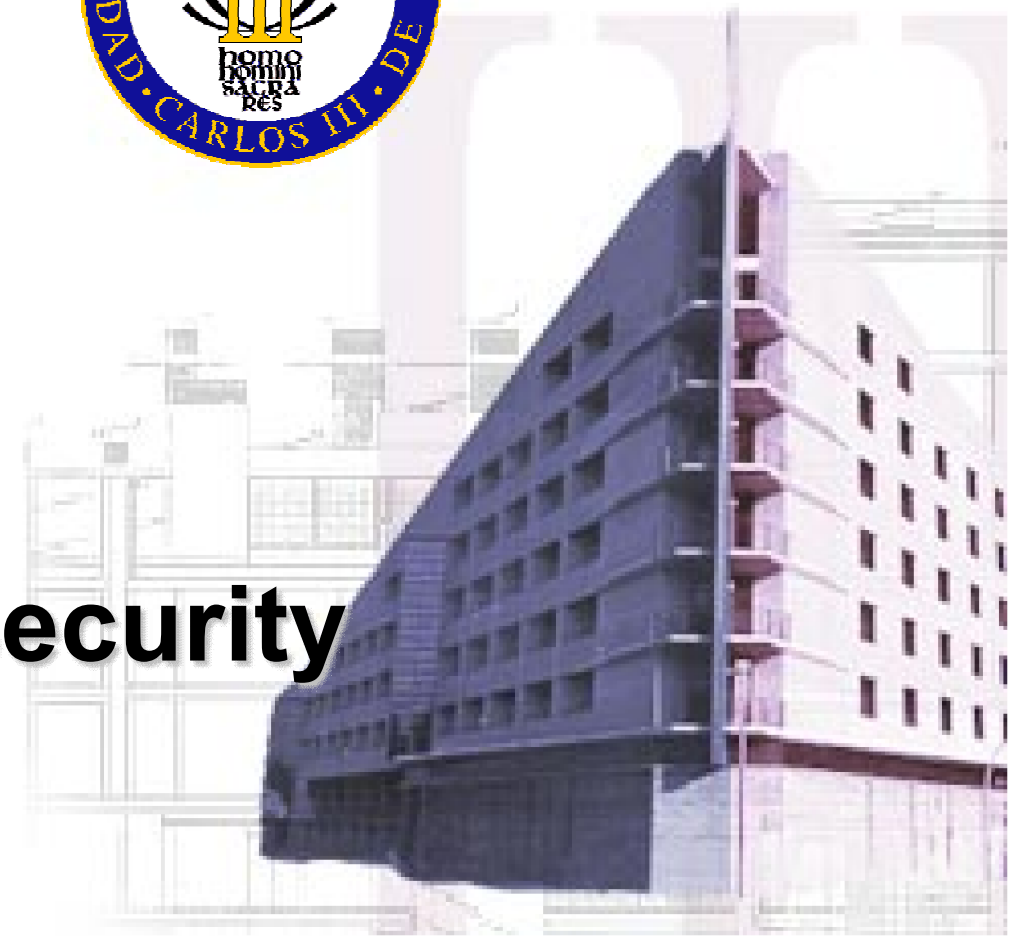

CHAPTER 2: Introduction to security

Coding Techniques

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WHAT IS SECURITY

"The only system which is truly secure is one which is switched off and unplugged, locked in a titanium lined safe, buried in a concrete bunker, and is surrounded by nerve gas and very highly paid armed guards. Even then, I wouldn't stake my life on it."

Slightly modified version of a quotation from Gene Spafford (Professor of computer science at Purdue University, USA)

"The only truly secure system is one that is powered off, cast in a block of concrete and sealed in a lead-lined room with armed guards - and even then I have my doubts."

From: "Computer Recreations: Of Worms, Viruses and Core War" by A. K. Dewdney, in Scientific American, March 1989, pp 110.

THREATS

- **To physical resources:**
  - Theft, destruction, accidents, damage, usage errors
- **To resource utilization:**
  - Reduction of availability, economic loss (disk space, CPU time, data volume transmitted on a leased line etc.)
- **To stored information:**
  - Loss of integrity, confidentiality, availability
- **To transmitted data:**
  - Loss of integrity, confidentiality, availability, authenticity, non-repudiation
- **To the image and reputation:**
  - Inability to prevent or detect attacks or identify offenders, impact on third party assets, own responsibility

EXAMPLES OF DISPUTED DOMAINS

The disputed domain names:

1. <pccillen.com>
2. <pccillon.com>
3. <pcillian.com>
4. <trendmico.com>
5. <trendmicroeurope.com>
6. <trendmicrosystems.com>
7. <trendmirco.com>
8. <trenmicro.com>

The disputed domain names:

1. <amadon.com>
2. <amazaon.com>
3. <amoazon.com>
4. <amoson.com>
5. <amozen.com>
6. <amozom.com>
7. <amozone.com>
8. <azazon.com>
9. <wwamazon.com>
10. <wwwamozon.com>

