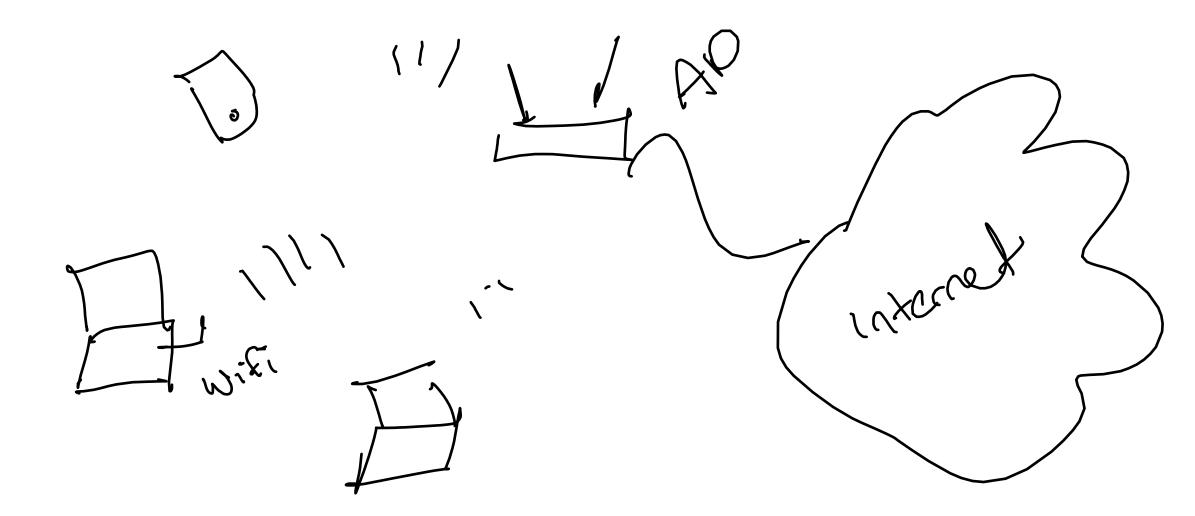
# Wireless Networking

### Access Point Networks



### **UNITED**

NOT ALLOCATED

8 4 6 8

RADIONAVIGATION

8 80 50 88

MARITIME MOBILE

### STATES

#### **FREQUENCY**

### **ALLOCATIONS**

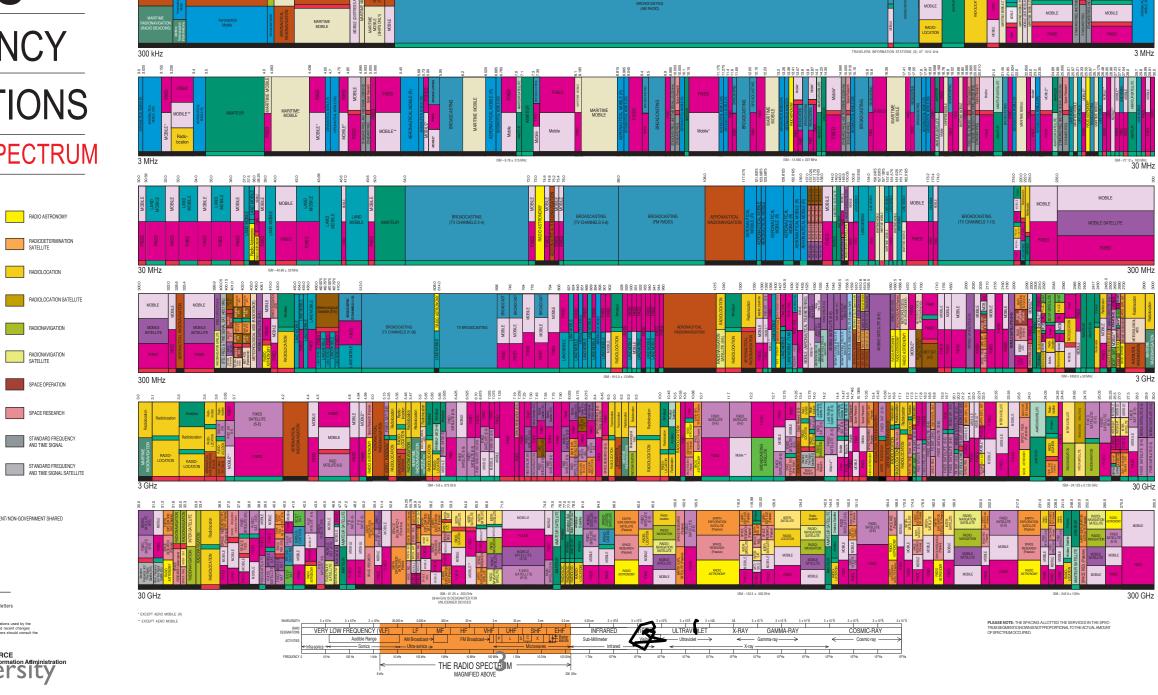
#### THE RADIO SPECTRUM



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

ALLOCATION USAGE DESIGNATION

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



MARITIME MOBILE

MARITIME MOBILE

