Network Security

Module 13

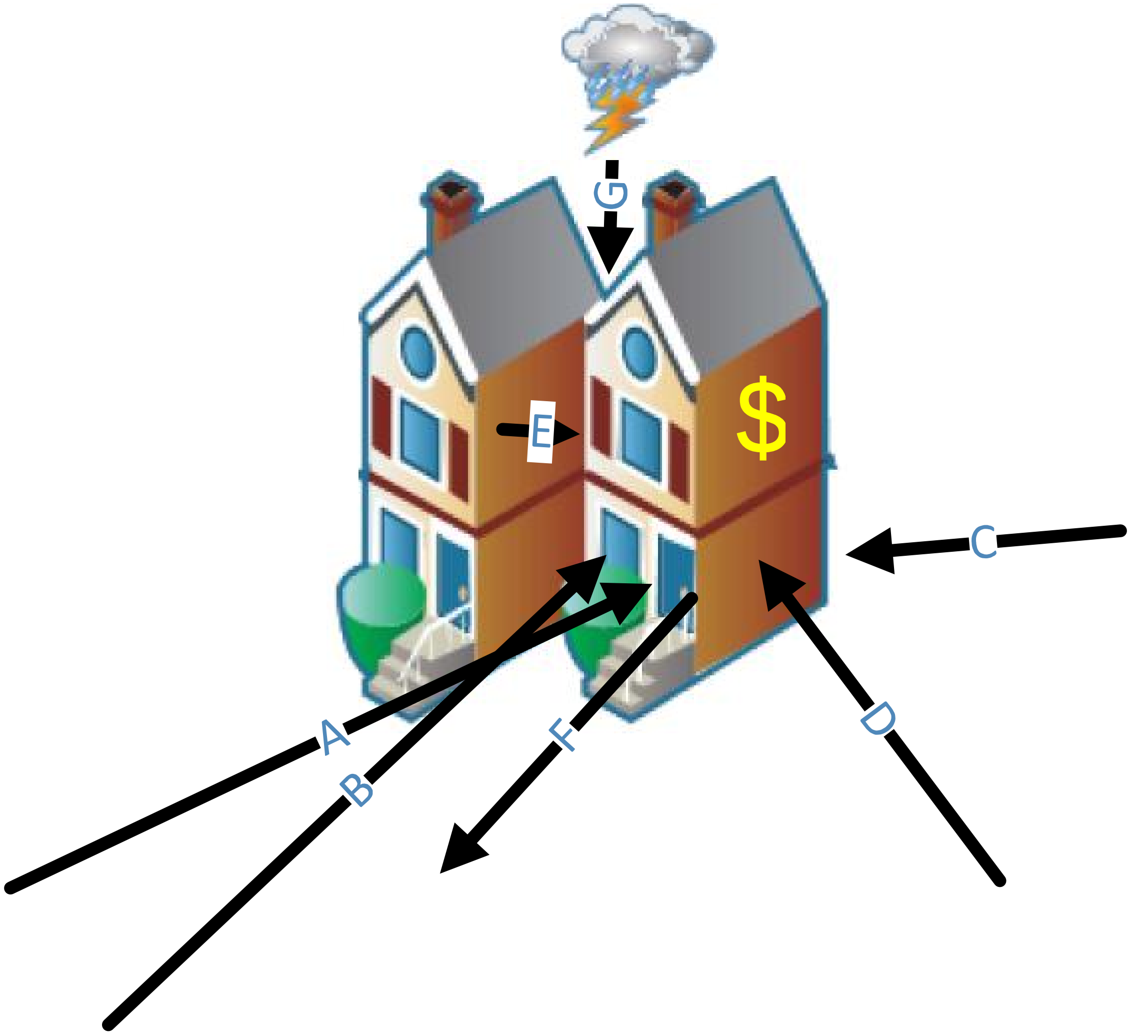
Defense in Depth

- Multiple overlapping mechanisms separate a valued resource from relevant threats
  – Mechanisms need not be all:
    - Technical (e.g. policies, procedures)
    - Preventative (e.g. monitoring, response)
    - Network oriented (e.g. OS policy, application authentication, patch management)

Defense in Depth

- In essence, it is a principle of defense diversity
  - Not relying on a single mechanism to protect what is valuable
- This approach guards against:
  - Loss of adequate protection due to mechanism maintenance, mechanism failure and an unexpected threat origin

