Microwave Systems
Microwave Intro (4 min.)

- [https://www.youtube.com/watch?v=0FnLfVPNZ2E](https://www.youtube.com/watch?v=0FnLfVPNZ2E)
Short Facts

- 3 to 30 GHz by definition
- 1 to 300 GHz broadly considered to be uW
- Point to Point
- Dish antennas (Yagi Antennas up to 3GHz)
- Line of sight
- High energy beams
- No penetration of buildings, walls etc.
- WiFi, GPS, Mobile Phones, Sky Sat, Phone towers
What Technologies use Microwaves?

- Mobile Phone coms
- Landline phones – PSTN systems
- Internet technology
- Satellite technology
- Media distribution SAT
- Radar
- Military coms
- Telemetry
- Door Openers
- Speed Measurement
- Traffic Signal Control
- Civil Aviation Radar
- Guided weapon systems
THE ELECTROMAGNETIC SPECTRUM

Radio waves  Microwaves  Infrared radiation  Visible light  Ultraviolet  X-rays  Gamma-rays
The Electromagnetic Spectrum

- Gamma ray
- X-ray
- Ultraviolet
- Visible
- Infrared
- Microwave
- Radio
Broadcast & Commercial Bands

- LW Band 150 to 250kHz – 100kHz
- MW Band 500kHz to 1.6MHz – 1.1MHz
- SW Band 2.3MHz to 21MHz – 20MHz
- FM Band 87.5MHz to 108MHz – 20MHz
- Air Traffic 110MHz to 135MHz – 25 MHz
- Industrial Marine Radio – 150 to 175MHz
- TV - 500 to 900MHz
- Mobile Phone – 900 and 1800 MHz
- WiFi + domestic Microwave oven 2.4GHz
- Satellite broadcasting 10 to 15GHz
- GPS
<table>
<thead>
<tr>
<th>Designation</th>
<th>Frequency range</th>
<th>Wavelength range</th>
<th>Typical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L band</strong></td>
<td>1 to 2 GHz</td>
<td>15 cm to 30 cm</td>
<td>military telemetry, GPS, mobile phones (GSM), amateur radio</td>
</tr>
<tr>
<td><strong>S band</strong></td>
<td>2 to 4 GHz</td>
<td>7.5 cm to 15 cm</td>
<td>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)</td>
</tr>
<tr>
<td><strong>C band</strong></td>
<td>4 to 8 GHz</td>
<td>3.75 cm to 7.5 cm</td>
<td>long-distance radio telecommunications</td>
</tr>
<tr>
<td><strong>X band</strong></td>
<td>8 to 12 GHz</td>
<td>25 mm to 37.5 mm</td>
<td>satellite communications, radar, terrestrial broadband, space communications, amateur radio</td>
</tr>
<tr>
<td><strong>Ku-band</strong></td>
<td>12 to 18 GHz</td>
<td>16.7 mm to 25 mm</td>
<td>satellite communications</td>
</tr>
<tr>
<td>Band</td>
<td>Frequency Range</td>
<td>Wavelength Range</td>
<td>Applications</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
<td>------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>K band</strong></td>
<td>18 to 26.5 GHz</td>
<td>11.3 mm to 16.7 mm</td>
<td>radar, satellite communications, astronomical observations, automotive radar</td>
</tr>
<tr>
<td><strong>K_a band</strong></td>
<td>26.5 to 40 GHz</td>
<td>5.0 mm to 11.3 mm</td>
<td>satellite communications</td>
</tr>
<tr>
<td><strong>Q band</strong></td>
<td>33 to 50 GHz</td>
<td>6.0 mm to 9.0 mm</td>
<td>satellite communications, terrestrial microwave communications, radio astronomy, automotive radar</td>
</tr>
<tr>
<td><strong>U band</strong></td>
<td>40 to 60 GHz</td>
<td>5.0 mm to 7.5 mm</td>
<td></td>
</tr>
<tr>
<td><strong>V band</strong></td>
<td>50 to 75 GHz</td>
<td>4.0 mm to 6.0 mm</td>
<td>millimeter wave radar research and other kinds of scientific research</td>
</tr>
<tr>
<td><strong>W band</strong></td>
<td>75 to 110 GHz</td>
<td>2.7 mm to 4.0 mm</td>
<td>satellite communications, millimeter-wave radar research, military radar targeting and tracking applications, and some non-military applications, automotive radar</td>
</tr>
<tr>
<td><strong>F band</strong></td>
<td>90 to 140 GHz</td>
<td>2.1 mm to 3.3 mm</td>
<td>SHF transmissions: Radio astronomy, microwave devices/communications, wireless LAN, most modern radars, communications satellites, satellite television broadcasting, DBS, amateur radio</td>
</tr>
<tr>
<td><strong>D band</strong></td>
<td>110 to 170 GHz</td>
<td>1.8 mm to 2.7 mm</td>
<td>EHF transmissions: Radio astronomy, high-frequency microwave radio relay, microwave remote sensing, amateur radio, directed-energy weapon, millimeter wave scanner</td>
</tr>
</tbody>
</table>
Fresnel Zone
1. A microwave repeater link is designed to transfer signals from one terminal station to another without loss of traffic or signal performance.
Oil and Gas Pipeline Telecommunications

1 + 1

<= 70 km

1 + 1

<= 70 km

1 + 1

Hot line phone
MUX
low speed interfaces

Hot line phone
MUX
low speed interfaces

N x E1
Eth 100 Mb/s
Microwave Antenna’s

- Wavelength between 10cm and 1cm
- 3 – 30GHz
Microwave Antennae Video (5 Min)

- https://www.youtube.com/watch?v=-U2iJyW4bc0
Yagi Radiation Pattern
Installing a Dish Video 7min

- https://www.youtube.com/watch?v=MU9Q2ZIKWsI
- Part 2 – 12min
- https://www.youtube.com/watch?v=RyMSjrOvBU8
Dish Alignment Video 5min

- https://www.youtube.com/watch?v=RTiU-BjnIjU
Health Effects

• When injury from exposure to microwaves occurs, it usually results from dielectric heating induced in the body.

• Exposure to microwave radiation can produce cataracts by this mechanism, because the microwave heating denatures proteins in the crystalline lens of the eye (in the same way that heat turns egg whites white and opaque).

• The lens and cornea of the eye are especially vulnerable because they contain no blood vessels that can carry away heat.

• Exposure to heavy doses of microwave radiation (as from an oven that has been tampered with to allow operation even with the door open) can produce heat damage in other tissues as well, up to and including serious burns that may not be immediately evident because of the tendency for microwaves to heat deeper tissues with higher moisture content.
Health Effects

• During World War II, it was observed that individuals in the radiation path of radar installations experienced clicks and buzzing sounds in response to microwave radiation.

• This microwave auditory effect was thought to be caused by the microwaves inducing an electric current in the hearing centers of the brain.

• Research by NASA in the 1970s has shown this to be caused by thermal expansion in parts of the inner ear.
Climbing the world’s tallest Radio tower! 7min

- https://www.youtube.com/watch?v=INbKYq0G9nU