for vendors to implement

Causes of Security Problems

- Exploitable bugs
- Bad configuration
  - TCB: Everything that security depends on
    Hardware, software, and **configuration**
  - Does formal policy say what I mean?
    - Can I understand it? Can I manage it?

- Why least privilege doesn't work
  - Too complicated, can't manage it

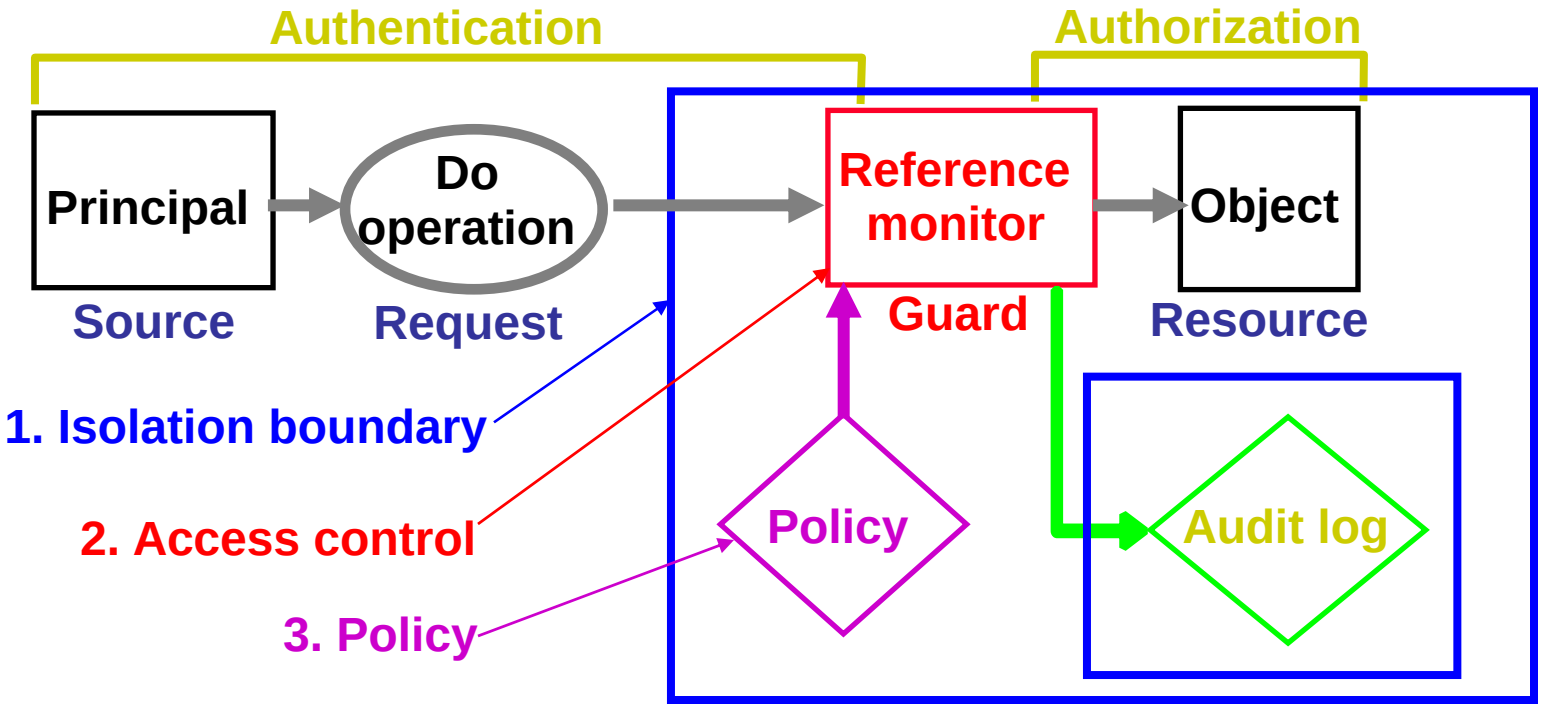
The unavoidable price of reliability is simplicity
—Hoare

Defensive strategies

- **Locks**: Control the bad guys
  - Coarse: Isolate—keep everybody out
  - Medium: Exclude—keep the bad guys out
  - Fine: Restrict—Keep them from doing damage
    Recover—Undo the damage
- **Deterrence**: Catch bad guys, punish them
  - Auditing, police, courts or other penalties