ARITIME MOBILE

MOBILE

MARITIME MOBILE



### **UNITED**

NOT ALLOCATED

RADIONAVIGATION

### STATES

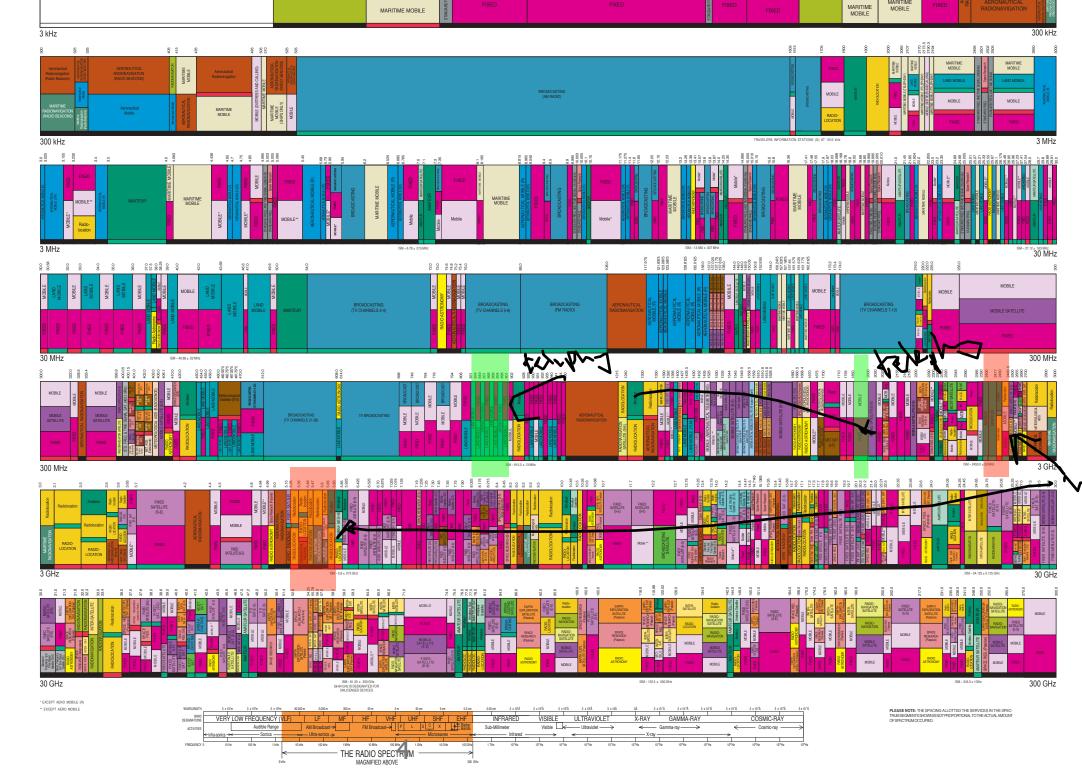
#### **FREQUENCY**

### **ALLOCATIONS**

#### THE RADIO SPECTRUM



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



MARITIME MOBILE

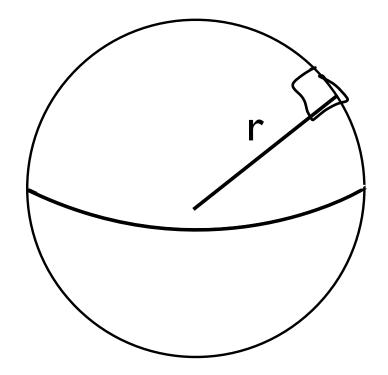
MARITIME MOBILE

ARITIME MOBILE



### Wireless Is Different

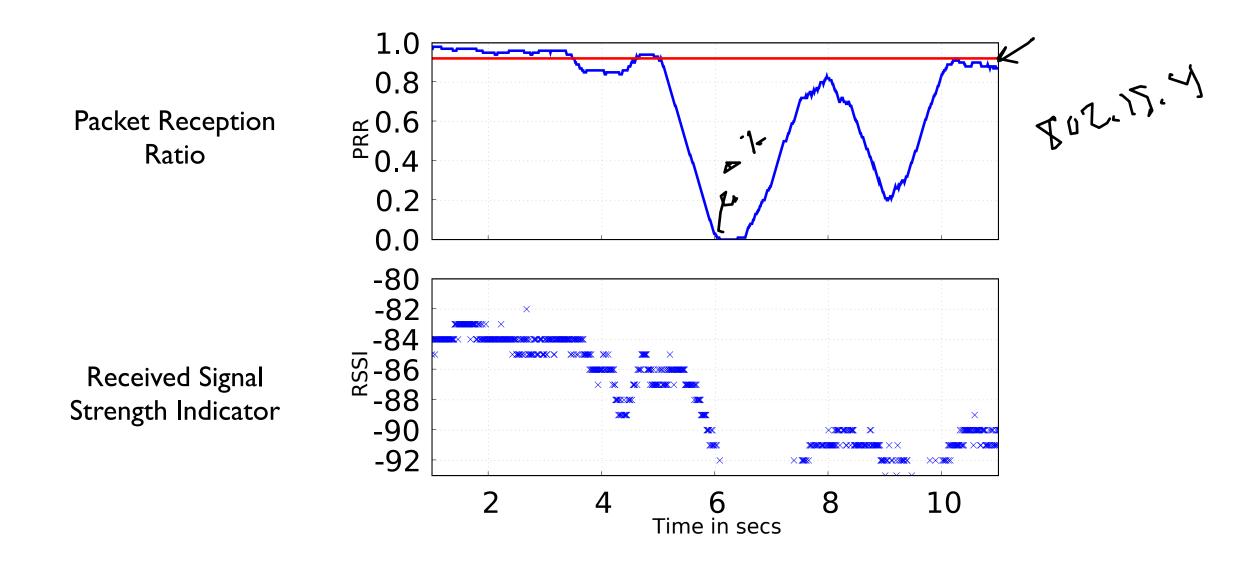
- Wireless transmission medium is not a wire
- Radiates over space
  - ► Signal weakens with distance: r² or faster
  - ► Intermediate links
- Uncontrolled medium
  - ► Signal strength changes over time
  - ► Interference from other transmitters



# Signal Strength

- Obstructions can further weaken signal
- Wireless signals can reflect
  - ► Multipath: can receive signal in multiple paths/reflections, with different delays (analogy: echoes in a canyon)
- There is no perfectly uniform antenna
- The world is continuously changing

