Wireless Systems Security

EE/NiS/TM-584-A/WS

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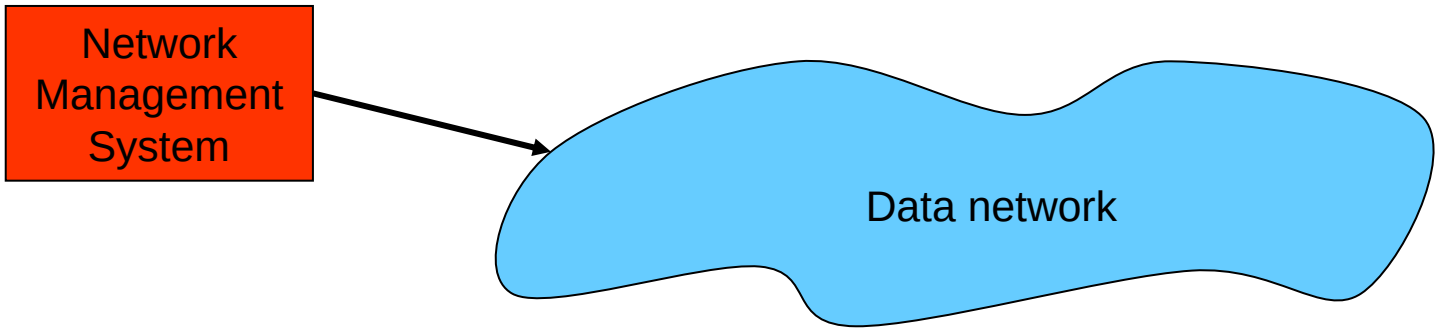
Week 5:
Still More Security Topics

Some Important Topics in Information System Security

- Minimum privilege/minimum functionality
- Compartmentalization/Containment
  - Separation of Responsibility
  - Dual Controls
- Security Perimeters
- Trustworthiness/Design Correctness
- Single-points-of-failure/Choke-points
- Covert Channels
- Inference
- Implicit vs. Apparent Security

Minimum privilege/Minimum functionality

- Network Management System



- Applications running on NMS have ultimate control over operation of data network
  1. What capabilities do users really need to have to perform their job?

     Do users need to be able to monitor traffic on the network?

     Including (potentially) sensitive user traffic?

Minimum privilege/Minimum functionality

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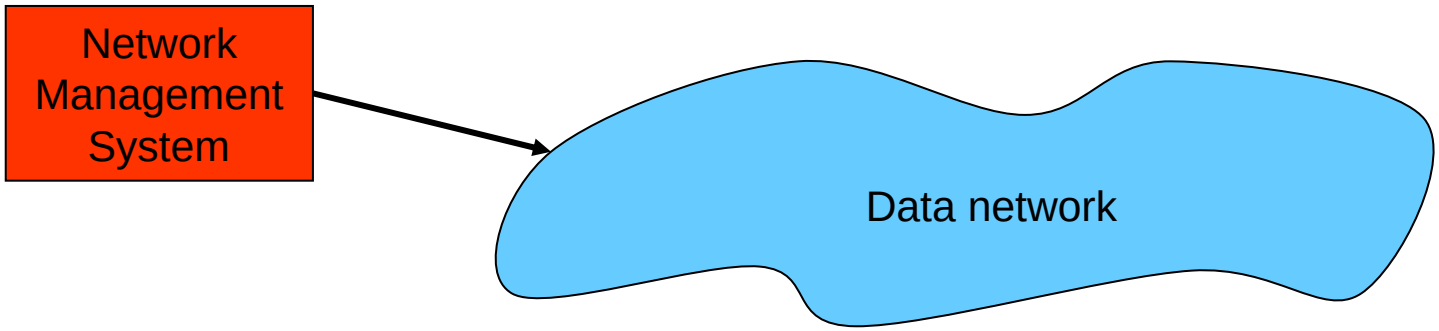

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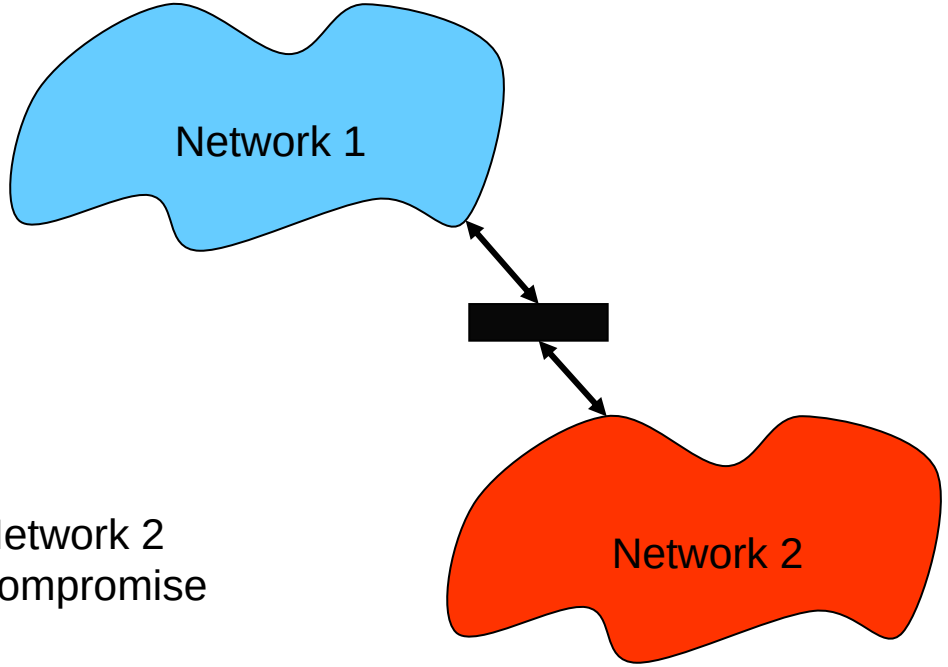
  1. What capabilities do users really need to have to perform their job?
     Do users need to be able to monitor traffic on the network?
     Including (potentially) sensitive user traffic?

  2. What features does system really need to enable it to operate?
     Does NMS application code get compiled on NMS or is it downloaded?

Compartmentalization/Containment

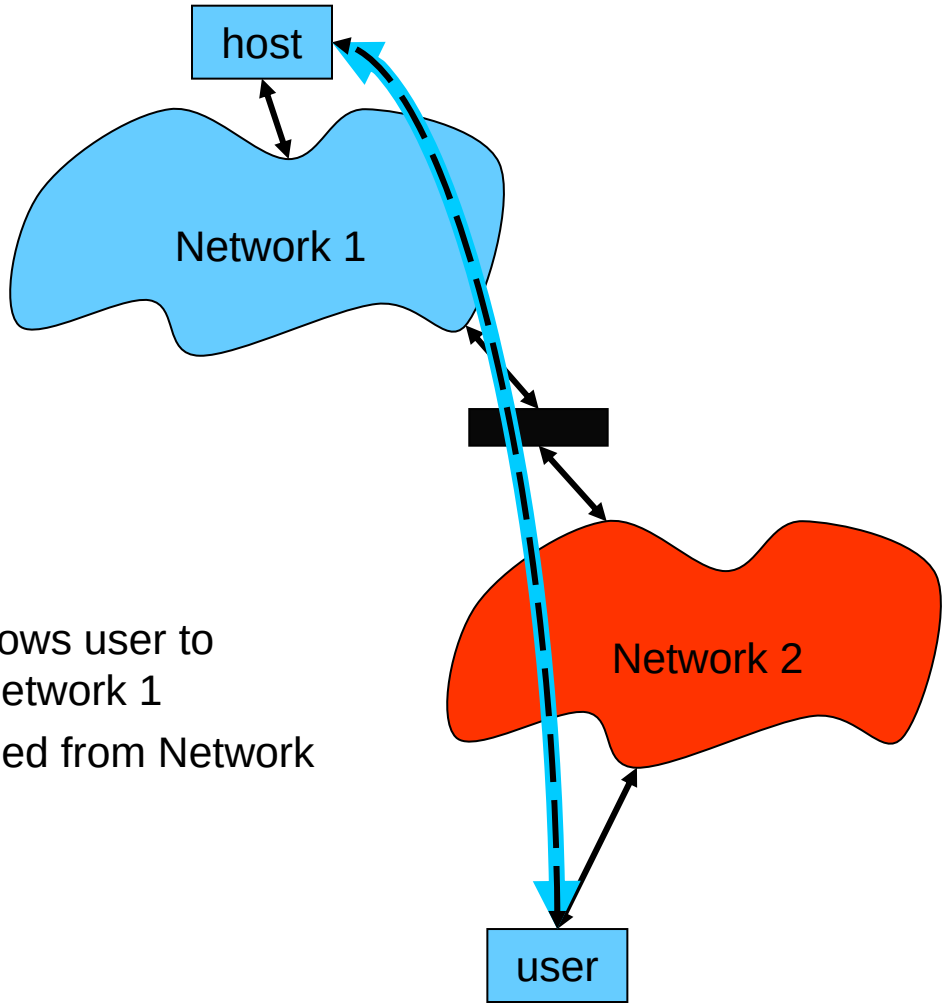
- Firewall



- Potential compromise of Network 2 should not be allowed to compromise Network 1
- Partitioning of traffic, namespace, services
- Entities on Network 1 may not even be visible to users on Network 2