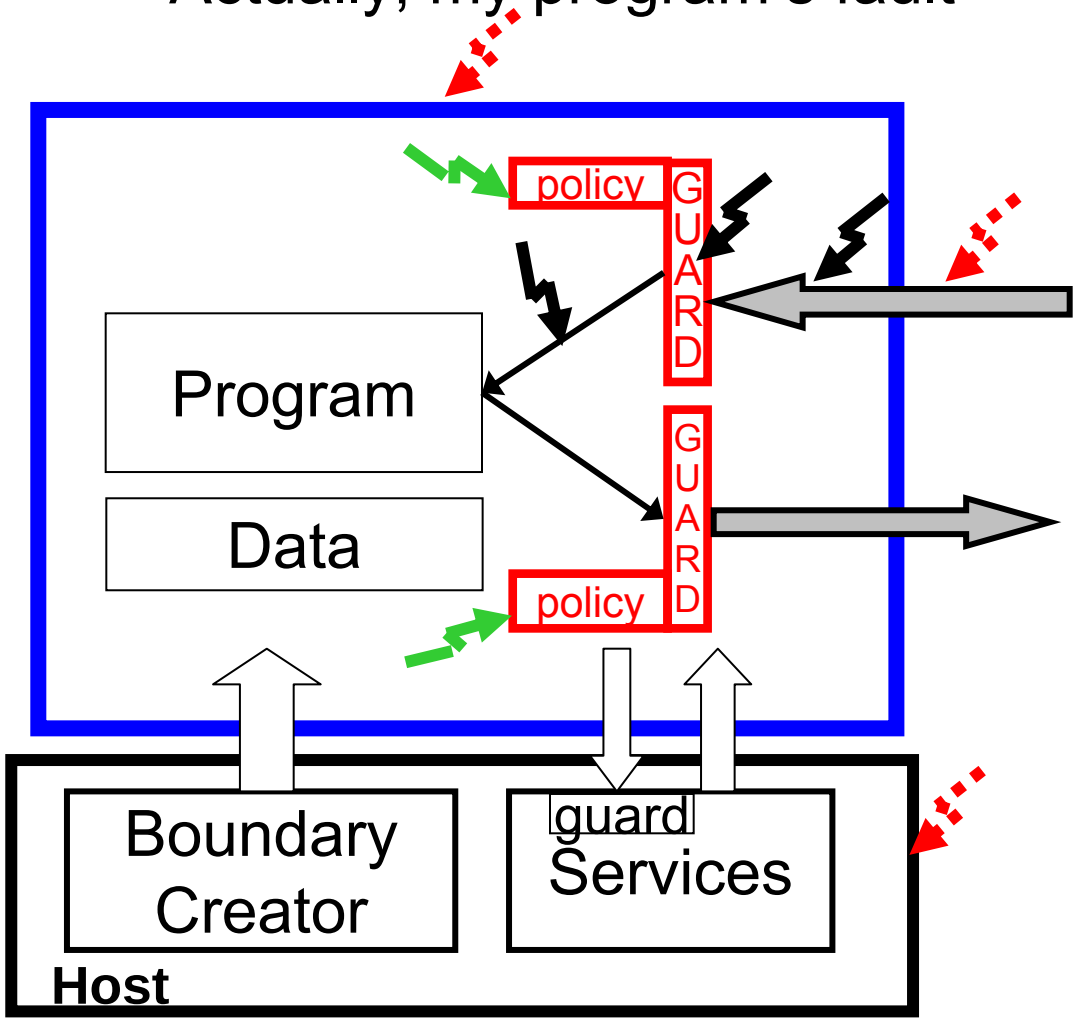
The Access Control Model

1. **Isolation Boundary** to prevent attacks outside access-controlled channels
2. **Access Control** for channel traffic
3. **Policy** management

