Announcements

- Reading Chapters 15
  - problems: 15.1, 15.2, 15.5, 15.8

Access Matrix

- Abstraction of protection for objects in a system.
  - Rows are domains (users or groups of users)
  - Columns are objects (files, printers, etc.)
  - Items are methods permitted by a domain on an objects
    - read, write, execute, print, delete, …
- Representing the Table
  - simple representation (dense matrix) is large
  - sparse representation possible: each non-zero in the matrix
  - observation: same column used frequently
    - represent groups of users with a name and just store that
  - create a default policy for some objects without a value
- Revocation of access
  - when are access rights checked?
  - Selective revocation vs. global

Access Matrix

	F1	F2	F3	Laser Printer	
D1	read		execute		
D2			execute	print	
D3	read, write		execute		
D4			execute		
D5		delete			

- Rows represent users or groups of users
- Columns represent files, printers, etc.

Capabilities

- Un-forgeable Key to access something
- Implementation: a string
  - I.e. a long numeric sequence for a copier)
- Implementation: A protected memory region
    - tag memory (or procedures) with access rights
      - example - x86 call gate abstraction
    - permit rights amplification

Monitoring

- Record (log) significant events
  - attempts to login to the system
  - changes to selected files or directories
- Possible to compromise the log
  - the user or software breaking in could delete all or part of the logs
  - could record logs to non-erasable storage
    - have a line printer attached to the machine
    - use WORM drives
  - send data to a secure remote host

Encryption: protecting info from being read

- Given a message m
  - use a key k, and function E_k to compute $E_k(m)$
  - store or send only $E_k(m)$
  - use a second second key k and function $D_{k'}$ such that
    - $D_{k'}(E_k(m)) = m$
  - E_k and $D_{k'}$ need not be kept a secrete
- If k=k' it's called private key encryption
  - need to keep k secret
  - example DES
- if k != k', it's called public key encryption
  - need only keep one of them secret
  - if k' is secret, anyone can send a private message
  - if k is secret, it is possible to "sign" a message
  - still need a way to authenticate k or k' for a user
  - example RSA

Transposition Cipher

- Block of text is used to break up digrams
- To Break:
  - each letter is itself, so normal distribution of letters is seen
  - guess number of columns (verify with known plaintext)
  - order columns using trigram frequency

M	E	G	A	B	U	C	K
7	4	5	1	2	8	3	6
p	l	e	a	s	e	t	r
a	n	s	f	e	r	o	n
e	m	i	l	l	i	o	n
d	o	l	l	a	r	s	t
o	m	y	s	w	i	s	s
b	a	n	k	a	c	c	o
u	n	t	s	i	x	t	w
o	t	w	o	a	b	c	d

Plaintext

pleasetransferonemilliondollarsto
myswissbankaccountsixtwotwo

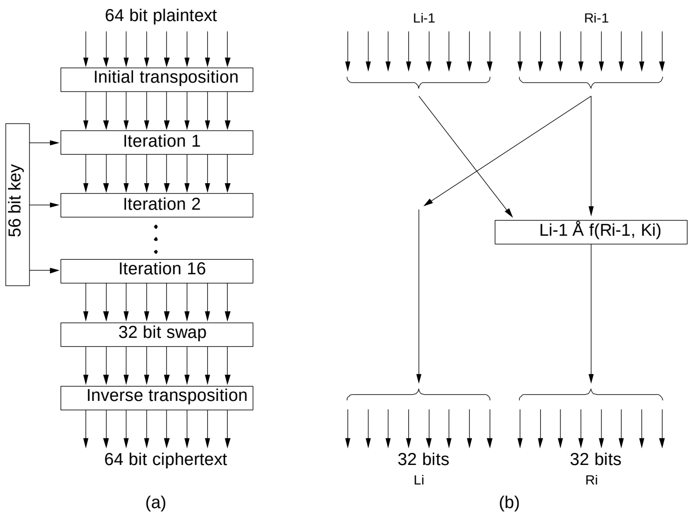
Ciphertext

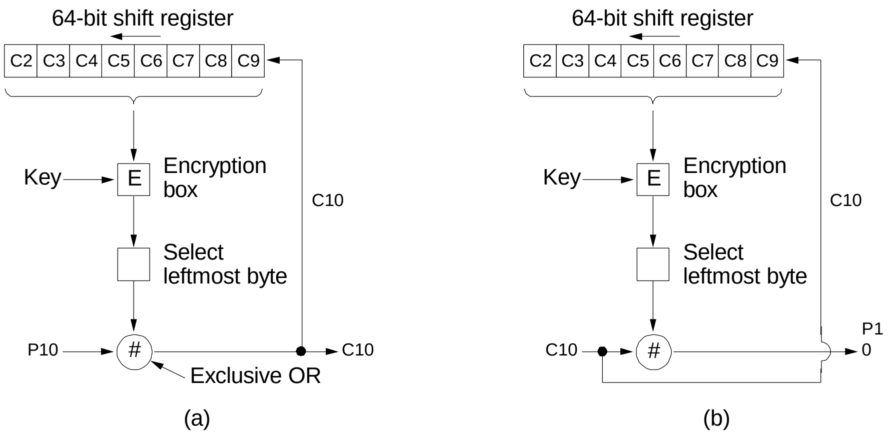
AFLLSKSOSELAWAIATOOSSCTCLNMOMANT
ESILYNTWRNNTSOWDPAEDOBUOERIRICXB

From: *Computer Networks*, 3rd Ed. by Andrew S. Tanenbaum, (c)1996 Prentice Hall.

