



Hybrid Wireless Assisted GPS Provides for E9-1-1 Public Safety

APCO/NENA E9-1-1 Symposium



*Irving, TX
January 25, 2002*



- The Technology Challenge
- Solutions For Carriers
- Performance Criteria
- Handset GPS Technology Availability
- Phase II Issues



Company Overview

- Founded in 1995 to focus on advanced GPS-based wireless location
 - Acquired by QUALCOMM in 2000
- Pioneered Hybrid Wireless Assisted GPS™ (WAG)
 - Field tested on all major air interfaces, including European GSM networks
 - Focus on technology for portable wireless terminals and applications
- Hybrid Wireless Assisted GPS™ technology leader with a broad intellectual property portfolio
 - Incorporated into gpsOne™ by QUALCOMM
 - Granted patents covering all essential aspects of Hybrid WAG
 - Broadly licensed to major wireless chipset, subscriber terminal and infrastructure/systems manufacturers

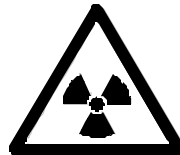




SnapTrack/gpsOne Partnerships and Licensees



Public Safety Applications for Wireless Location



- Tactical coordination
 - Police
 - Fire
 - Rescue
 - EMS
- Tracking
 - Vehicle
 - Hazmat
 - Offender tracking
- Roadside Assistance
- AVL





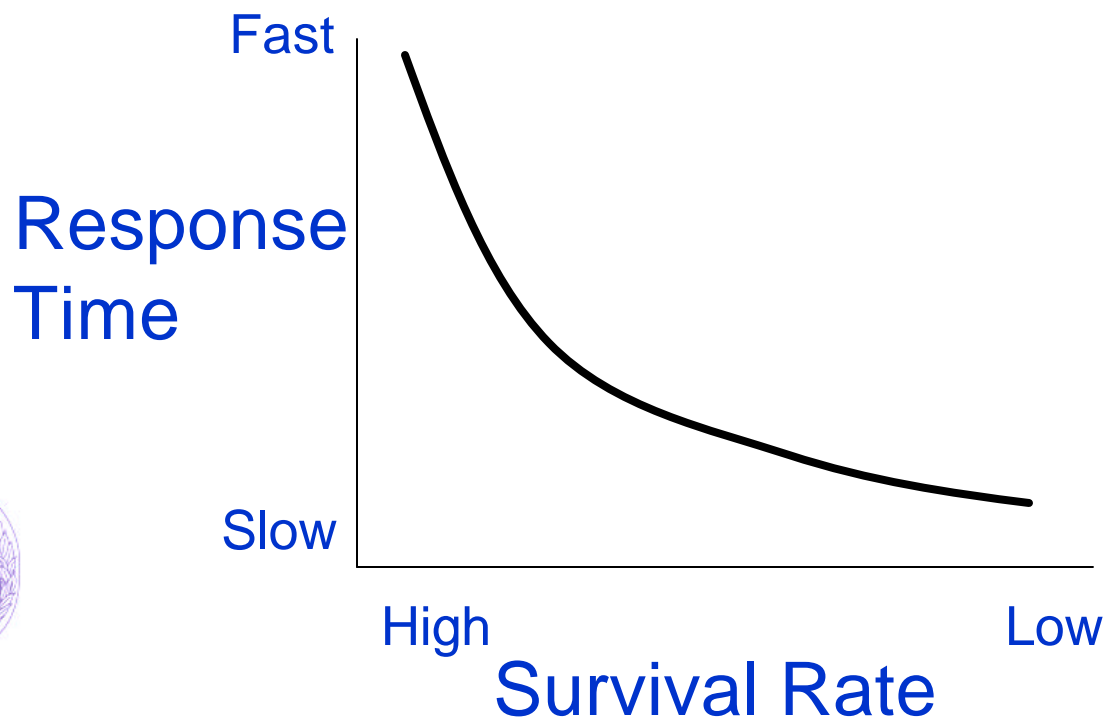
The E9-1-1 Wireless Location Challenge: Time = Lives

- **Availability** – High yield of location fixes in all environments
 - Location determination in all mobile coverage areas including urban canyons, inside buildings, in vehicles, and in rural areas with minimal base station coverage
- **Street Level Accuracy:** *5-50 meter accuracy across all environments*
- **Rapid first fixes** from totally cold start even in heavily blocked environments
- **Low Cost** - minimizes overall cost of modifications (network and mobiles)



