

Advanced Electronic Communication Systems



Lecture 1 Introduction

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Course Info

Title

Advanced Electronic Communication Systems

Lecturer:

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References

Multiple references will be used:

- Wayne Tomasi - Advanced Electronic Communications Systems
- L.Frenzel - Principles of electronic communication systems
- Recent Scientific Research Papers

Assessment 100/50

1. Final Term Exam (100)
2. Mid Term Exam (20)
3. Other Assignments (30)



Main Topics

- 1. Basics of Satellite Communication Systems**
- 2. Recent Trends in Communication Systems**



Schedule (Draft)

Topics	Estimated Duration (# Lectures)
Course Introduction and Policies	1
Introduction to Satellite Communication Systems	3:4
Global Positioning system (GPS)	1
Midterm	7 th Week
Assignment Report & Presentation Preparation Week (تفرغ)	8
First Group of Teams (may be multiple hours)	9
Second Group of Teams & Course Closeout	10
Laboratories Exam Week	11



😊 Policies 😊

- The Second Part of this course targets the following skills:

1. Team-work
2. Self-motivation
3. Information gathering, filtering, organizing, and linking
4. Scientific writing
5. Presentation skills

2. Proposed Recent Trends in Communication Systems:

- **Software-Defined Networks (SDN)**
- **Internet-of-Things (IoT)**
- **Millimeter-waves Communications (mmW)**
- **Device-to-Device Communications (D2D)**
- **Cooperative Communications**
- **Free-Space Optical communication (FSO)**

😊 Policies 😊

- Your Minimum Tasks:

1. Team Gathering
2. Topic Selection (Send me your priorities 1:3)
3. Search for ((new)) References related to this topic (Books- IEEE, IET, Sciencedirect, Springer Papers)
4. Prepare a survey paper on this topics at least 15 pages, double columns/30 pages single columns
5. Prepare a presentation based on your survey paper



😊 Policies 😊

• Bonus:

1. Proposing a (point of view / Methods classification) different from those existing in the published papers (5 degrees)
2. Proposing modifications/Improvements to one the cited papers (at least 3 reasonable ideas) (3 degrees)
3. Implementing the proposed modifications (Simulations with Matlab) (at least of one idea) (15 degrees)
4. Best file (Evaluated By the Instructor) will have extra Bonus (3 degrees)
1. Best Presentation (Evaluated By the all students) will have extra Bonus (3 degrees)



😊 Policies 😊

- Rules:

1. No plagiarism is allowed (each word in the prepared file is your own words- no exact copy and paste)
2. Each team will have a team leader
3. All used references must be cited and their files need to be attached to final assignment CD with highlighting used parts (between 30 and 50)
4. English language will be evaluated
5. A Toss will be made to see the order of presentation (all groups will be involved unless a group asks to present in the first week)

😊 Good Luck 😊



Introduction to Satellite Communication System



Introduction to Satellite Communication System

- What is the meaning of “Satellite”?

- A satellite is a physical object that orbits, or rotates about, a celestial body.
- A Satellites may be artificial or a natural body:
 - The earth and other planets are satellites rotating about the sun.
 - The moon is a satellite to the earth.

Funny History

Communicating through a satellite first appeared in the short story titled:

“The Brick Moon,”

written by an American author Edward Hale
and published in 1869.



Introduction to Satellite Communication System

• What is the meaning of “Satellite” in Aerospace ?

- A satellite is a space vehicle launched by humans and orbits Earth or another celestial body.

• What is the meaning of “Communication Satellite”?

- is basically a man-made electronic communication package placed in orbit around earth whose prime objective is to initiate or assist another through space.
- A communication satellite is a station in space that is used for telecommunication, radio and television signals.
- **The first practical concept** of satellite communication was proposed Arthur C. Clarke in a paper titled “**Extra-Terrestrial Relays: Can Rocket Stations Give World-wide Radio Coverage?**” published in the **1945** issue of “Wireless World”.