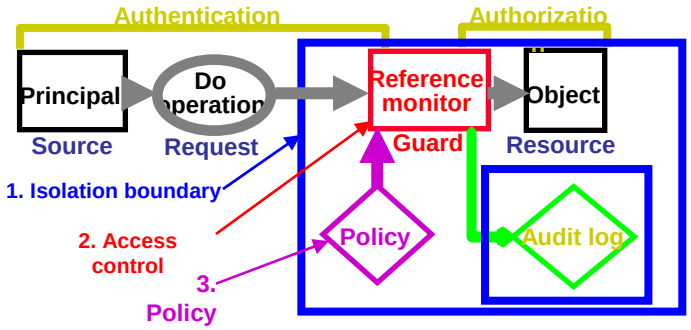


Isolation

- I am isolated if anything that goes wrong is my fault
  - Actually, my program's fault



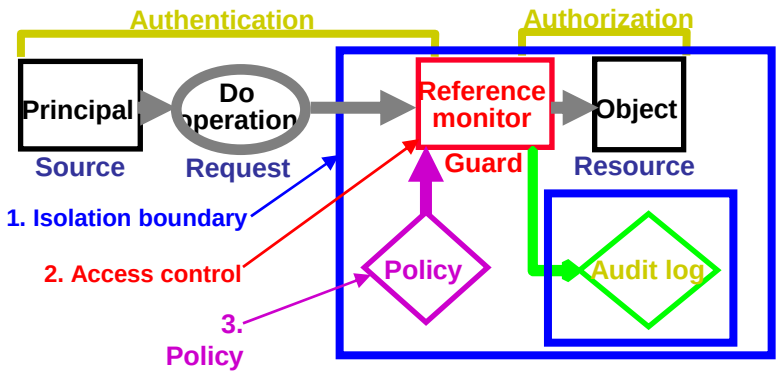
- Attacks on:
  - Program
  - Isolation
  - Policy



Access Control Mechanisms: The Gold Standard

- **Authenticate** principals: Who made a request
  - Mainly people, but also channels, servers, programs (encryption implements channels, so key is a principal)
- **Authorize** access: Who is trusted with a resource
  - *Group* principals or resources, to simplify management
    - Can define by a property, e.g. “type-safe” or “safe for scripting”
- **Audit**: Who did what when?

- *Lock = Authenticate + Authorize*
- *Deter = Authenticate + Audit*



Making Isolation Work

- Isolation is imperfect: Can't get rid of bugs
  - TCB = 10-50 M lines of code
  - Customers want features more than correctness
- Instead, don't tickle them.
- How? Reject bad inputs
  - Code: don't run or restrict severely
  - Communication: reject or restrict severely
    - Especially web sites
  - Data: don't send; don't accept if complex

Accountability

- Can't identify bad guys, so can't deter them
- Fix? End nodes enforce accountability
  - Refuse messages that aren't accountable enough
    - or strongly isolate those messages
  - Senders are accountable if you can punish them
  - *All trust is local*
- Need an ecosystem for
  - Senders becoming accountable
  - Receivers demanding accountability
  - Third party intermediaries
- To stop DDOS attacks, ISPs must play

Enforcing Accountability

- Not being accountable enough means end nodes will reject inputs
  - Application execution is restricted or prohibited
  - Communication is restricted or prohibited
  - Information is not shared or accepted
  - Access to devices or networks is restricted or prohibited

For Accountability To Work

- Senders must be able to make themselves accountable
  - This means pledging something of value
    - Friendship
    - Reputation
    - Money
    - …
- Receivers must be able to check accountability
  - Specify what is accountable enough
  - Verify sender's evidence of accountability

Accountability vs. Access Control

- “In principle” there is no difference

  but
- Accountability is about punishment, not locks
  - Hence audit is critical
- Accountability is very coarse-grained

The Accountability Ecosystem

- Identity, reputation, and indirection services
- Mechanisms to establish trust relationships
  - Person to person and person to organization
- A flexible, simple user model for identity
- Stronger user authentication
  - Smart card, cell phone, biometrics
- Application identity: signing, reputation

