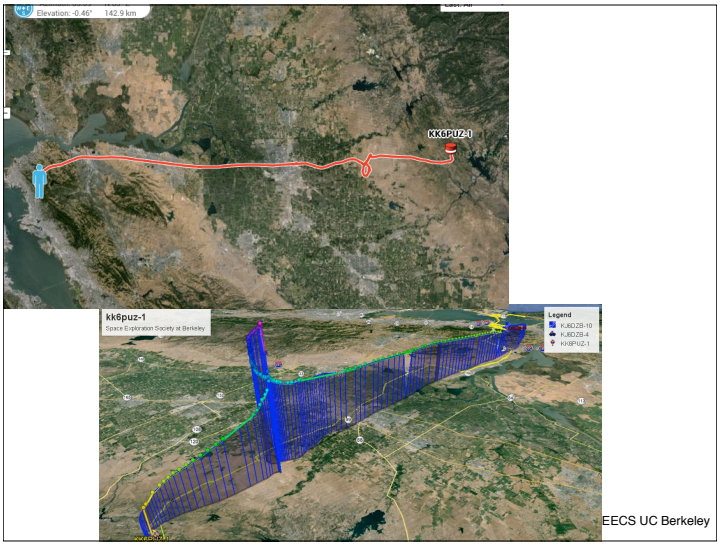
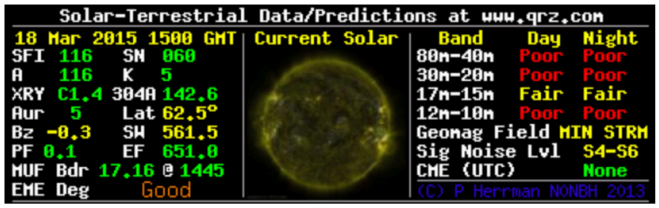
EE123 Digital Signal Processing

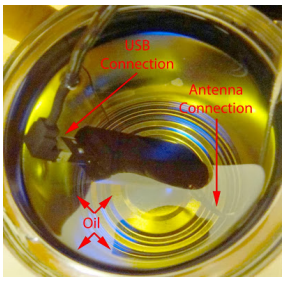
Lecture 22
Lab 4: Frequency Calibration using GSM
Compressed Sensing





Lab 4

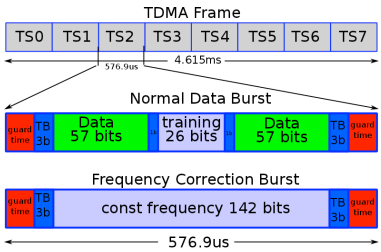
- SDR crystal oscillator has often has offset
- Also drifts with temperature
- Cellphones do the same!
- GSM protocol has built in synchronizations



http://sdrformariners.blogspot.com/2013/12/cooling.html

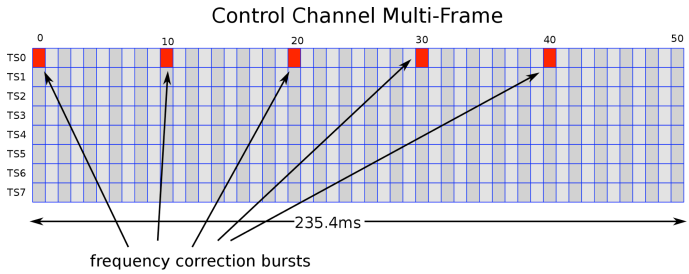
GSM-850

- Frequencies 200KHz channels
  - –Uplink 824-849
  - –Downlink 869-849
- TDMA: Time division multiple access

