

Advanced Computer Networks



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Introduction



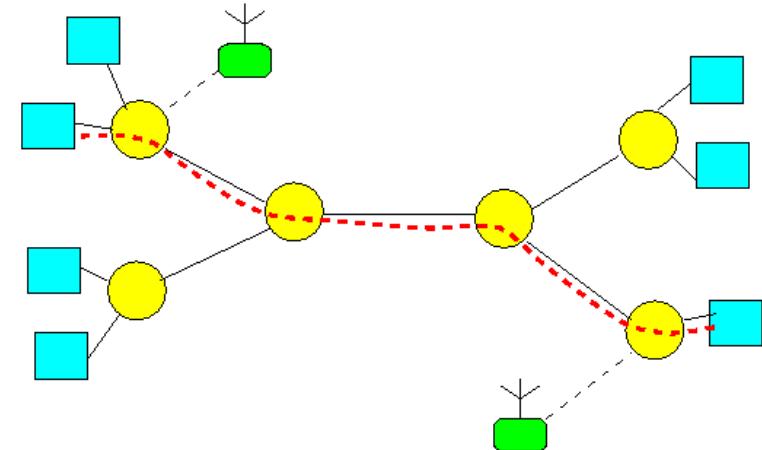
**DSSRG: Decentralized
Smart Systems Research
Group**

<https://sites.google.com/iitbbs.ac.in/dssrg>
Or Google dssrg iitbbs



View of Computer Networks

- We need some "view" of a computer network
- Luckily, everyone uses the internet and have some experience with using a computer network.
- A high level description of the network as perceived by a user of the Internet:



Basic goals

- Tools of performance analysis:
 - Markov analysis
- Use of Markov analysis to study network protocols:
 - Aloha
 - CSMA
 - IEEE 802.11
- Performance issues/problems in TCP:
 - TCP Congestion control
 - Synchronized TCP flows
 - TCP shortcomings in high speed networks

