


 Marmara University, 2021

# Wireless and Mobile Networks


Subject 3  
Basics of Microwave Communication

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Associate Professor


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 INTRODUCTION

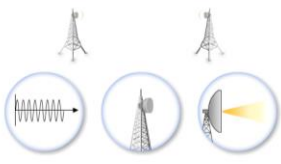
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 Introduction




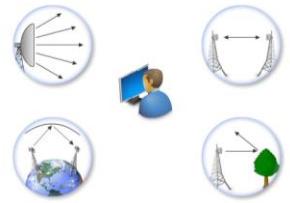
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 Introduction



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 Introduction



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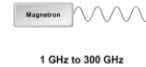


# MICROWAVE COMMUNICATION

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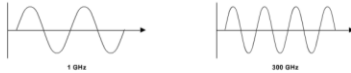
## Microwaves



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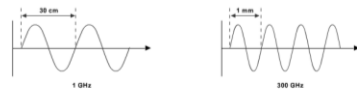
## Microwaves



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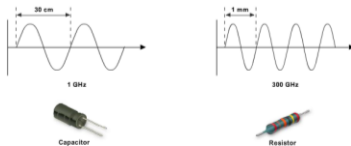
## Microwaves



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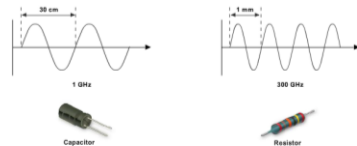
## Microwaves



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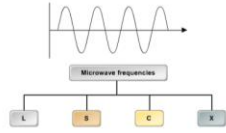
## Microwaves



*Electronic components behave  
in a different manner  
at microwave frequencies*

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## Microwaves


 $K_u, K, K_s, Q, U, V, W, F, D$ 

Homework

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## Microwaves



Designation	Frequency range	Wavelength range	Typical uses
<b>L band</b>	1 to 2 GHz	15 cm to 30 cm	military telemetry, GPS, mobile phones (GSM), amateur radio
<b>S band</b>	2 to 4 GHz	7.5 cm to 15 cm	weather radar, surface ship radar, and some communications satellites (microwave ovens, microwave devices/communications, radio astronomy, mobile phones, wireless LAN, Bluetooth, ZigBee, GPS, amateur radio)
<b>C band</b>	4 to 8 GHz	3.75 cm to 7.5 cm	long-distance radio telecommunications
<b>X band</b>	8 to 12 GHz	25 mm to 37.5 mm	satellite communications, radar, terrestrial broadband, space communications, amateur radio
<b>K<sub>u</sub> band</b>	12 to 18 GHz	16.7 mm to 25 mm	satellite communications
<b>K band</b>	18 to 26.5 GHz	11.3 mm to 16.7 mm	radar, satellite communications, astronomical observations, automotive radar
<b>K<sub>a</sub> band</b>	26.5 to 40 GHz	5.0 mm to 11.3 mm	satellite communications
<b>Q band</b>	33 to 50 GHz	6.0 mm to 9.0 mm	satellite communications, terrestrial microwave communications, radio astronomy, automotive radar
<b>U band</b>	40 to 60 GHz	5.0 mm to 7.5 mm	
<b>V band</b>	50 to 75 GHz	4.0 mm to 6.0 mm	millimeter wave radar research and other kinds of scientific research
<b>W band</b>	75 to 110 GHz	2.7 mm to 4.0 mm	satellite communications, millimeter-wave radar research, military radar targeting and tracking applications, and some non-military applications, automotive radar
<b>F band</b>	90 to 140 GHz	2.1 mm to 3.3 mm	SHF transmissions: Radio astronomy, microwave devices/communications, wireless LAN, most modern radars, communications satellites, satellite television broadcasting, DBS, amateur radio
<b>D band</b>	110 to 170 GHz	1.8 mm to 2.7 mm	EHF transmissions: Radio astronomy, high-frequency microwave radio relay, microwave remote sensing, amateur radio, directed-energy weapon, millimeter wave scanner

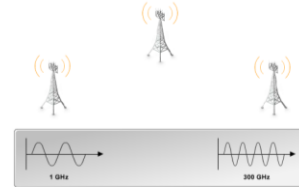
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## Microwave Communication



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## Microwave Communication



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## Microwave Communication



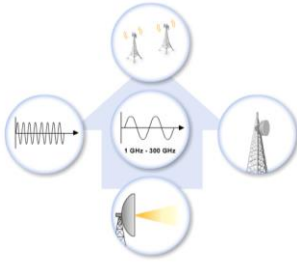
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## Advantages and Disadvantages of Microwave Communication



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## Advantages and Disadvantages of Microwave Communication



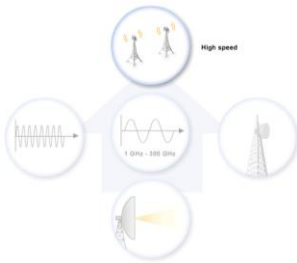
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## Advantages and Disadvantages of Microwave Communication