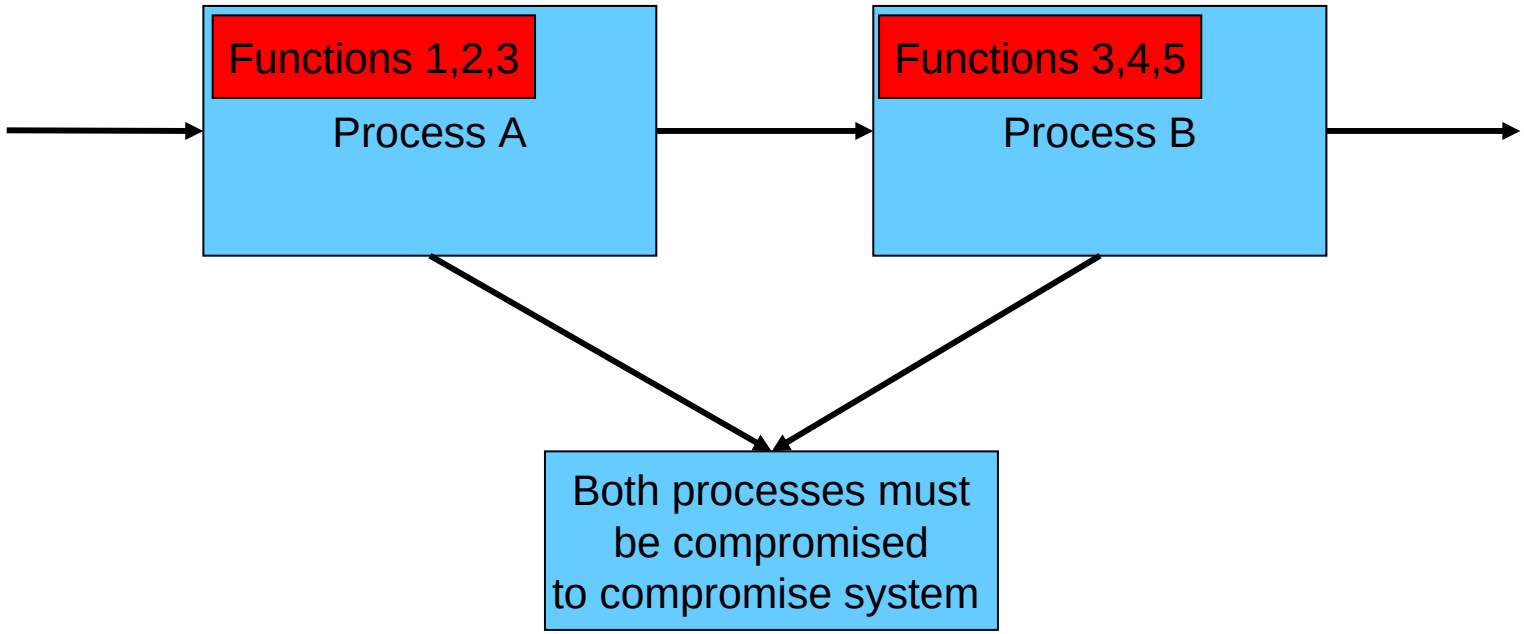
Compartmentalization/Containment

- Virtual Private Network

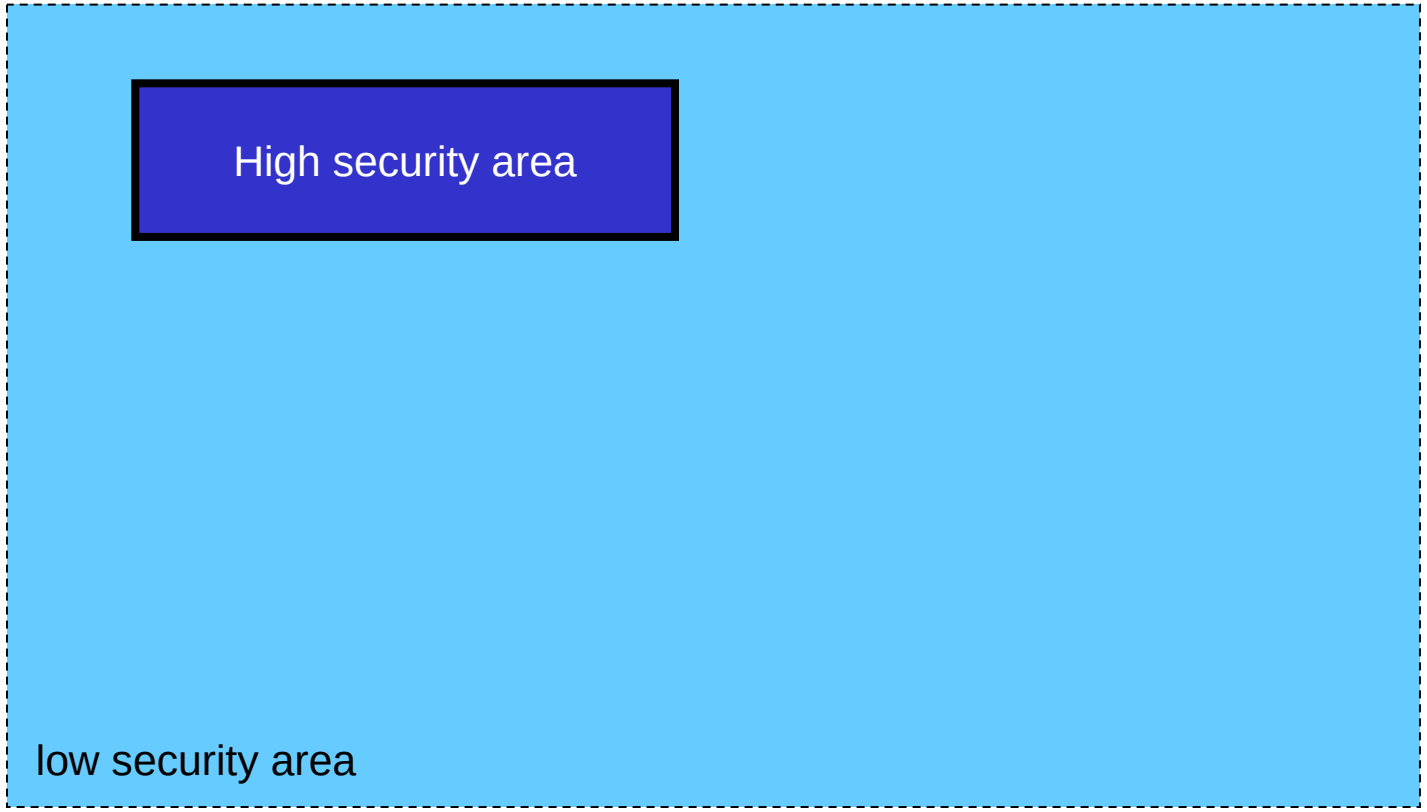


- Encrypted VPN ‘tunnel’ allows user to appear to be virtually on Network 1
- Tunnel is compartmentalized from Network 2

Separation of Responsibility

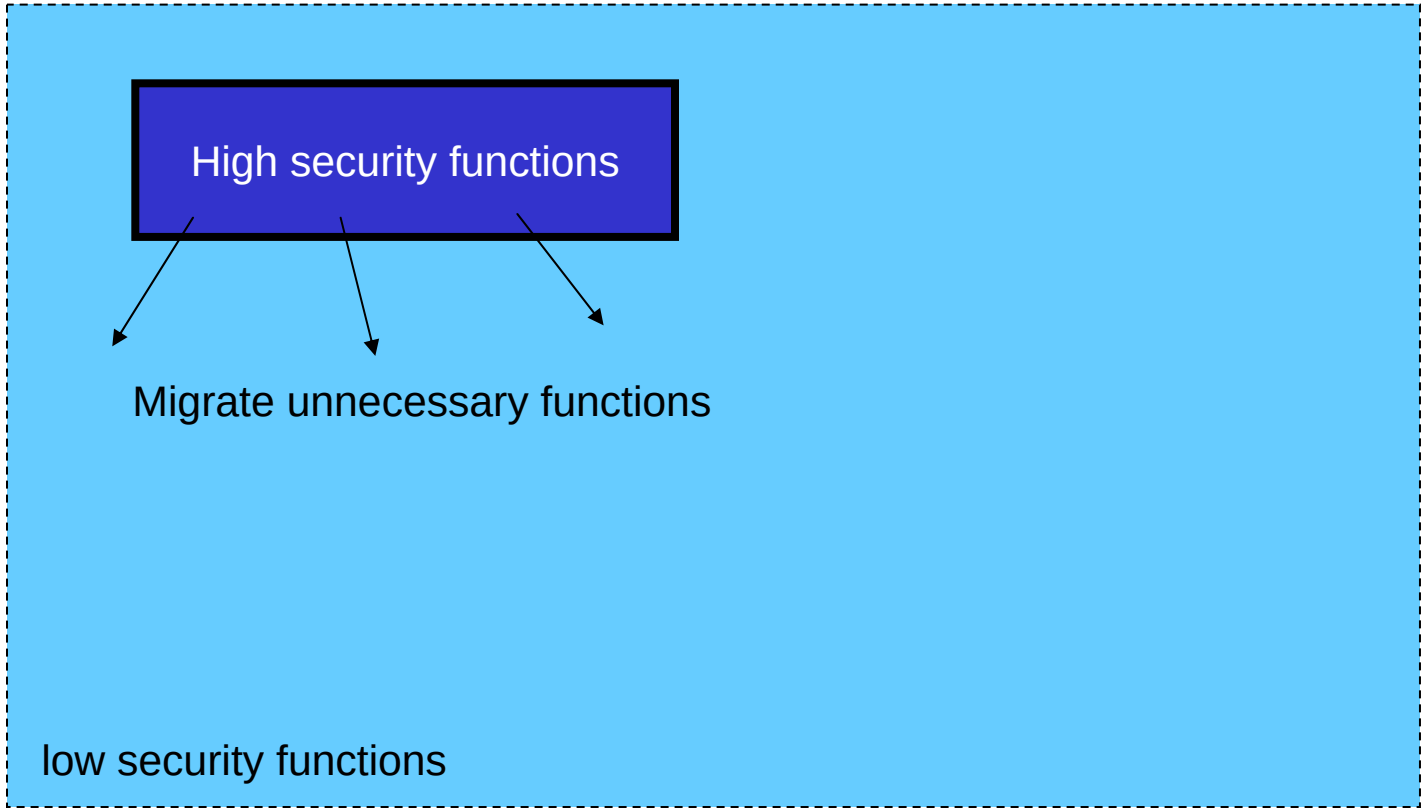


Security Perimeters



- Cost of protection scales with size of secure area
- Defining a small security perimeter containing critical assets allows focus on security priorities

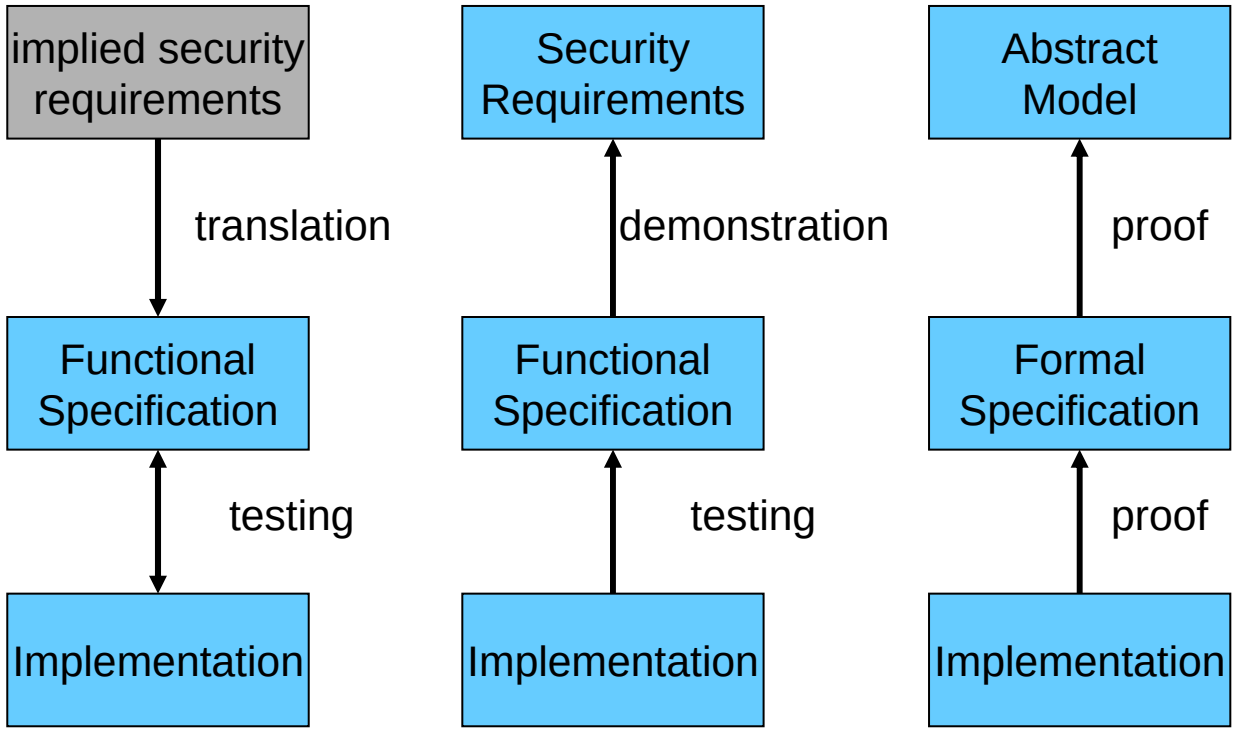
Security Perimeters



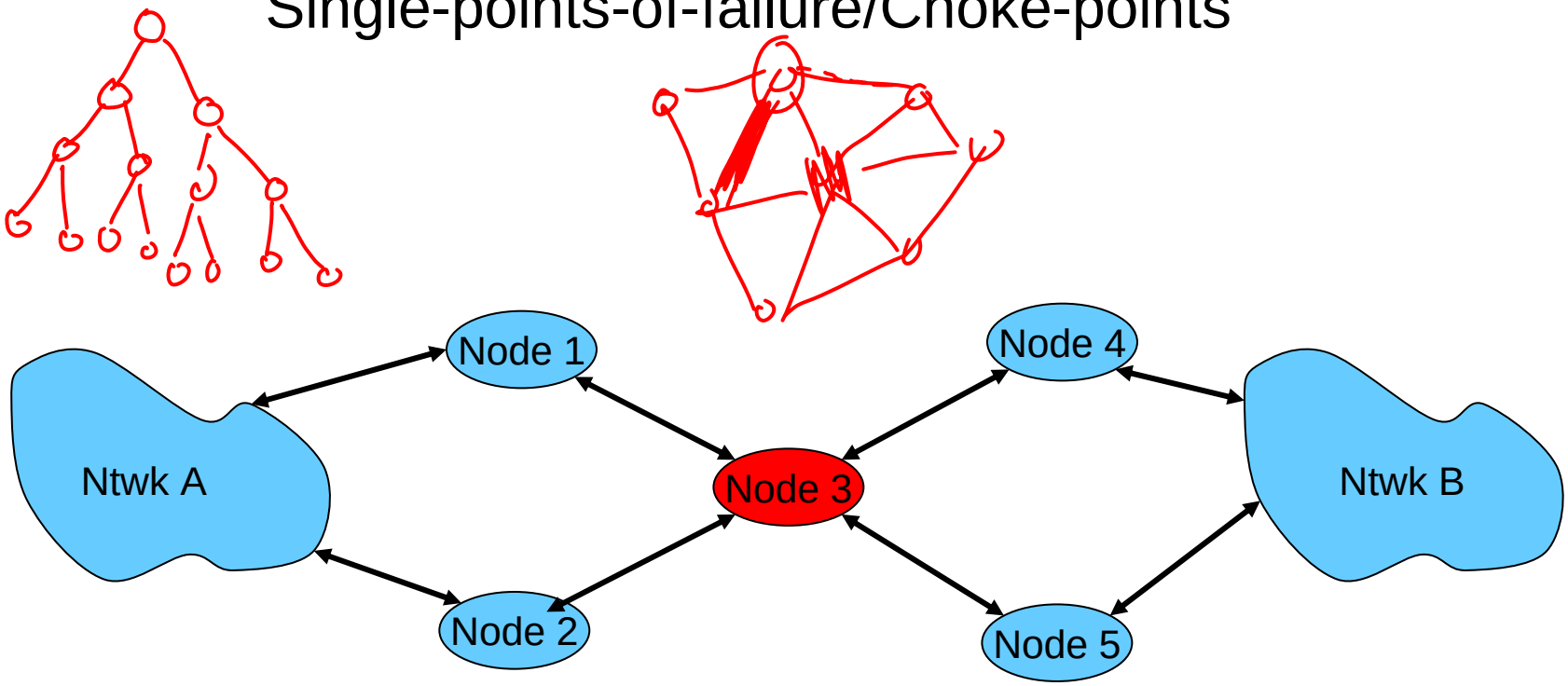
- Migrating unnecessary functions out of secure perimeter reduces need for inspection/assurance
- Reduces risk of compromise