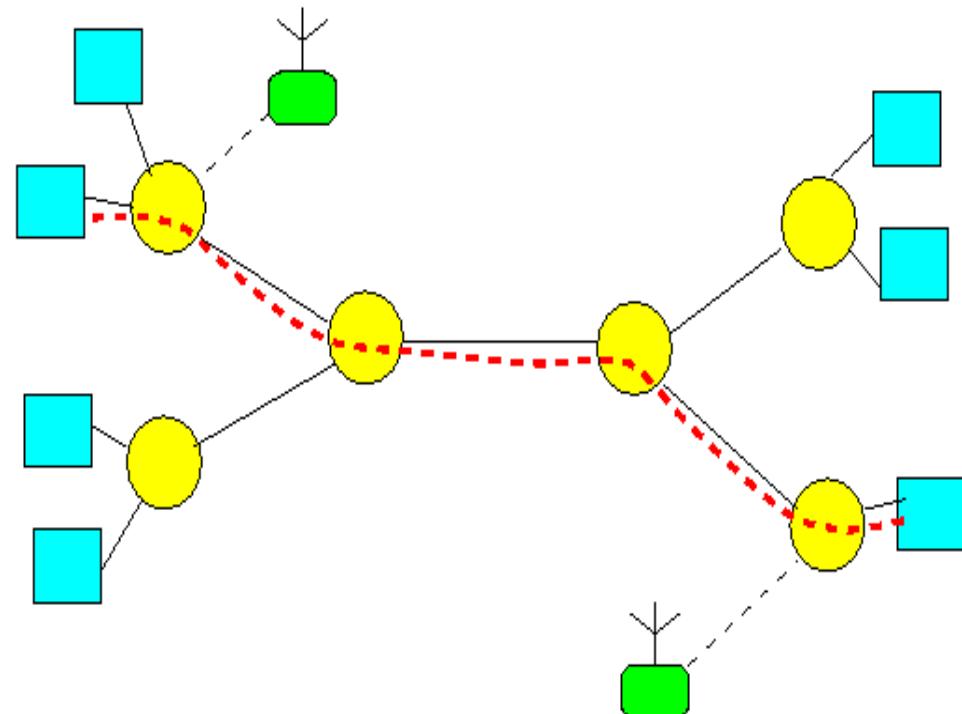


View of Computer Networks

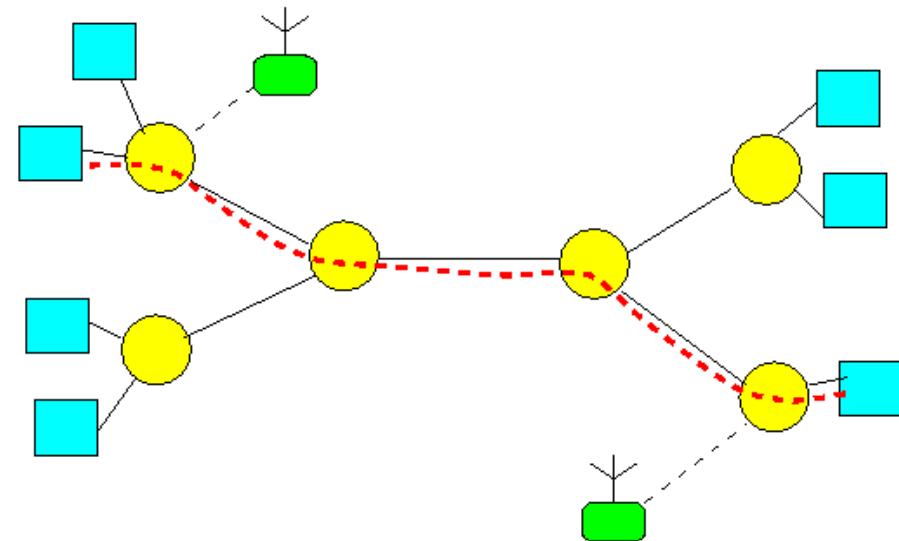
A high level description of the network as perceived by a user of the Internet:

Router/nodes (circles) and **hosts** (squares) interconnected with wired/wireless links.

Applications are run on hosts – while the routers forward the packets to the destination (host) –

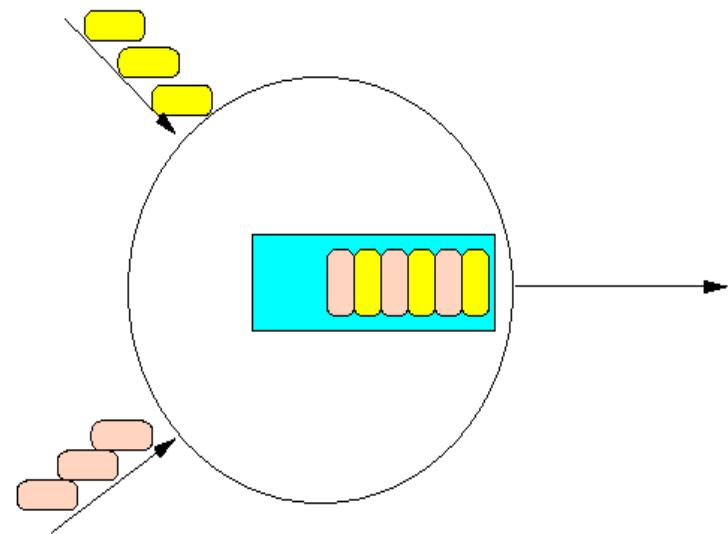


- In this course, you must assume that the routers **know** where to send a packet so that it will reach the destination
 - How part is discussed in the undergrad course!....



Queues ...

- Packets enroute to a destination will always encounter some **queueing** inside every **router**:
- Routers have some buffer space to hold packets
 - Even when every link of the network has the **same** transmission speed, packets will still be queued when 2 different packet flows enter the same router and are sent on the same output link.



Thus ...

- A packet enroute to the destination can:
 - Arrive intact (the most common case)
 - Lost
 - Duplicated (multiple copies are received)



Syllabus and Other issues ...



Full Syllabus

- Module 1: (4 hours) **Queue**: Introduction, Queueing Theory and Performance Analysis, Performance analysis: Average queue length, Other performance measures
- Module 2: (10 hours) **MAC**: Analysis of the Carrier Sense Multiple Access (CSMA) scheme: Introduction to broadcast networks, Aloha, CSMA
- Module 3: (10 hours) **Congestion**: Congestion control on the Internet: Congestion control methods, TCP's congestion avoidance mechanism, Problems with the TCP's congestion avoidance mechanism
- Module 4: (5 hours) High Speed TCP: High Speed TCP protocol, RFC 3649, FAST TCP, BIC, Cubic
- Module 5: (7 hours) Fairness in Sharing Bandwidth: The Deficit Round Robin Scheduling Method, General Processor Sharing and the Exponential Server, Weighted Fair Queueing (WFQ)—a Packet-by-Packet Approximation, and Self-Clocked Fair Queueing (SCFQ).
- Module 6: (5 hours) Multicast Routing: Shortest Path—Broadcast Link State Information, Computing Shortest Path Routes in the Link State Algorithm, Multicast Communication, Cost of Multicast Routes, Single Tree Multicasting -- Core Base Tree Multicast Routing, Multiple Tree Multicasting.