Adversarial View



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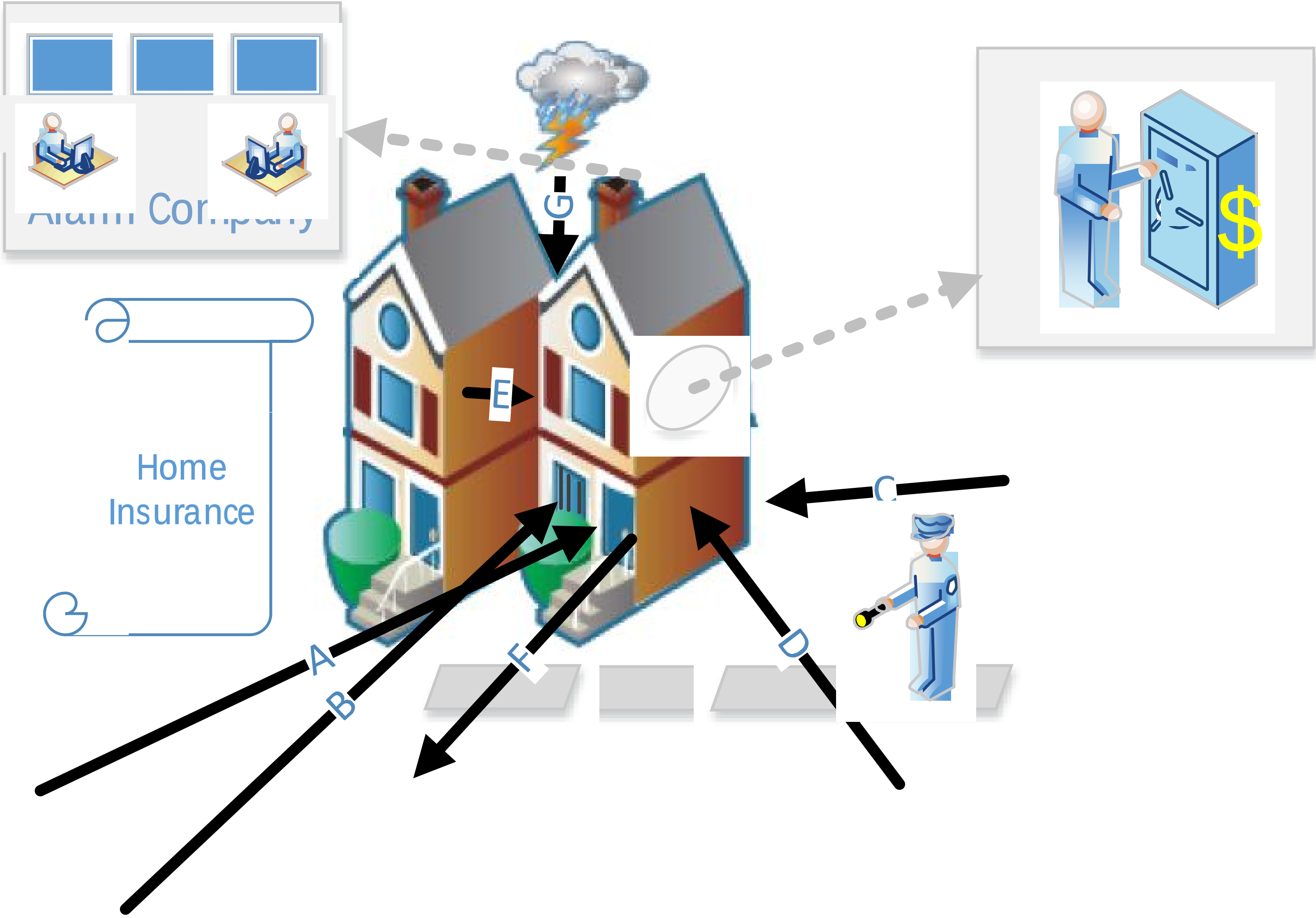
Defensive In Depth



