

Network Security and Resilience / Advanced Security

Network security overview

Lecture one

Outline of Lecture

- What is security
- History and development of network security
- Security policy and implementation
- Important concepts and technologies in network security

Learning objectives

- You should be able to
 - describe what security is concerned with
 - describe (briefly) the evolution of approaches to network security in the past thirty years
 - explain the role of security policy in implementing appropriate security mechanisms
 - explain the meaning of confidentiality, integrity and availability
 - name the main technologies used in implementing a security policy

General security concepts

- Vulnerability – a weakness in a system
- Risk – a risk is a possible event that could exploit the vulnerability to cause a loss
- Threat – a threat is a method of triggering a risk event
- Countermeasure – a countermeasure is a way to stop a threat from triggering a risk event
- Assurance – assurance is the level of guarantee that a security system will behave as expected

(From wikipedia)

Information and network security

- Security involves tradeoffs
 - Security / functionality / cost
- Perfect information security is (usually) impossibly expensive
 - It is impossible to eradicate all risk
- The level of information security should be appropriate to the value of the information or loss its compromise might cause
 - Information security is about risk management
 - Is the cost of the security measures we put in place commensurate with the cost to the organisation should the system be compromised?
- Need some measure of 'cost'
 - Different approaches
 - In a later lecture we will have a quick look at two of the most common

History of network security

- Before the 80s computing services were expensive, highly centralised and arcane
 - Usually dumb terminals connected to a central mainframe or mini via RS232 links
 - IBM370, Burroughs 6700, DEC PDP-11 etc...
- Late 70s, early 80s
 - First large scale commercial networks deployed
 - Education, Gambling, Banking, Government
 - Networks secured by physical isolation
 - Physical access to networked terminals strongly restricted
 - No customer access
- Hacking mainly in the telecommunications environment
 - Phone “phreaking”

History of network security

- Phone “phreaking”
 - Unauthorised use of phone system to (primarily) make long distance calls
 - Attacks on metering, signaling, switching and configuration and end systems
 - Long distance calls expensive
- A big political element to “phreaking”
 - Telecommunications companies huge, tightly regulated, bureaucratic monopolies
 - Individual customer service not necessarily a priority
 - Telecommunications companies had a long and not always commendable relationship with Law Enforcement

History of network security

- Metering attacks
 - Earliest used “inband” signalling
 - Typically the sound of coins dropping on a metal plate then pulses
 - Could be simulated fairly easily
 - Later metering attacks included clipping phones onto an unsuspecting residential line who got hit with the bill “clip-on fraud”
- Signalling attacks
 - 2600 Hz based attacks
 - “inband” attack
 - Would call toll free 0800 number
 - 2600 Hz would clear the call at the remote end but leave the caller with a trunk (long distance) line who would then dial the number they wanted
 - 2600 Hz signal generators known as “Blue boxes”

History of network security

- Mid to late 80s
 - Some devices with limited network capabilities became available to customers
 - Automatic teller machines (ATMs)
 - AutoTote (gambling) machines
 - Very limited and very tightly controlled functionality
 - Bulletin boards and TCP/IP begin to be widely used
 - Corporate networks start to be developed
 - Financial transactions built on X.25 networks
 - Networked computers commonplace but mainly LAN services such as printing and file-server
 - email common in academic environment

History of network security

- Exploits from this time include hacking into the many insecure networks around the world usually via telnet or other insecure protocols
- Melbourne at the forefront
 - ABC documentary (available in library) “In the Realm of the Hackers”
 - Famously broke into NASA
 - Creation of first political worm (The “WANK” worm – Worms Against Nuclear Killers, complete with a quote from Midnight Oil)
- Interesting read on the topic “Underground: Tales of Hacking, Madness, and Obsession on the Electronic Frontier” by Suelette Dreyfus and contributions from Julian Assange
<http://www.underground-book.net/download.php3>