Accountable Internet Access

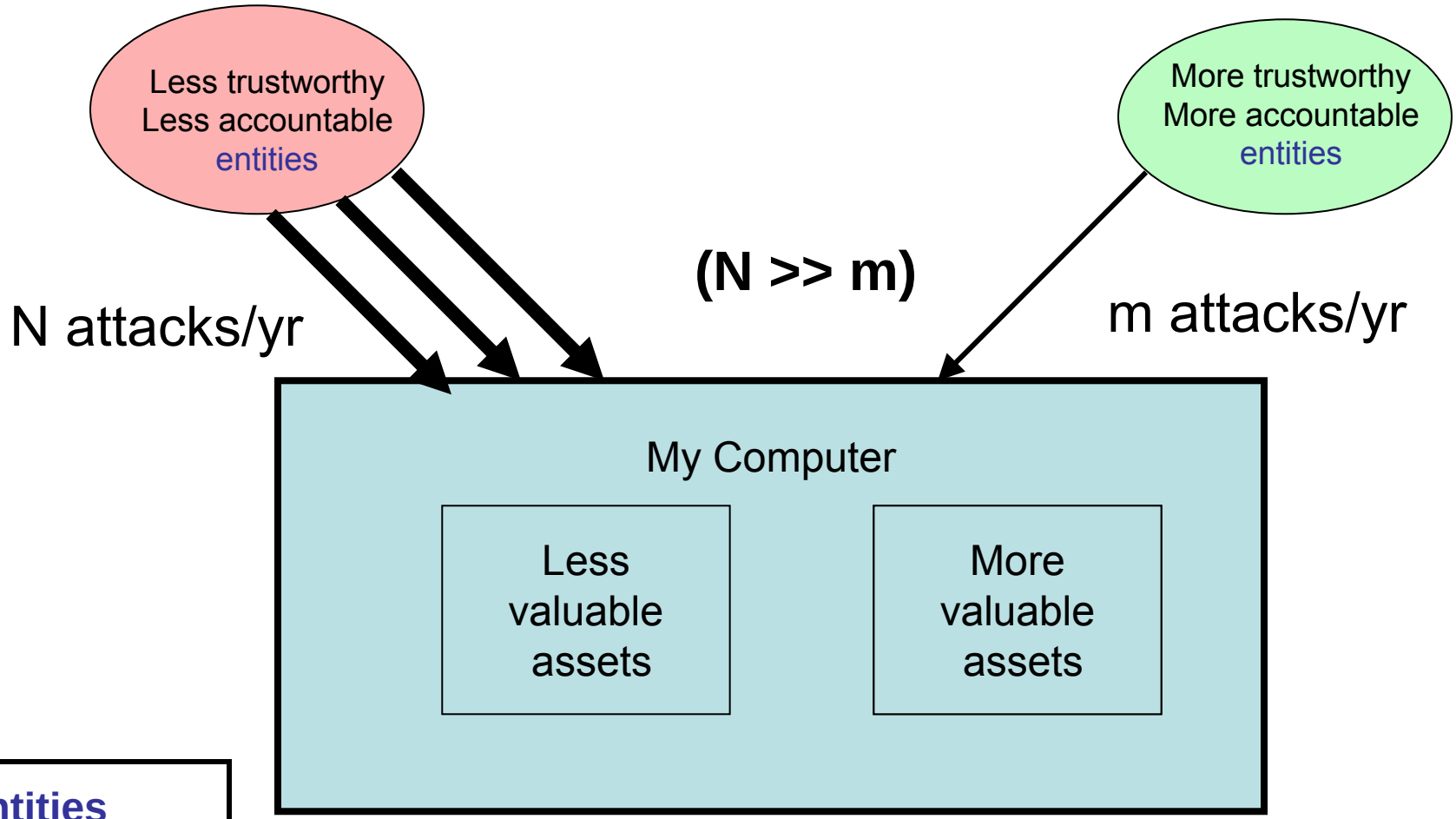
- Just enough to block DDoS attacks
- Need ISPs to play. Why should they?
  - Servers demand it; clients don't get locked out
  - Regulation?

- A server asks its ISP to block some IP addresses
- ISPs propagate such requests to peers or clients
  - Probably must be based on IP address
  - Perhaps some signing scheme to traverse unreliable intermediaries?
- High priority packets can get through

Accountability vs. Freedom

- Partition world into two parts:
  - Green Safer/accountable
  - Red Less safe/unaccountable
- Two aspects, mostly orthogonal
  - User Experience
  - Isolation mechanism
    - Separate hardware with air gap
    - VM
    - Process isolation