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Perimeter

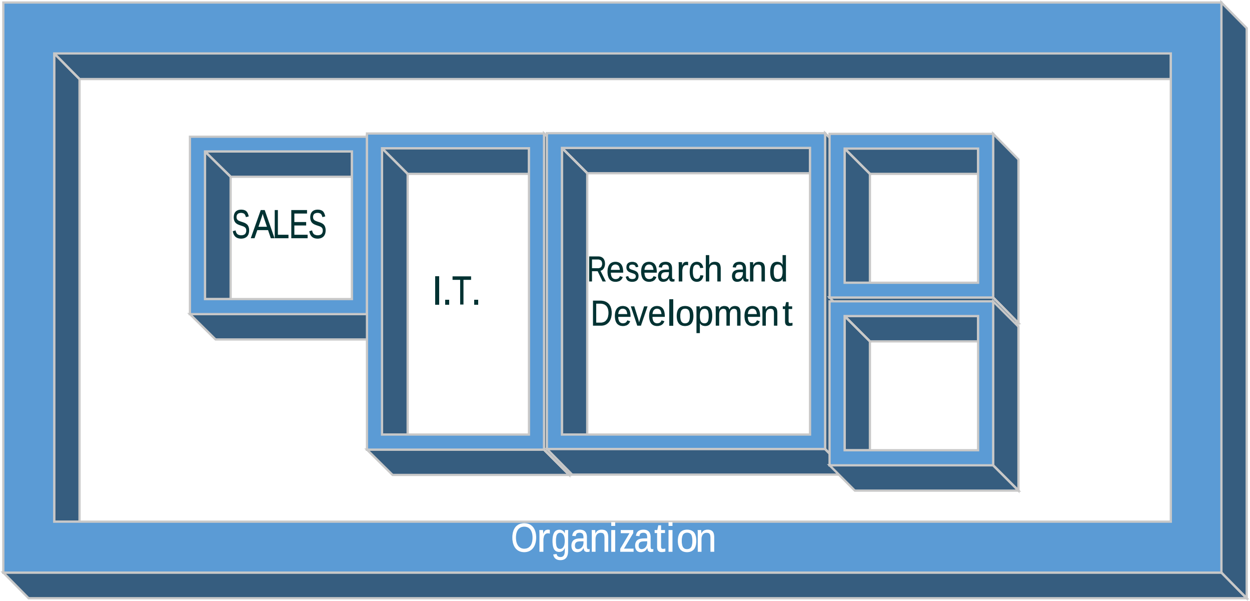
- The boundary between what is being protected and the likely source of threats.
  - Commonly associated with property lines or physical dimensions of a facility
    - Examples: Office building, manufacturing complex, military installation
- Although many cyber threats originate from the Internet, a good number do not.
  - An inside attack may eventually use the Internet after some level of success.

Perimeter

- Inside threats successfully breach the exterior perimeter
- Sources of inside threats:
  - Employees and Contractors
  - Visitors
  - Compromised portable devices
  - Poor worker security awareness and training
    - Victim of phishing
    - Drive by download

Perimeter

- Compartmenting resources (e.g. tools, technology and information) creates perimeters within the interior



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Perimeters

- Logically perimeters are the result of one or more controls maintaining confidentiality, integrity and availability of one or more resources (e.g. processes, people, information, systems).
- As the threat sources become more pervasive, so will the establishment of perimeters

