Satellites Will Suffice?

for the Invitational Workshop on
Opportunistic RF Localization for Next
Generation Wireless Devices

June 16-17, 2008

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\[ \{\rho^{(k)}\} \text{: Pseudoranges (measurements)} \]
\[ \{(x^{(k)}, y^{(k)}, z^{(k)})\} \text{: Satellite positions (known)} \]

\[ \rho^{(k)} = \sqrt{(x^{(k)} - x)^2 + (y^{(k)} - y)^2 + (z^{(k)} - z)^2} - b \]

\( k = 1, 2, \ldots, K \)

If \( K \geq 4 \), solve for user position \((x, y, z)\),
and receiver clock bias \( b \)

from Misra and Enge, 2006
Evolution of Service

- Availability (Sparse constellation)
- Accuracy (Selective Availability)
- Integrity (Aviation)
- Coverage (Downtown & Indoors)
- Security (Geo-fencing & geo-encryption)
Accuracy

May 2000

from Sherman Lo, Stanford University

Differential Integrity

Opportunistic RF Localization for Next Generation Wireless Devices

June 16-17, 2008
Worcester Polytechnic Institute
Worcester, MA, USA
Coverage for the Consumer

GPS Indoor Survey Locations
A collaboration with Polaris Wireless
149 sampling locations on Stanford University campus

- 37 % of sites have C/N0>15 dB-Hz
  - Durand
- 24 % of sites have C/N0>15 dB-Hz
  - Mitchell
- 63 % of sites have C/N0>15 dB-Hz
  - Terman
- 9 % of sites have C/N0>15 dB-Hz
  - Quillen
about the codes ....
Next Frontier: Security

Physical Security
- Police & fire
- Hazardous materials
- Olympic athletes

Cyber Security
- Synchronization for telecom & the power grid
- Road tolling
- Electronic communication (secure source & destination by location & time)
- Data (enable access by location & time)

Spoofing
- Mock signals
- How do you know you are where you think you are?
- How do I know you are where you say you are?
- Authentication required

Jamming
- Denial of service
- Satellite signals are weak
- Anti-jam required

Geo-encryption Based on Loran-C
(Di Qui co-advised by Profs. Enge & Boneh)
Summary

- GPS has a wonderful history
- New signals & constellations are coming
  - MEO & perhaps LEO
  - more from Dr. Misra
- Security for and from GNSS
  - Geo-fencing
  - Geo-encryption
  - Terrestrial signals will be needed