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## Advantages and Disadvantages of Microwave Communication



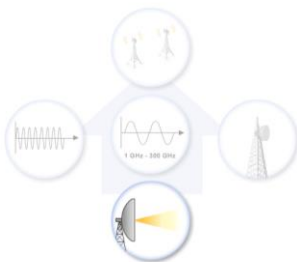
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## Advantages and Disadvantages of Microwave Communication



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## Advantages and Disadvantages of Microwave Communication



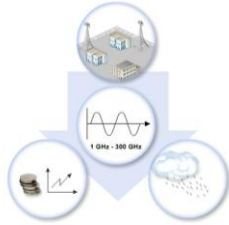
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## Advantages and Disadvantages of Microwave Communication



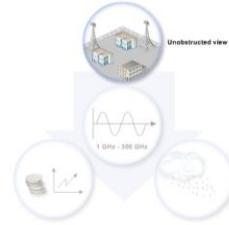
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## Advantages and Disadvantages of Microwave Communication



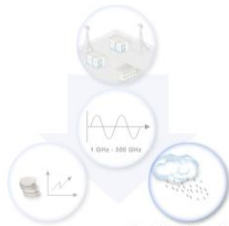
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## Advantages and Disadvantages of Microwave Communication



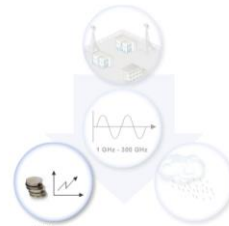
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## Advantages and Disadvantages of Microwave Communication



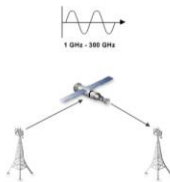
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## Advantages and Disadvantages of Microwave Communication



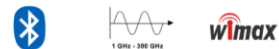
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## Applications of Microwave



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## Applications of Microwave



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## Applications of Microwave



Wireless Local Area Network

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## Applications of Microwave



Global Positioning System

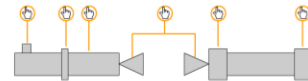
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## MICROWAVE TRANSMISSION



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## The Microwave System Architecture



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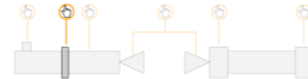
## The Microwave System Architecture



**Microwave source**  
Consists of electronic tubes called klystrons or magnetrons that generate microwaves by vibration of electrons. It is part of the transmitter subsystem.

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## The Microwave System Architecture



**Quarterwave transformer**  
Devices used to connect two waveguides. They can be part of both the transmitter and receiver subsystems.

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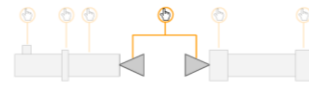
## The Microwave System Architecture



**Waveguide**  
A structure made up of reflective material that provides a transmission path for microwaves to travel from the transmitter to the receiver. It is part of both the transmitter and receiver subsystems.

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## The Microwave System Architecture



**Transmitting/ receiving antenna**  
Transmits the microwave into the waveguide and also receives microwaves from the waveguide on the receiver side. It is part of both the transmitter and receiver subsystems.

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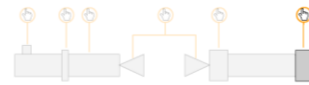
## The Microwave System Architecture



**Microwave amplifier**  
It amplifies the microwave signals that might have been attenuated while being transmitted through the waveguide. It is part of the receiver subsystem.

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## The Microwave System Architecture



**Microwave receiver**  
Receives the microwaves after they are amplified. It is part of the receiver subsystem.

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## Microwave Antennas



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## Microwave Antennas



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## Line of Sight Propagation



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## Line of Sight Propagation



Line of Sight

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## Line of Sight Propagation



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## Line of Sight Propagation



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## Line of Sight Propagation



Line of Sight Propagation

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## Line of Sight Propagation



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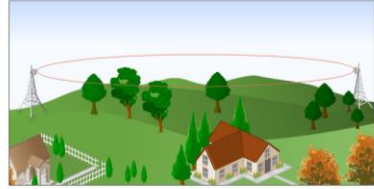


## Fresnel Zones



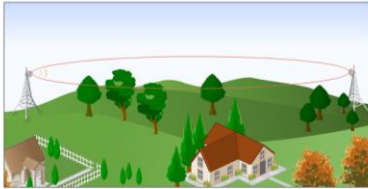
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## Fresnel Zones



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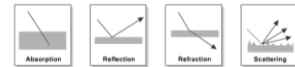
## Fresnel Zones



*Fresnel zone should be  
devoid of any obstructions*

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## Fresnel Zones



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## Modes of Microwave Propagation



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## Modes of Microwave Propagation



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## Modes of Microwave Propagation



Skywave Propagation

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## Modes of Microwave Propagation



Skywave Propagation

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## Modes of Microwave Propagation



Ground Reflected Path

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## Modes of Microwave Propagation



Ground Reflected Path

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## Modes of Microwave Propagation



*Mode of propagation  
decided based on distance  
and terrain*

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