http://arbiter.wipo.int/center/index.html

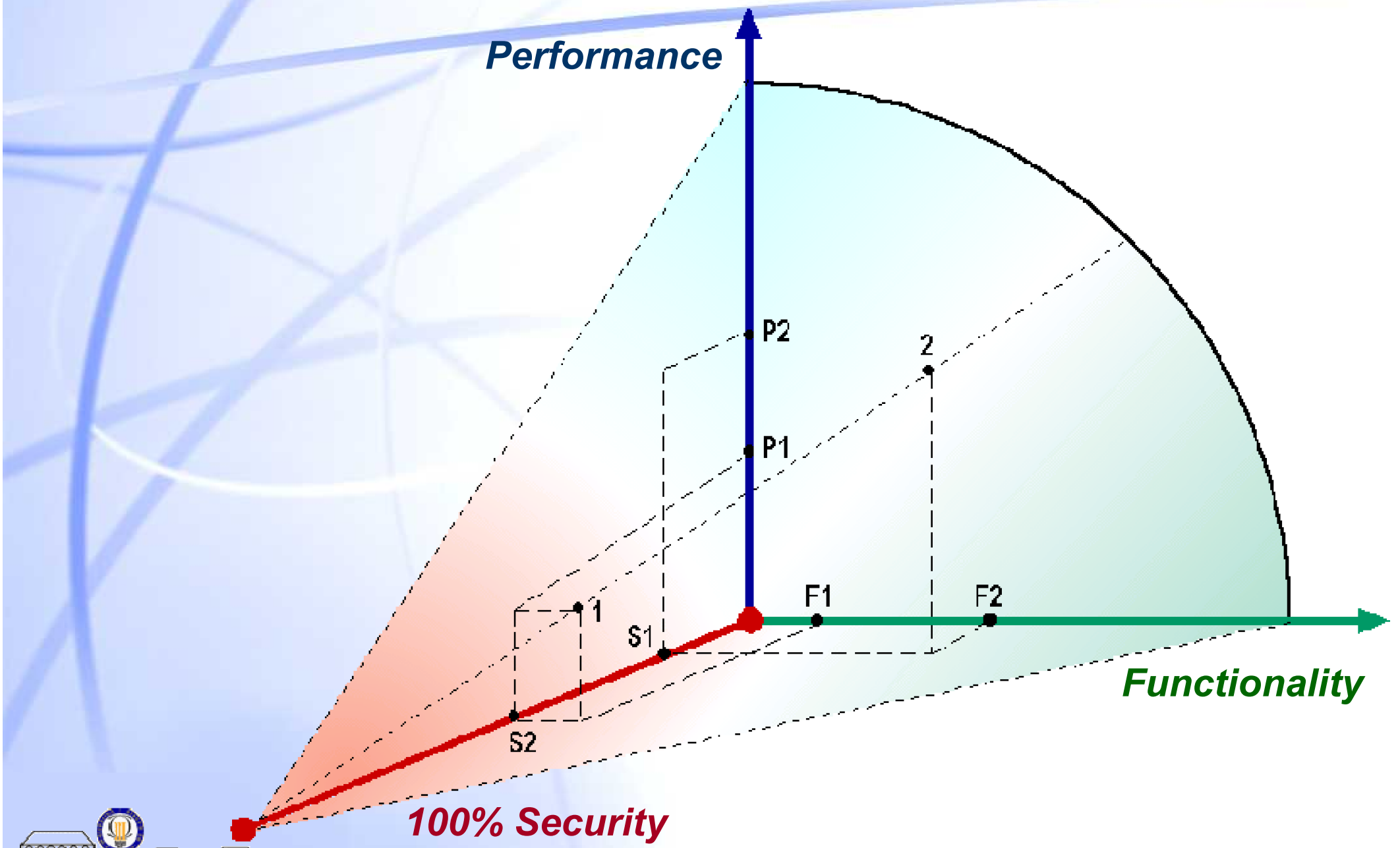
COMMON ATACKS

- Masquerading
  - Spoofing
  - Pharming
- Eavesdropping
  - Sniffing
- Tampering
- DoS
- Shoulder surfing
- Scavenging
- Buffer overflow
- Tiny Fragment
- Tear Drop
- ICMP flooding
- DDoS
- Spam
- Routing protocols
- SMTP, FTP, HTTP
- Social engineering
  - Phishing
- Malware

SECURITY COSTS

- Investment (equipment, systems)
- Expenses (maintenance/staff)
- Reputation
- Complexity of use
- Service restrictions
- Performance reduction

