The Wireless World and the Data You Leak
EE 26N

Introduction

Today

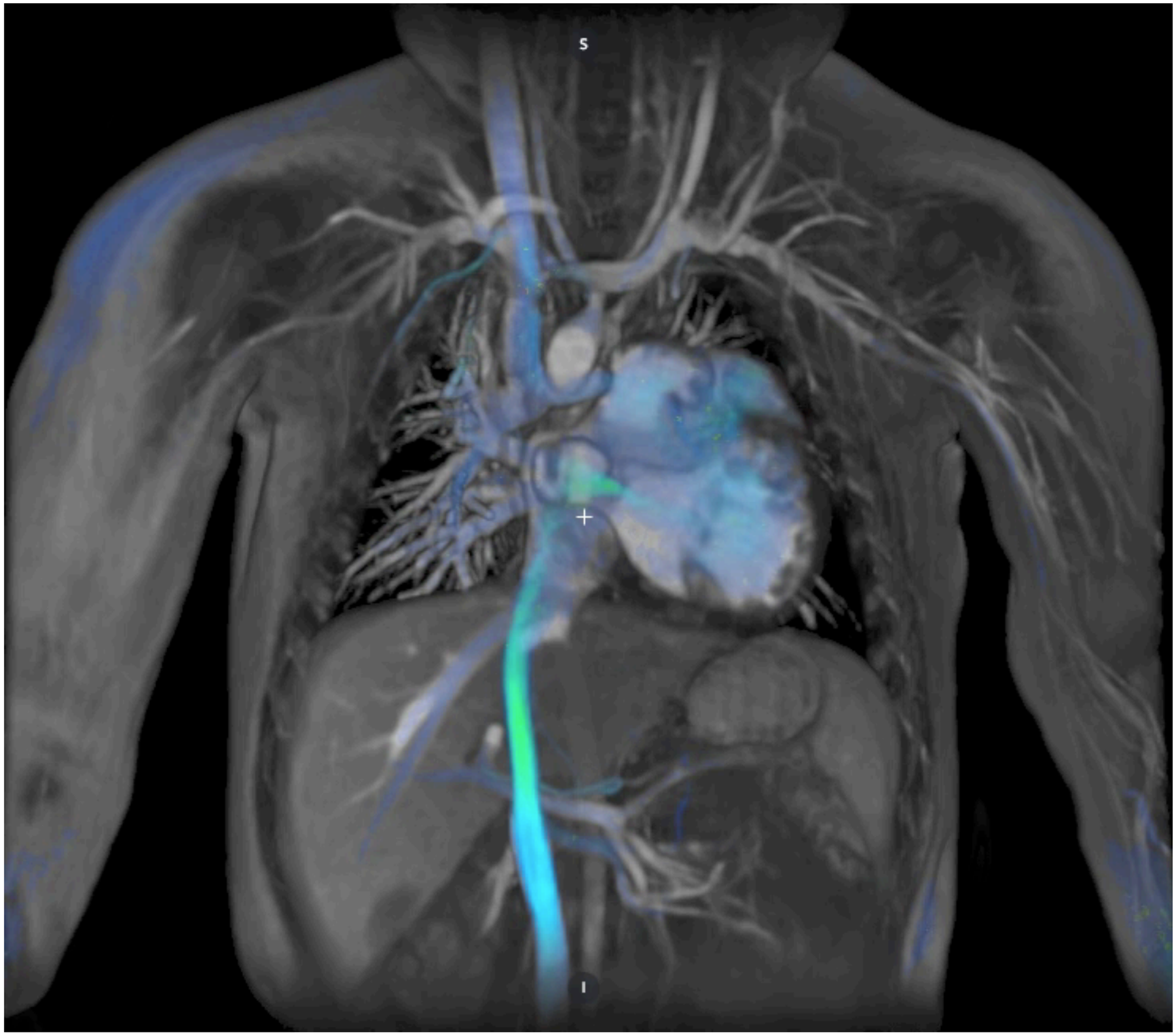
- Introductions
- Wireless Devices
- Topics
- Class structure
- RF spectrum

Introductions

- Name
- Computer, OS, experience (install public domain software, compile code, program, etc)
- Interest in the course
- Any interesting hack you've heard of

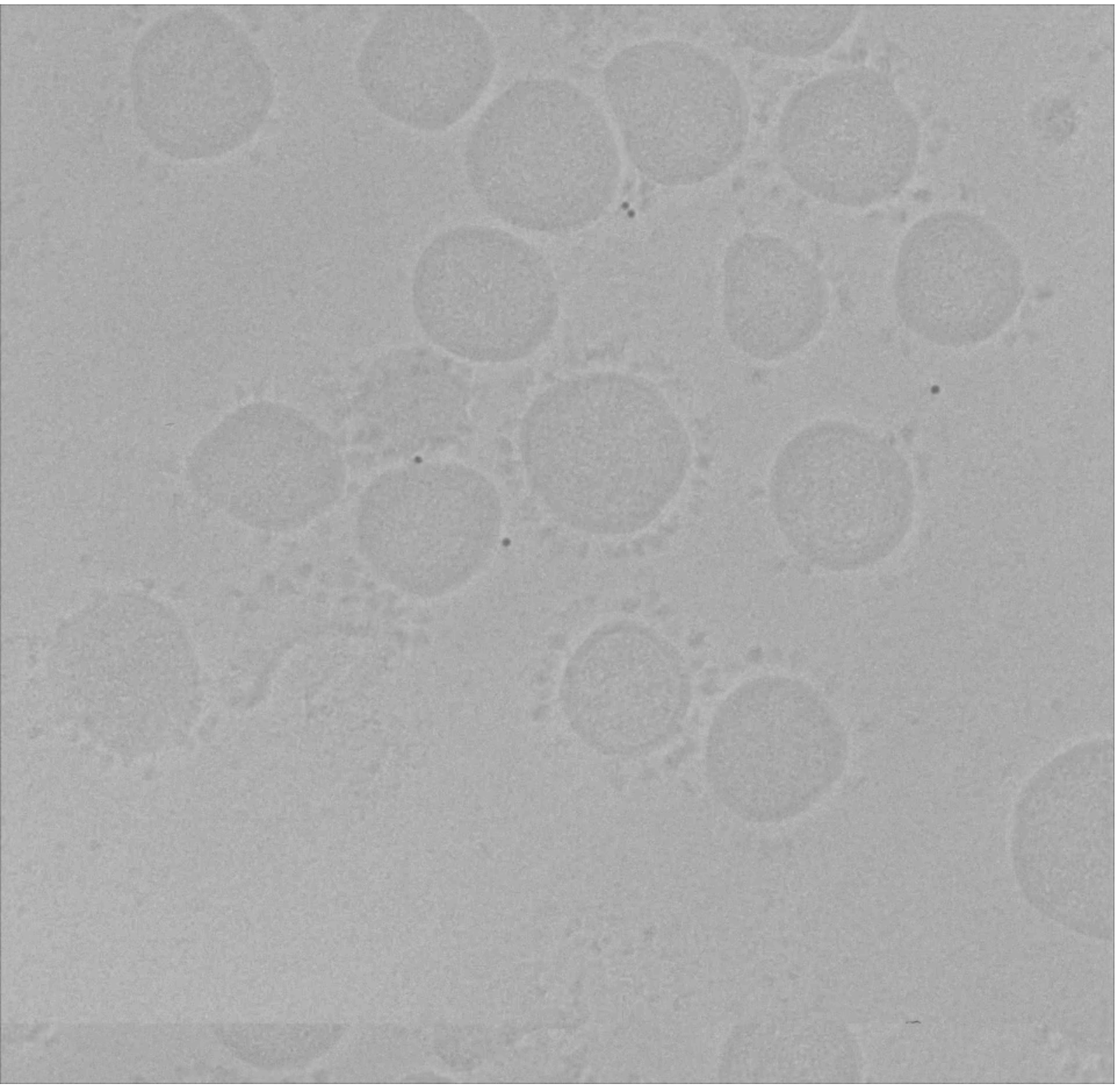
John Pauly

- Medical Imaging
- Magnetic Resonance Imaging (MRI)
- Radio, RF
- Computational Imaging



