SnapTrack, Inc.

FCC Location Roundtable

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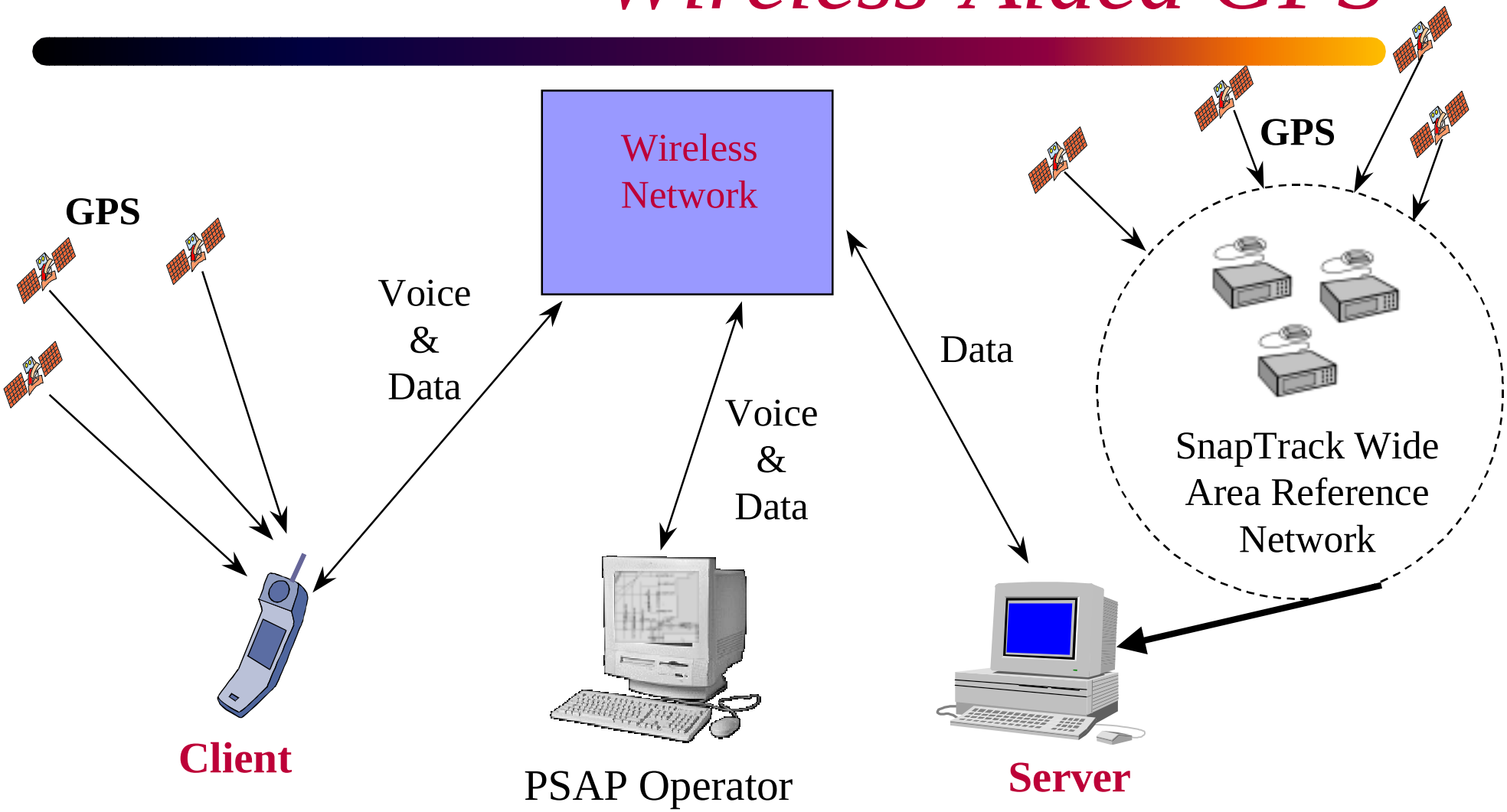
SnapTrack's Personal Location Technology

- Combine GPS receiving capability with a cell-based wireless network
  - Air interface independent
- Divide location determination task between client and server
- Extract key information from the wireless network
  - E.g., approximate location, carrier frequency
- Software-based solution
  - Use phone's own DSP chip to rapidly process an information-rich snapshot of GPS data using fast convolution software