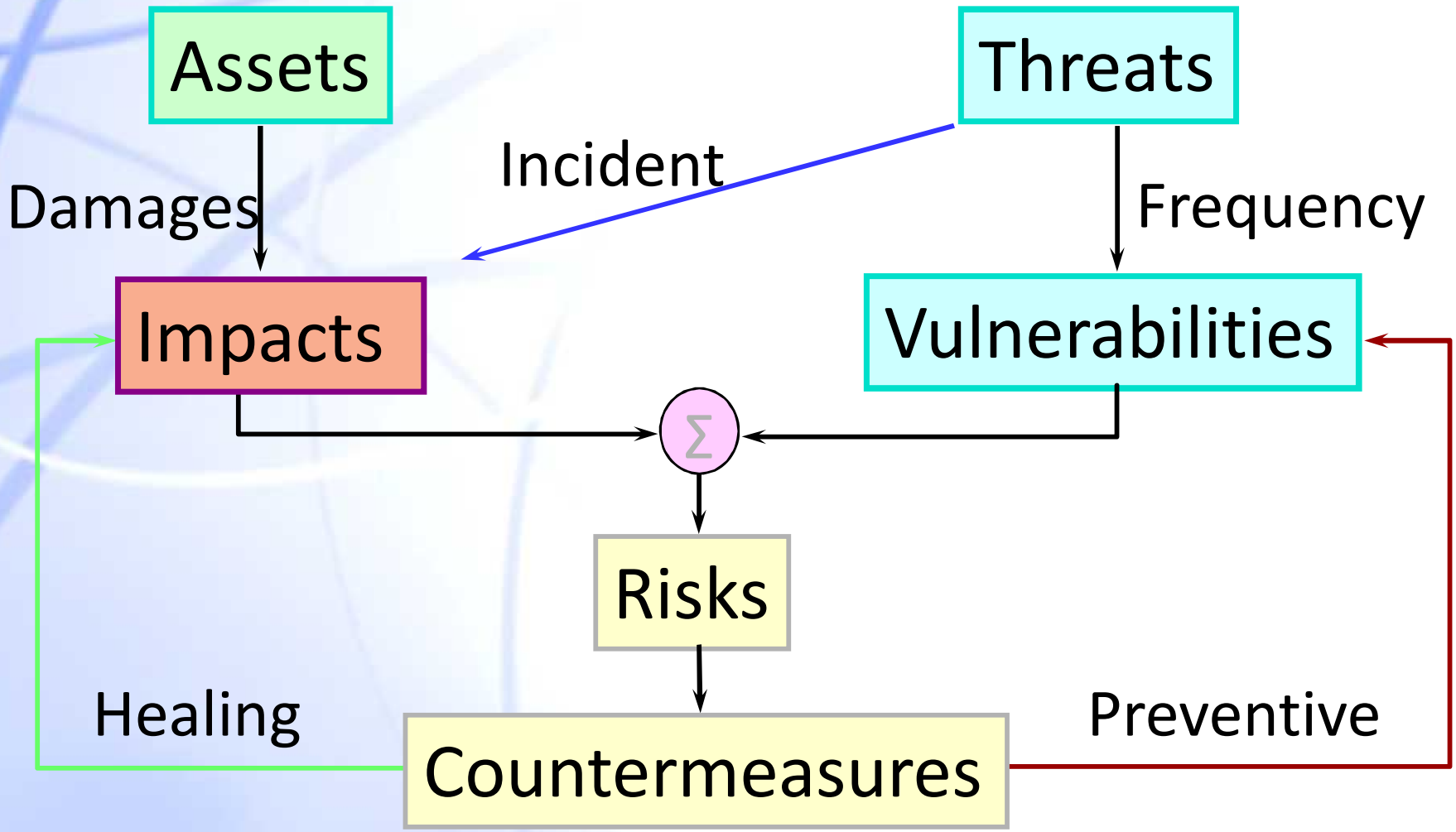
RESTRICTION CONE



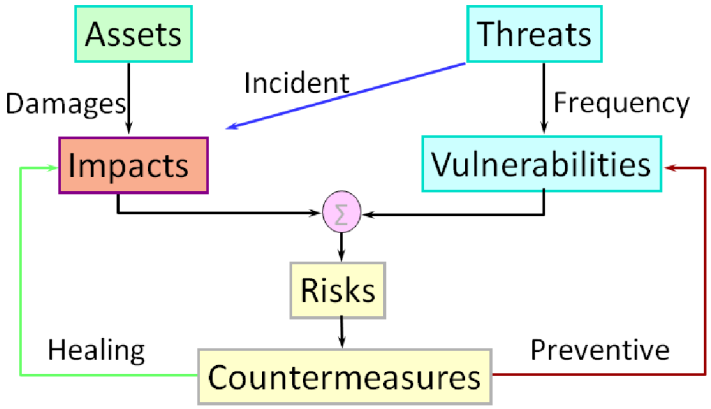
THE SECURITY CYCLE

- Identify the elements to protect
  - Named “assets”
- Determine the possible incidents (threats)
- Determine the likelihood of a threat
  - How critical they can potentially become?
- Implement countermeasures
- Review the process periodically