Firewalls

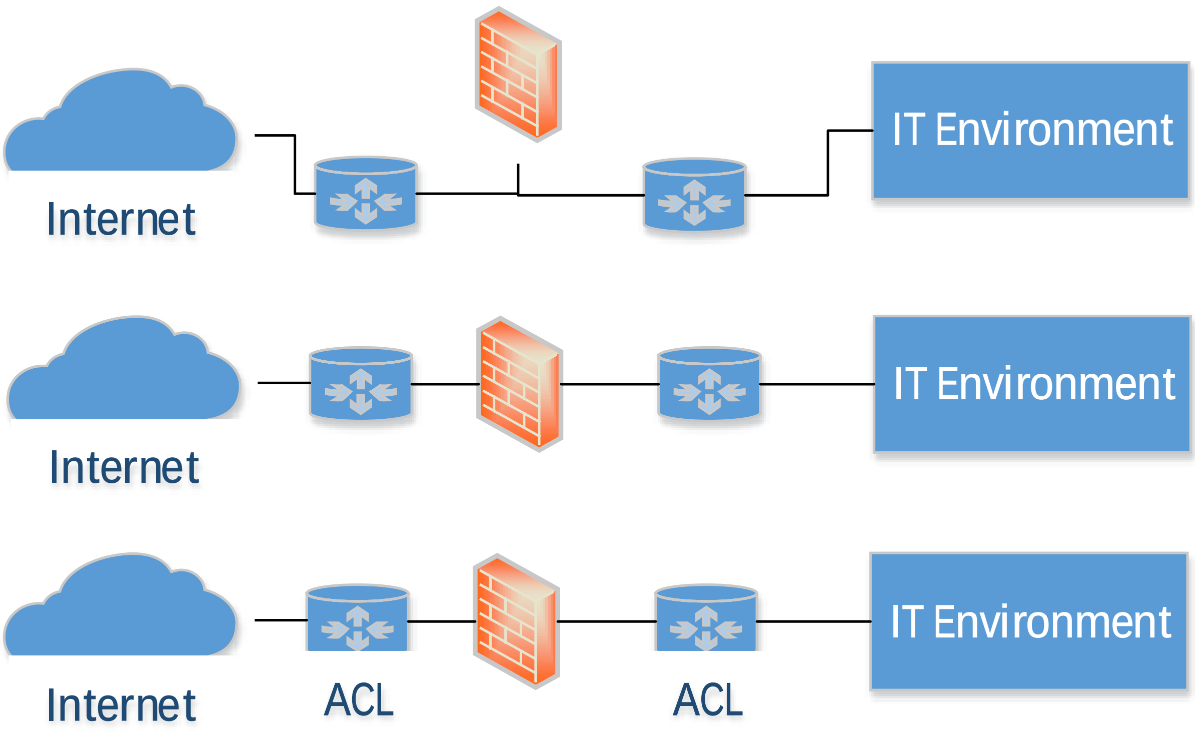
- Information flow is needed between parties even though:
  - The parties may not be fully trusted
  - The method of communication is not trusted
    - Example: Internet
- Firewalls are intended to limit exposure
  - Control which parties may communicate across it
  - Control the type of communication flowing through it

Firewalls

- Firewalls Product Types
  - – Dedicated devices
  - – Multi-function security devices
    - Unified Threat Management – AV, FW, IDS, etc.
  - – Software application running on generic computer
  - – Routers with access control enforcement

Firewalls

- Some deployment configurations



Internet — IT Environment — Single Homed Firewall

Internet — IT Environment — Dual Homed Firewall

Internet — ACL — ACL — IT Environment — Screened Subnet Firewall

Firewalls

- Firewall logical types
  - Based on what layers of the protocol stack the policy enforcement takes place
  - Layer 3 – IP Networking Layer
    - Enforces rules regarding IP addressing and IP protocol parameters
    - Commonly enhanced to be "stateful"
      - TCP protocol is stateful and many firewalls of this type are aware of the beginning, end and middle of a TCP connection

Firewalls

- Layer 5 (TCP/IP model) or Layer 7 (OSI model) – Application Layer
  - Logic ensures protocol (e.g. HTTP, FTP, SMTP) is being used properly
  - Logic is able to restrict protocol options
  - Logic is able to inspect more of the application payload
  - A common implementation method is through proxies

Intrusion Detection & Prevention

- Firewalls permit a restricted flow of traffic
  - Traffic that does flow may have malicious intent
- Intrusion detection systems (IDS) inspect traffic looking for suspicious behavior
- Originally this technology was meant to be a detection not a prevention technology

Intrusion Detection & Prevention

- Suspicious traffic is determined by:
  - Signatures or patterns of known suspicious behavior
    - A new threat may not be detected
  - Anomalies within traffic
    - Anomalies may not be malicious, so related alerts may not be useful
- Intrusion Prevention System (IPS)
  - Stop suspicious traffic using mentioned detection techniques
    - Instruct firewall to change policy
    - Block traffic at the IPS device

IDS and CDC

- Cyber Defense Competitions have by design an abnormally high rate of threats.
  - You know you are under attack
  - It may help identify the type of attack, but it may not!