SnapTrack Wireless-Aided GPS



Performance v. Conventional GPS

	SnapTrack	Conventional GPS
Accuracy	3-75 m	50-200 m
Time to first fix	seconds	up to 15 minutes
Acquisition yield	excellent	poor with any blockage
Power consumption	nominal	high
Cost to deploy	software-based ➔ minimal cost	hardware-based ➔ more expensive

Comparison to Terrestrial Triangulation

SnapTrack Wireless-Assisted GPS

- Negligible network impact
  - air interface independent
  - server software can run on an existing platform
- Can achieve accurate fix with only a single base station as long as cell phone can communicate
  - first fix, cold start, 1-sigma accuracies generally range from 3-75 meters, depending on call environment
  - average accuracy of ≈20 meters
- Must use modified handsets

Terrestrial Triangulation

- Extensive network impact
  - modifications required to entire cellular network (new hardware and software at most if not all sites)
  - new receiver sites must be built to increase accuracy and coverage
  - accuracy dependent on cell configuration
  - requires at least 3-4 receivers in appropriate geometric pattern to provide accurate fix (unavailable in many environments)
- Severe multipath limitations

"Terrestrial triangulation systems are inevitably limited by multipath; wireless-assisted GPS is expected to achieve an order of magnitude better accuracy." - Lucent Technologies, TR 45 filing

Test Groups

- Goals
  - Test and evaluate SnapTrack technology, serve as focus for standards activity
- SnapTrack CDMA test group
  - AirTouch, Ameritech, Bell Mobility, GTE, PrimeCo, Sprint PCS, U S WEST Wireless, Motorola, Samsung, LGIC, Hyundai, Denso, Fujitsu, Texas Instruments, VLSI
  - Wireless-assisted GPS messages being standardized in TR 45.5
    - Baseline text agreed, balloting scheduled for 8/99 completion
  - Audited tests have been conducted on two separate CDMA networks in Tampa, Florida (USA)
    - At 800 MHz (GTE Wireless) and 1900 MHz (Sprint PCS)
    - Prototypes from multiple handset vendors tested
- Recently launched SnapTrack GSM test group: 11 European and U.S. carriers

Major Field Tests

- United States
  - San Francisco Bay Area: analog (11/97)
  - Denver: analog/CDMA end-to-end E9-1-1 trial (8/98)*
  - Washington, D.C. : analog (11/98)
  - Tampa (SnapTrack CDMA Test Group): CDMA (3/99)
  - San Francisco (U.S. Marines Urban Warrior Exercise): GSM (4/99)
- Japan
  - Tokyo (NTT DoCoMo): PDC (12/97)
  - Kyoto (Manufacturer): PHS (2/98)
- Europe
  - Finland (Manufacturer): GSM (1/99)
  - Italy (Carrier): GSM (4/99)