THE SECURITY CYCLE

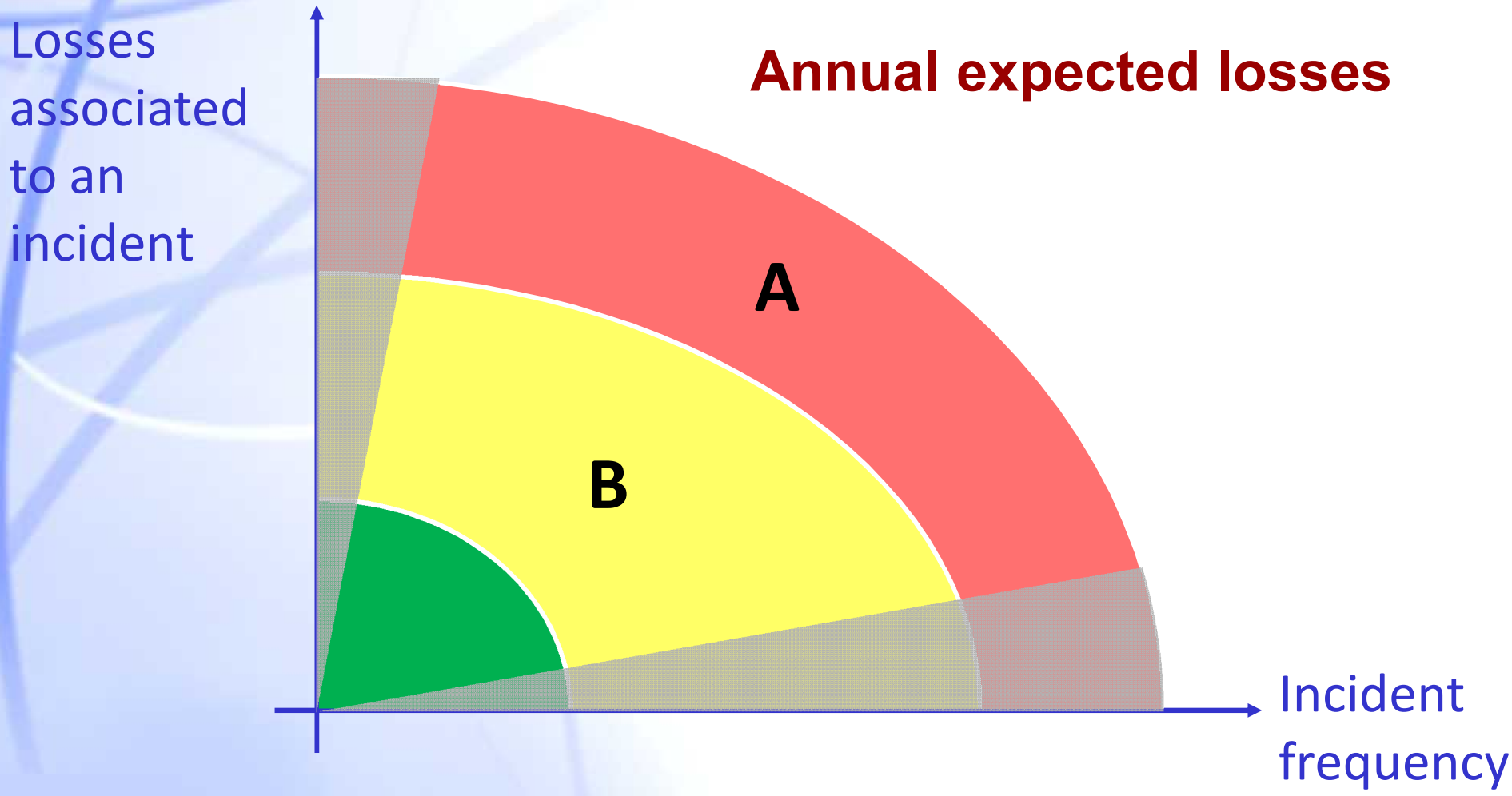


ELEMENTS

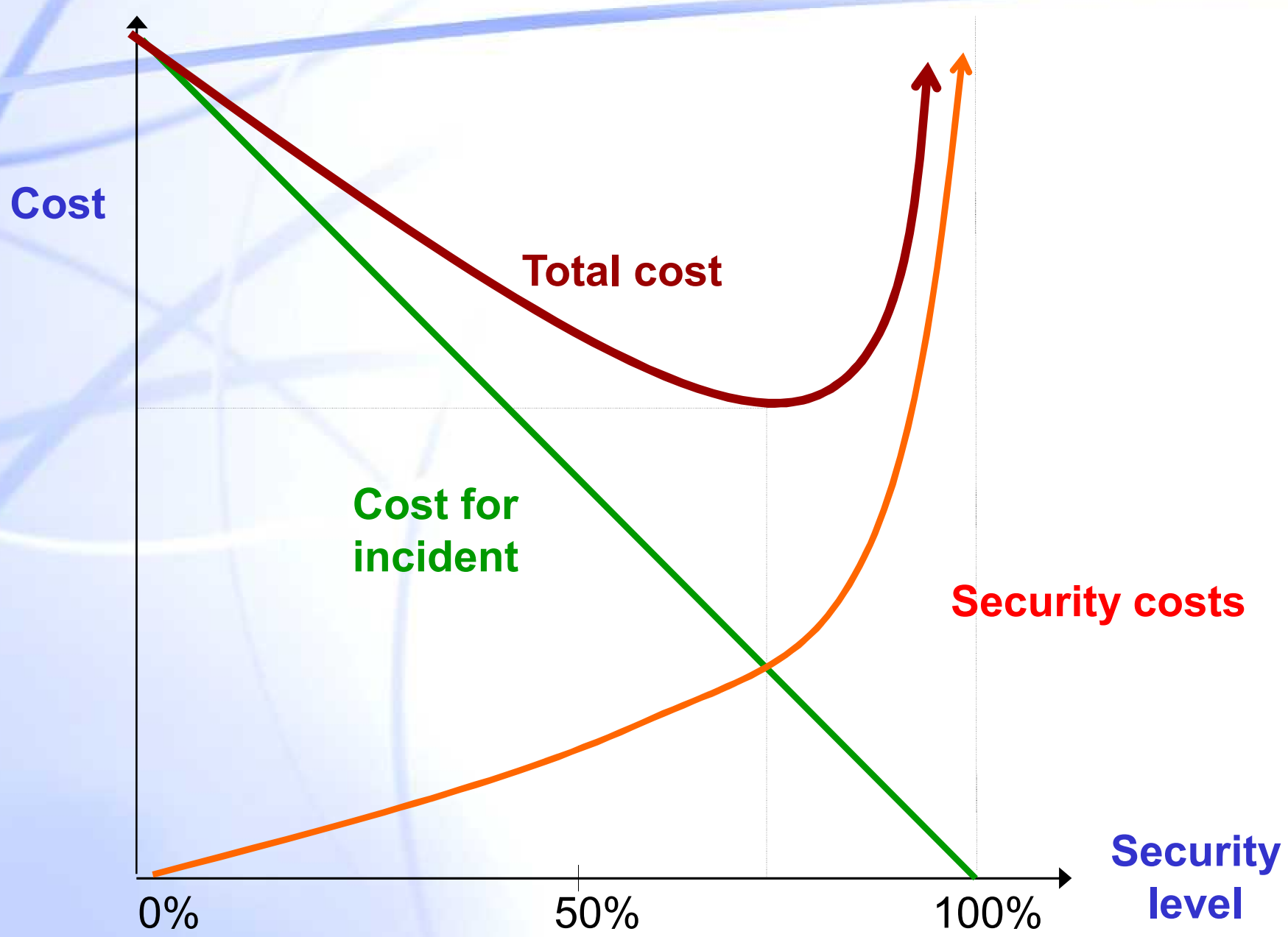


- **Assets to protect**
- **Threats to the assets**
  - **People, things, events…**
- **Vulnerabilities**
  - **Points where the threats may turn into an incident**
    - Vulnerabilities have a certain probability
- **Impact of the incident**
- **Risks of running in a real environment:**
  - **Never null, based on a compromise**
- **Countermeasures (or safeguards):**
  - **Reduce the vulnerabilities (preventive)**
  - **Limit the impact of an incident (healing)**

INCIDENT PRIORITIZATION



POINT OF FINANCIAL EQUILIBRIUM



GENERAL SOLUTION?