MRI

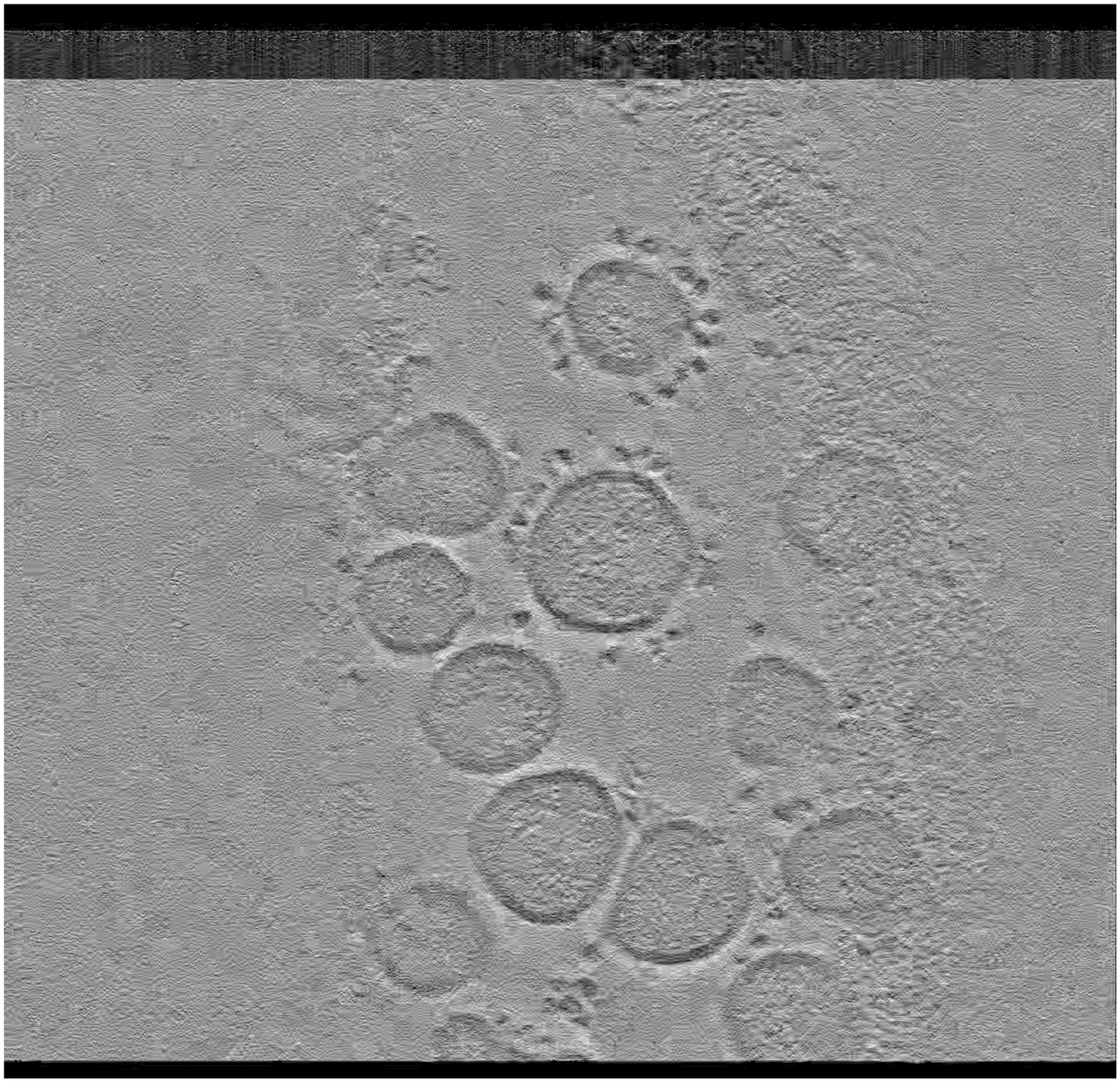
with Joseph Cheng, Shreyas Vasanawala



Cryo-Electron Microscopy

- Corona virus (not Covid)
- Flash frozen
- -54 to 54 degrees at 3 degree steps
- Registered to gold fiducial dots