* With Denver and Adams County PSAPs, SignalSoft, SCC, U S WEST Wireless

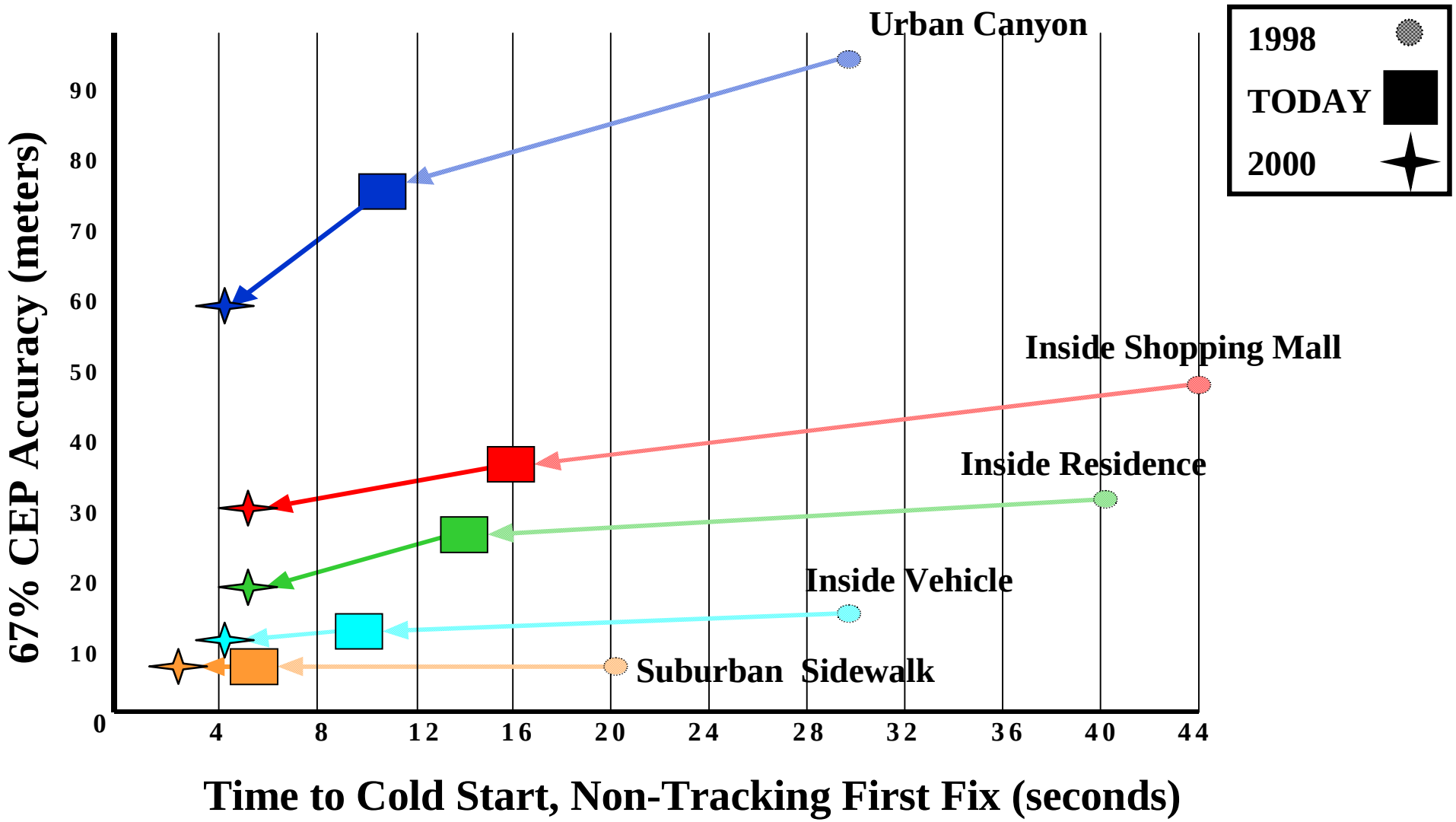
Tampa CDMA Field Trial (1)

- Structured field test to validate SnapTrack GPS performance when operating in a CDMA network
  - Time and base station ID passed to GPS client in handset
  - Network carrier frequency used to calibrate GPS oscillator
- Prototype integration of SnapTrack GPS client with CDMA handset
  - 1st step in the GPS/handset commercialization process
  - Substantial hardware and software integration
  - Validated GPS performance within handset package
  - Measured performance with miniature antennas and head blockage

Tampa CDMA Field Trial (2)

- SnapTrack server located on the wireless network
  - Used existing circuit switched wireless data service to communicate with the GPS client in the handset
  - Next field test will use standards based protocols for data connection, independent of the voice path
- All tests were independent, single, cold start fixes
  - Absolute worst case GPS scenario
  - Multi-fix averaging (3 - 5 fixes) can be applied to improve yield and precision in difficult environments
- Full range of environments: rural, urban, suburban, vehicles, indoor
  - 17 sites selected by wireless carriers to test operational limits

SnapTrack Technology Evolution Curve



Note: 2000 performance comes from faster DSP and further GPS algorithm improvements

Impact on Handset Cost

- SnapTrack's software based handset solution minimizes incremental manufacturing cost
  - Uses existing, standard processors already in handset
  - Many opportunities for sharing the few RF hardware components required
- Current estimates from semiconductor and handset manufactures are $7 - 10 incremental cost, including licensing fees, for first generation integrated implementations
  - Costs will drop sharply as semiconductor densities and levels of integration increase
- Use of standard processing elements will continually drive down cost, size and power consumption
  - Moore's law on transistor density (same cost and processing power trend seen in PCs)

Commercial Agreements

- Motorola
  - equity investment and commercial license agreement
- Texas Instruments
  - equity investment and commercial license agreement
- NTT DoCoMo (Japan's largest wireless carrier)
  - commercial license agreement
- Denso (SnapTrack-enabled PDA)
  - commercial license agreement
- NEC (Japan server distribution)
  - commercial license agreement