Trustworthiness/Design Correctness

$955 \times 77.1 = 65536 \quad 2^{16}$

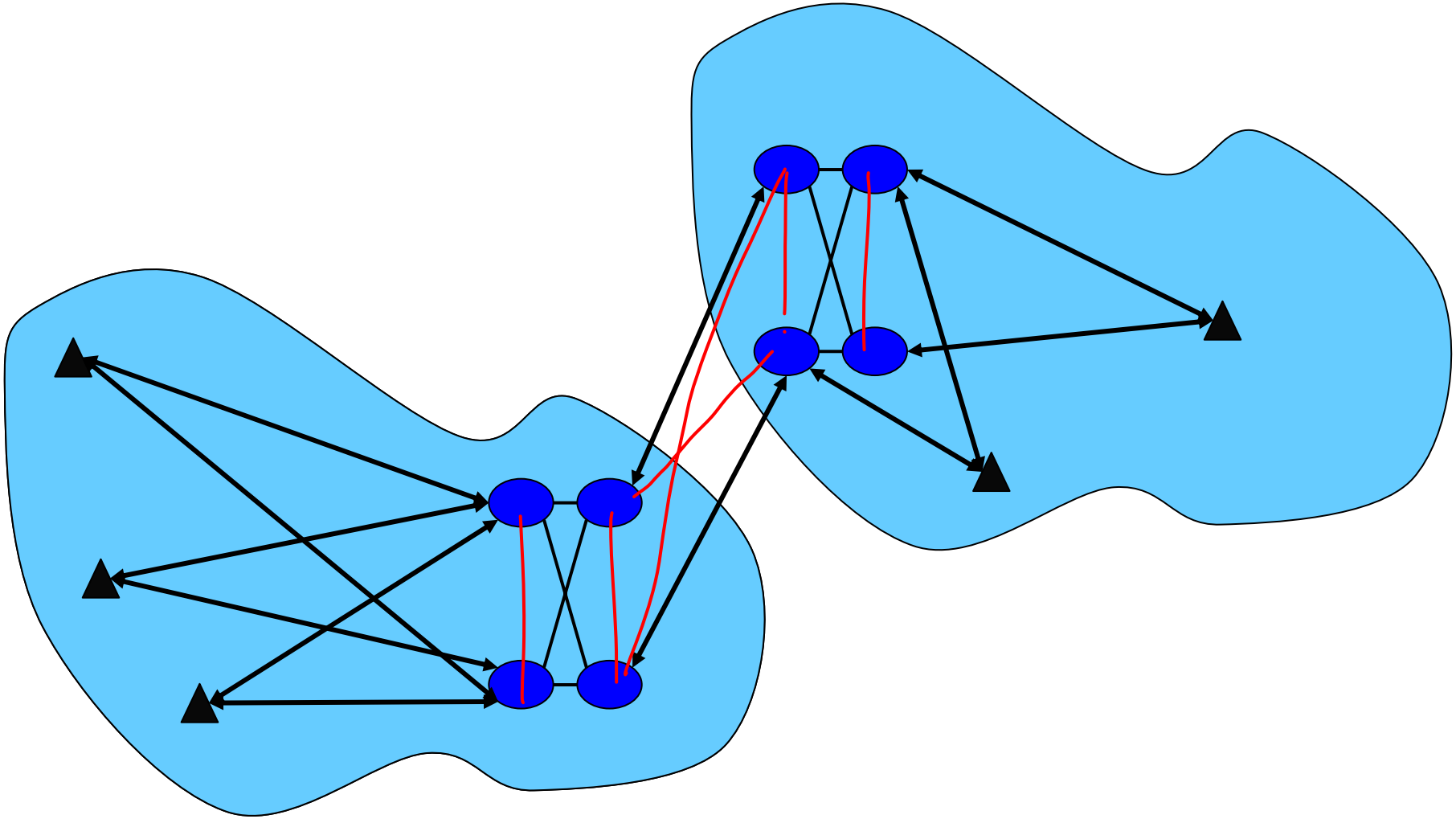


Single-points-of-failure/Choke-points

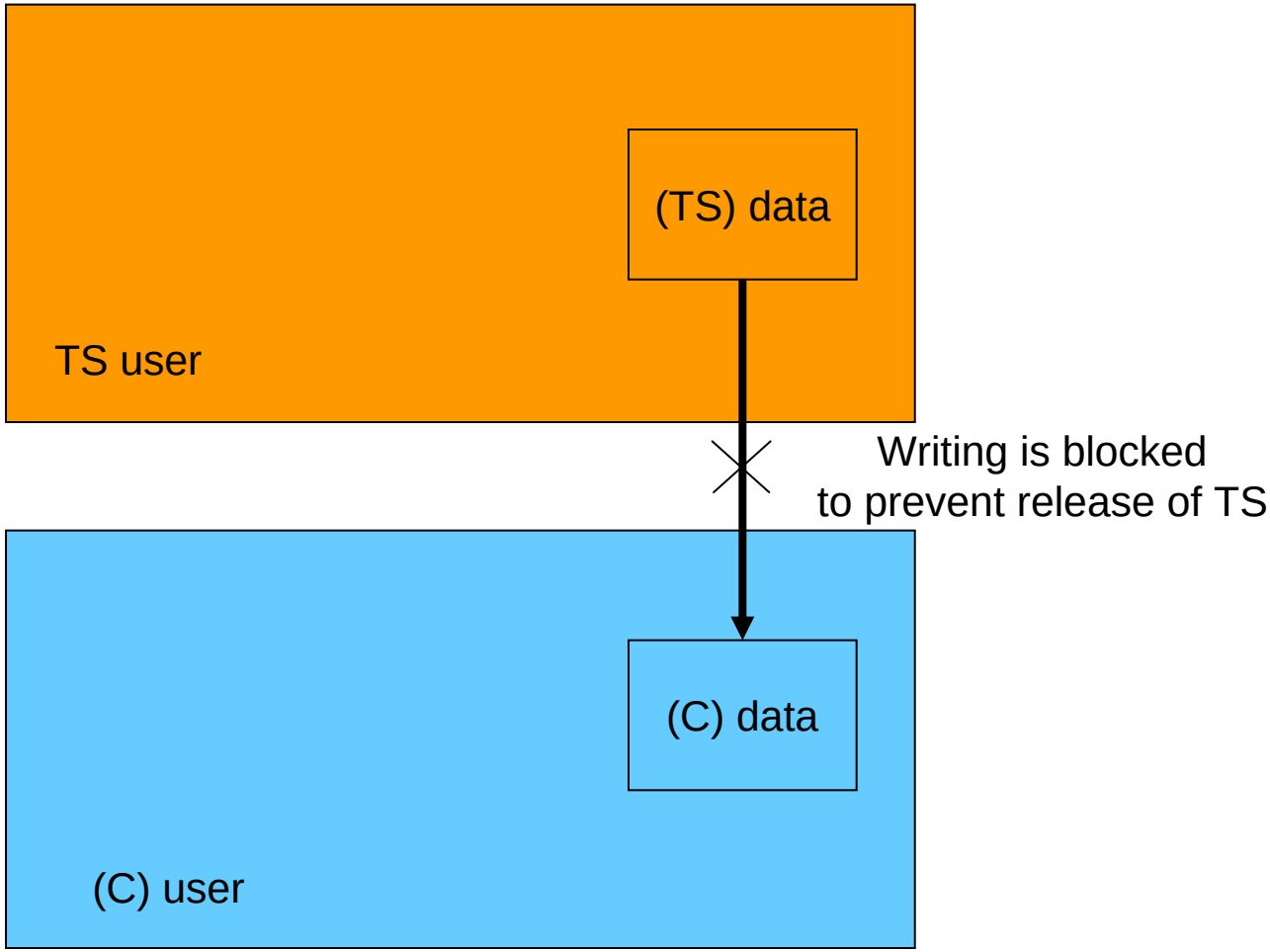


Node 3 is a single-point-of-failure (or attack) and a choke-point

Survivable Signalling Network (SS7)



Covert Channels - Storage Channel



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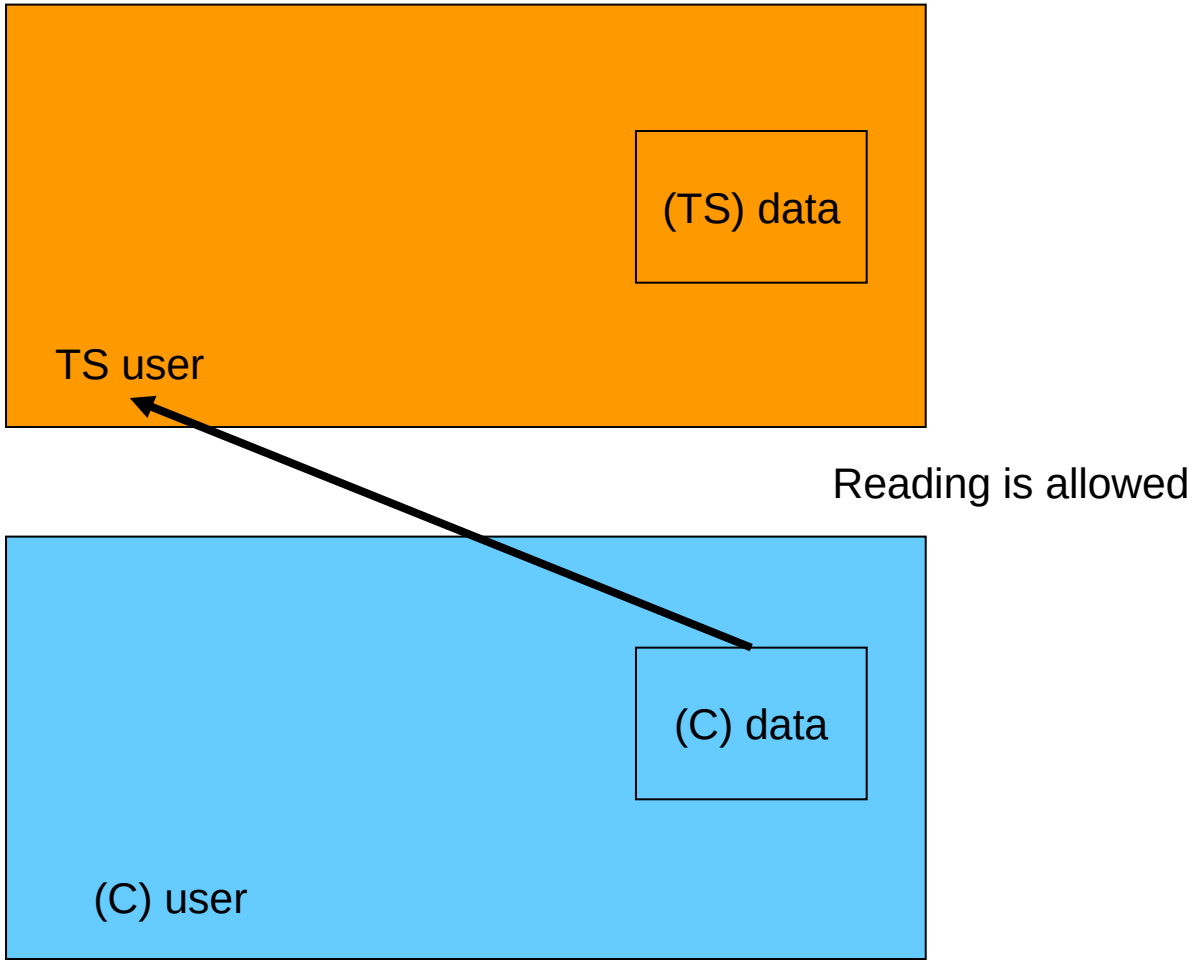