with Wah Chiu, Liyue Shen



Reconstructed Volume

- Filtered Backprojection for each column

Astrophotography

Today

- Introductions
- **Wireless Devices**
- Topics
- Class structure
- RF spectrum

Wireless Devices

Smart Phone

Laptop

Router

iPhone 6

https://www.ifixit.com/Teardown/iPhone+6+Teardown/29213

Wireless Devices

Home Automation

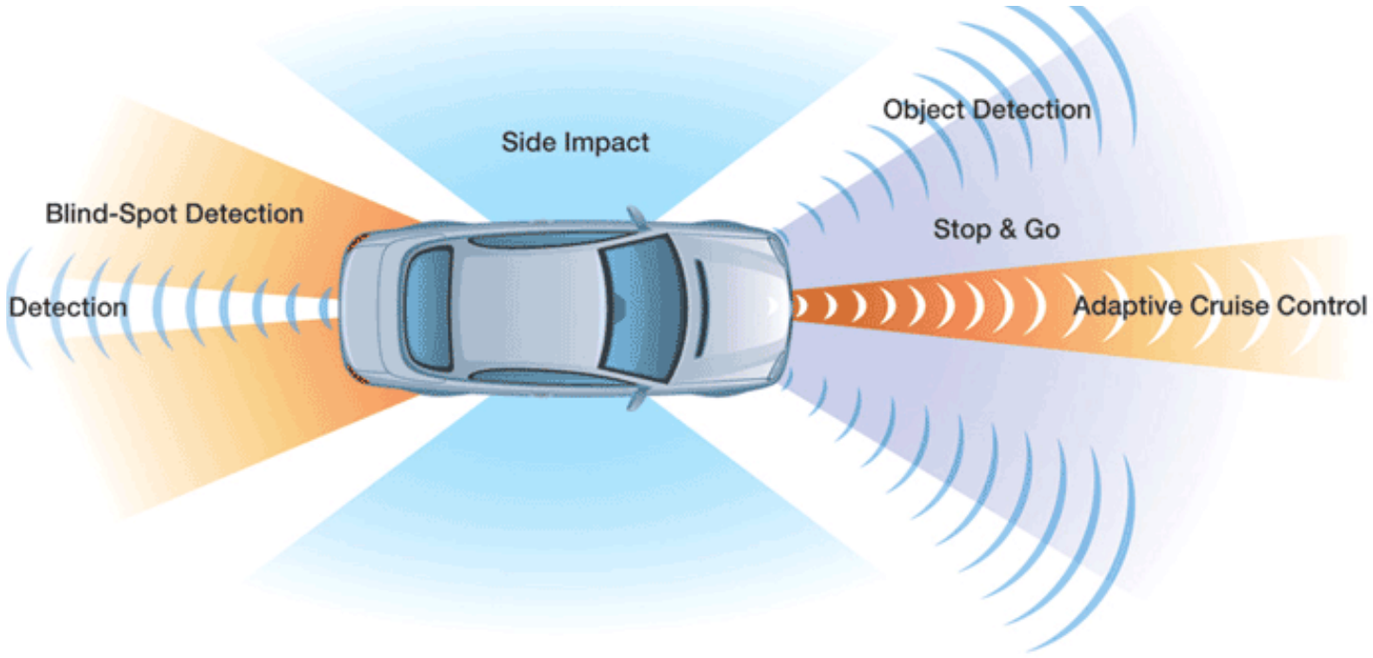
Cars

Sensors

Cars

Keys

Tire Pressure



Radar

Entertainment/Display

Wireless Device Characteristics

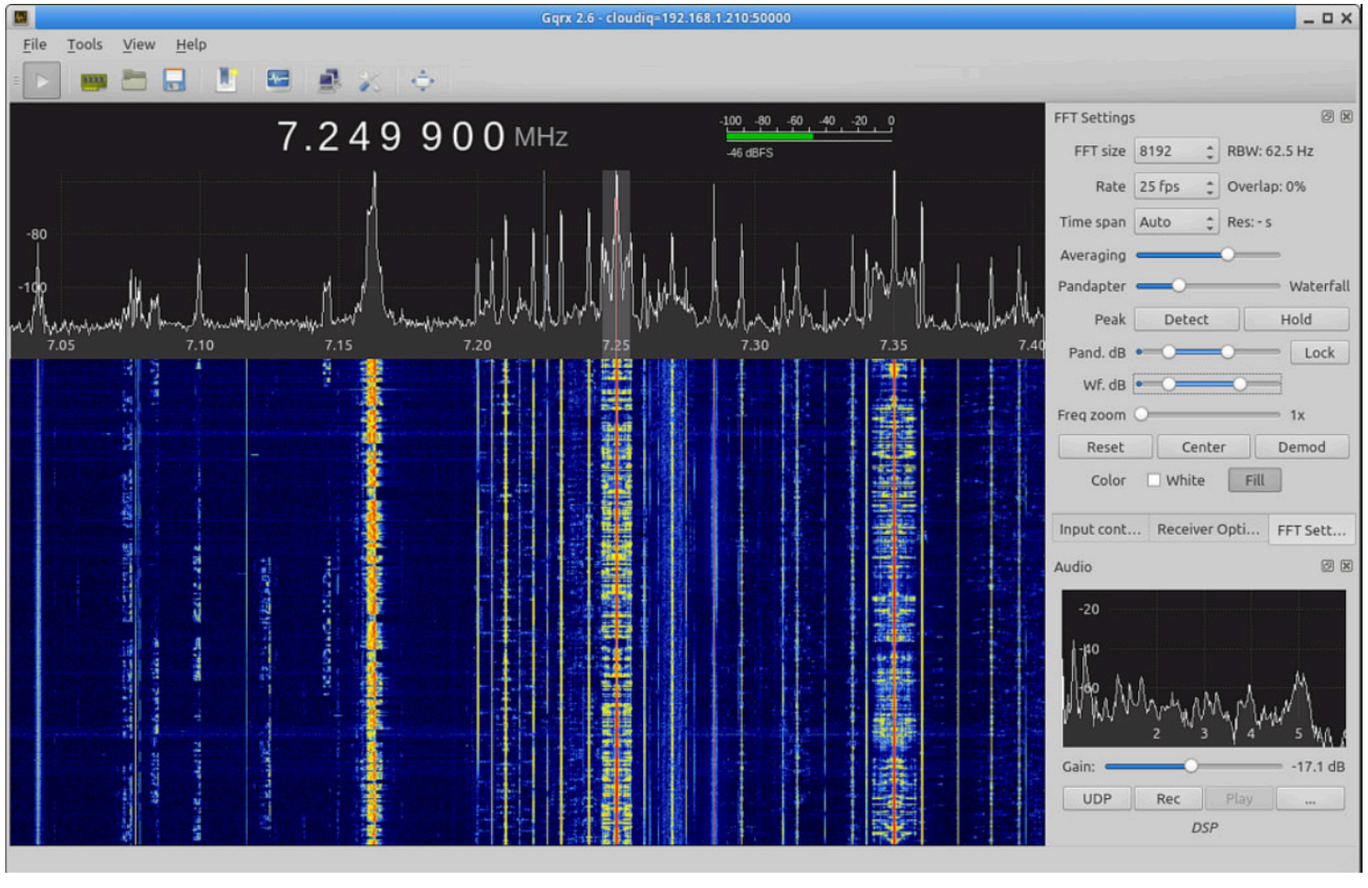
- What is the device's function?
- How does it encode information?
- Security? Common comments:
  - Why would anyone hack device X?
  - No one will figure out how this device works
  - No one has the equipment to decode this device

Some Devices We'll Talk About

- Public service radio
- ADS-B and airband radio
- ISM bands
- Utility meters
- WiFi
- Cell phones
- Cars

Tools We Will Use

- RTL-SDR
- Public domain software



Amateur Radio

- FCC license class this quarter
- 5 classes, followed by FCC exam
- License to play in the RF spectrum
- Wednesdays at 7:30

W6YX

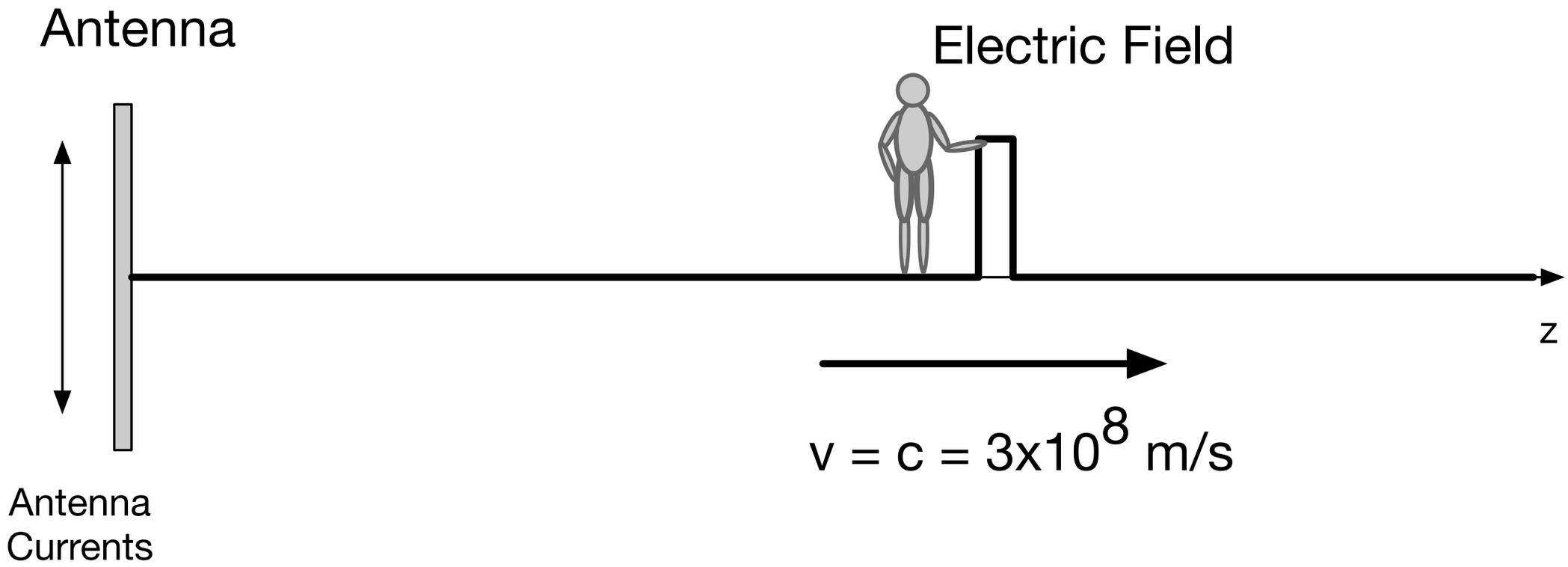
- W6YX Radio Club meeting tonight at 7:30 (second Tuesday of every month)
- Packard 302
- Pizza provided

Class Structure

- Thursdays:
  - Introduction to this weeks topics
  - Labs, demonstrations
  - Assignments (articles, youtube videos, short responses)
- Tuesdays:
  - Small group discussions
  - Presentations

