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Availability

EECE 412
Session 18

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Last Session Recap

- Types of malicious logic
- Theory of detecting malware
- Protection and detection techniques

 2


Where We Are


Protection				
Authorization	Accountability	Availability		
Access Control	Data Protection	Audit	Service Continuity	Disaster Recovery
Authentication				
Cryptography				

 3

Outline

- Availability in the presence of failures
 - FT terminology
 - k fault tolerance
 - two army problem
 - Byzantine Generals problem
 - Services continuity and disaster recovery
- Availability in the presence of attacks
 - Failures vs. attacks
 - Random vs. scale-free networks
 - Internet tolerance to attacks and failures
 - Services continuity and disaster recovery

 4




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Availability in the Presence of Failures

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Failures, Errors, and Faults

- A system is said to fail when it cannot meet its promises
- Error may lead to a failure
- Fault -- a cause of an error




Fault Types

- **Transient:** occur once and then disappear
- **Intermittent:** occurs, then vanishes, then reappears
- **Permanent:** continues to exist



Availability and Reliability

- **Availability:** Probability that a system operates correctly at any given moment and is available to perform its functions
- **Reliability:** time period during which a system continues to be available to perform its functions
- **Problem:** calculate system availability and reliability if it's unavailable for 1 second every hour.



Fault Tolerance

A fault tolerant system can provide its services even in the presence of faults



Classification of Failure Modes

Type of failure	Description
Crash failure	A server halts, but is working correctly until it halts
Omission failure Receive omission Send omission	A server fails to respond to incoming requests A server fails to receive incoming messages A server fails to send messages
Timing failure	A server's response lies outside the specified time interval
Response failure Value failure State transition failure	The server's response is incorrect The value of the response is wrong The server deviates from the correct flow of control
Arbitrary (a.k.a. Byzantine) failure	A server may produce arbitrary responses at arbitrary times



Achieving k fault tolerance

A system is k fault tolerant if it can survive faults in k components

- silent failure vs. Byzantine failure

k+1

2k+1



Agreement among honest players with unreliable communications: Two-army Problem

Even with nonfaulty processes, agreement even between two processes is not possible in the face of unreliable communications



Agreement among dishonest players with perfect communications: Byzantine Generals Problem

Results:

1. In a system with m faulty processes, agreement can be achieved only if $2m+1$ correctly functioning processes are present (total $3m+1$). (Lamport et al., 1982)

2. If messages cannot be guaranteed to be delivered within a known, finite time, no agreement is possible even with one faulty process. (Fischer et al., 1985)



Ways to Deal with Failures

- Service continuity
 - Masking failures via
 - Redundancy of
 - information
 - time
 - physical
- Disaster recovery
 - Backward recovery
 - check pointing
 - Forward recovery
 - bringing system into a correct new state
 - Don't underestimate backups!

14



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Availability in the Presence of Attacks

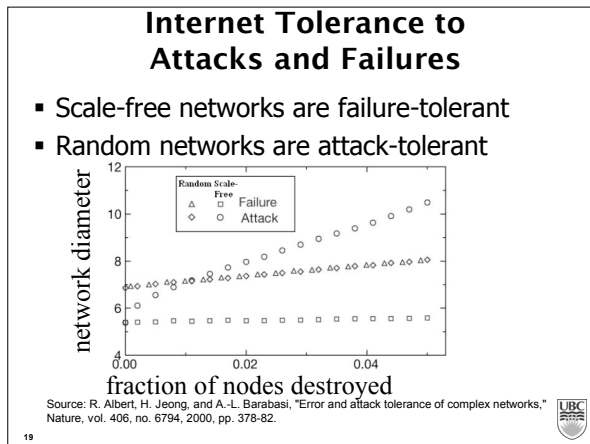
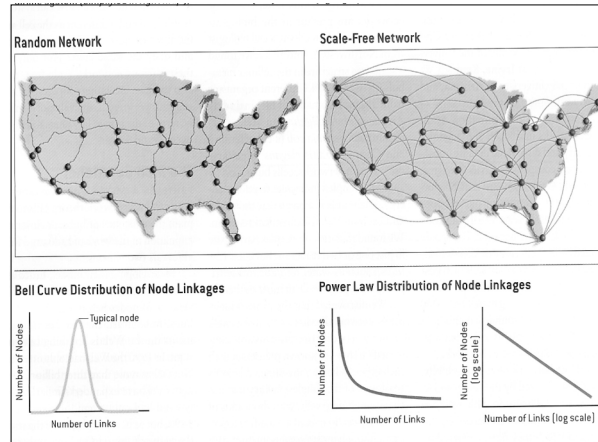
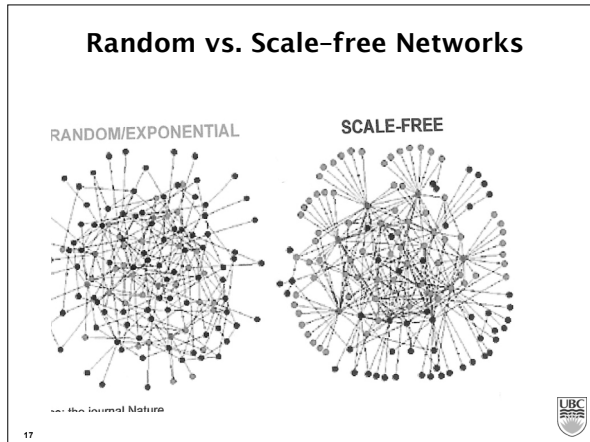
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Failures vs. Attacks

- **Failure**
 - Random unavailability of participants and/or infrastructure elements
- **Attack**
 - Systematic unavailability of participants and/or infrastructure elements

16





- ### Ways to Deal with Attacks
- Service continuity
 - Same as for FT, plus
 - Heterogeneity
 - Diversification
 - Avoid monocultures
 - Randomization
 - Avoid "hubs"
 - Disaster recovery
 - Same as for FT
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