History of network security

- Early 90s
 - Internet becomes ubiquitous
 - World Wide Web and the Mosaic Browser
 - Commercial transactions still based on X.25
 - No security mechanisms for the Internet
 - Attacks on very insecure Mobile telephony systems ('scanning')
 - Mid-90s
 - Work on encryption, Public key infrastructure makes commercial transactions over the Internet feasible
 - Addressed the confidentiality and integrity issues, but not the availability issues
 - Late-90 / Early 2000s
 - Internet boom with many commercial ventures
 - Major denial of service attacks on commercial sites
- School of Science, Computing and Engineering Technologies

History of network security

- Mid to late 2000s
 - Many hacking tools become available online
 - Rise of the 'script kiddies'
 - WLAN exploits
 - Lots of interesting exploits which we will look at
 - Conficker 2008
 - Stuxnet 2010
 - Athens phone tapping scandal 2004 - 2005
 - BGP outages 2010
 - News of the World voicemail hacking 2005 - 2007
 - Gemalto SIM card key compromise 2014
 - Lenovo Superfish 2015

History of network security

- Now a very different world from even five years ago
 - Cloud computing, Smart phones, Social Networks, VoIP, 3G, 4G, 5G, Many new exploits
 - Social networking exploits
 - Online bullying
 - Death of privacy
- More on these later

History of network security

- What can we make of all this?
- Has become ridiculously easy to mount attacks
 - But tools and technologies to defend against attacks are available that weren't available ten to fifteen years ago
- Systems have become much more open
 - It is possible to learn about the strengths and weaknesses of a technology in a way that wasn't possible in the days of 'closed' computing systems
 - Closed systems tended to rely on 'security by obscurity'
 - But large numbers of users of a compromised technology means resources available to fix it
 - Also, if there is a weakness it will probably be found. Not always the case with closed systems

Security management

- There is a trade-off between security / functionality / cost
- Security management is largely about managing that trade-off
- Need to work out what risks are acceptable and what are unacceptable
 - It is not possible to be connected and have no risk
 - A balance needs to be found
- Security needs to be implemented in a coherent fashion
 - A security programme (or program)
- Usually sponsored and controlled by senior management
 - Top down rather than bottom up

Security management

- Goal is to identify the security requirements, goals and assurance levels needed for different parts of the organisation
 - These are collated in the Security Policy of the organisation
- The Security Policy is then implemented through Administrative, Physical and Technical controls
 - Our interest in this unit is primarily on Technical controls but all are of equal importance and all will be used in implementing most Security Policies

Security policy

- Level of security needs to be assessed
 - Has to be appropriate to the purpose of the network, the risk associated with the enterprise
 - It is too expensive and too restrictive to make any modern network totally secure
- Need to have a methodical way of assessing risk and deciding on appropriate level of security
 - Need to develop a security policy
 - The security policy is concerned with confidentiality, integrity and availability
 - Depending on the size and nature of an organisation it will have different requirements for each of these

Confidentiality

- What information needs to be kept secret and how secret does it need to be?
- What is the appropriate level of confidentiality needed for particular information
 - Passwords, encryption keys need to be absolutely secure
 - Credit card numbers, customer lists, customer transactions probably very high
 - Stock lists probably very low
- Different ways of providing confidentiality
 - passwords on files and servers
 - physical access restrictions
 - encryption

Integrity

- Usually concerned with timeliness and accuracy
- What information must be accurate in realtime and what information is less important?
- What is an appropriate level of integrity for the particular information
 - Financial transactions probably very high
 - Personal Emails on corporate server probably quite low
- Usually some broad kind of classification
 - High, Moderate, Low
- Can be provided through passwords, physical isolation or digital signing

Availability

- Part of Business Continuity Planning
- A global online business such as Amazon.com or eBay.com will have much greater requirements for availability than a home user's blog
- Some systems within an organisation will have more stringent availability requirements than others
 - Eg. After an outage a bank will want its customer transaction processing systems to be back up and running immediately
 - Other systems such as payroll (while important) can probably tolerate more delay
- Can be provided through backup machines, alternate sites, backup power supplies, alternate ISPs etc
 - Again, key issue is how much money will it cost the organization for these systems not to be operational

Question

On a scale of 1 to 3 (1 low, 3 high) evaluate the confidentiality, integrity and availability risks of the following information