Precision is Critical

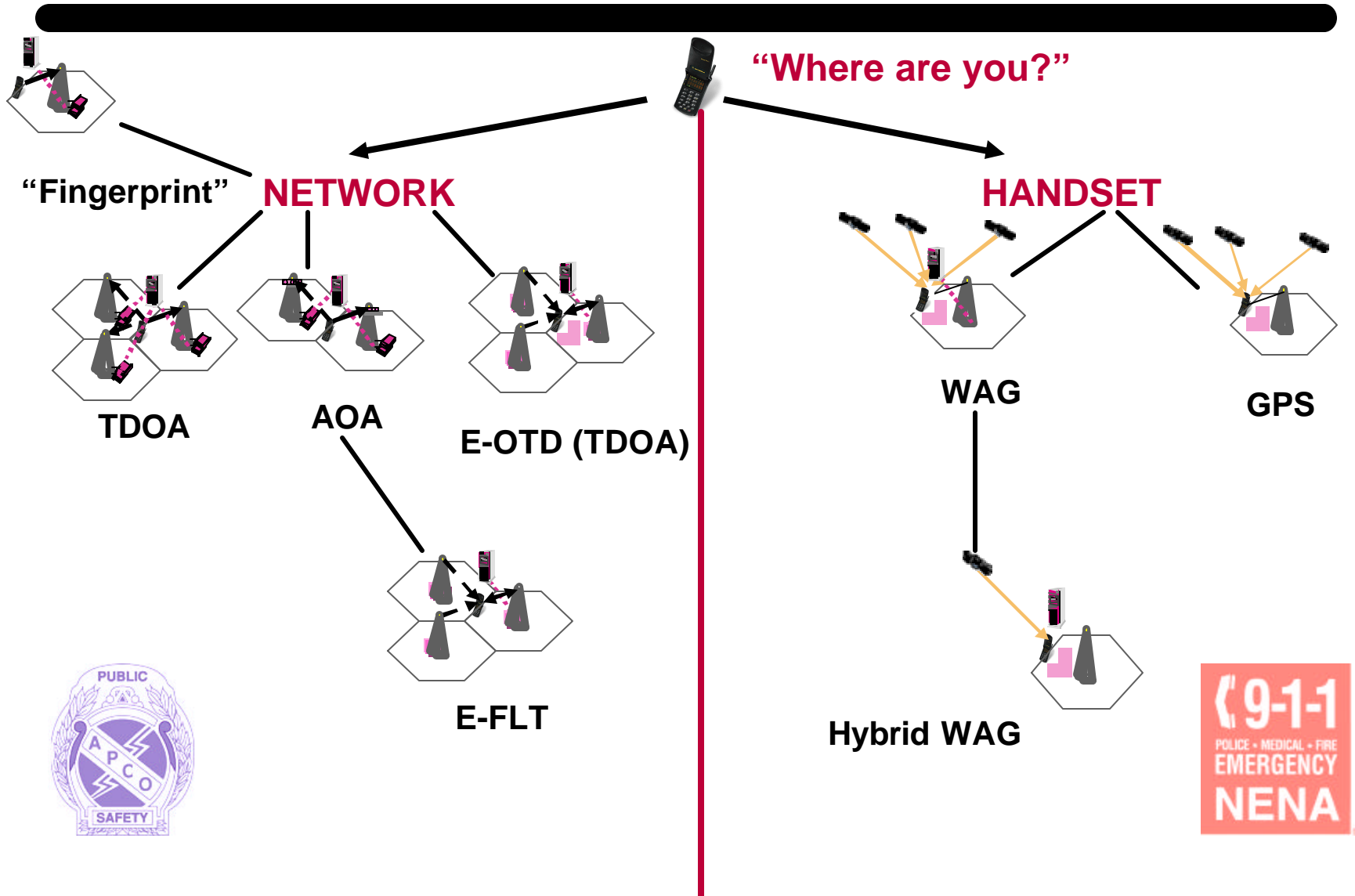
- **Highly personal street-corner location capability**
 - Speeds emergency response time
 - Increases public safety response effectiveness
 - Will save lives



