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Network Simulation

1st year Academic Master

Networks and Technologies of Information and Communication

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Traffic generation models

Traffic generation models

- Traffic generation models are essential components of network simulation tools used to mimic real-world network traffic patterns.
- These models help researchers and network engineers understand how different types of traffic affect network performance and how network protocols behave under varying conditions.
- There are many commonly used traffic generation models in network simulation

Traffic generation models

Constant Bit Rate (CBR) model:

- CBR generates traffic at a constant rate, which is suitable for applications like voice or video streaming, where a consistent flow of data is required.
- Each packet is sent at regular intervals, maintaining a constant bit rate.

Variable Bit Rate (VBR) model:

- Used to model data traffic that varies in its transmission rate over time.
- It's commonly used to simulate irregular traffic, where packets arrive randomly but with an average rate over time.

Traffic generation models

Exponential Distribution model:

- A kind of VBR model where packets are generated with augmented rates.
- The augmentation of sending rates is variable.

On-Off Model:

- This model alternates between active (on) and inactive (off) periods.
- During the "on" period, packets are generated at a certain rate, while during the "off" period, no packets are generated.
- It's suitable for modeling bursty traffic patterns observed in many applications, such as network downloads and file sharing.

Traffic generation models

Trace-based Models:

- Trace-based models use real network traffic traces captured from operational networks to simulate traffic patterns.
- Researchers analyze these traces to understand network behavior and develop more accurate models for simulation.

Principles of network simulation

Principles of network simulation

➔Elements of network simulation

1. Entities: objects that interact with each other in a simulation program.

2.Resources : limited resources that can be shared like : servers, bandwidth, clock,etc.

3.Events: different events that are generated by entities or that may result during the simulation

4.Random number generators : function that generates random numbers that are necessary for the simulation model.

5.Statistics collector: module that collects simulation data in order to generate statistics.

Principles of network simulation

➔Steps of network simulation

1. Choose the right network simulator
2. Specify the simulation scenario
3. Run simulation
4. Visualize the graphical simulation and trace the simulation results
5. Set the performance evaluation parameters
6. Extract relevant simulation results
7. Plot the results
8. Analyse the evaluation results

Principles of network simulation

➔Performance evaluation metrics

1. **Throughput**: Throughput measures the rate of successful message delivery over the network within a given time frame. It is often expressed in bits per second (bps) or packets per second (pps).

2. **Latency**: Latency refers to the time delay between the initiation of a communication and the receipt of the corresponding message. It includes transmission delay, propagation delay, queuing delay, and processing delay.

3. **Packet Loss**: Packet loss occurs when packets transmitted across the network fail to reach their destination. It is often expressed as a percentage of packets lost relative to the total number of packets sent.

Principles of network simulation

➔Performance evaluation metrics

4. **Jitter**: Jitter measures the variability in packet arrival times at the destination. It can negatively impact real-time applications such as voice over IP (VoIP) and video conferencing.

5. **Network Utilization:** Network utilization measures the percentage of the available network bandwidth that is being utilized at a given time. It helps in understanding how effectively the network resources are being utilized.

6. **Network overhead**: Network overhead refers to the extra data, processing, and time required to manage and support the transmission of useful data over a network. This overhead does not contribute directly to the content being delivered but is necessary for communication, reliability, and control.

Principles of network simulation

➔Performance evaluation metrics

7. **Scalability**: Scalability assesses how well the network performance scales as the size of the network or the number of users/flows increases. It helps in determining the network's ability to handle growing traffic demands.

8. **Reliability**: Reliability measures the network's ability to deliver data accurately and consistently, even in the presence of network failures or disruptions.

9. **Energy Efficiency**: In wireless networks, energy efficiency is an important parameter that evaluates the amount of energy consumed by network devices to transmit and receive data.

Principles of network simulation

➔Performance evaluation metrics

10. **Security**: Security parameters evaluate the effectiveness of security mechanisms such as encryption, authentication, and access control in protecting network communications from unauthorized access and attacks.

- it is worth mentioning that security mechanisms have there special evaluation parameters like : detection accuracy, resilience ratio, etc.