- The office footy-tipping competition
- A customer list including discount arrangements
- Emails to and from clients
- Emails between staff members
- Student academic records
- Minutes of senior management meeting
- Personal credit card number used for online purchases

Security policy implementation

- Policies are implemented through Procedures
- Procedure might be a manual procedure
 - ‘Check criminal record of new recruits’
- Procedure might be a technical procedure
 - ‘Block all telnet sessions on web server’
 - Use stateful firewalls at network perimeter
- Technical procedures typically implemented through Firewalls, Authentication systems, Virtual Private Networks, Intrusion Detection Systems, Intrusion Prevention Systems
- Our emphasis is on technical procedures, but manual procedures should not be neglected
 - Will often be used to supplement or in concert with technical procedures

Technologies used to implement security policy

- Firewalls
 - Used to specify who can access what information from where
 - Proxy gateways and packet filters
 - Specify what protocols are allowed through the network and what are not
- Authentication Systems and Procedures
 - How do we guarantee that we are who we claim to be?
 - Something that we know
 - Passwords, PINs
 - Something that we have
 - Tokens, ATM Card
 - Something that we are
 - Biometrics
 - Strong authentication requires Biometrics and one of the others

Technologies used to implement security policy

- Virtual Private Networks
 - Specify how private communications channels (tunnels) can be implemented across public networks
 - Makes use of many technologies
 - Proxies, IPSec, SSL/TLS, CHAP, S-HTTP
 - Tunnelling technologies
 - GRE, PPTP, L2TP
 - Authentication technologies
 - Kerberos, RADIUS, DIAMETER
 - Encryption technologies
 - RSA, AES, IKE, SHA256

Technologies used to implement security policy

- Intrusion Detection and Prevention Systems
 - How to identify when your system is under attack or has been compromised?
 - Need to differentiate between normal and damaging use
 - Made up of sensors, monitors, resolvers and controller
 - Sensors collect data
 - Monitors process the data
 - Resolver determines response
 - Controller used for configuring the IDS

Technologies used to implement security policy

- Anomaly detection
 - Technology underpinning intrusion detection but can be used in a more general setting
 - For example, BGP failures are often caused by misconfiguration
 - Can we detect anomalies in BGP behavior that might indicate an error on behalf of an ISP
 - An interesting and difficult area
 - Banking transactions in which in-store customer transactions come from a variety of overseas locations within a short time-frame

Technologies used to implement security policy

- Cryptography
 - Many security technologies are built upon cryptography
 - VPNs, passwords, other authentication systems
 - Encryption can be used to provide confidentiality and integrity
 - Different kinds of encryption
 - symmetric key (sometimes secret key encryption)
 - Examples include DES, AES, RC5
 - asymmetric key (sometimes public key encryption)
 - Examples include RSA, Elliptic Curve

Technologies used to implement security policy

- Public key infrastructure
 - How can you trust a communication through the Internet? For example:
 - How can you be sure it is from the person it claims to be from?
 - An email
 - How can a consumer be sure that they are interacting with the real Westpac.com and not a phishing site?
 - Public key infrastructure is used to provide some assurances as to the integrity of a communication
 - Makes use of the concept of a digital signature

Technologies used to implement security policy

- Wireless and IoT specific technologies
 - Wireless communication is inherently insecure
 - Wired networks have some physical security. Wireless networks (usually) don't
 - Not possible (at a reasonable cost) to restrain a wireless signal to a specific area
 - Wireless device performance (usually) constrained by battery power and processor capacity
 - Different solutions are needed for wireless communications security than are used for wired networks
- Cloud specific technologies
 - Geographical separation of processor and user
 - Virtualisation of services
 - Introduce new issues

Conclusion

- Networks much more open than in the past
- Perfectly secure network is usually not possible
- Three facets to security
 - Confidentiality, Integrity and Availability
- Need some methodical way of assessing risk and implementing appropriate solutions
 - Security policy
- Security policy implemented using a mix of manual and technology based procedures
- Wireless and cloud introduces new security issues