- Security audit

- Security policies

SECURITY DEFINITIONS

- **Security:** actions that allow one to
  - Detect and prevent: reducing the probability of harmful incidents
  - Recovery: reducing the negative consequences when a harmful incident occurs
  - Reporting: Identifying the causes when a harmful incident occurs
- **Attack:** any action capable of compromising the security of the information in an organization
- **Security mechanism:** any mechanism designed to detect, prevent or recover from a harmful incident
- **Security service:** a service that improves the security of data processing or transfer and that in general makes use of one or more security mechanisms

SECURITY SERVICES

- **Availability:**
  - **Guarantees the availability of the information for authorized entities whenever required**
    - Threat: Elimination of data or resources
- **Confidentiality:**
  - **Information only accessible to authorized entities**
    - Threat: Non-authorized access to data or traffic analysis
- **Integrity:**
  - **Only authorized entities may modify the information**
    - Threat: Modification of data or introduction of false data

SECURITY SERVICES

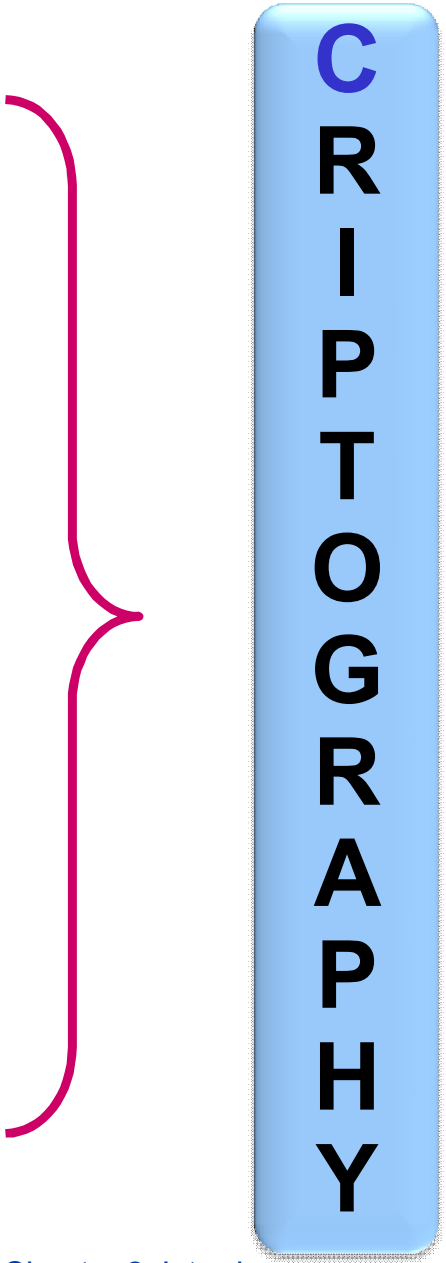
- **Authentication:**
  - **Guarantees the correct identification of origin and destination of the information**
    - Threat: Third-party masquerading as sender / receiver
- **Non-repudiation:**
  - **Guarantees that sender and receiver of a message can't deny its transmission**
    - Threat: Deny having transmitted or received certain data
- **Access Control:**
  - **Guarantees controlled access to information and systems to authorized entities**
    - Threat: Access of confidential data to non authorized entities

SCENARIOS

- **Integrity of the message**
  - How does B know that the message received from the sender A is the original and not a fake message?
- **Authenticity of the sender**
  - How does B know that the message received from the sender who says he is A is really that person?
- **Message Date**
  - How does B know that the message from A is recent and not a replay of a message previously sent from A?
- **Non-repudiation of the sender**
  - How can B prove that the message sent by A, and who now denies having sent it, really must have come from A?
- **Non-repudiation of the receiver**
  - How can A prove that the message sent to B, and who now denies having received it, really was sent?

SECURITY MECHANISMS

- Data encryption
- Message Digests
- Digital Signatures
- Authentication
- Key Exchange
- …



LOGICAL ACCESS CONTROL: AUTHENTICATION

- **Something that only one knows (password)**
  - ☺ Low costs, easy to invalidate / to configure / to register
  - ☹ Cession, capturing on introduction, guessing, induction
- **Something that is portable (key, intelligent card,...)**
  - ☺ Similar to passwords, but higher security
  - ☹ Multiple access, loss, robbery / copies / falsification, costs
- **Some physical characteristic (biometrics)**
  - ☺ Very secure
  - ☹ High costs

AUTHENTICATION: PASSWORDS

- Easy to remember
- Difficult to guess(?)
- Attacks on passwords very common:
  - Use well-known user accounts (“guest”)
  - Use known user accounts
    - Try trivial passwords, very often successfully!
  - Theft of data bases with ciphered keys
    - Used for password cracking
      - Example: dictionary attack (25% in less than 2 hours)
  - Copy ciphered keys and retransmit them

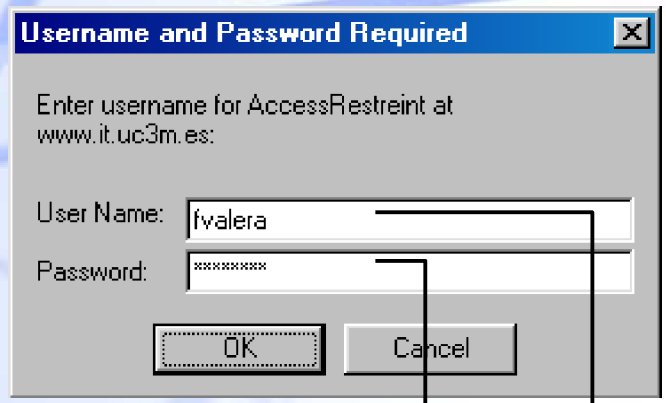
PASSWORDS POLICIES

- **Important: Users must choose good passwords**
  - A single bad key can compromise the whole system
- **Recommendation:**
  - Mix letters, digits and alphanumeric signs
  - Mix uppercase and lowercase
  - Never: Dictionary word or variations.
- **Example: UNIX passwords**
  - 8 characters, 7 bits/character, 56 bits DES
  - Problem: Passwords from a dictionary
    - ✓ Not equally probable (some are very popular)
    - ✓ Equivalent to a ~19 bit key
  - ➢ Easier to break using brute-force methods
- **Control mechanisms**