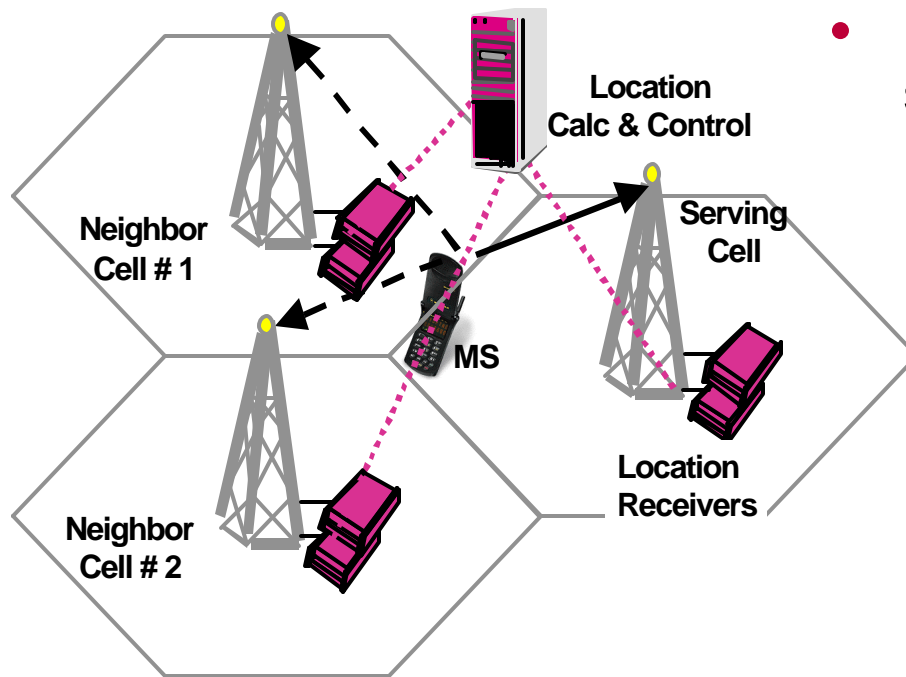
FCC Rules Recap

- Accuracy
 - Network solutions
 - 100 m, 67% of the time
 - 300 m, 95% of the time
 - Handset solutions
 - 50 m, 67% of the time
 - 150 m, 95% of the time
- Deployment
 - Network solutions: Must deliver Phase II E9-1-1 to the PSAP within six months of PSAP request
 - Handset solutions: Carriers must meet handset activation milestones (No PSAP request required)
 - ALI-capable handset activation by Oct. 1, 2001
 - 25% of new handset activations ALI-capable by Dec. 31, 2001
 - 50% of new handset activations ALI-capable by June 30, 2002
 - 100% of new handset activations ALI-capable by Dec. 31, 2002
 - 95% ALI-capable handset penetration of subscriber base by Dec. 31, 2005

Network or Handset?



Typical Network Overlay Architecture



- Entire network must be modified with special equipment and software
 - Often requires additional base stations to ensure location coverage
 - Expensive in terms of upfront, ongoing and RF planning impact
 - Not conducive to roaming services



Typical Network Overlay Architecture (continued)

- Utilizes variety of terrestrial radio triangulation methods
 - AOA, TDOA, AFLT, EFLT, EOTD
 - Air interface specific
 - Some methods require new handsets as well as infrastructure modifications
- Accuracy dependent upon cell configuration
 - Requires 2-6 receivers in appropriate geometric pattern
 - Average 150m-500m accuracy



Global Positioning System (GPS) 101



GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

- The Global Positioning System (GPS) is a highly accurate, worldwide navigation system developed and maintained by the U.S. Government
- The GPS system consists of a constellation of 24 satellites – which use very precise clocks that keep accurate time to within three nanoseconds
- GPS-enabled devices use this timing information for position location calculations
- Some devices attempt to use conventional GPS as a headset based



Conventional GPS Not Suitable for E9-1-1



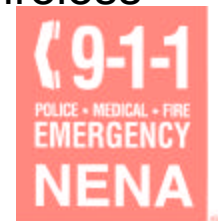
- Requires minimally obstructed view of sky
 - Does not work indoors or in areas of high blockage
 - “Yield” on fixes decays rapidly with blockage experienced in everyday movement
 - Urban areas, trees, hills, etc.
- Relatively long acquisition time
 - From ?30 seconds to 15 MINUTES from “Cold Start”
 - Totally unacceptable for Location-based Services and public safety type applications
- Significant power consumption in handset environment reduces battery life
 - Tracking causes continuous power drain
 - Adverse impact to handset standby times