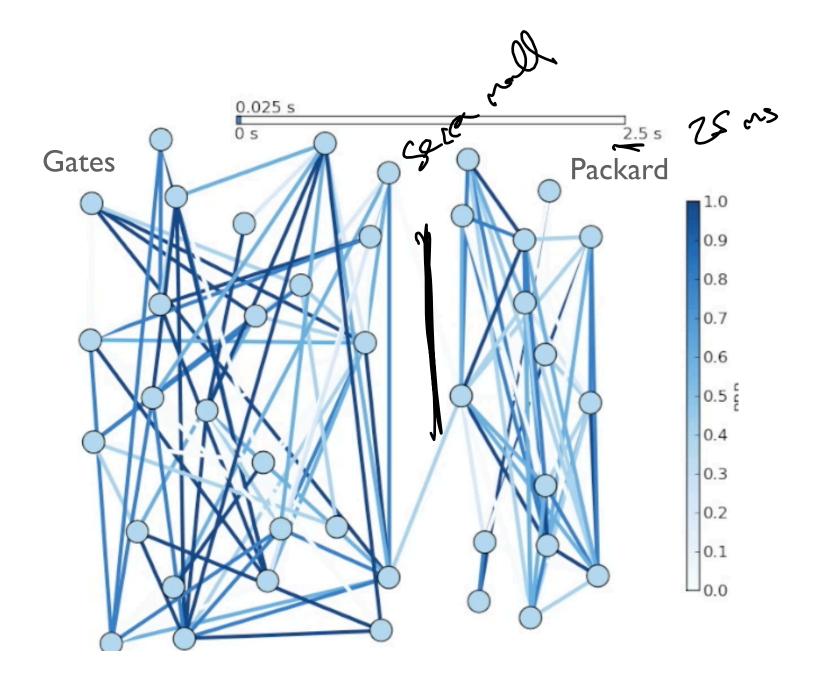
# Changing Over Time



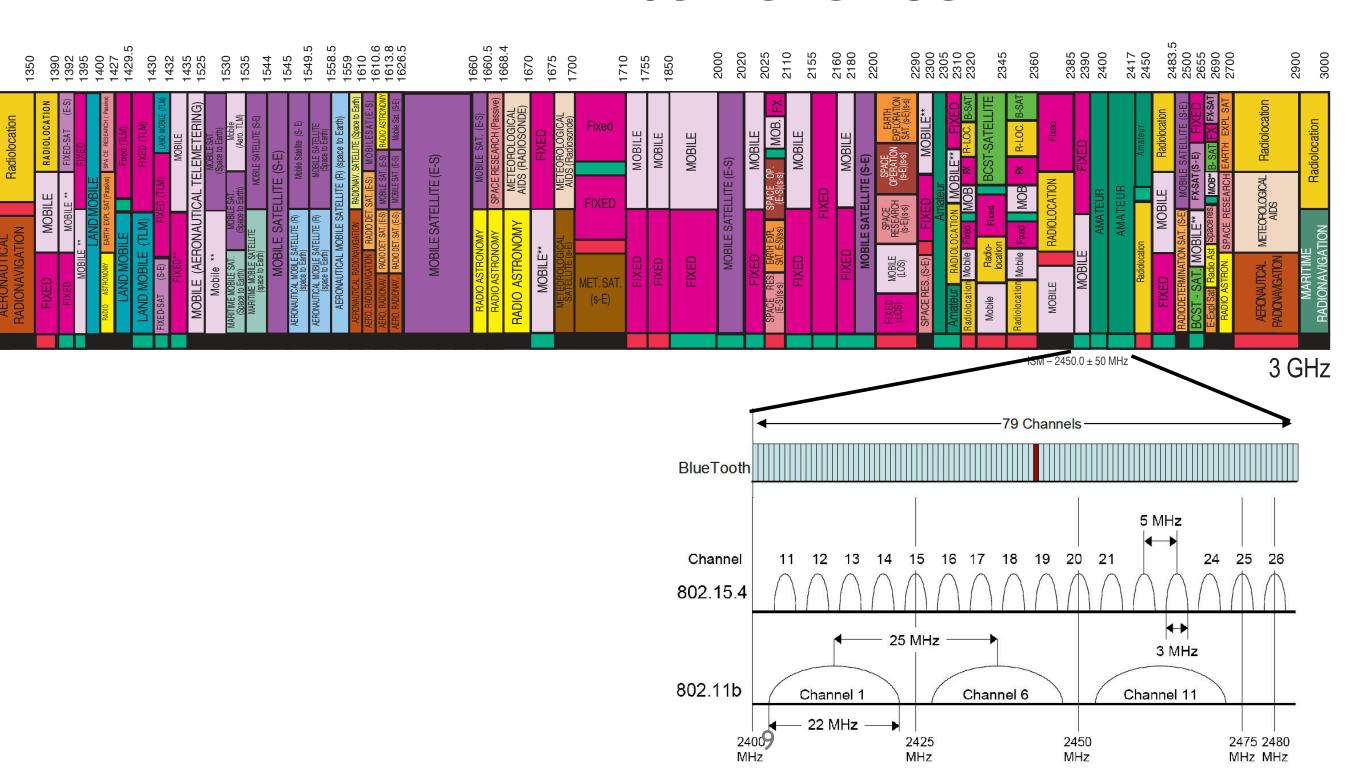
## A Real Network: SWAN

2.5 seconds

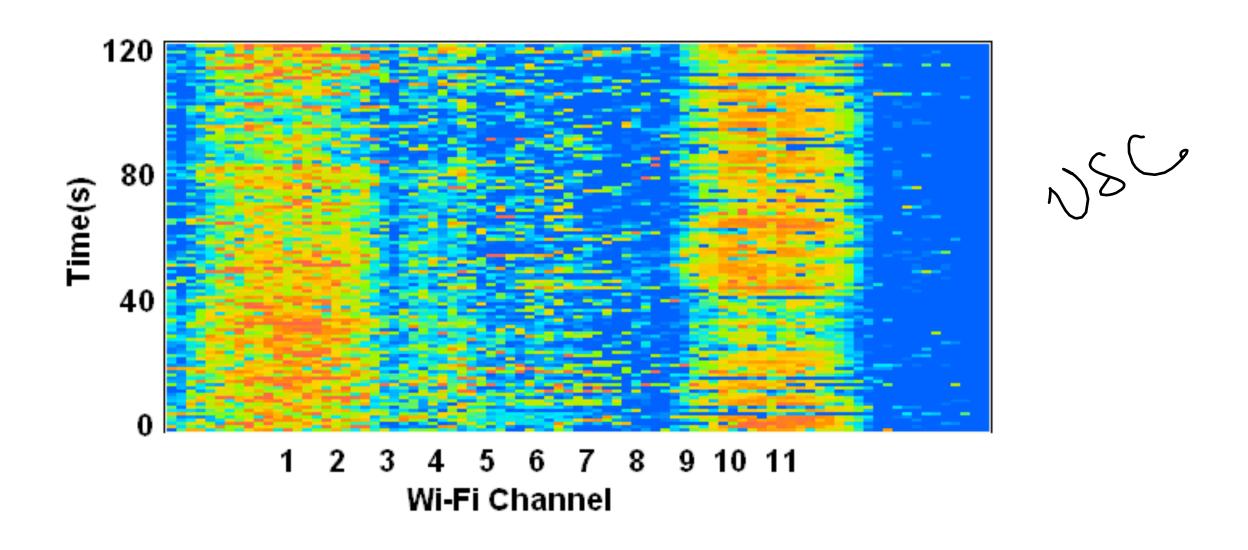
The Stanford Wireless Access Network (SWAN) is an 802.11b/g testbed at Stanford. It is part of a research collaboration with King Abdullah University of Science and Technology (KAUST).



### Interference



### Interference



### Overview

- Wireless networks are increasingly the last hop for personal communications
  - But generally don't work as well
- Wireless behaves very differently from wired: many complex behaviors!
  - Signal weakens over distance
  - Signal affected by environment
  - ► Intermediate links
  - ► External interference
- Different behavior leads to different protocols and algorithms