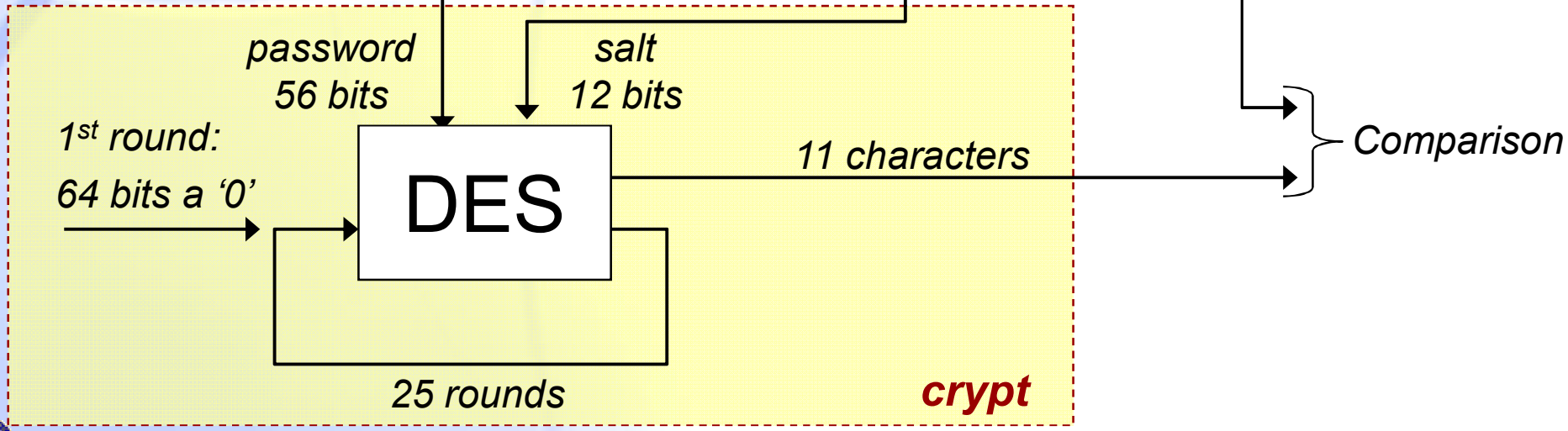
PASSWORDS POLICIES

- Change default passwords!
- Never store passwords in network files
- Restrict the access to files (/etc/passwd)
- Don’t give “hints” (finger daemon)
- Invalidation after “n” failures
  - Password blocking
- Force periodic password changes
  - Password aging
- Don’t send clear-text passwords
  - POP, telnet!

EXAMPLE: DES IN UNIX



LOGIN	SALT	PASSWORD
krogers	1w	tzf2DA0SZM.
pointer	oo	HJKJt8Ecqc6
master	13	mO7McGka4Kg
decimus	Gl	SMfUPWkhh/c
dracula	oo	CQMcBxVlb3l
cartman	xs	ARpupQK8hQE
fvalera	ro	tli3t3/cLql
smartman	lQ	YkoMoy0.O6w
michael	32	w3liMtCRAaE
jpintur	i1	V1k9xE4bH5g
japon	13	G7HMb/DMaXo
luke	po	rexMTCgEsHE



TERMINOLOGY

http://www.britannica.com

Cryptology. (from gr. *κρυπτος* hidden and *-logos*). *f.* the scientific study of cryptography and cryptanalysis

Cryptography. (from gr. *κρυπτος* hidden and *-grafía*). *f.* enciphering and deciphering of messages in secret code or cipher

Cryptanalisys. ***m.*** the solving of cryptograms or cryptographic systems

Cryptogram. ***m.*** a figure or representation having a hidden significance

TERMINOLOGY

http://www.britannica.com

Encrypt. *tr.* Encipher, encode.

Encode. *tr.* to convert from one system of communication into another; *especially*: to convert (a message) into code.

Code. *tr.* a system of symbols (as letters or numbers) used to represent assigned (and often secret) meanings.

Encipher. *tr.* to convert (a message) into cipher.

Cipher. *tr.* (a) a method of transforming a text in order to conceal its meaning. (b) a combination of symbolic letters