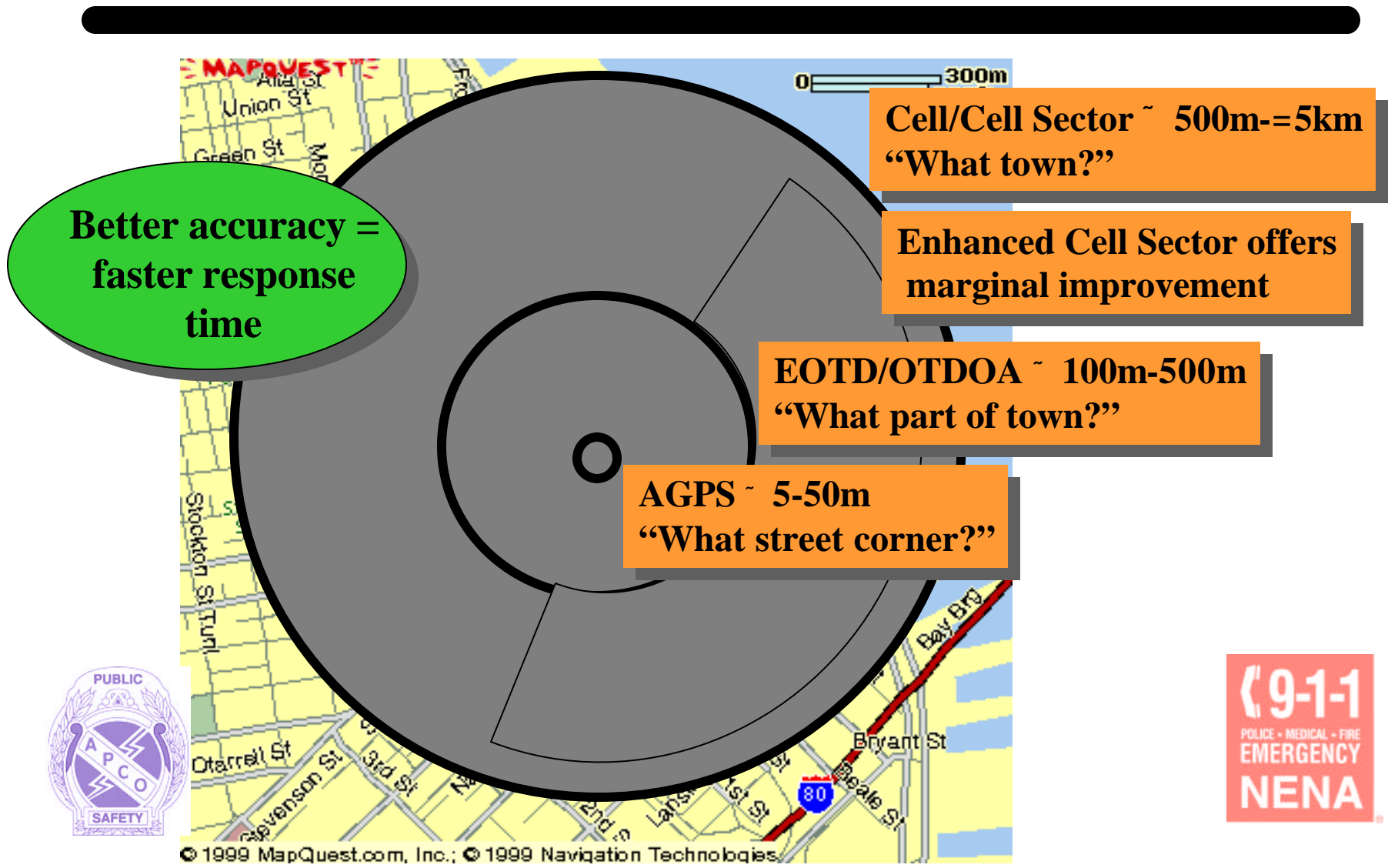


Wireless Assisted GPS? Pioneered by SnapTrack

- SnapTrack pioneered Wireless Assisted GPS™ to overcome limitations of conventional GPS and provide GPS Indoors™
 - All-terrain coverage: Homes, offices, urban canyons and the Grand Canyon
 - Average 5-50m accuracy in most environments, indoors & outdoors
- Takes advantage of key information from the wireless network to speed processing
- A network server assists the handset in determining location
- Software-based solution allows easy, cost-effective integration into handsets and carrier infrastructure. Easily upgraded.
- Air-interface independent and proven on all wireless standards
- Foundation for Hybrid Wireless Assisted GPS
 - Integrated into QUALCOMM chip products and gpsOne hybrid Wireless Assisted GPS solution