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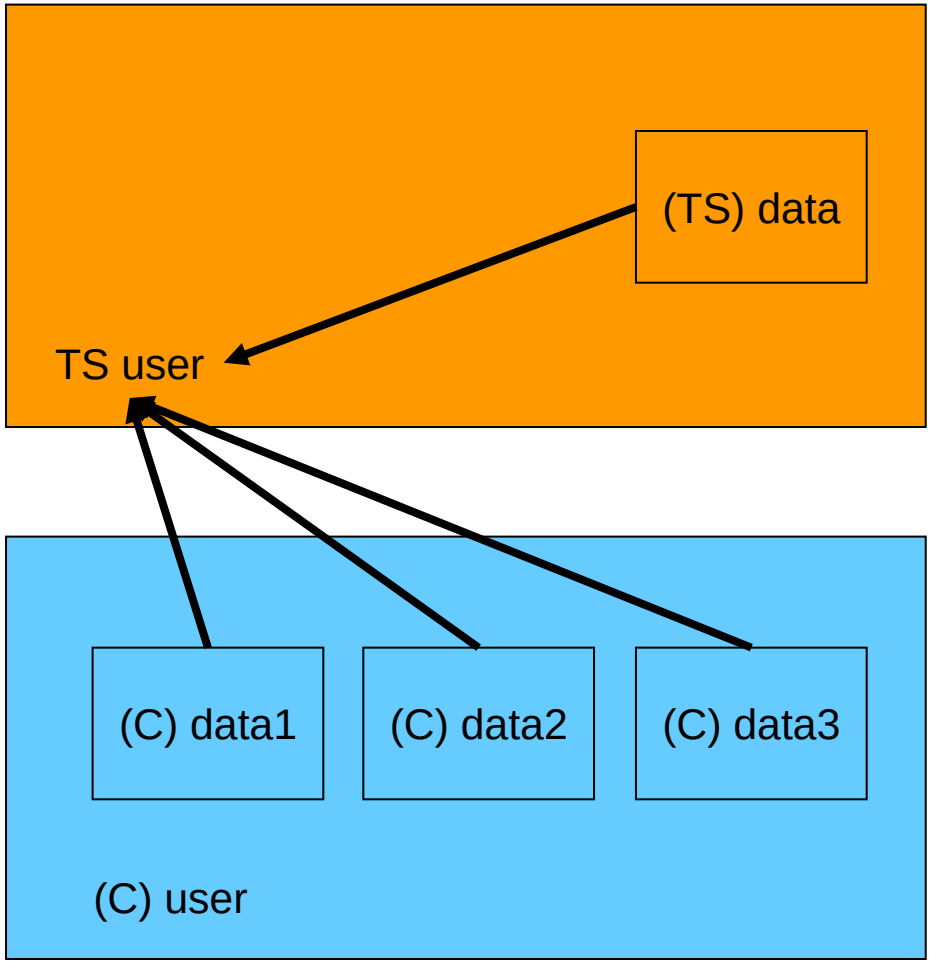
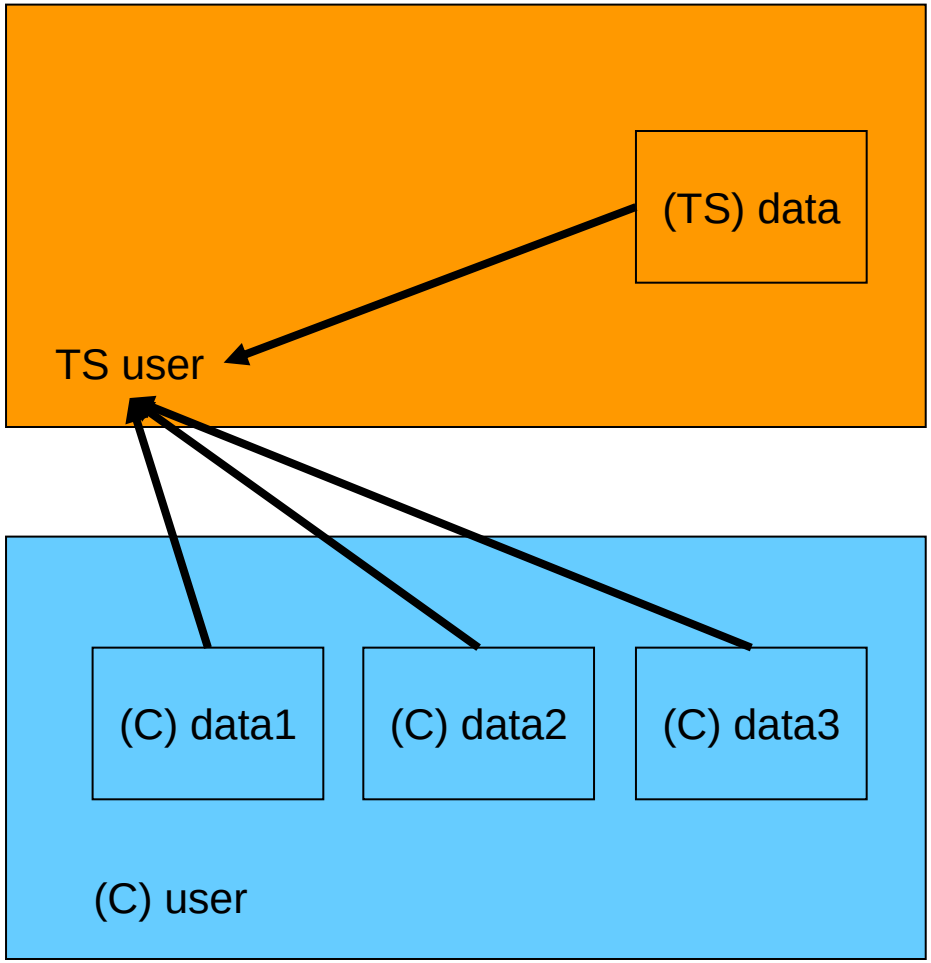


Consider a DB with record locking:

TS: Open1, Open2
C: Open1(blocked), Open2(blocked),
Open3(succeed)
Until(Open1) {}
Close3, Close1
TS: While(!Open3){}
Close1, Close2, Close3
// TS just sent a “0”

TS: Open2, Open3
C: Open1(succeed)
Until(Open2){}
Close1, Close2
TS: While(!Open1){}
Close1, Close2, Close3
//TS just sent a “1”

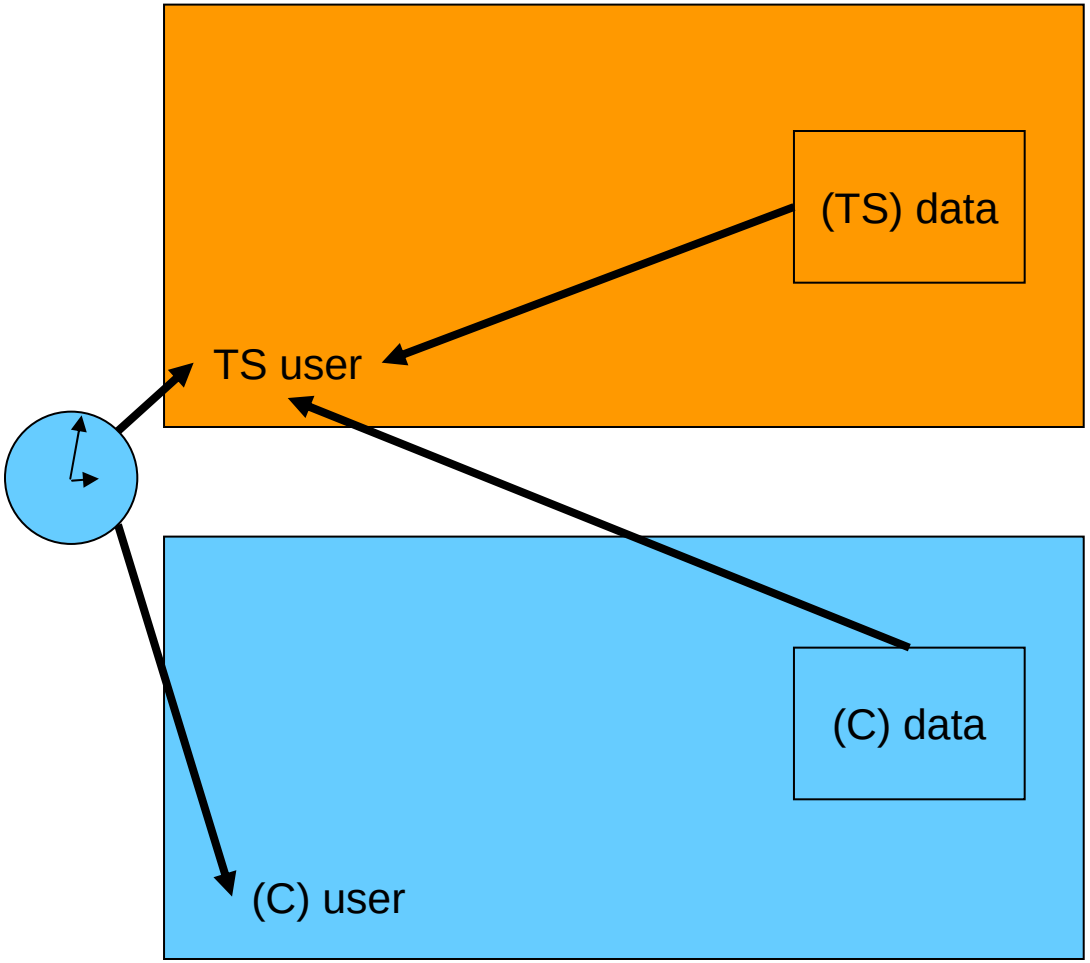
Covert Channels - Storage Channel



This is an obvious covert channel, with wide bandwidth (on the order of the open/close speed of a data record)

Arbitrary covert channels can be exploited with P(detection) related to utilized bandwidth.

Covert Channels - Timing Channel



Synchronized access to lower level data is used by TS user to convey TS data to lower level user

Note: "TS user" might be Trojan Horse operating on behalf of TS user

Inference

- Example 1:
  - Stevens has used Social Security Numbers as Student IDs for many years. Grades were posted by SSN. Name/SSN are never displayed together publicly
  - AT&T Bell Labs (That name carbon-dates the age of the issue) switched from Payroll Account Numbers (PANs) to SSNs as employee identifiers
  - The POST employee directory was searchable by PAN or SSN, but did not display them
  - Individual privacy can be compromised by SSN fairly easily
    - How can two relatively secure systems be played against each other?