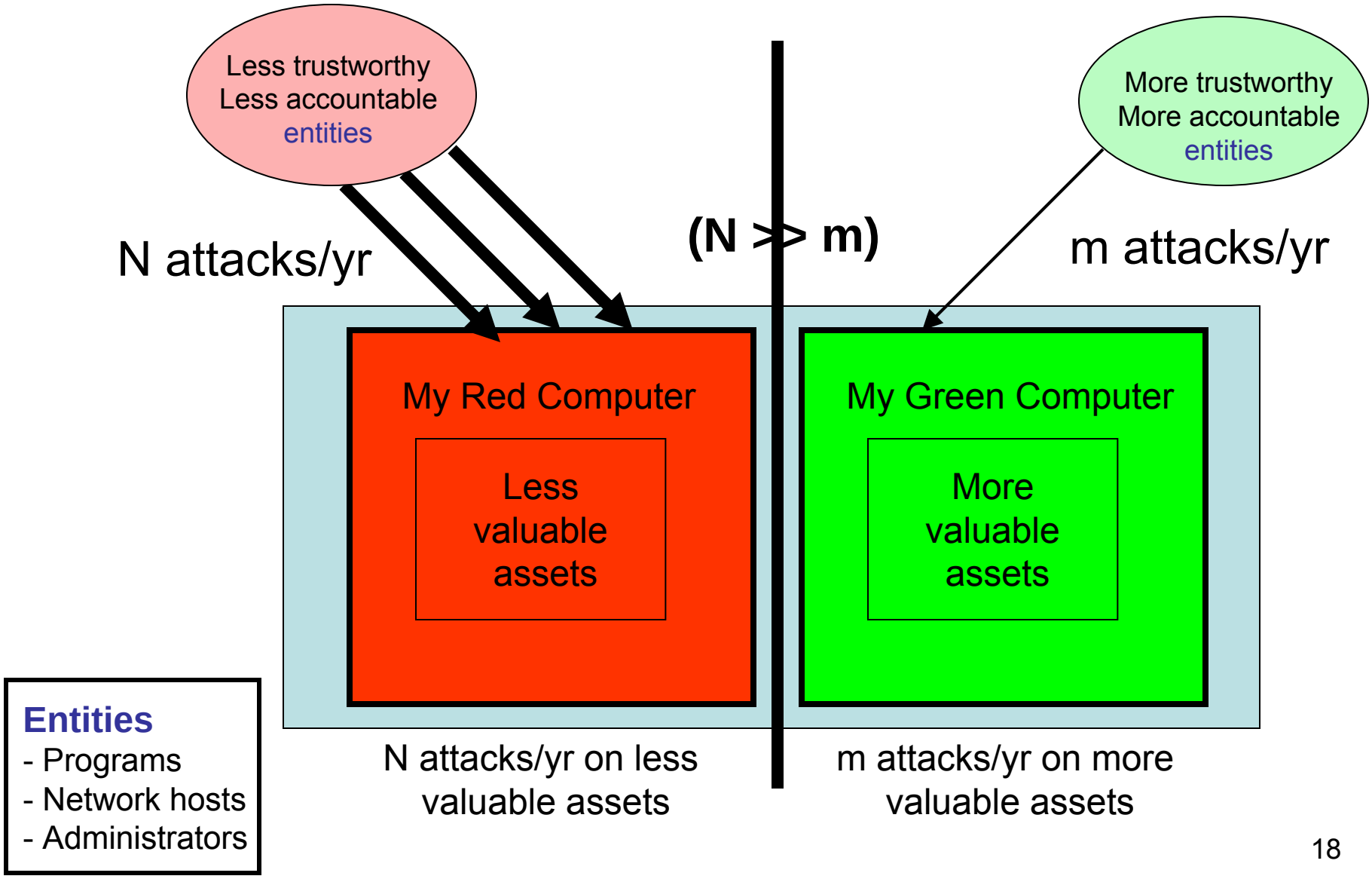
Without R|G: Today



Entities
- Programs
- Network hosts
- Administrators

Total: N+m attacks/yr on all assets

With R|G


Less trustworthy
Less accountable
entities
More trustworthy
More accountable
entities
N attacks/yr
(N >> m)
m attacks/yr
My Red Computer
Less
valuable
assets