Accuracy Has Large Influence on Safety





*Average Network Accuracy of
~300m = Area of 7 Stadiums*

**Seven Football Stadiums is a LARGE margin area of error
for E911 and Location-based Services**

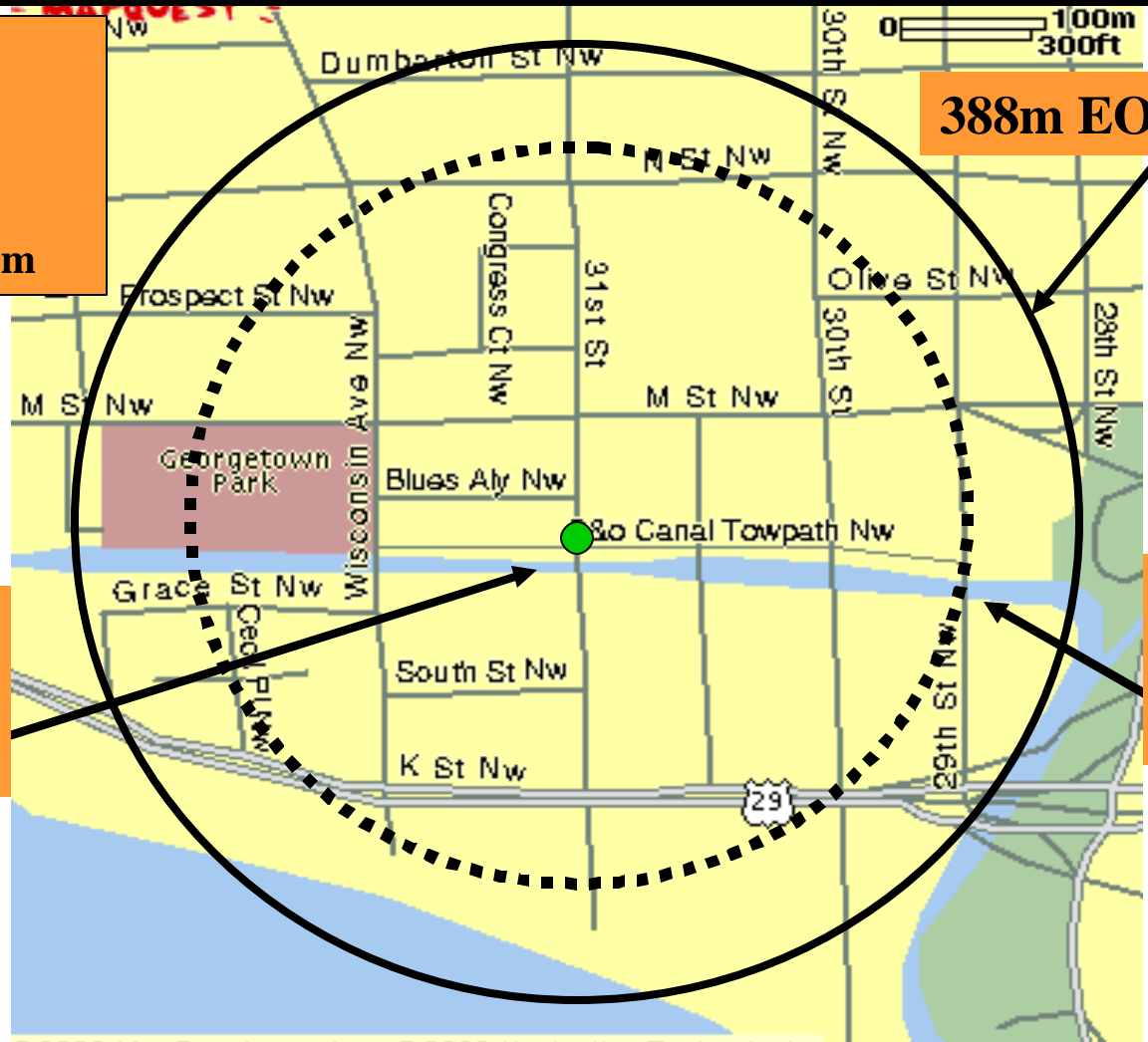


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*May vary depending on call environment



Proven Industry Leading Accuracy in Carrier Trials

**Mean Accuracy
(67% of fixes)**
A-GPS: 19.9m
EOTD: 547m
RadioCamera: 567m



388m EOTD Accuracy*

9m Wireless Assisted GPS Accuracy*

288m RadioCamera Accuracy*



*Results from Nextel trials, Washington DC. See Nextel FCC filing 5-21-01, Docket 94-102, Test Site 12

SnapTrack and gpsOne Proven Worldwide on Major Air Interfaces



Denver, CO (analog/CDMA)
outdoor, open: 1-? = 4 m



San Francisco, CA (analog/GSM/CDMA)
inside urban parking garage: 1-? = 45 m



Tampa, FL (CDMA)
1st story, 2-story house: 1-? = 20 m



Tokyo, Japan (PHS/PDC)
dense urban: 1-? = 18 m



Madrid, Spain (GSM)
dense urban: 1-? = 37 m



Washington, D.C. (analog)
urban alley: 1-? = 50 m

*Sample data from specific field tests, may not be representative of all conditions