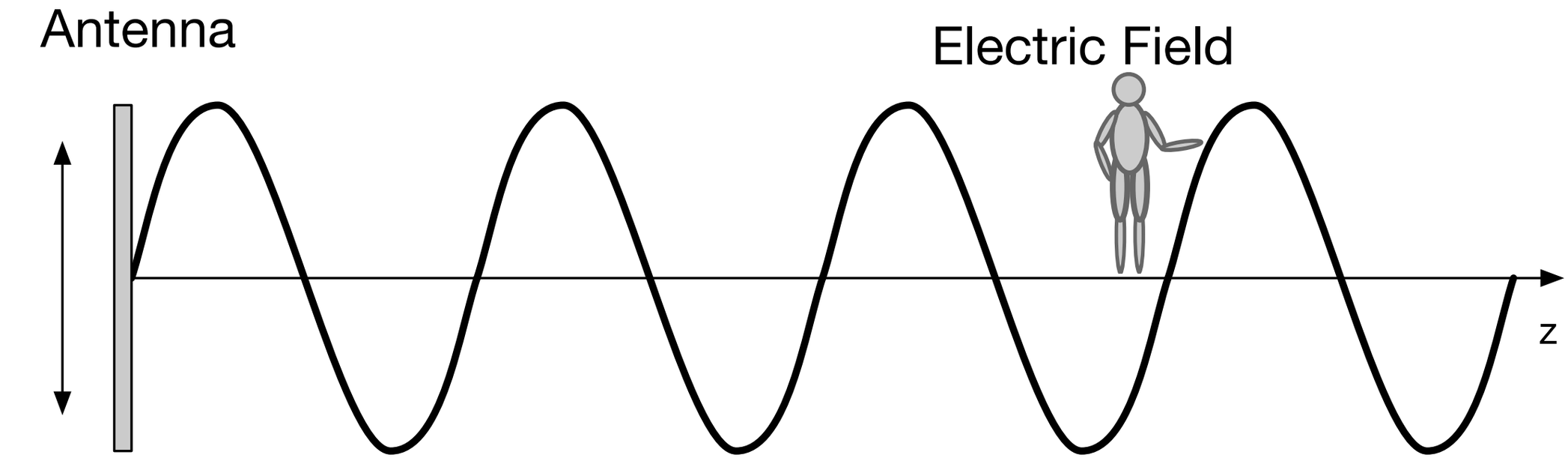
Frequency and Wavelength

Radio Waves



- Short pulse
- Travels at the speed of light
- Not usually what we do in radio (this is radar!)

Sinuoidal Radio Waves

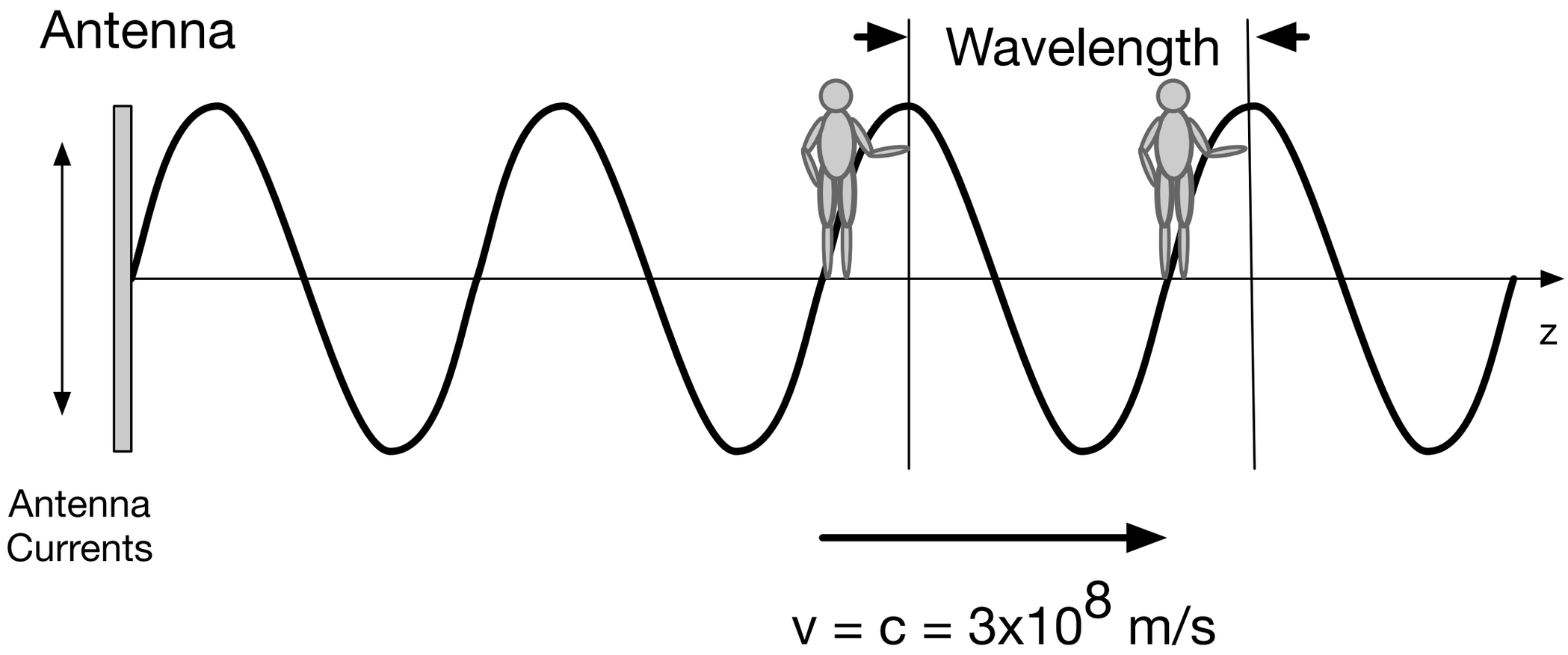


Antenna
Currents

$v = c = 3x10^8$ m/s

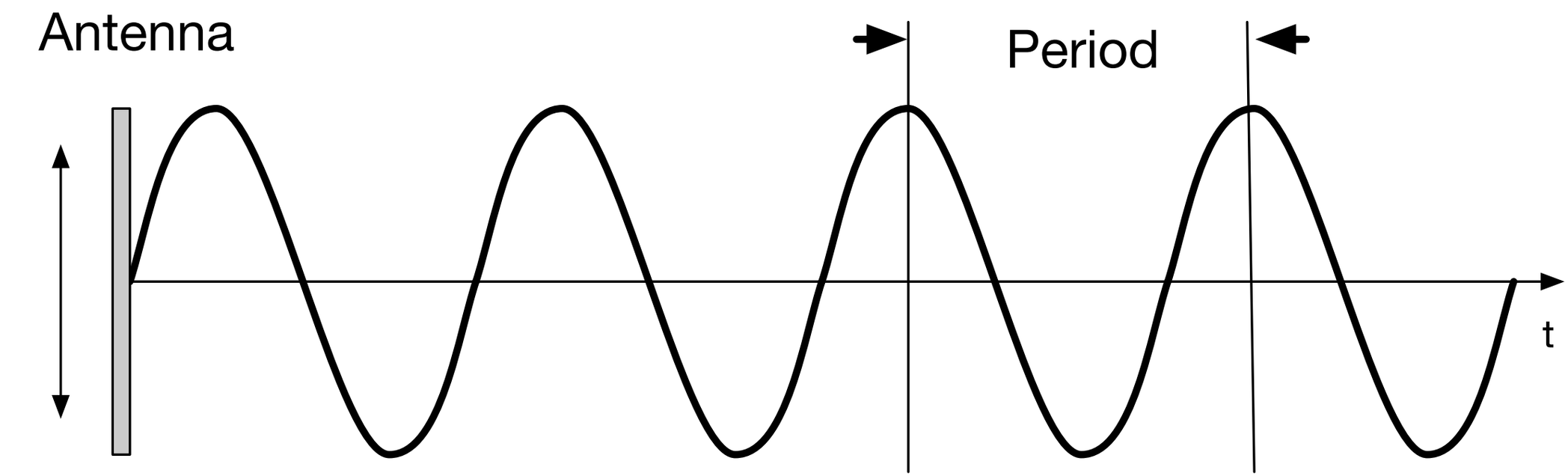
- Sinusoidal drive
- Wavefronts travel at the speed of light
- We can use any frequency we want, cycles/second, or Hz
- Any special frequencies come to mind?

Wavelength



- Wavelength is distance traveled over one cycle
- If one cycle was 1 second, what is the wavelength?