Netflow

- What is it?
  - A proprietary protocol designed by Cisco
  - Multiple variants exist, such as: sFlow, NetStream, IPFIX, J-Flow
  - Network activity recording technique
    - Record is an “IP flow”
      - Concept is not native to IP protocol definition
    - For Cisco, a unique “IP flow” is designated based on 5 to 7 packet attributes

Netflow

- Cisco’s selected attributes are:
  - IP Source Address
  - IP Destination Address
  - Source Port (Transport protocol)
  - Destination Port (Transport protocol)
  - Layer 3 protocol type (e.g. ICMP,TCP,UDP,OSPF)
  - Class of Service
  - Router or switch interface

Netflow

- A new record is opened for each unique combination
  - A timer is set for each record
    - If a new packet arrives matching an existing attribute combination the counters for packet count and number of bytes transferred are updated for the “IP Flow”
    - Timer is reset
    - If timer expires, the “IP Flow” is considered terminated
  - TCP SYN and TCP FIN, RST help designate the begin and end of a TCP connection

Netflow

- Additional information recorded in each “IP Flow” record
  - Timestamps
  - Next hop address
  - Subnet mask of source and destination addresses
  - TCP flags

Netflow

- Uses:
  - Application and network usage
  - Impact analysis of network changes
  - Unusual network activity patterns and network threat tracking
  - Network productivity and utilization

Netflow in the Playground

- Netflow support is greatest among network devices, which can not be virtualized
- Pfsense, FreeBSD and OpenBSD are platforms that support Netflow
- As of vSphere 5, VMWare supports Netflow on virtual switches.
  - Requires additional licensing, not available

Netflow

- Configuration
  - Need to establish a Netflow collector
    - Receives exported Netflow records
    - Loads records in a database
  - A reporting and/or monitoring tool
    - Dynamic views of Netflow require a monitoring tool
      - Tool retrieves updates from collector
      - Renders information in various visual formats

Malware Defenses

- Primary vector of malware is the network
  - Worms
  - User web browsing
  - Email
  - File transfers
- Physical transfer of malware still occurs
  - Infected USB thumb drive
  - Infected portable computing device attaching to network

Malware Defenses

- Methods of Detection:
  - Signatures – content of a file is compared to a list to determine if the file is present on a list of known threats
  - Heuristics – a “generic” signature that is able to identify multiple variations of malware that have characteristics in common
  - Isolated testing – suspected file is executed in an isolated and instrumented environment to determine its nature

Malware Defenses

- Firewalls, Patch Management, Configuration Management, Security Awareness
  - Limit exposure to vulnerabilities that malware exploits
- Defense in Depth
  - Anti-virus engine at the perimeter
  - Anti-virus engine on email servers
  - Anti-virus engine on file servers
  - Anti-virus engine on endpoints (PCs, tablets, smartphones)

Malware Defenses

- Signature Updates
  - Anti-virus is not effective if signatures are not maintained by organization or vendor
  - Enterprise anti-virus products provide centralized monitoring and control
    - It can be determined which hosts are not current
    - It is possible to push signatures and initiate AV scans
      - AV is a useful tool to corroborate or confirm indications of possible infection on a host

Malware Defenses

- Weakness of AV:
  - Relies heavily on vendors having a sample to analyze
  - Can be disabled or rendered ineffective if host compromise is severe
    - Malware with access to the kernel can block detection
    - Solution is to reboot host with a clean OS and scan the hard drive contents.
      - Disruptive and labor intensive

Malware Defenses

- Vendor Diversity
  - Not knowing the delay a vendor may have in preparing and distributing signatures to the newest threats
  - Deploy different vendor for:
    - Malware that is missed by one engine type will be caught by the next type.
    - Perimeter protection
    - Email server protection
    - File server protection
    - Endpoint protection

Malware Defense

- Downsides to Vendor Diversity
  - Costs
    - Licensing tends to be volume oriented
      - Fewer licenses bought results in higher per license costs
    - Labor efficiency
      - More products to manage separately
        - » Unified management interface is unlikely
      - More products to train on
- Uncertain security benefit in the long run
- Multiple engines on one host may not function and will consume more CPU time and generate more I/O

Public Key Infrastructure

- Certificates
  - The binding of public key to an identity
    - Service
    - Person
    - Organization
  - Trust in the binding is necessary
    - You want to know with whom or what you are sharing sensitive information
    - Public keys are distributed to strangers by strangers

Public Key Infrastructure

- Asymmetric or public key cryptography provides the literal security services of:
  - Encrypting/decrypting information
  - Integrity
- These basic services can be extended to provide:
  - Authentication
  - Non-repudiation

Public Key Infrastructure

- Encrypting sensitive information for use by another is great so long they were the recipient you intended
- Authentication relies on at least one factor
  - Private key could be either “what you have” or “what you know” (you have good memory)
  - But whose key is it really?
    - Are we letting in a stranger?
- Non-repudiation relies on involved parties not being able to wiggle out of something they did or said
  - Did we accept a digital signature from the wrong person?
    - Could a party legitimately claim that the digital signature was not theirs?