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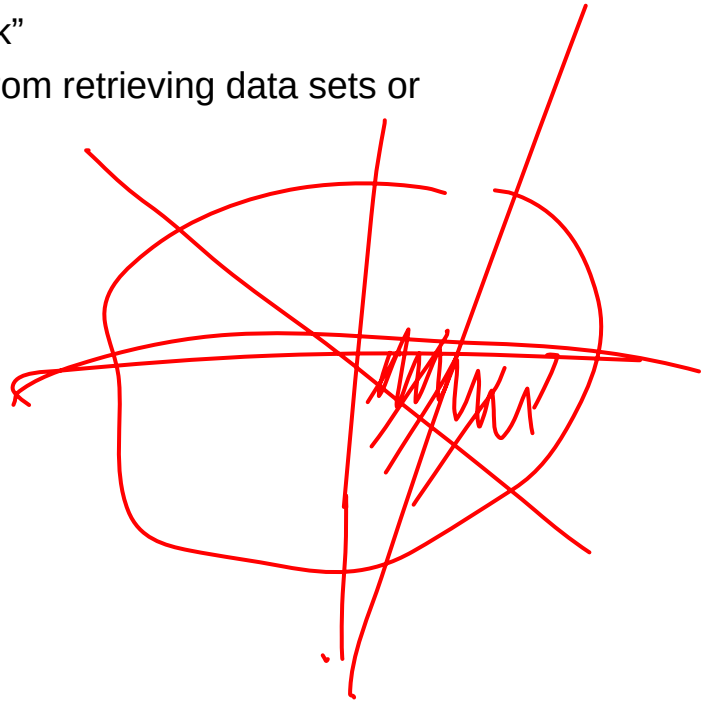
    - How can two relatively secure systems be played against each other?
      - A large percentage of part-time Stevens EE/CpE & CS graduate students have historically come from AT&T/Bell Labs
      - Obtain the SSNs of Stevens EE/CpE/CS graduate students from posted grades
      - Search the POST data base by SSN to identify individuals.
        - » Individual privacy is compromised by the joint weakness of two systems that are relatively secure separately

Inference

- Example 2
  - ref: Dorothy Denning, “The tracker - inference issues in database security”
  - Database contains User names, department, ages, salary, etc.
  - Individual records are protected against search by low level users: only trusted users may read separate records
  - Aggregate database statistics may be viewed by lower level users, e.g.,
    - “Show average salary of male employees”
    - “Show number of users earning more than $100k”
  - Database security system prevents lower level user from retrieving data sets or statistics based on small number of records



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  - Database security system prevents lower level user from retrieving data sets or statistics based on small number of records
    - The DB Inference problem:

      Attacker creates a series of queries that have a small sample size in their intersection

      Unless DB security system can assess sample sizes for all possible combinations of queries user has ever made, it is subject to an inference attack.

      Even if it does this, innocent queries can be denied because they MIGHT create inference vulnerability

Implicit vs. Apparent Security

- User chosen passwords are notoriously insecure, often subject to dictionary attacks. Machine generated passwords are suggested as an alternative. Which is more secure?
  - Password scheme1:

    character(k) = {a-z, 0-9, !@#$%^&*() } (46 symbols)

    PW = kkkkkk

    sample passwords: a5&98!, tfhe5&, 3thp1,

  - Password scheme2

    vowel(v) = {aeiou}

    consonant(c) = {bcdfghjklmnpqrstvwxz}

    PW = cvcvcvcvcv

    sample passwords: ponihavoka, risehipeta, tojifatese

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    sample passwords: a5&98!, tfhe5&, 3thp1,
    Total password space: 9,474,296,896
  - Password scheme2
    vowel(v) = {aeiou}
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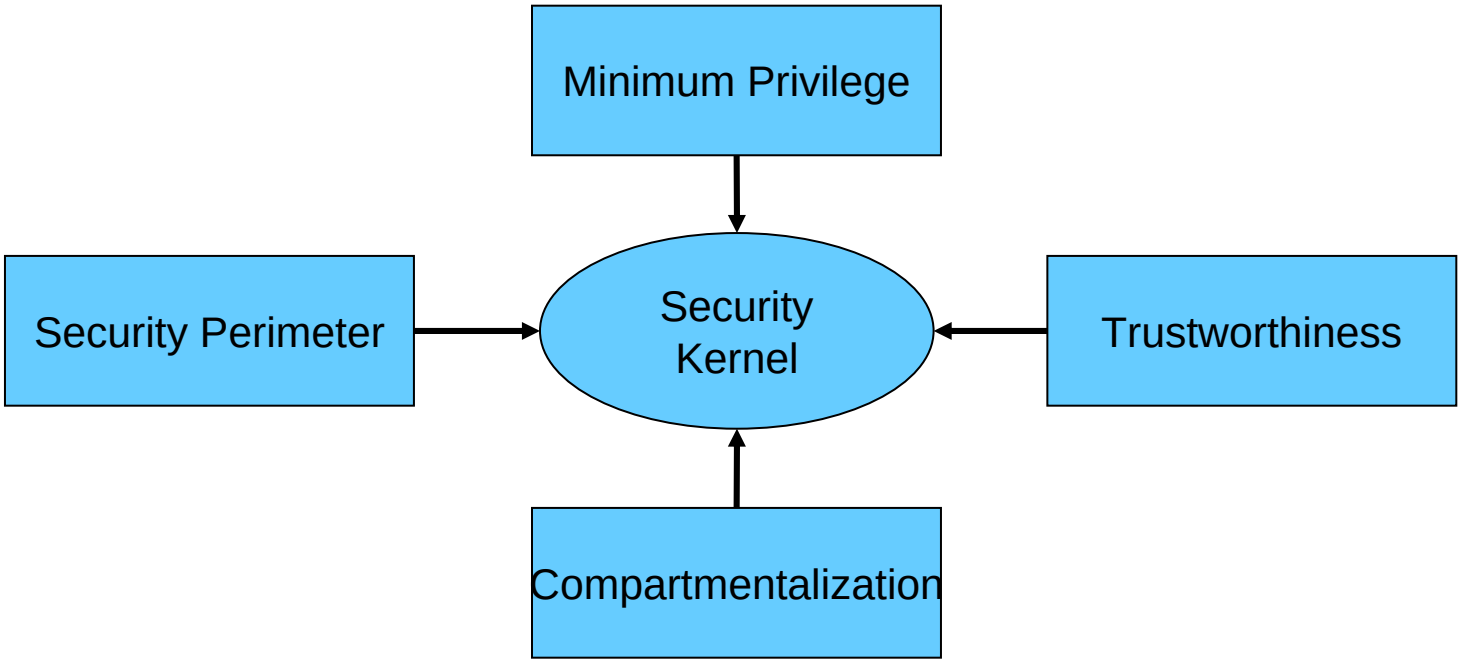
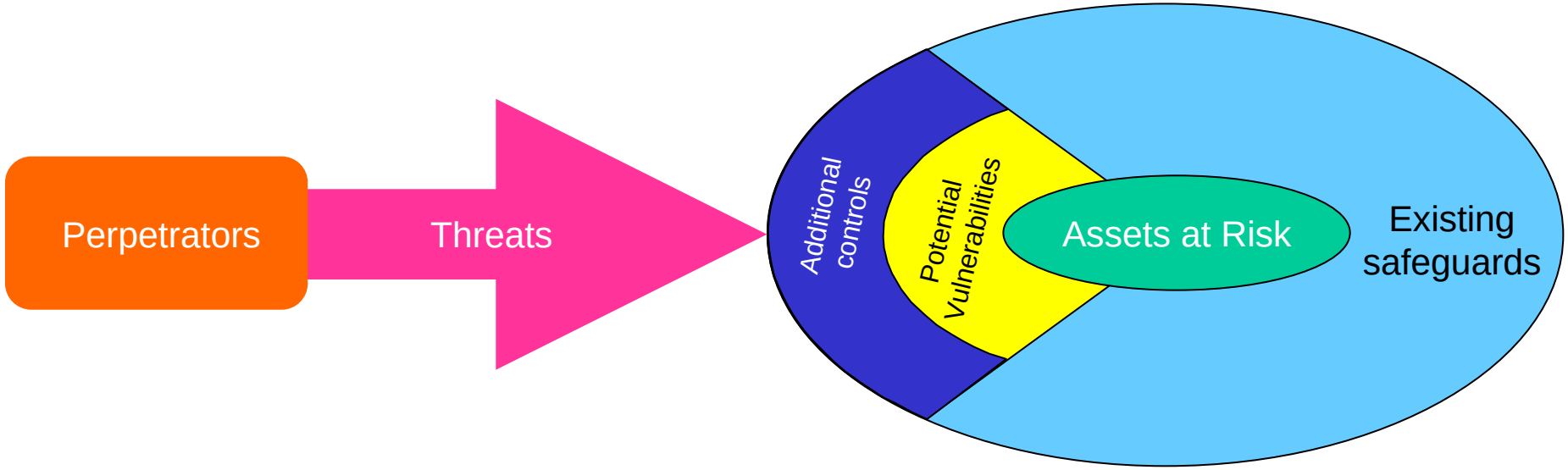
    PW = cvcvcvcvcv
    sample passwords: ponihavoka, risehipeta, tojifatese
    Total password space: 10,000,000,000
- Apparent complexity of first scheme suggests higher security, but ease of memorization of second makes passwords more secure

Combining Concepts



Security Assessment

- The structure:



- The process:
  - Structured brainstorming

STOP HERE

READ THE NOTES BEFORE PROCEEDING

Brainstorming

- True brainstorming occurs in two phases:
  - Free flowing idea generation without any analysis
  - THEN, analysis to weed out the useful ideas

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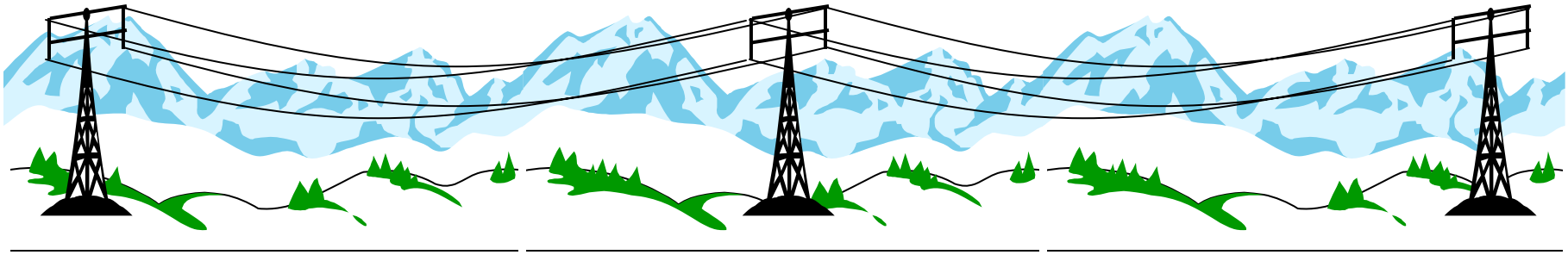

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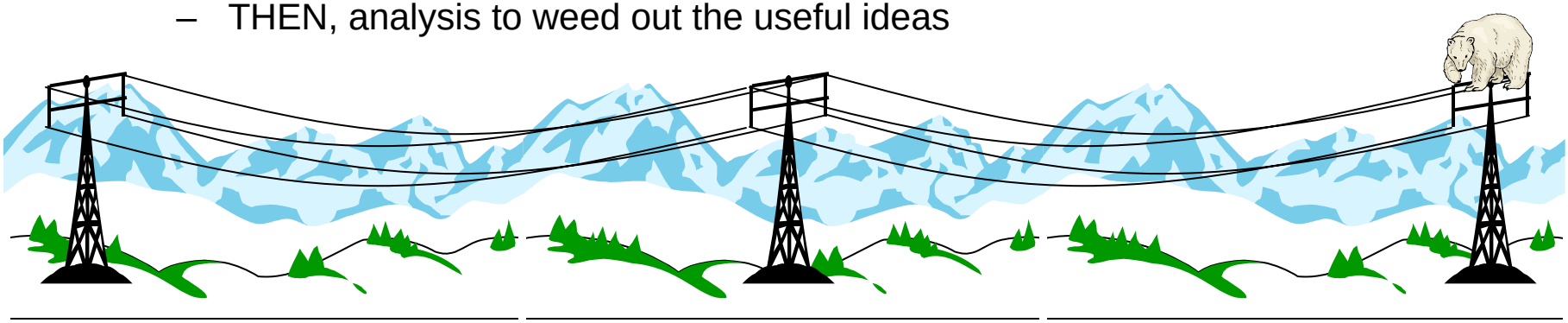

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- Brainstorming led to a suggestion to train polar bears to climb the towers to shake the wires, breaking the ice

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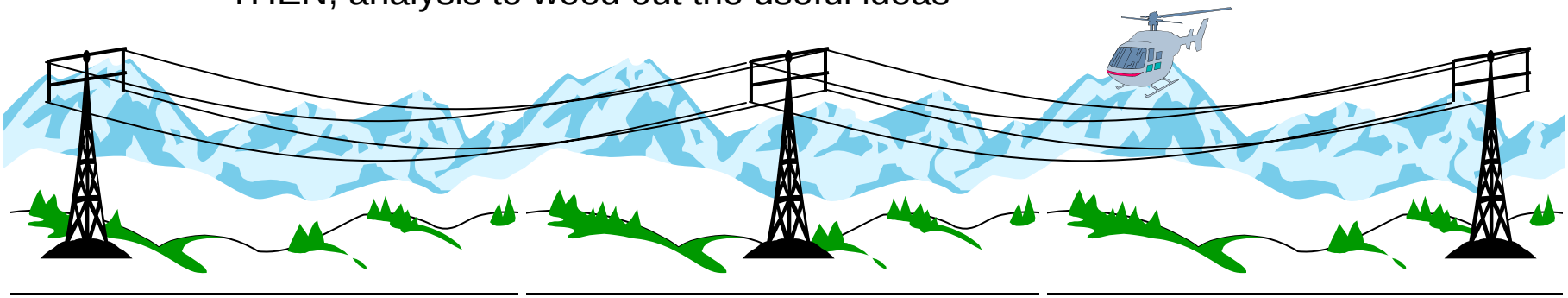

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- Brainstorming led to a suggestion to train polar bears to climb the towers to shake the wires, breaking the ice
- While that idea is not a sensible suggestion, it led to the idea of having helicopters fly over the wires to vibrate them, breaking the ice free.