Period



- We can also think of the radio wave in time, as some fixed position, like next to the antenna

- The time it takes for one cycle is the period

- This is the inverse of the frequency, period = 1/frequency

Wavelength and Frequency

- wavelength = (speed of light)X(period)
- wavelength = (speed of light)/(frequency)
- If we measure speed in 10^6 m/s, and frequency in MHz, then

wavelength (in m) = 300 / frequency (in MHz)

Finding Wavelengths

- What are the wavelengths for
  - Citizens band (CB) ~30 MHz
  - FM radio ~100 MHz
  - Cell phone ~900 MHz
  - WiFi ~ 2.4 GHz and 5.5 GHz

Finding Frequencies

- What are the frequencies for
  - 33 cm ISM band
  - 2 m Amateur band
  - 60 m shortwave band
  - 200 m AM band

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

- AERONAUTICAL MOBILE
- AERONAUTICAL MOBILE SATELLITE
- AERONAUTICAL RADIONAVIGATION
- AMATEUR
- AMATEUR SATELLITE
- BROADCASTING
- BROADCASTING SATELLITE
- EARTH EXPLORATION SATELLITE
- FIXED
- FIXED SATELLITE
- INTER-SATELLITE
- LAND MOBILE
- LAND MOBILE SATELLITE
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- MARITIME MOBILE SATELLITE
- MARITIME RADIONAVIGATION
- METEOROLOGICAL
- METEOROLOGICAL SATELLITE
- MOBILE
- MOBILE SATELLITE
- RADIO ASTRONOMY
- RADIODETERMINATION SATELLITE
- RADIOLOCATION
- RADIOLOCATION SATELLITE
- RADIONAVIGATION
- RADIONAVIGATION SATELLITE
- SPACE OPERATION
- SPACE RESEARCH
- STANDARD FREQUENCY AND TIME SIGNAL
- STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

ACTIVITY CODE

- GOVERNMENT EXCLUSIVE
- GOVERNMENT/NON-GOVERNMENT SHARED
- NON-GOVERNMENT EXCLUSIVE

ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

This chart is a graphic single-point-in-time portrayal of the Table of Frequency Allocations used by the FCC and NTIA. As such, it does not completely reflect all aspects, i.e. footnotes and recent changes made to the Table of Frequency Allocations. Therefore, for complete information, users should consult the Table to determine the current status of U.S. allocations.

U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management

August 2011

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* EXCEPT AERONAUTICAL MOBILE (R)

** EXCEPT AERONAUTICAL MOBILE

PLEASE NOTE: THE SPACING ALLOTTED THE SERVICES IN THE SPECTRUM SEGMENTS SHOWN IS NOT PROPORTIONAL TO THE ACTUAL AMOUNT OF SPECTRUM OCCUPIED.

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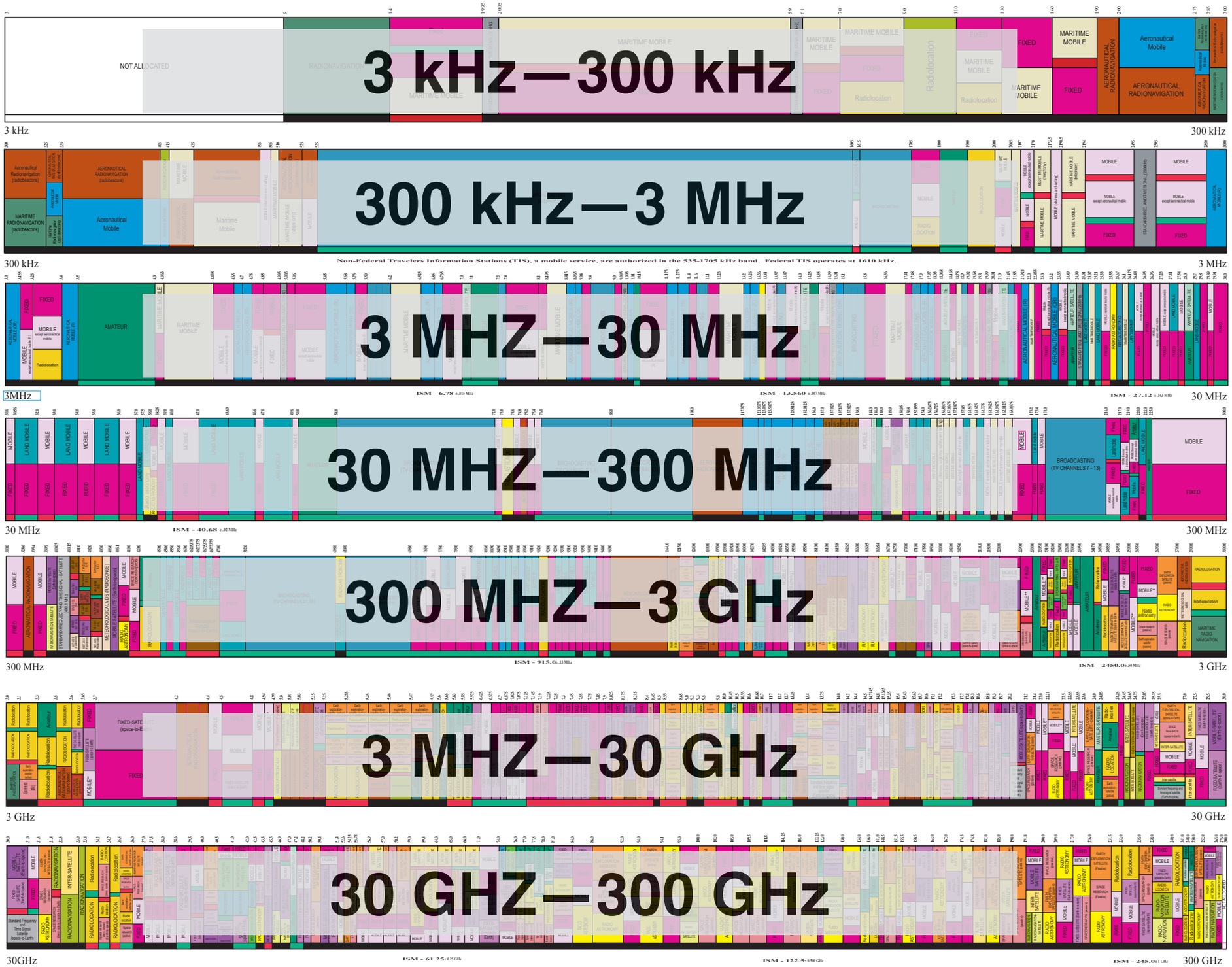

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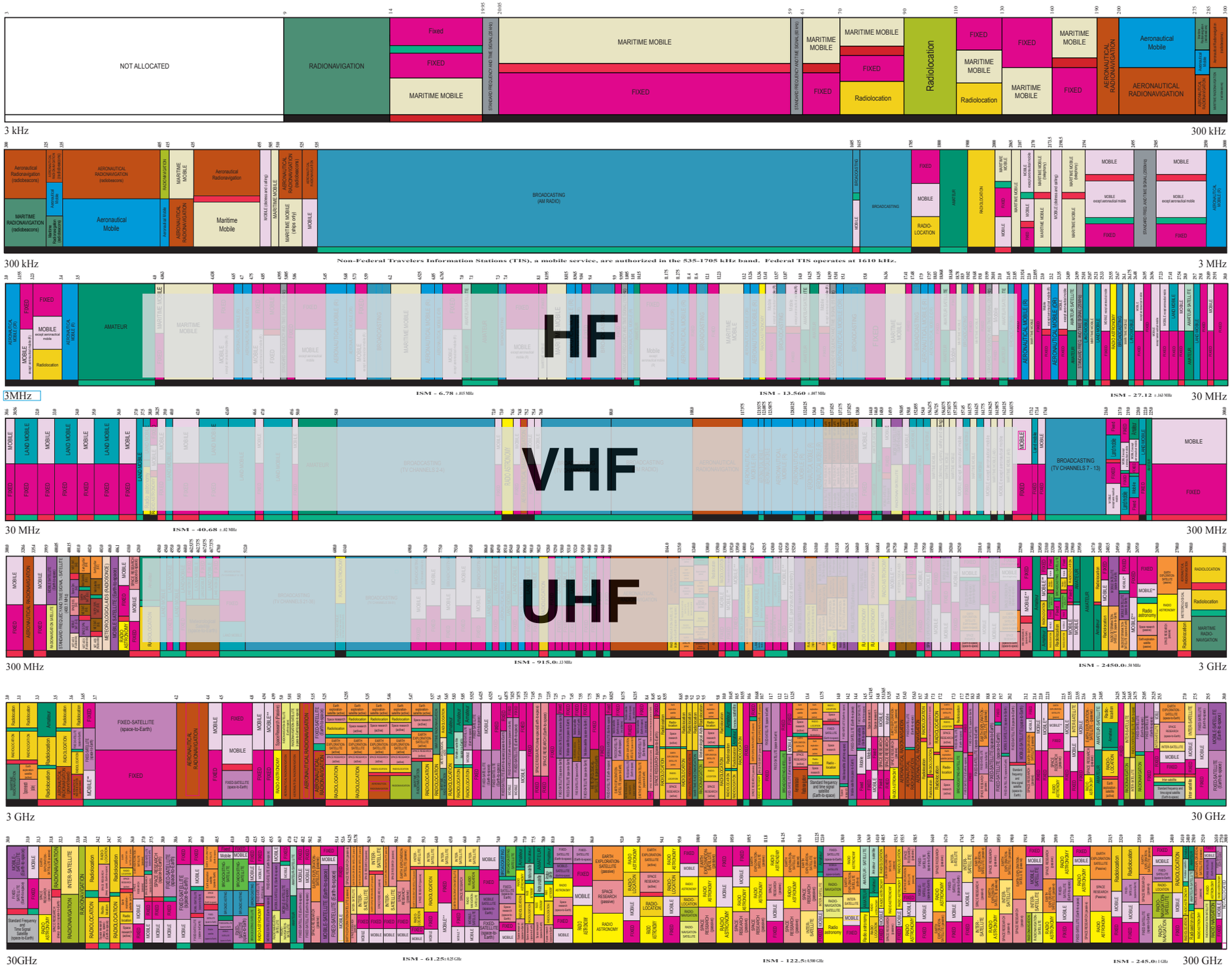