Pan-European Roaming Trial Results



Hyde Park of London, UK
Outdoor: 8.89m accuracy
Yield: 100%



Shaftsbury Hotel, London, UK
Urban Outdoor: 29.76m accuracy
Yield: 100%



San Isidro Church, Madrid, Spain
Dense Urban: 37.6m accuracy
Yield: 99.5%



Place de Pantheon, Paris, France
Urban Outdoor: 37.84m accuracy
Yield: 100%

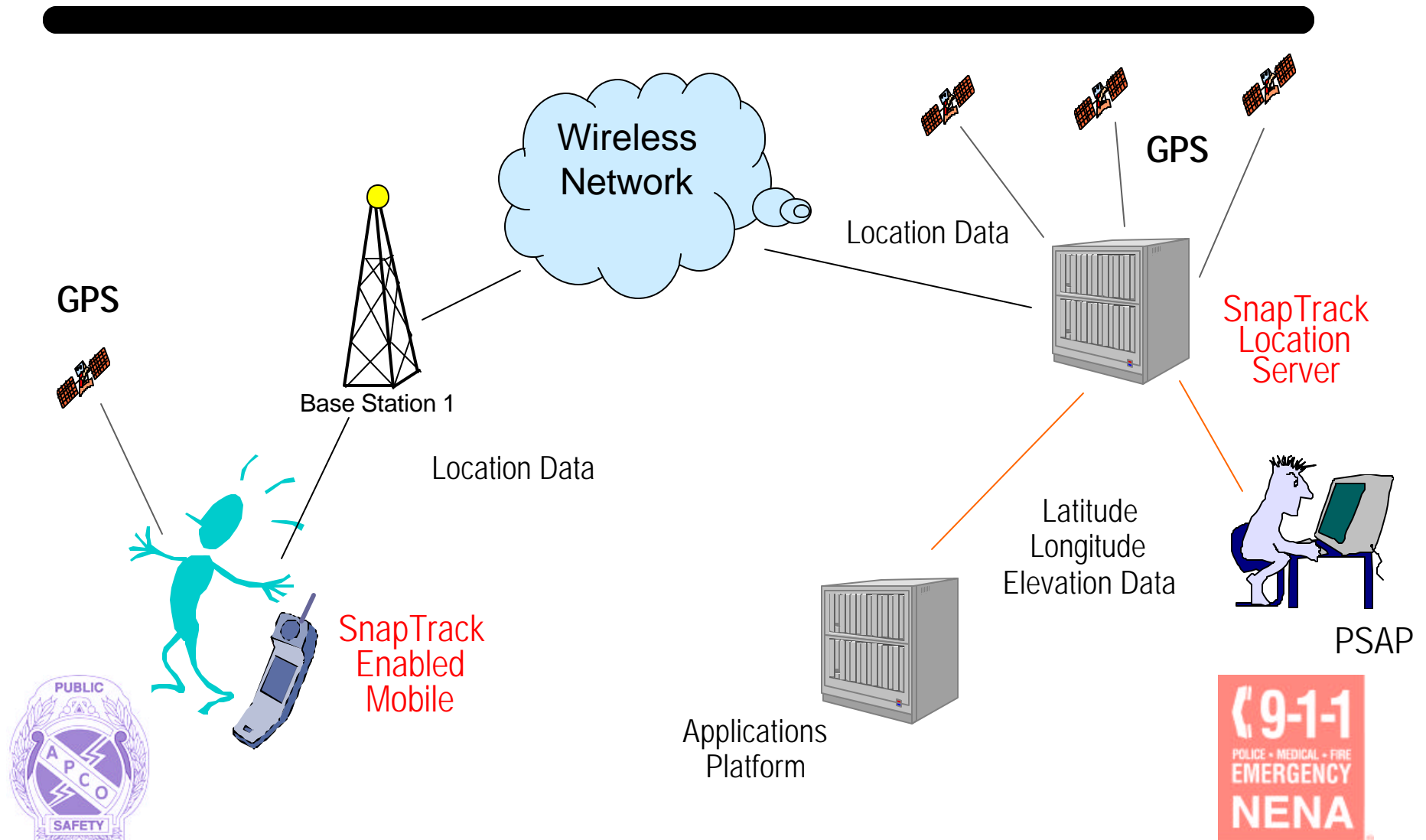


Downtown San Francisco, Indoor
1st floor of skyscraper, Briazz Deli
Inside, Deep Urban Canyon:
108m accuracy
Yield: 97%

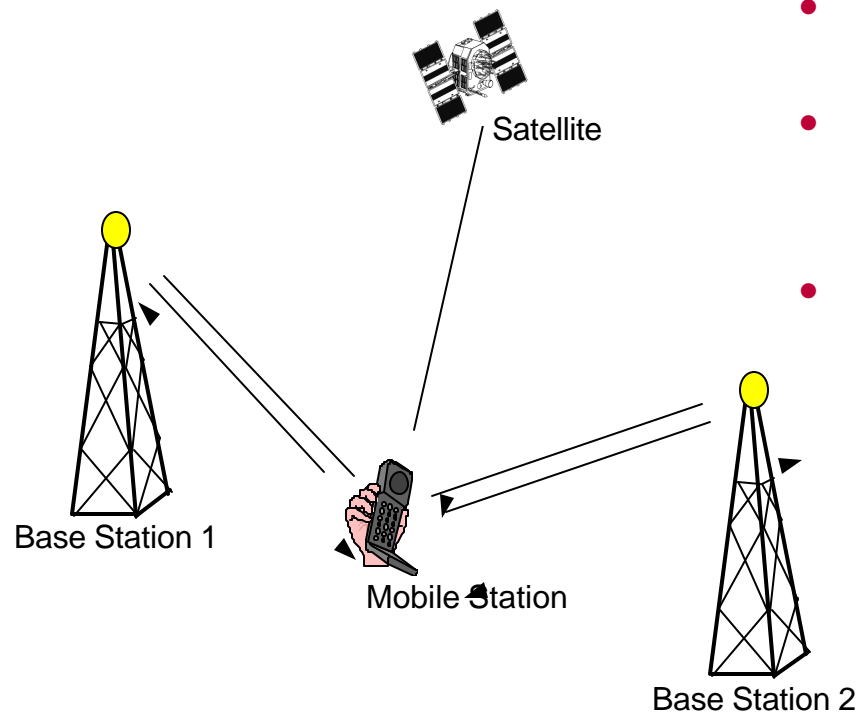


Restaurant Les Chevaux de
Marly, Paris, France
Indoor: 31.52m accuracy
Yield: 98.1%