Public Key Infrastructure

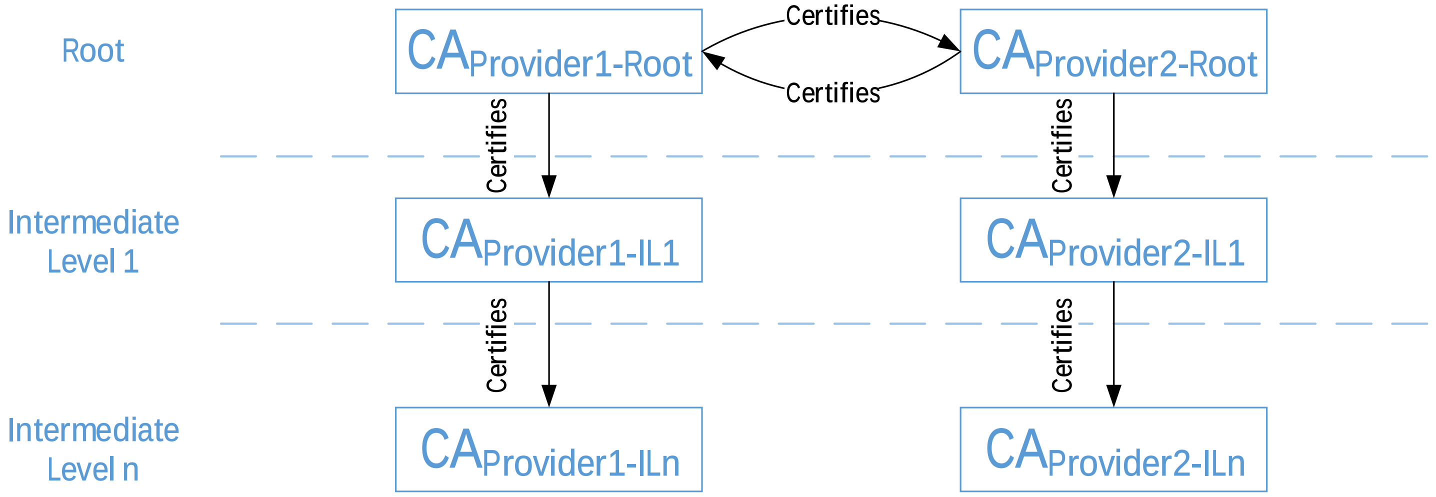
- Those issues are the reason for certificates
- But, who do we trust to bind public keys to identities?
  - Anybody?
    - Do they know what they are doing?
    - Are they who they say they are?
      - I, Frank, certify that public key DAF23D is Sally's
      - Who is Frank? Do you know and trust him?

Public Key Infrastructure

- Certificate Authority (CA)
  - – An entity that issues, distributes, verifies and manages certificates
    - Certificate lifecycle – issuance, use, expiration
      - – Revocation may be necessary if public-private key pair is compromised or control of it was lost
  - – Has the necessary technology, people and procedures to perform certificate services, users can trust

Public Key Infrastructure

- Certificate authorities can issue certificates for other CAs
  - Users do not trust CA_1 but trust CA_2
    - User may trust CA_1 if and only if CA_2 trusts CA_1
- CAs can be deployed in a hierarchical fashion



Public Key Infrastructure

- Registration Authority (RA)
  - Performs a subset of CA services
    - Verifies the identity of the entity requesting a certificate
    - Acts a liaison between entity requesting a certificate and the CA
    - Could assist an entity by accepting requests to revoke an issued certificate

Public Key Infrastructure

- Self-Signed Certificates
  - Certificate is issued by the person or organization that generated the key pair
    - CA’s certificate needs to be added trusted list used by applications like a web browser to avoid warnings and mistaken trust
- Commercial Certificates
  - Certificate is issued by a CA that is recognized
    - Typically application developers provide an initial list of “root certificates”