An Exercise in Brainstorming

- You are inside of a room 10’x10’x10’
- The walls, floor and ceiling of the room are solid concrete
- Embedded in the center of the floor is a steel pipe that projects 1 foot from the floor
- There is a ping-pong ball at the bottom of the pipe
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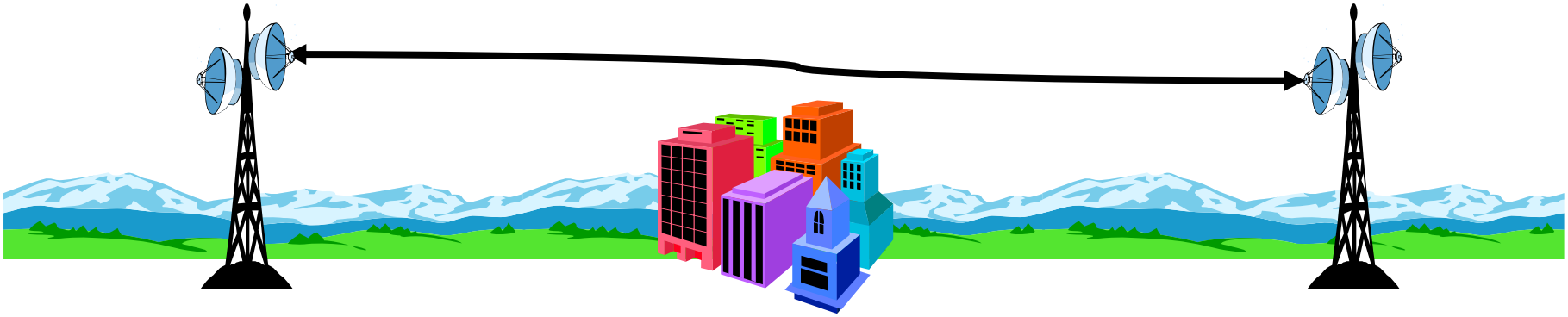
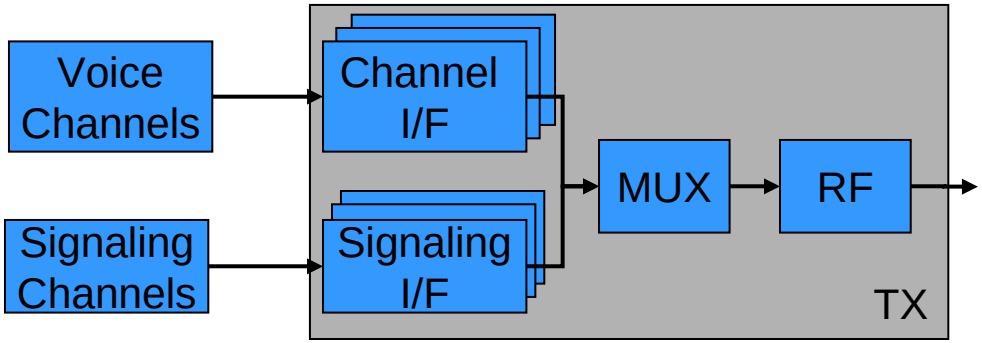
- Compare the effectiveness of the two techniques (individual vs. group brainstorming) for developing ideas

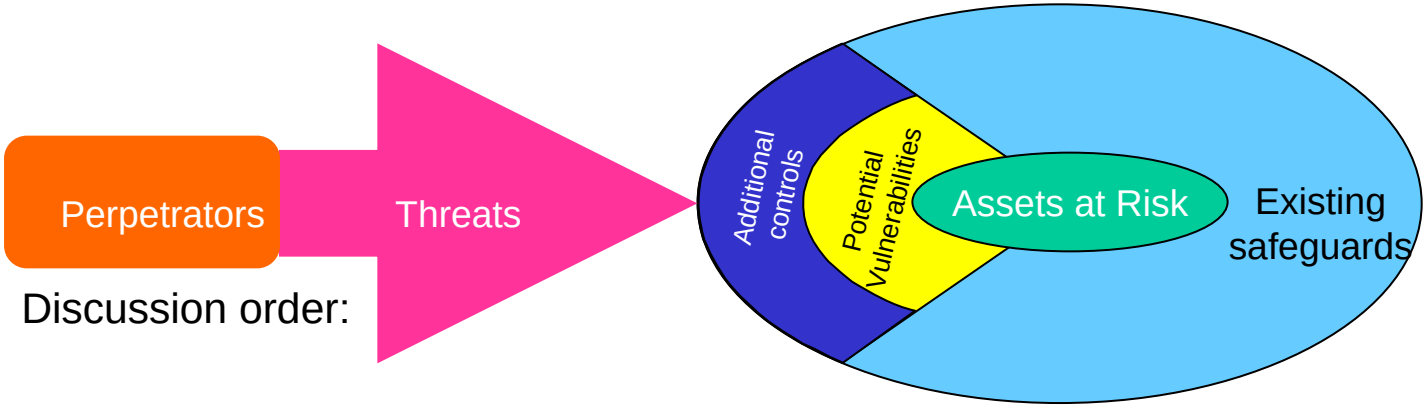
Case 1
Terrestrial Microwave RF Telephone Relay System



4 GHz
Analog SSB FDMA
Multichannel Voice traffic
CCS signaling
Washington, DC area

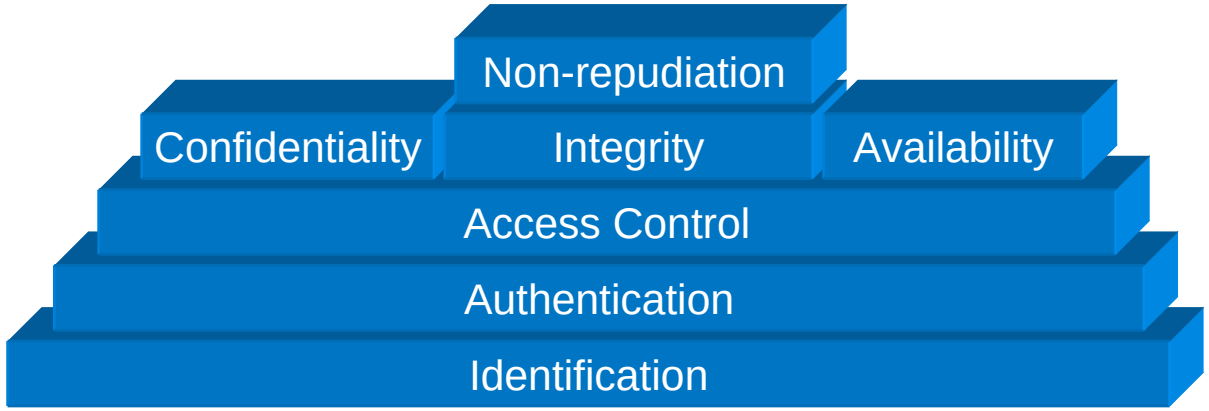
Network Architecture

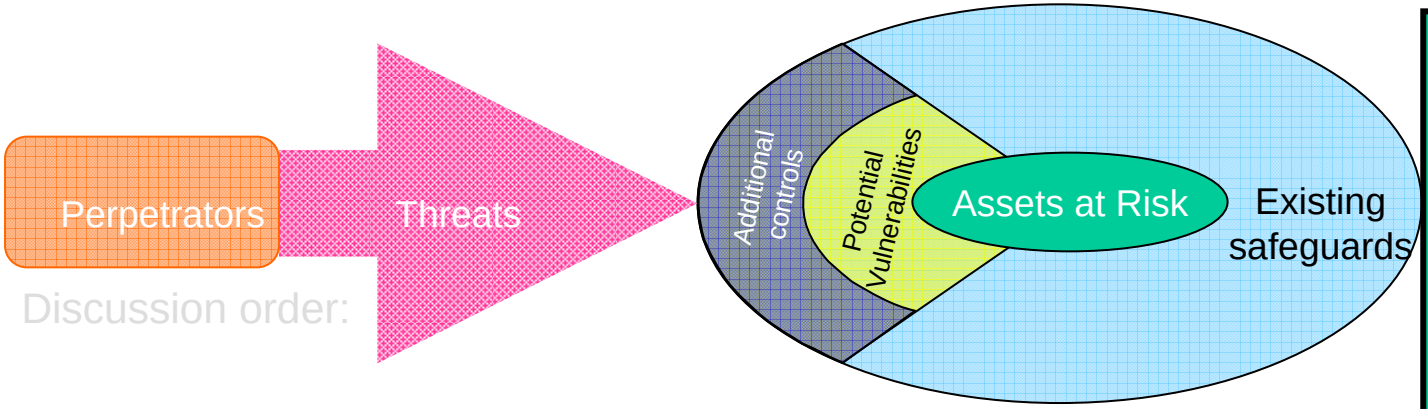




Discussion order:

- Assets
- Perpetrators
- Threats
- Existing Safeguards
- Potential Vulnerabilities
- Additional Security Controls





ASSETS
- **Bandwidth**
- **Connectivity info**
- **Capacity info**
- **Calling card data**
- **Called number info**
- **Signaling integrity**
- **Service provider reputation for privacy; integrity; reliability**
-
-
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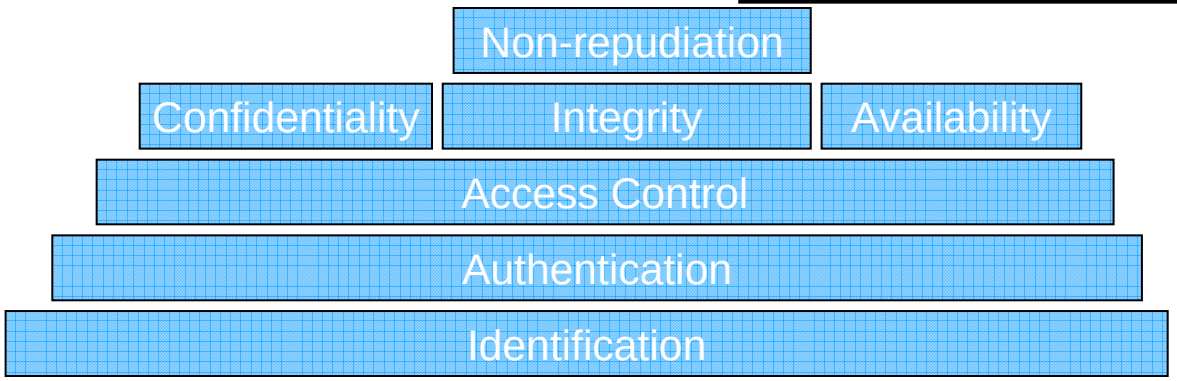