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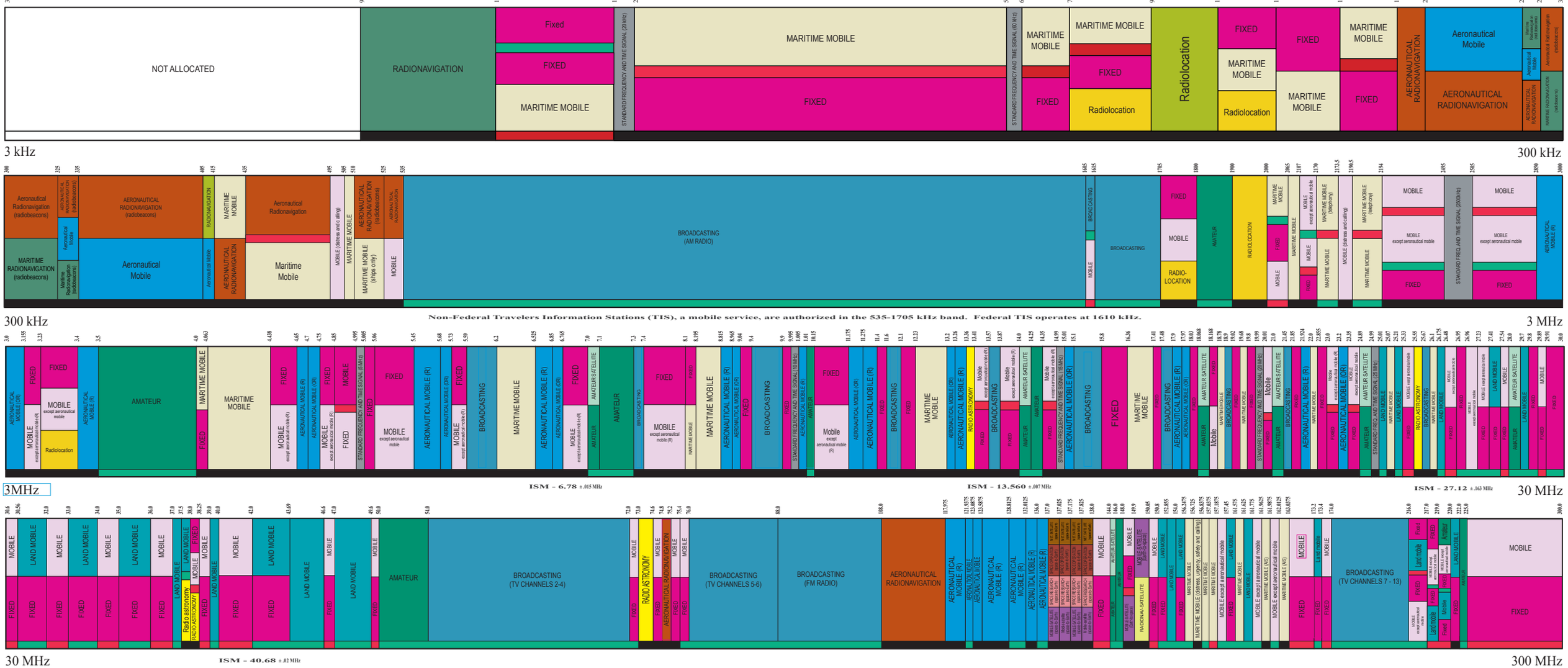