My Green Computer
More
valuable
assets
N attacks/yr on less
valuable assets
m attacks/yr on more
valuable assets
Entities
- Programs
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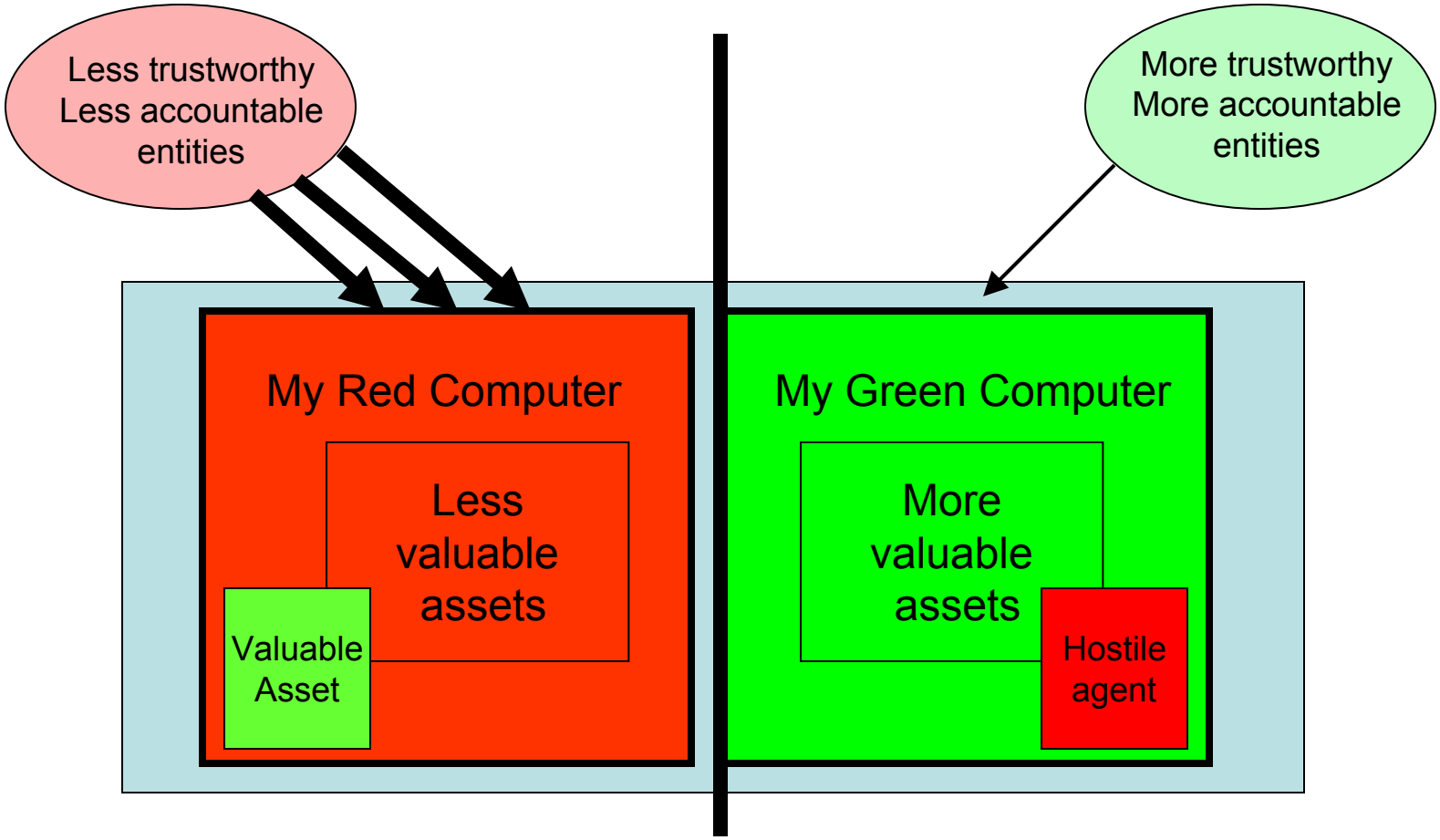
Must Get Configuration Right

- Keep valuable stuff out of red
- Keep hostile agents out of green



Why R|G?