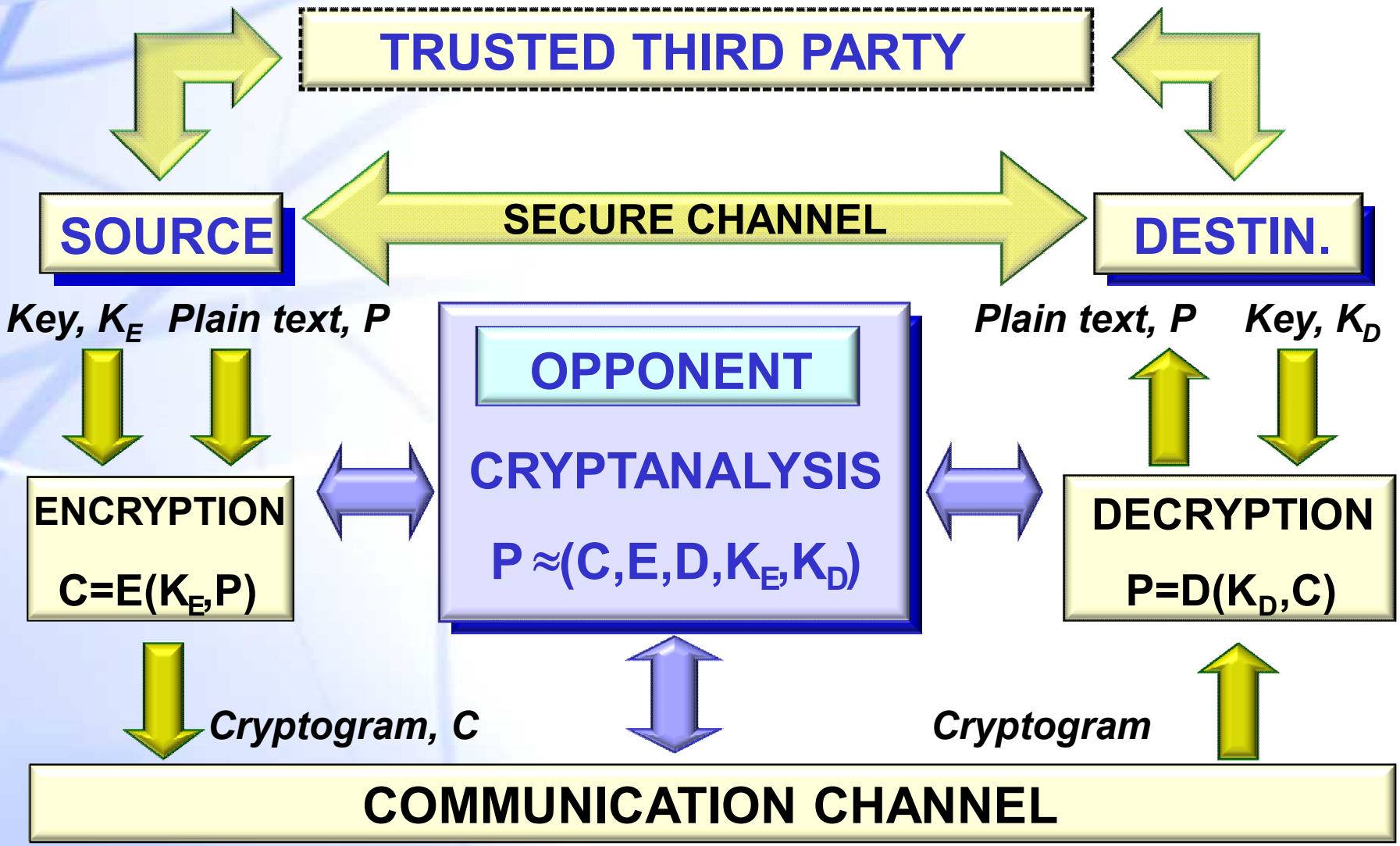
CRYPTOSYSTEM

- **Cryptosystems:**
  - Alphabet: for writing not encrypted text (P, plain text or clear text) and encrypted text (C, cryptograms)
  - Key space: all possible keys for encryption (kc) and decryption (kd)
  - Encryption (E) and decryption (D) transformations: function from the alphabet to the same alphabet.

$$D_{kd}[C=E_{ke}(P)]=P$$

- **Cryptosystem transformation:**
  - Symmetric (conventional encryption, secret key encryption): the encryption and decryption key are the same (ke=kd=k)
  - Asymmetric (public key encryption): the encryption key and decryption key are different (ke≠kd)