SnapTrack/Qualcomm Hybrid Wireless Assisted GPS System



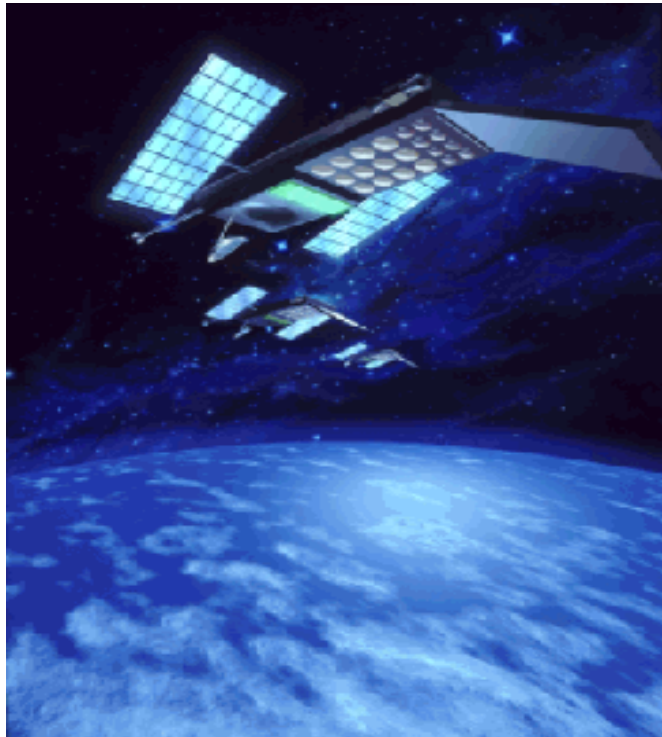
Hybrid Wireless Assisted GPS: Network and GPS in Concert



- Client-server architecture reduces battery, processing load on mobile device
- Using phone knowledge of time and Range to satellite and Basestations, the system can determine 3-D location
- Combination of synchronized signals from wireless network and available GPS satellite signals improves sensitivity and availability
 - Can achieve quality position determination **with several or even only one GPS satellite available**
 - Proven performance in synchronized networks (CDMA)
 - Extensions to asynchronous networks
- Location availability in nearly 100% of all environments where phone operational



Hybrid WAG Wireless Location Benefits



- High availability – all-terrain, reliable positioning capability
 - Coverage includes indoor, outdoor, urban, suburban and rural environments
- Rapid positioning with no cold start
- Highest accuracy
 - **5-10 meter outdoor (clear sky) accuracy**
 - **SnapTrack GPS Indoors™ capability provides industry leading indoor accuracy**
- Low cost
 - No cell site hardware modification
 - Integrated solution on handset
- Rapid deployment
 - Easy integration into network infrastructure and range of mobile terminals
 - Minimal maintenance requirements



Dispatch Accuracy Due to Choice of Location Technology

Typical accuracy dramatically affects the dispatcher's ability to provide effective incident management

At 5m to 50m accuracy, the Assisted-GPS solution answers "**What Street Corner?**"

At 300m accuracy, a TOA-based solution only answers "**What part of Town?**"



How the Technologies Compare

	Cell-ID	EOTD	OTDOA	GPS	A-GPS	Hybrid
Yield	Excellent	Average	Poor	Average	Very Good	Excellent
Consistency	Poor	Average	Average	Average	Very Good	Very Good
Accuracy	Poor 100m-20km 2-D positioning	Average 100-500m 2-D positioning	Average 100m-500m 2-D positioning	Good 5m-100m 3-D positioning	Excellent 5m-50m 3-D positioning	Excellent 5-50m 3-D positioning
TTFF	Excellent 1s	Very Good 5s	Very Good 5s	Poor 30s-15m	Very Good 5-10s	Very Good 5-10s
Handset Mods	No	Yes	Yes	Yes	Yes	Yes
Roaming	Excellent	Poor	Poor	Excellent	Excellent	Excellent
Network Efficiency	Excellent	Poor	Poor	Excellent	Excellent	Excellent
Network Expansion	Excellent	Poor	Poor	Excellent	Excellent	Excellent
Air Interface Compatibility	Excellent	Poor	Poor	Excellent	Excellent	Excellent
Overall Cost	Low	High	High	Moderate	Low	Low
Summary	Average	Average	Poor	Average	Very Good	Excellent

Location: Safety or Surveillance?