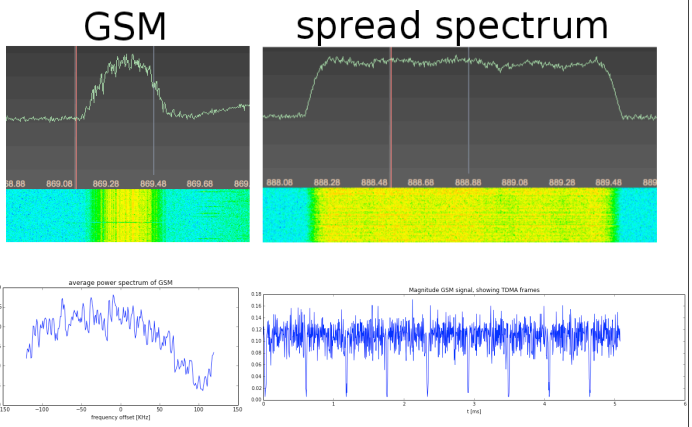


GSM Frequency Correction Channel

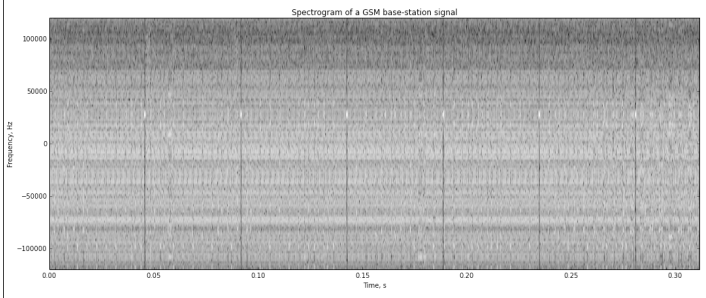
- Pure frequency bursts @67.7083KHz



How to find GSM Base Stations

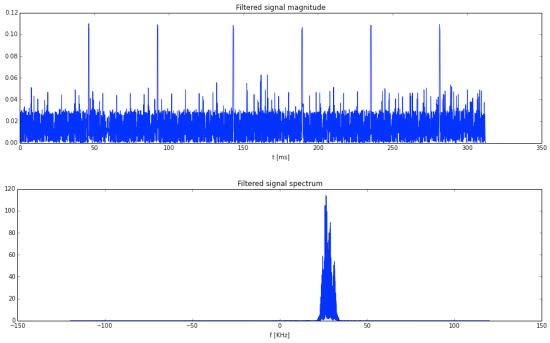


Spectrogram of GSM



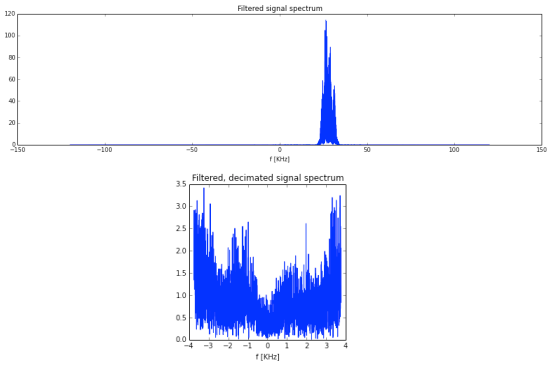
How to find Bursts?

- Use Bandpass filter and compute magnitude of result



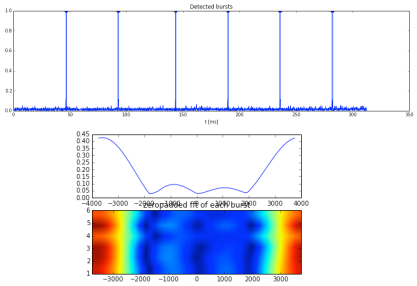
How to find Bursts?

- Can process at lower rate!

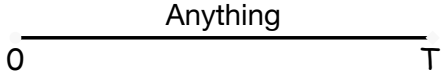


Detect Bursts and Compute Frequency

- Detect bursts at low rate sampling
- Compute frequency
- Calculate the original frequency!



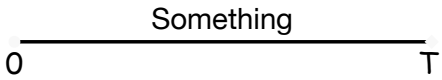
Compressive Sampling



Q: What is the rate you need to sample at?

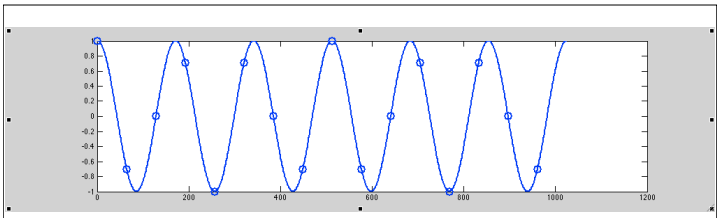
A: At least Nyquist!

Compressive Sampling



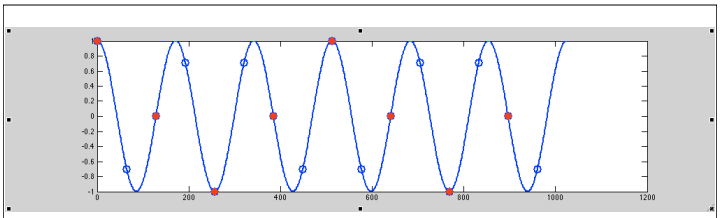
Q: What is the rate you need to sample at?

A: Maybe less than Nyquist....