Tentative Plan – Before MidSem

- Module 1: (4 hours) **Queue**: Queueing Theory and Performance Analysis, Performance analysis: Average queue length, Other performance measures
- Module 2: (10 hours) **MAC**: The Carrier Sense Multiple Access (CSMA) scheme: Introduction to broadcast networks, Aloha, CSMA [Maybe upto this ...]
- Module 3: (10 hours) **Congestion control**: on the Internet: Congestion control methods, TCP's congestion avoidance mechanism, Problems with the TCP's congestion avoidance mechanism



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Textbooks:

1. W. R. Stevens. TCP/IP Illustrated, Volume 1: The Protocols, Addison Wesley, 1994.
2. G. R. Wright. TCP/IP Illustrated, Volume 2: The Implementation, Addison Wesley, 1995.
3. W. R. Stevens. TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols, Addison Wesley, 1996.
4. R. Handel, M. N. Huber, and S. Schroeder. ATM Networks: Concepts, Protocols, Applications, Addison Wesley, 1998.



Reference Books

1. C. E. Perkins, B. Woolf, and S. R. Alpert. Mobile IP: Design Principles and Practices, Addison Wesley, 1997.
2. Peter Loshin. IPv6 Clearly Explained, Morgan Kauffman, 1999.
3. M. Gonsalves and K. Niles. IPv6 Networks, McGraw Hill, 1998.



Term Projects

- From a Group of **5 students** (17 groups total ~ 85 students)
- Use the knowledge gained in the subject in addressing some networking issue in the following networks –
- **Satwik (TA) 6 groups**
 1. Networking in multi-robot systems
 2. Multi-Drone conveyance
 3. Spy drone network for surveillance
- **Anwesha (TA) 6 groups**
 1. Collaboration for building intelligent systems
 2. Health monitoring using Body Area Networks
 3. Voice over resource-constrained networks
 4. Video over resource-constrained networks
- **Subham (TA) 5 groups**
 1. Privacy in Social Robotics
 2. Trustable multi-robot systems
 3. Security in IoT



How to select a topic

1. **Application**: Select an **Application** area
2. **Aspect**: Select which **Aspect** to study in that area
3. **Affair**: Select specific interesting **Situation**

- Example:
- Area: **Multi-Drone Conveyance System**- Mobile Networks
- Aspect: **Charging of the Drones** in multi-hop conveyances
- Situation: Average waiting time under **high rate of requests**



Term Project - Components

IEEE / ACM Format

1) A smart and comprehensive title

3) Research gap analysis

What is not done yet?

2) Literature survey –

At least 20 recent papers –
[googlescholar.com](https://www.google.com/search?q=google+scholar)

Published in IEEE Journal or transaction,
ACM journal or transaction, Elsevier
Q1/Q2 journals.

Reputed core ranked conference (>=B),
Published in

2026, 2025, 2024, 2023, 2022, 2021

A summary table with categories

4) Proposed solution approach

How can we add? How it makes sense?

5) Solution detailed design

Details of the solution

6) Implementation

Code



Composition

Not decided yet - Possibilities are given below -

- | | | |
|------------------------|---|------------------------------|
| 1. MidSem | : | 25 (20% ?) |
| 2. EndSem | : | 35 (30% ?) |
| 3. Class Test | : | 15 (10% ?) |
| 4. Term Project | : | 20 (15%? 20%? 30% ?) |
| 5. Attendance | : | 5 (15%? including CP) |

**CP = Class Performance
(QA based on the last class)**



Communication

- **Groups:** All communications with the group will happen through **WhatsApp** group (unless explicitly needed and except the very first communication!...)
- All slides and materials will be posted in the groups
- **A Google Spreadsheet:** will contain all your marks and attendance details which will be on the fly shared with your FAs (Read-only)
- Sometime the read access to the file will be also removed (when we update the marks!)-



Class Timings

- **Wednesday 8 to 10 am U10M** Theory
 - Main theory class...s
- **Friday 9 to 10 am U11M** Theory
 - Residue or tutorials as needed...