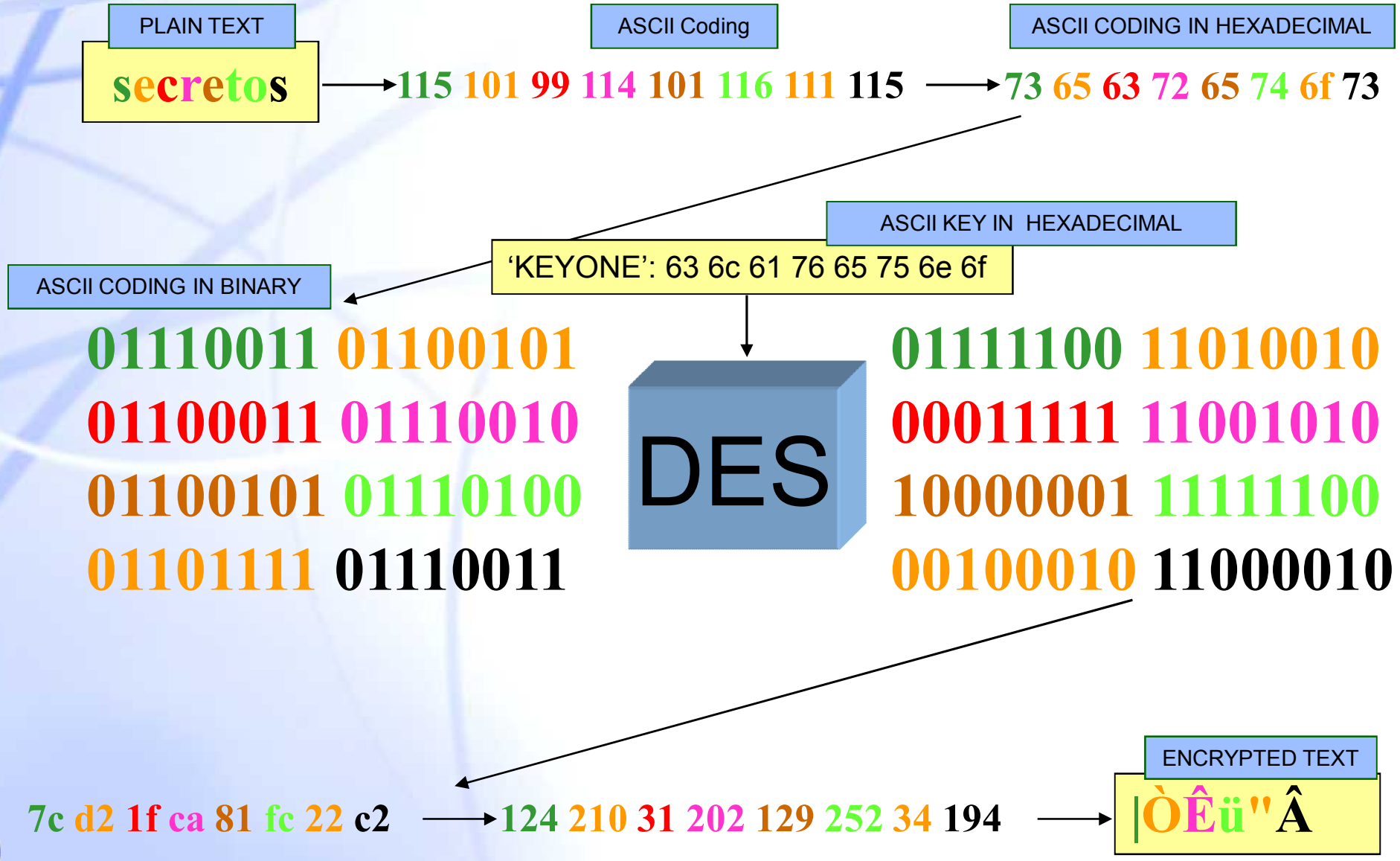
CRYPTOSYSTEM MODEL



ASSUMPTIONS

- **To carry out a "threats analysis" we have to suppose the opponent's resources**
- **Worst case (exaggerated?)**
  - Real time interception and inspection of every packet
  - Message alteration, creation and repetition
  - Brute-force attack against obsolete algorithms or when having enough information
  - Sources of attacks are known users
- **These days, wireless networks proliferation makes perfectly valid some of the above assumptions.**

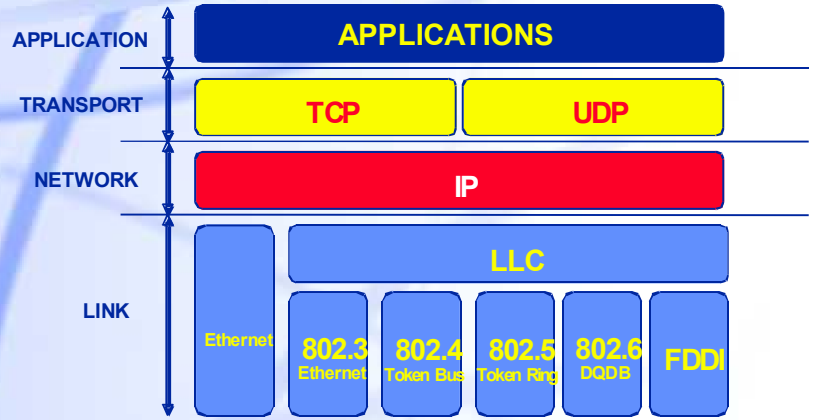
ENCRYPTION EXAMPLE

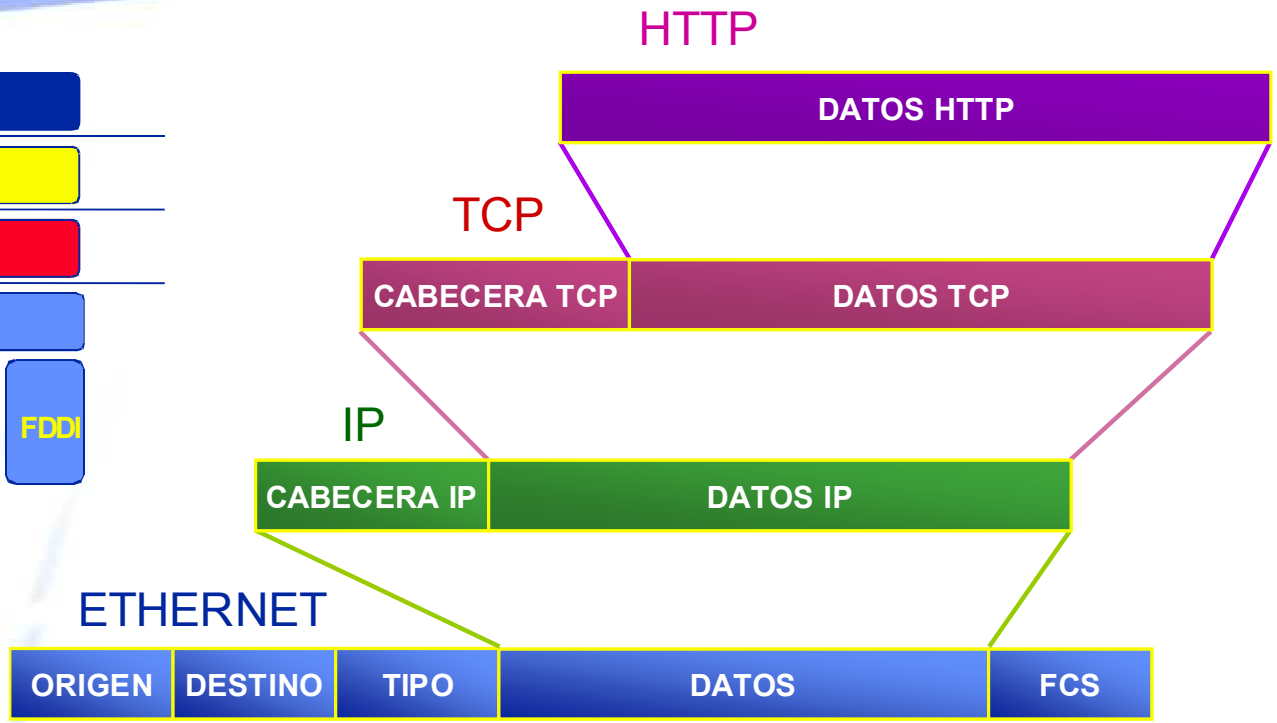


PLACEMENT OF ENCRYPTION

- Hop-by-bop
- End-to-end

PLACEMENT OF ENCRYPTION





- The lower you encrypt:
  - More information to encrypt
  - Easier to do it in hardware
  - Fewer keys in the open
  - Fewer keys necessary
  - Authentication at a coarser level