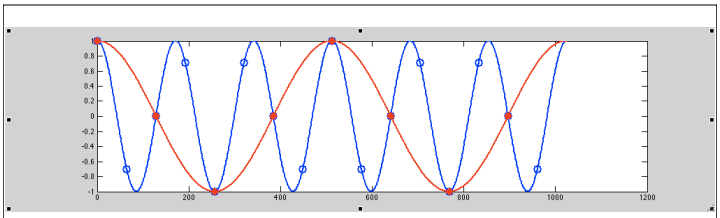
You are given samples of an harmonic function. You know there's only 1 frequency, but you don't know which.

1. Is it Nyquist sampled?
2. How would you reconstruct?



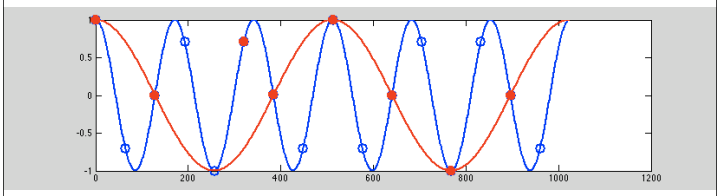
You collect half the samples at half the rate

1. Is it Nyquist sampled?
2. Can you reconstruct?



You collect half the samples at half the rate

1. What's the problem?
2. How can it be resolved?



Non-uniform sampling solves the ambiguity!

1. What if there are 2 frequencies? What would you do?

Image Compression

Images are compressible

Standard approach: First collect, then compress

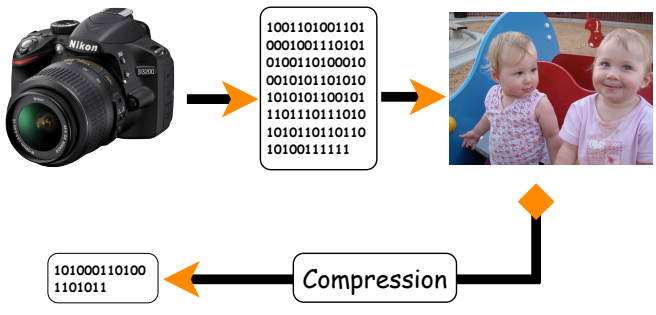
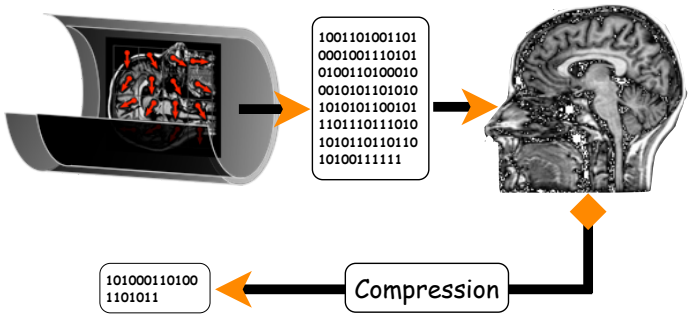


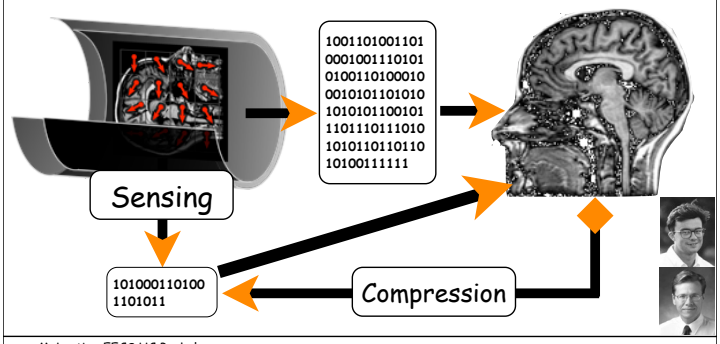
Image Compression

Medical images are compressible
Standard approach: First collect, then compress



Compressed Sensing

Medical images are compressible
Standard approach: First collect, then compress



Compressed Sensing

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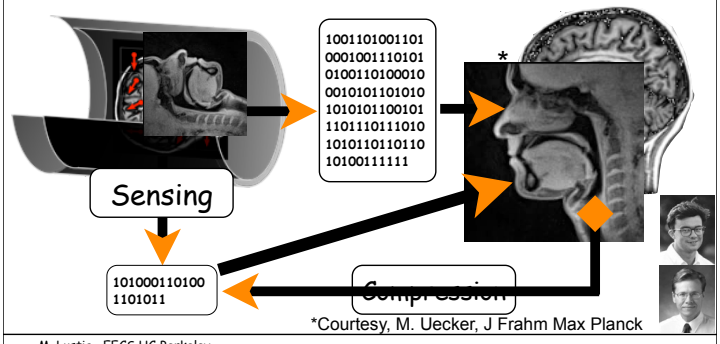

*Courtesy, M. Uecker, J Frahm Max Planck