Why Do We Care About Time?

- Every digital system needs a clock
- Accurate time is important for
  - Communication systems (TDMA, CDMA, etc)
  - Signal Processing, Data Fusion
- Typical crystals drift over the commercial temperature range
- Standard solution: Temperature Compensated Crystal Oscillators (TCXO)
- Problems: expensive, high power consumption
Exploiting Dual Crystals

- Every crystal has a unique drift curve
- We can exploit two such curves to compensate for the drift
- We developed a two phase algorithm:
  - Factory calibration (similar to TCXO)
  - Runtime compensation
- Advantages:
  - Cheaper than TCXO because it is digital
  - Potential for lower power consumption
Some Results

Clock Stability vs. Temperature

- X1
- X2
- XCXO

mean: 0.47ppm
stddev: 0.31ppm

Current Measurement of XCT on TMote

Average Power: 1.4 mW, compared to 6 mW of a TCXO

MSP430 Microcontroller

Two 8MHz Crystals

Timer Overflows

Compensation Calculations

Current [mA]

Time [s]