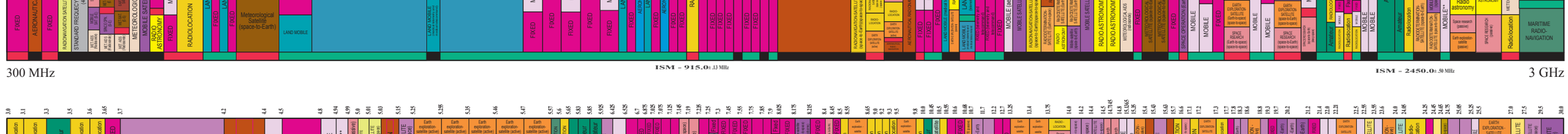

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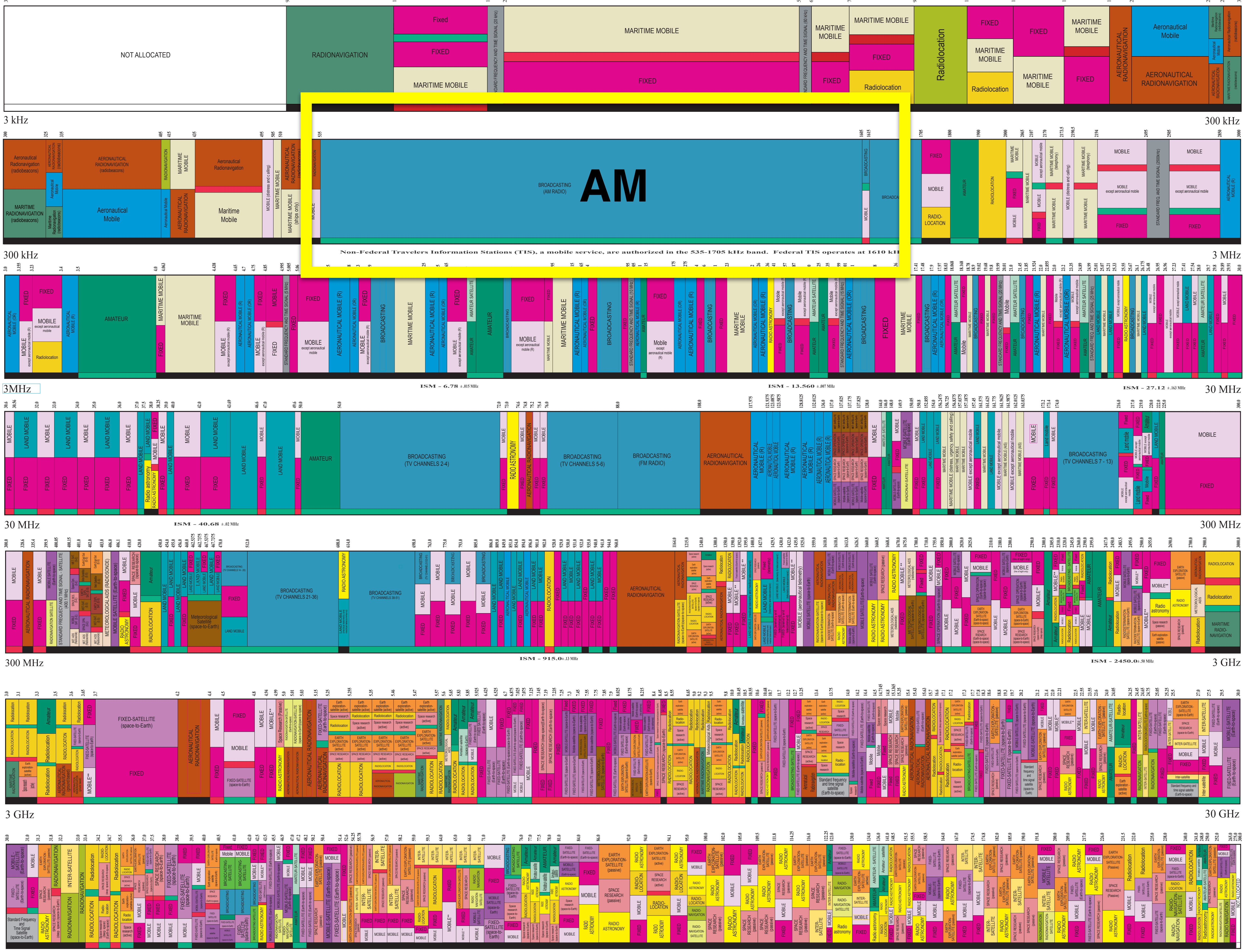
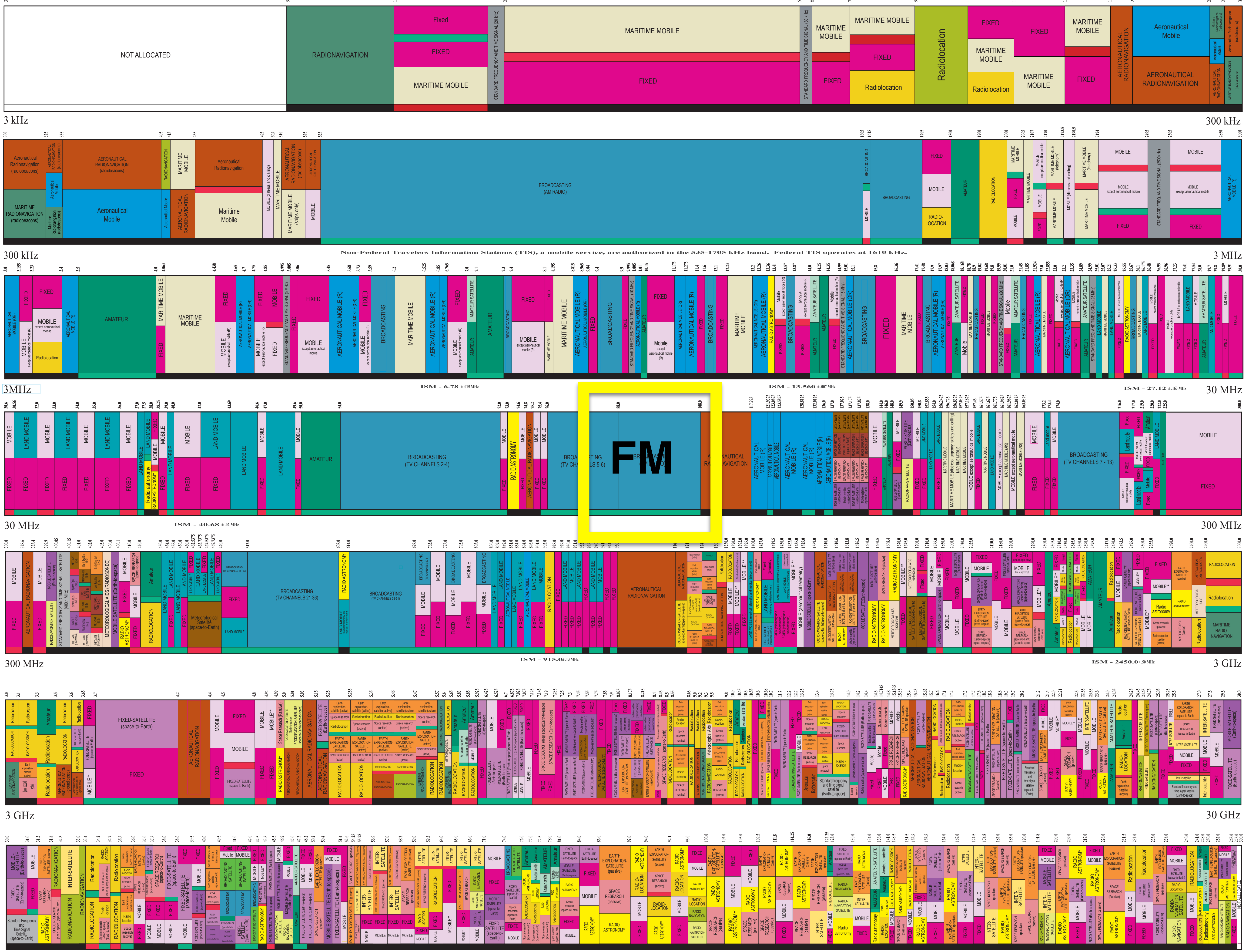

NOT ALLOCATED
RADIONAVIGATION
MARITIME MOBILE
FIXED
Radiolocation
AERONAUTICAL RADIONAVIGATION
Aeronautical Mobile
3 kHz
300 kHz
BROADCASTING (AM RADIO)
AM
Non-Federal Travelers Information Stations (TIS), a mobile service, are authorized in the 535-1705 kHz band. Federal TIS operates at 1610 kH
300 kHz
3 MHz
AMATEUR
BROADCASTING
ISM – 6.78 ±.015 MHz
ISM – 13.560 ±.007 MHz
ISM – 27.12 ±.163 MHz
3MHz
30 MHz
BROADCASTING (TV CHANNELS 2-4)
BROADCASTING (TV CHANNELS 5-6)
BROADCASTING (FM RADIO)
BROADCASTING (TV CHANNELS 7 - 13)
AERONAUTICAL RADIONAVIGATION
30 MHz
ISM – 40.68 ±.02 MHz
300 MHz
BROADCASTING (TV CHANNELS 21-36)
BROADCASTING (TV CHANNELS 38-51)
ISM – 915.0±.13 MHz
ISM – 2450.0±.50 MHz
300 MHz
3 GHz
FIXED-SATELLITE (space-to-Earth)
3 GHz
30 GHz


NOT ALLOCATED
RADIONAVIGATION
Fixed
FIXED
MARITIME MOBILE
STANDARD FREQUENCY AND TIME SIGNAL (20 kHz)
MARITIME MOBILE
FIXED
Radiolocation
AERONAUTICAL RADIONAVIGATION
Aeronautical Mobile
3 kHz
300 kHz
BROADCASTING (AM RADIO)
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30 MHz
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BROADCASTING (TV CHANNELS 5-6)
FM
AERONAUTICAL RADIONAVIGATION
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MOBILE
FIXED
30 MHz
ISM – 40.68 ±.02 MHz
300 MHz
BROADCASTING (TV CHANNELS 21-36)
BROADCASTING (TV CHANNELS 38-51)
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ISM – 2450.0±.50 MHz
3 GHz
FIXED-SATELLITE (space-to-Earth)
3 GHz
30 GHz