- Problems:
  - Any OS will always be exploitable
    - The richer the OS, the more bugs
  - Need internet access to get work done, have fun
    - The internet is full of bad guys
- Solution: Isolated work environments:
  - Green: important assets, only talk to good guys
    - Don't tickle the bugs, by restricting inputs
  - Red: less important assets, talk to anybody
    - Blow away broken systems
- Good guys: more trustworthy / accountable
  - Bad guys: less trustworthy or less accountable

Configuring Green

- Green = locked down = only whitelist inputs
- Requires professional management
  - Few users can make these decisions
  - Avoid “click OK to proceed”
- To escape, use Red
  - Today almost all machines are Red

R|G User Model Dilemma

- People don't want complete isolation
  - They want to:
    - Cut/paste, drag/drop
    - Share parts of the file system
    - Share the screen
    - Administer one machine, not multiple
    - …
- But more integration can weaken isolation
  - Add bugs
  - Compromise security

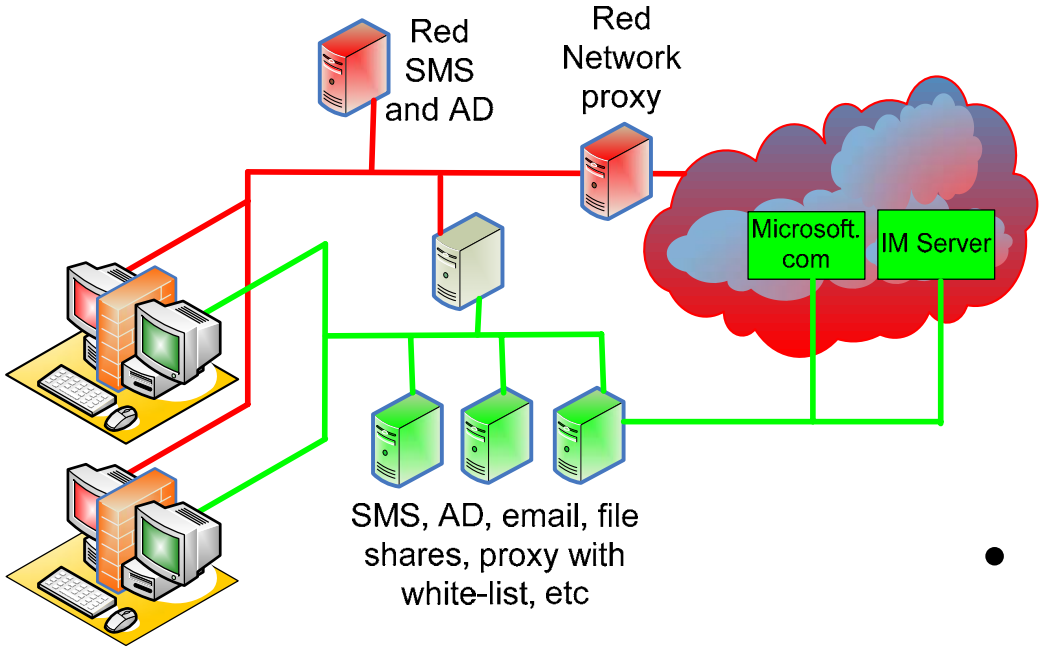
Data Transfer

- Mediates data transfer between machines
  - Drag / drop, Cut / paste, Shared folders
- Problems
  - Red → Green : Malware entering
  - Green → Red : Information leaking
- Possible policy
  - Allowed transfers (configurable). Examples:
    - No transfer of ".exe" from R to G
    - Only transfer ASCII text from R to G
  - Non-spoofable user intent; warning dialogs
  - Auditing
    - Synchronous virus checker; third party hooks, ...

Where Should Email/IM Run?

- As productivity applications, they must be well integrated in the work environment (green)
- Threats—A tunnel from the bad guys
  - Executable attachments
  - Exploits of complicated data formats
- Choices
  - Run two copies, one in Green and one in Red
  - Run in Green and mitigate threats
    - Green platform does not execute arbitrary programs
    - Green apps are conservative in the file formats they accept
  - Route messages to appropriate machine

R|G and Enterprise Networks



- Red and green networks are defined as today:
  - IPSEC
  - Guest firewall
  - Proxy settings
  - …
- The VMM can act as a router
  - E.g. red only talks to the proxy

Summary

- Security is about risk management
  - Cost of security < expected loss
- Security relies on deterrence more than locks
  - Deterrence requires the threat of punishment
  - This requires accountability
- Accountability needs an ecosystem
  - Senders becoming accountable
  - Receivers verifying accountability
- Accountability limits freedom
  - Beat this by partitioning: red | green
  - Don't tickle bugs in green, dispose of red