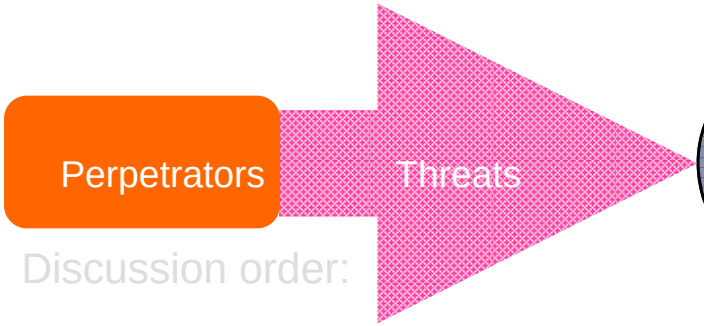

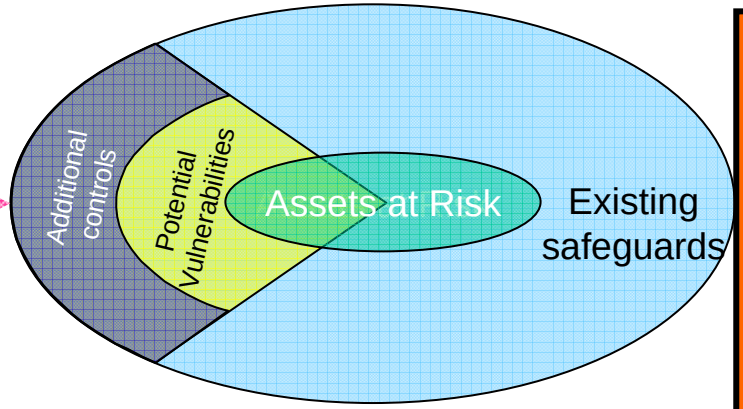

PERPETRATORS
- **Disgruntled employee**
- **Foreign govt.**
- **Terrorist**
- **Teenage hacker**
- **Organized crime**
-
-

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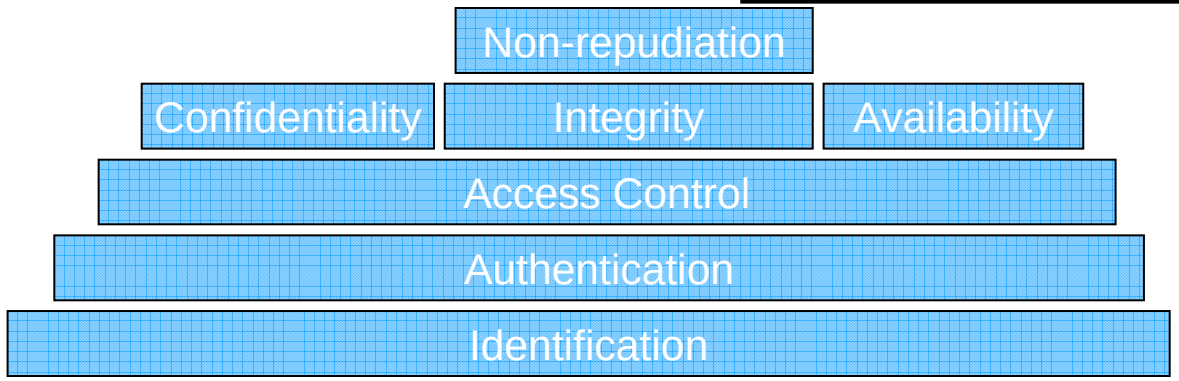

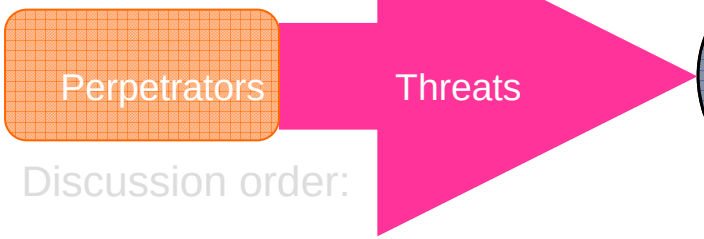

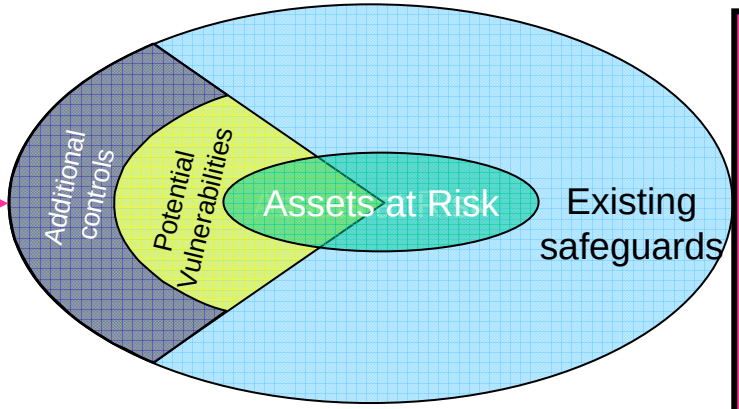

THREATS
- **Jam link**
- **Copy calling card #**
- **Monitor called #**
- **Record conversations**

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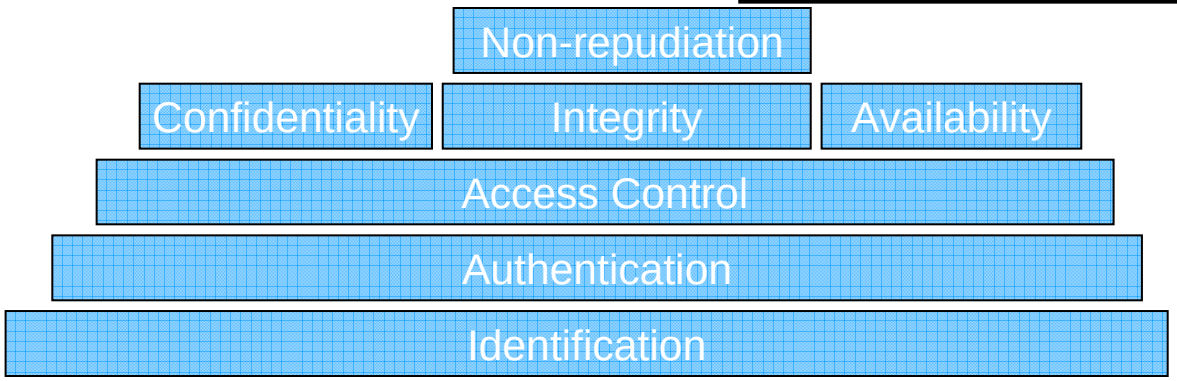

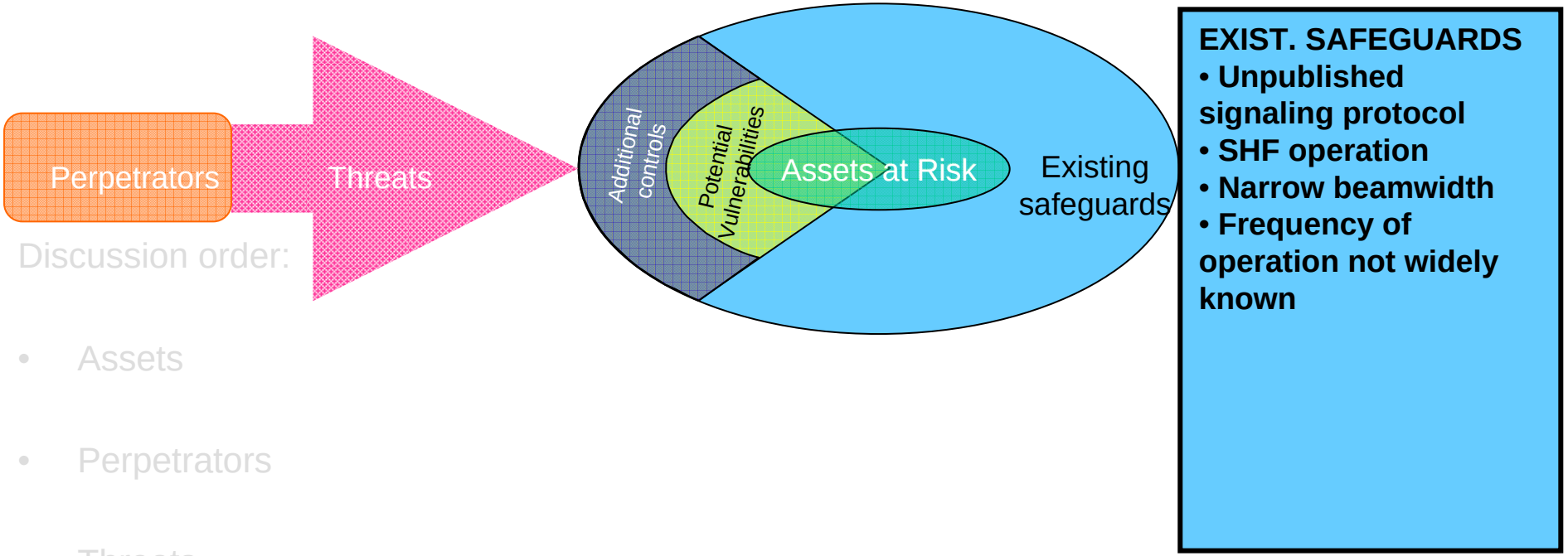

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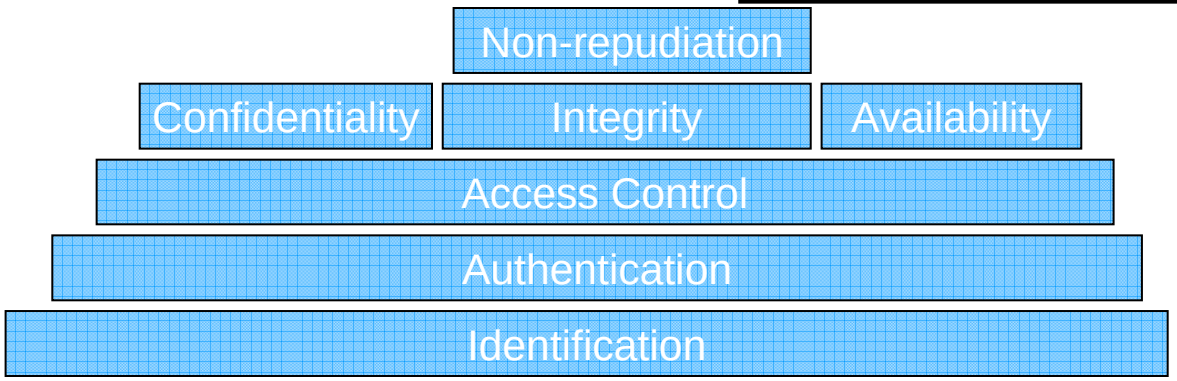
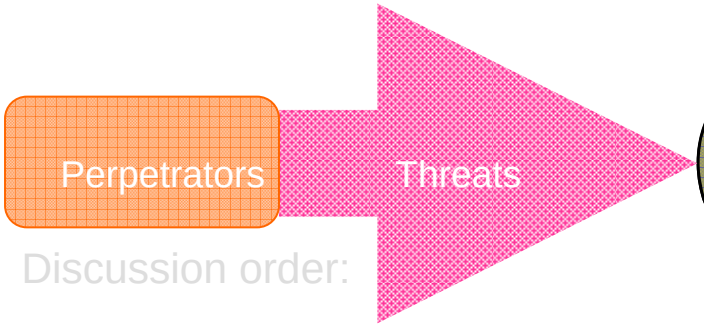
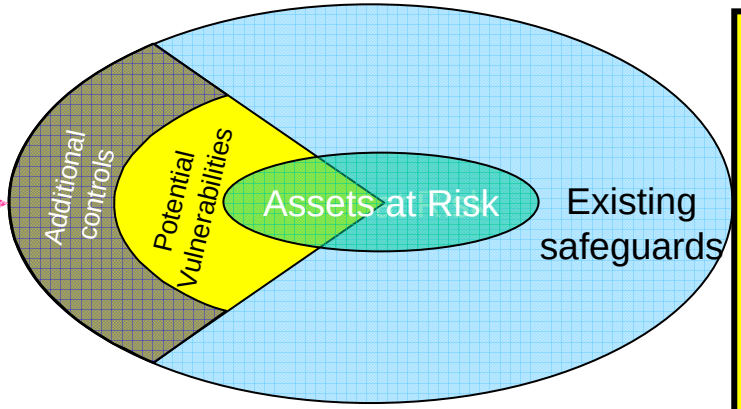