Communication Satellite

➤ In essence, a communications satellite is a **microwave repeater** in the sky that consists of a diverse combination of one or more of the following:

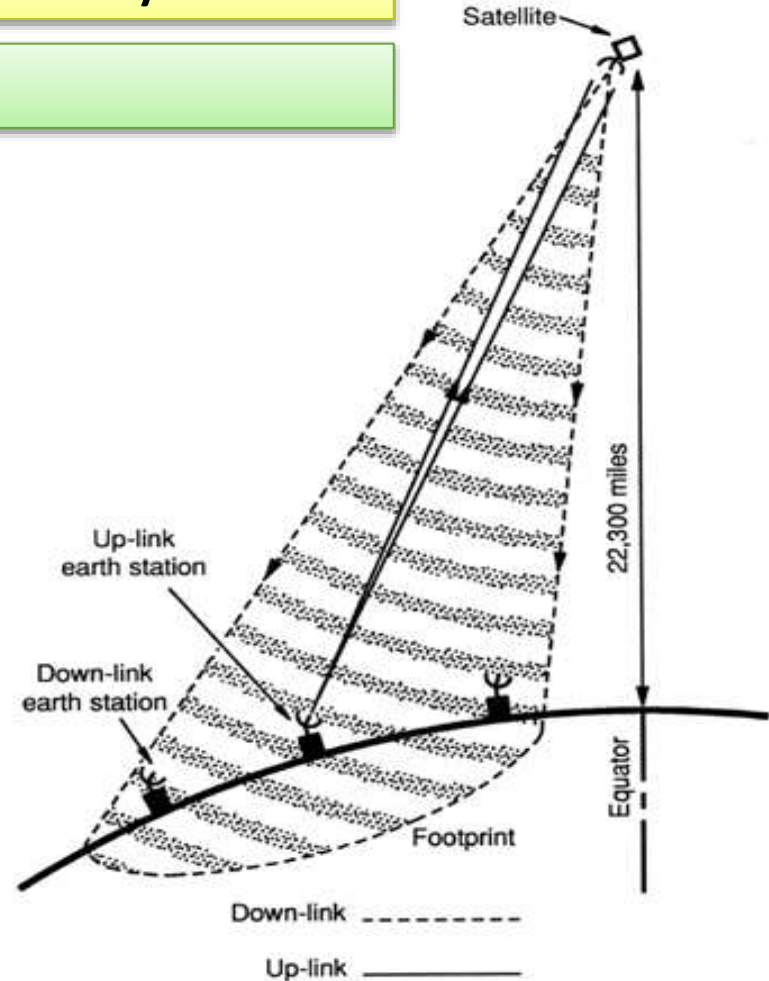
- Receiver,
- Transmitter,
- Amplifier,
- Regenerator,
- Filter,
- Onboard computer,
- Multiplexer, demultiplexer,
- Antenna/Multiple Antennas

- A satellite radio repeater is called a **transponder**, of which a satellite may have **many**.
- Transponder listens to some portion of spectrum, amplifies the incoming signal and broadcasts it in another frequency to avoid interference with incoming signals.

Satellite Communication System

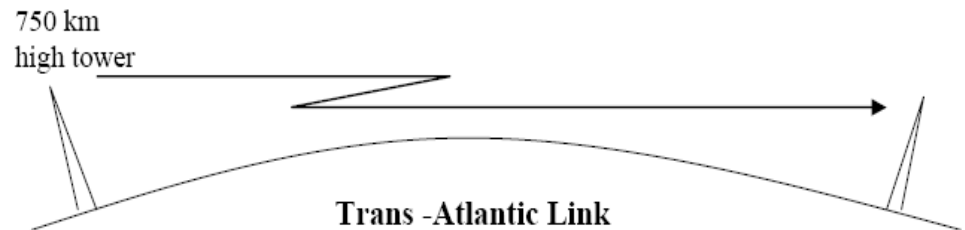
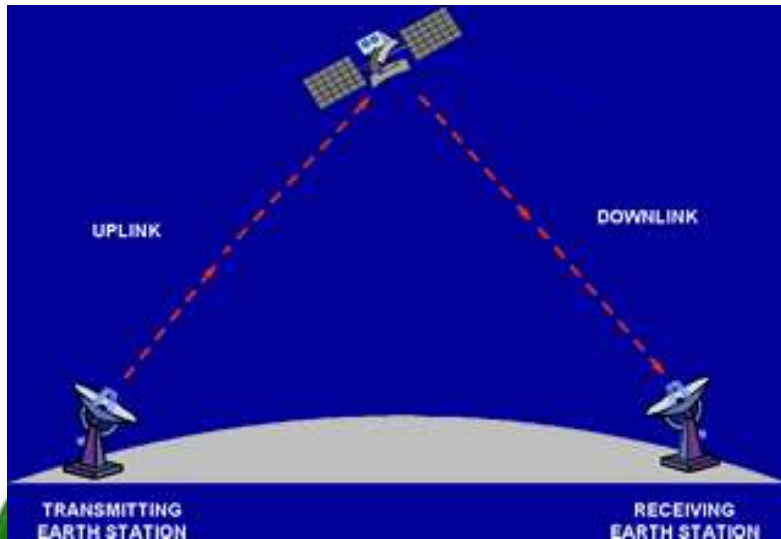
➤ A satellite system consists of:

- ✓ One or more satellite space vehicles,
- ✓ Ground-based station to control the operation of the system, and
- ✓ User network of earth stations that provides the interface facilities for the transmission and reception of terrestrial communications traffic through the satellite system



How Satellites Work

- Two Stations on Earth want to communicate through radio broadcast but are too far away to use conventional means.
- The two stations can use a satellite as a relay station for their communication
- One **Earth Station** sends a transmission to the satellite (**This is called a Uplink**)
- The satellite **Transponder** converts the signal and sends it down to the second earth station (**This is called a Downlink**)



One motivation for Sat. Comm.

Types of satellite transmissions

➤ Transmissions to and from satellites are categorized as either bus or payload.

1. The bus includes control mechanisms that support the payload operation.
2. The payload is the actual user information conveyed through the system.

Payload examples:

- ✓ Data services
- ✓ Television broadcasting
- ✓ Conventional speech telephone signals (in analog or digital form) is still the bulk of satellite payloads.



Passive reflector as satellite

- The simplest type of satellite is a passive reflector, which is a device that simply “bounces” signals from one place to another.
- A passive satellite reflects signals back to Earth, as there are no gain devices on board to amplify or modify the signals.
- The moon is a natural satellite of Earth, visible by reflection of sunlight and having a slightly elliptical orbit.

Moon Passive Satellite

- In 1954, U.S. Navy successfully transmitted the first message over this Earth-to-moon-to-Earth communications system.
- In 1956, a relay service was established between Washington, D.C. and Hawaii and, until 1962, offered reliable long-distance radio communications service **limited only by the availability of the moon.**
- Over time, however, the moon proved to be an inconvenient and unreliable communications satellite, as it is above the horizon only half the time and its position relative to Earth is constantly changing

Artificial Passive Satellites

Advantages:

- They do not require sophisticated electronic equipment on board, although **they are not necessarily void of power**.
 - ✓ Some passive satellites require radio beacon transmitters for tracking and ranging purposes.
 - ✓ A beacon is a continuously transmitted unmodulated carrier that an earth station can lock on to and use to determine the exact location of a satellite so the earth station can align its antennas.

Disadvantages:

- Inefficient use of transmitted power. For example, as little as 1 part in every 10^{18} of an earth station's transmitted power is actually returned to earth station receiving antennas.



A little bit History

Early Artificial Active Satellites

- An active satellite is capable of receiving, amplifying, reshaping, regenerating, and retransmitting information.
- **Sputnik 1** was launched successfully by the Soviet Union on October 4, 1957. (Followed by Sputnik 2)
- It was only 58 cm in diameter with four antennas sending low-frequency radio signals at regular intervals.
- It orbited Earth in a **elliptical orbit**,
- Took 96.2 minutes **to complete one revolution**.
- It transmitted telemetry information signals for only 22 days until its battery ran out
- It Was in orbit for only three months



- The American followed by launching an experimental satellite **EXPLORER** In January 1958.
- It was the first spacecraft to detect the Van Allen radiation belt,
- It transmitted data until its batteries were exhausted after nearly four months (111 days)



- The world's first commercial communications satellite was “Early Bird or Intelsat I” built for the Communications Satellite Corporation (COMSAT) in 1965,
- It was placed in geosynchronous orbit (That meant it was always on position to provide line of sight communications between Europe and North America.)
- Early Bird didn't have a battery - and worked only when its solar panels were exposed to the sun.