DES

- Block cipher: uses 56 bit keys, 64 bits of data
- Uses 16 stages of substitution
- Variations
  - cipher block chaining: xor output of block n with into block n+1
  - cipher feedback mode: use 64bit shift register
    - can produce one byte at a time





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One Time Pad

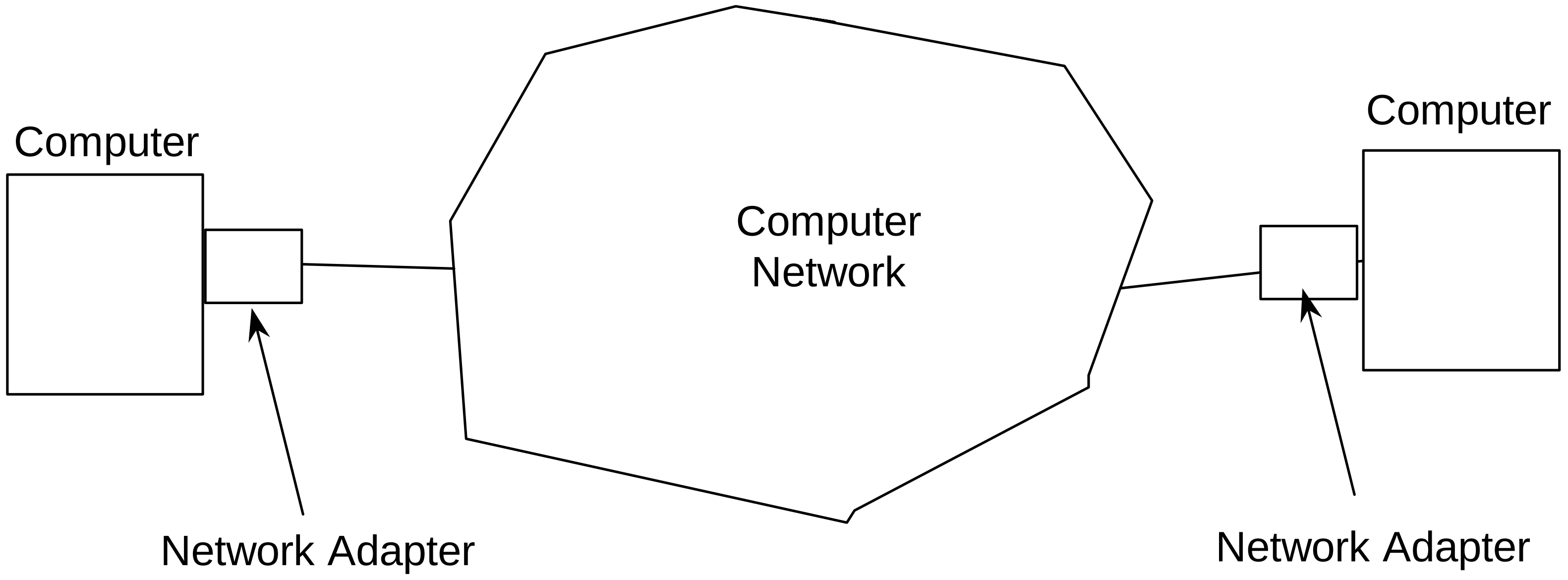
- Key Idea: randomness in key
- Create a random string as long as the message
  - each party has the pad
  - xor each bit of the message with the a bit of the key
- Almost impossible to break
- Some practical problems
  - need to ensure key is not captured
  - a one bit drop will corrupt the rest of the message

Networks are divided into layers

- ISO - seven layer reference model
  - Application (end application)
    - firewalls work at this layer
  - Presentation (encryption or compression)
  - Session (end-to-end connections)
  - Transport (splitting data into packets)
  - Network (routing packets)
    - routers work at this later
  - Link (moves frames and detects errors)
    - bridges at this layer
  - Physical (EE type stuff)
- TCP/IP - three layer model
  - link, network, transport/session/presentation

Networks

- Communication channels between semi-autonomous computers
- Attached to host system by an adapter



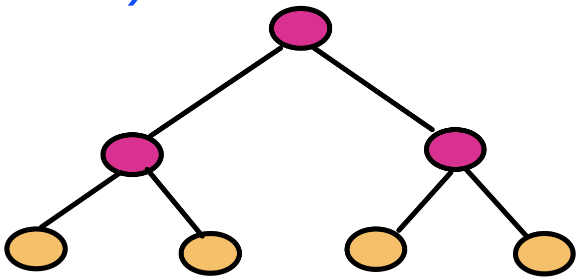
Networks

- Topology
  - Fully connected - link between all sites
  - Partially connected
    - links between subset of sites
    - can be an arbitrary graph
  - Hierarchical networks
    - network topology looks like a tree
    - internal nodes route messages between different subtrees
    - if an internal node fails, children can not communicate with each other
    - star network - hierarchical network with single internal node

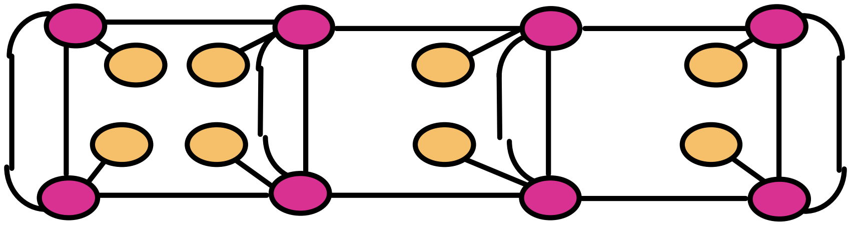
Network Topologies

● Network device ● Processor

- Tree (TMC CM-5)



- Mesh
  - 2-d Intel Parago
  - 3-d Cray T3E



- Star (Ethernet 10Base-T, physical only)