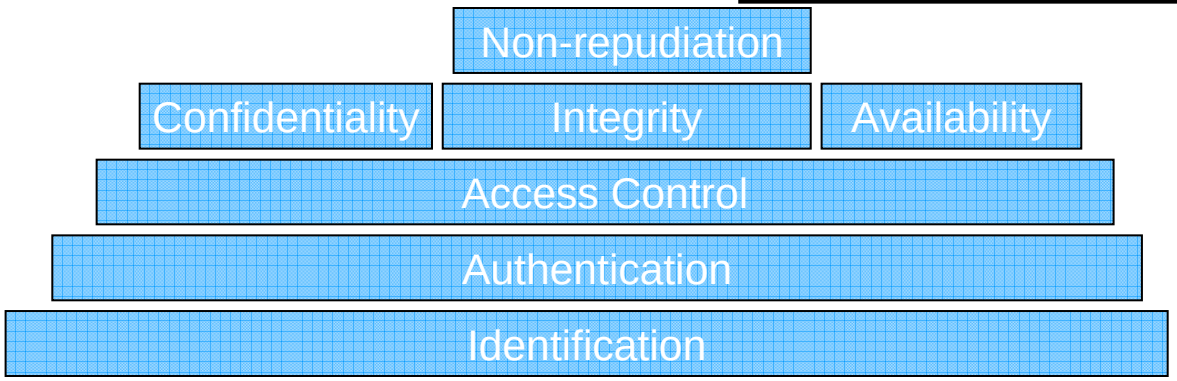


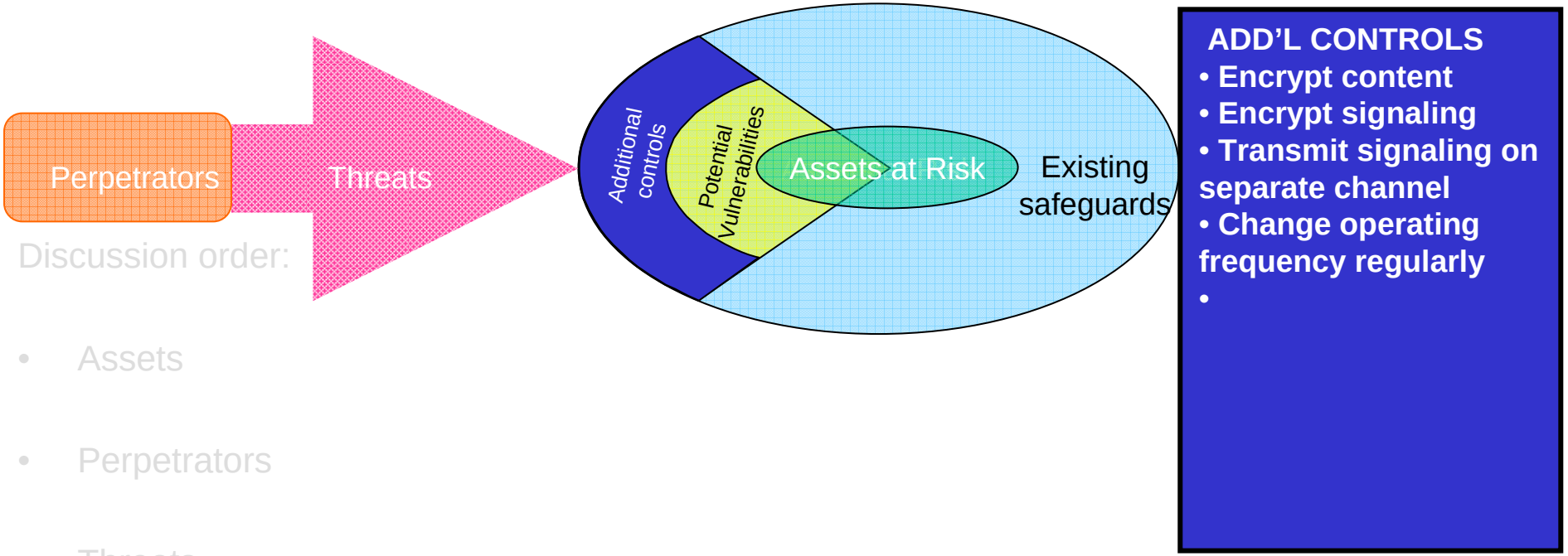
VULNERABILITIES

- **Attacker learns protocol**
- **Attacker learns/finds frequency**
- **Signaling sent in clear**
- **Signaling sent on common channel**
- **Content in clear**
-
-
-
-

Discussion order:

- Assets
- Perpetrators
- Threats
- Existing Safeguards
- Potential Vulnerabilities
- Additional Security Controls





Discussion order:

- Assets
- Perpetrators
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- Existing Safeguards
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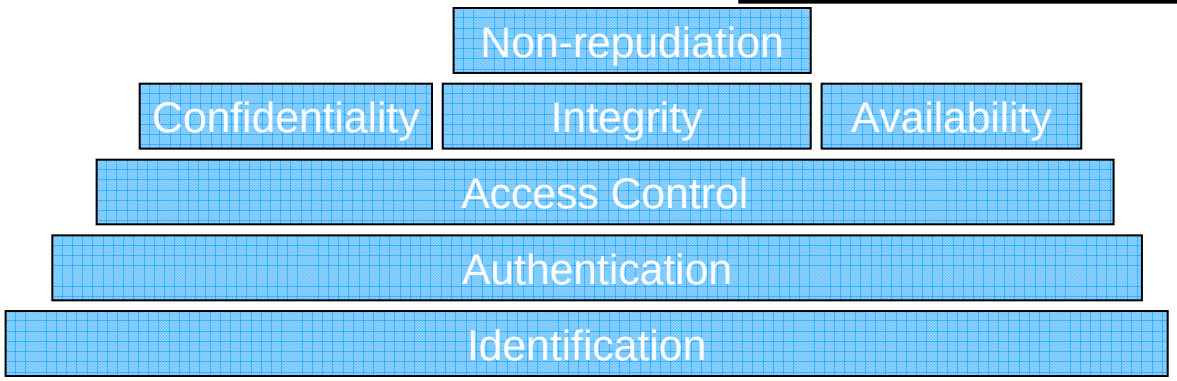


ASSETS
- Bandwidth
- Connectivity info
- Capacity info
- Calling card data
- Called number info
- Signaling integrity
- Service provider reputation for privacy; integrity; reliability
-
-
-

PERPETRATORS
- Disgruntled employee
- Foreign govt.
- Terrorist
- Teenage hacker
- Organized crime
-
-

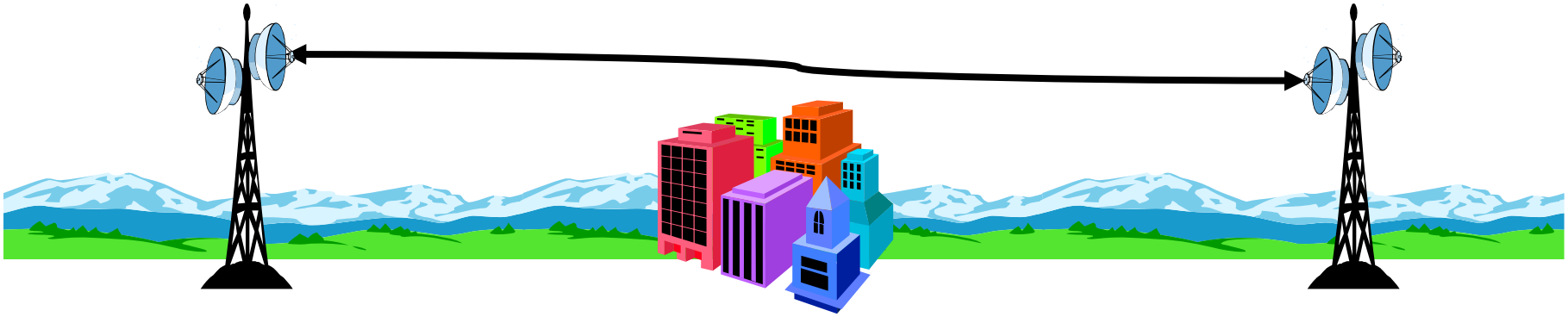
THREATS
- Jam link
- Copy calling card #
- Monitor called #
- Record conversations

EXIST. SAFEGUARDS
- Unpublished signaling protocol
- SHF operation
- Narrow beamwidth
- Frequency of operation not widely known

VULNERABILITIES
- Attacker learns protocol
- Attacker learns/finds frequency
- Signaling sent in clear
- Signaling sent on common channel
- Content in clear
-
-
-
-

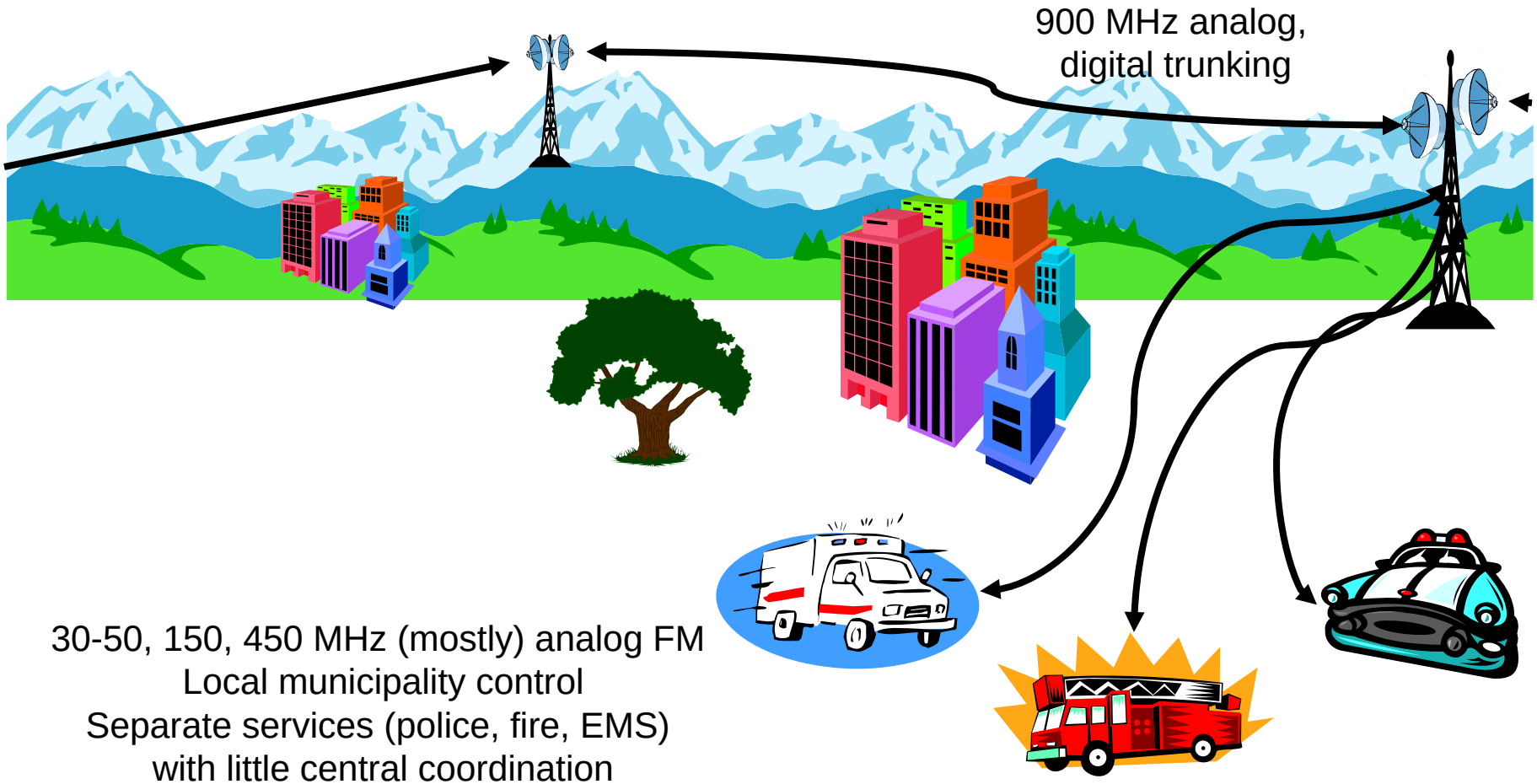
ADD'L CONTROLS
- Encrypt content
- Encrypt signaling
- Transmit signaling on separate channel
- Change operating frequency regularly
-

Case 1
Terrestrial Microwave RF Telephone Relay System



4 GHz
Analog SSB FDMA
Multichannel Voice traffic
CCS signaling
Washington, DC area

Case 2 – Public Safety Wireless Networks



30-50, 150, 450 MHz (mostly) analog FM
Local municipality control
Separate services (police, fire, EMS)
with little central coordination
Some point-to-point; heavy use of RF repeaters