3 kHz
300 kHz
300 kHz
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30 MHz
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27.12 ±.163 MHz
30 MHz
ISM – 40.68 ±.02
300 MHz
TV
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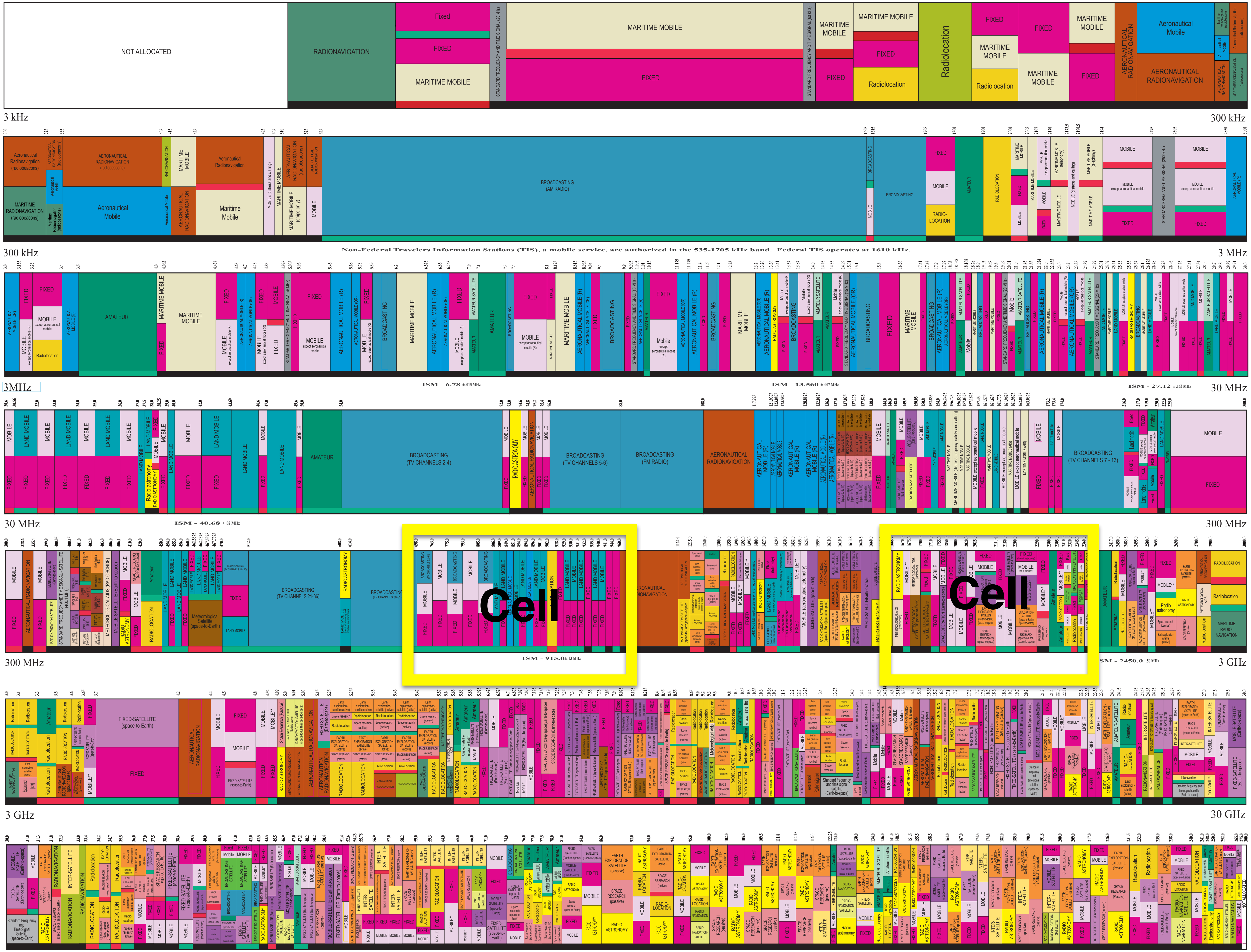
3 GHz
3 GHz
30 GHz


NOT ALLOCATED
RADIONAVIGATION
Fixed
FIXED
MARITIME MOBILE
FIXED
Radiolocation
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AERONAUTICAL RADIONAVIGATION
3 kHz
300 kHz
Aeronautical Radionavigation (radiobeacons)
MARITIME RADIONAVIGATION (radiobeacons)
Aeronautical Mobile
Maritime Mobile
BROADCASTING (AM RADIO)
BROADCASTING
AMATEUR
RADIOLOCATION
MOBILE except aeronautical mobile
300 kHz
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300 MHz
BROADCASTING (TV CHANNELS 21-36)
Meteorological Satellite (space-to-Earth)
Cell
Cell
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ISM – 2450.0±.50 MHz
300 MHz
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FIXED-SATELLITE (space-to-Earth)
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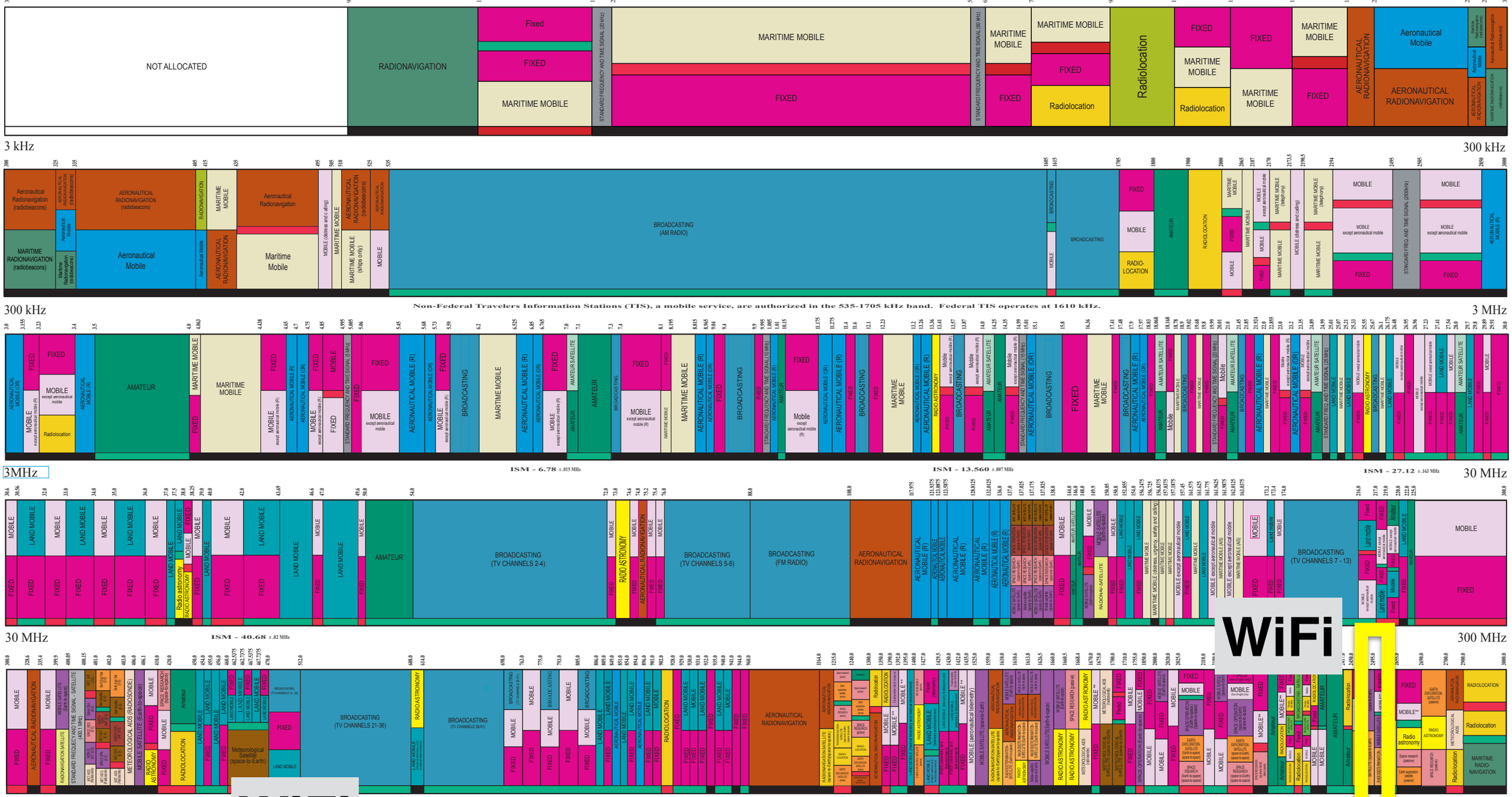

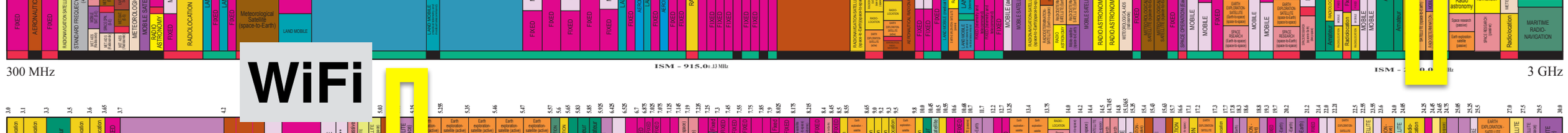

3 kHz
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30 GHz
FIXED-SATELLITE (space-to-Earth)

Amateur Bands

Next Time

- Identifying wireless devices
- Antennas
    - Frequency, wavelength, size, power
- FCC data base
    - Looking up devices
    - What you can find out