- Wireless assisted GPS technology can be implemented so location is determined only on dialing 9-1-1 or upon user request
- Network overlay systems are inherently always on, and have the ability to continuously monitor a caller's position and movement, with neither their permission nor their knowledge
- Location information should be generated only when specifically requested or authorized by a subscriber – consistent with SnapTrack's Location On Demand?

feature



gpsOne and WAG Proven in Commercial Deployments



- January, 2000: NTT DoCoMo deploys DoCoNavi service with Naviewn terminals by Denso
- April, 2001: Secom deploys CoCo Secom service with gpsOne terminals manufactured by Hitachi, on KDDI network
- October 2001: Sprint PCS deploys gpsOne phones and services with SPH-N300 phones from Samsung
- November 2001: Audiovox announces availability of 9155GPX gpsOne phone for E911 services
- December 2001: KDDI deploys *EZ Navigation* gpsOne phones and services across Japan with terminals from Toshiba, Hitachi and Kyocera
- December 2001: Verizon deploys Samsung SPH-N300 gpsOne phones into market to meet FCC mandate

US gpsOne-enabled Handsets

- Denso 3300
- gpsOne
- MSM3300
- Web-enabled
- Available: October 2001



- Samsung SPH-N300 (GPT)
- gpsOne
- MSM3300
- Web-enabled
- Available: October 2001



- Audiovox 9155GPX
- gpsOne
- MSM5100
- Tri-mode
- Web-enabled
- Available: Q102





E9-1-1 by October 2001: the Push for Readiness

- 60% of US carriers chose handset-based solutions to meet E9-1-1
 - Carriers currently deploying or planning to deploy gpsOne -based solutions from QUALCOMM include Sprint PCS, Verizon and majority of CDMA industry
- PSAPs nationwide were pushing to be Phase II-compliant by October 2001
 - Many major metropolitan areas will be Phase II ready by YE 2001 (Los Angeles, Dallas/Fort Worth, Chicago, Houston, St. Louis)
 - Many states working on state-wide Phase II deployments (California, Minnesota, New Jersey)
- PSAPs must file valid Phase II requests with carriers six months prior to activation
 - APCO Project Locate (Project 38) can assist with filing steps
- PSAPs should anticipate other issues for E9-1-1 response
 - Search-space issue: Phase II technology results will range from 5m to 300m+ accuracy
 - Public awareness/education of Phase II capabilities

US FCC E911 Update

- Only Sprint PCS and Verizon in compliance at present with E911 mandate
 - Sprint launches E911 in Rhode Island statewide (December), has gpsOne phones for sale on website (October)
 - Nationwide footprint expected by mid 2002
 - Verizon sells phones on website (December), no service launches to date.
 - Says 65% of footprint coverage by April 2002
- Most US carriers not in compliance with E911 mandate
 - AT&T launches GSM services without E-OTD in violation of their FCC waiver (no action by the FCC to date on this) (November).
 - VoiceStream filed new waiver request with the FCC (November).
 - Cingular files petition for reconsideration on E911 with the FCC (November).
 - Nextel files waiver requesting delay of E911 activation (November)
- Draft legislation in US Senate that would deny wireless operators the ability to acquire new spectrum licenses in a service area until they meet their E911 obligations for their current licenses in that service area.

Japan-wide Commercial E911 Service

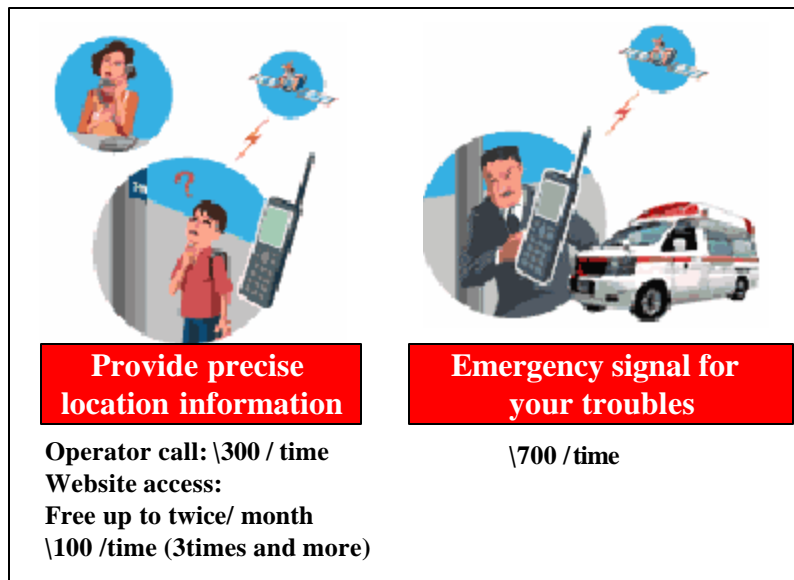


Security Service Responding to Emergency Signals

Registration fee: ¥3,675 / Monthly fee: ¥315



Applicable handset
C3001H



Top





Advantages of gpsOne and Hybrid Wireless Assisted GPS

- Time to market advantage – solution commercially available today
- Small upfront expense
 - Incremental handset cost will decline sharply over time
 - Costs map directly to deployment rate – pay as you grow
 - Tight integration = no handset impact or battery impact and incremental deployment costs
- Minimal adverse impact on network infrastructure
 - No changes to existing cell sites
 - Maximum leverage of existing network
 - Minimize maintenance and system upgrade complexity
- High accuracy / High yield / Rapid location detection
 - Speeds E9-1-1 response times
- Full range of operating environments
- Seamless roaming
 - Same quality of service across networks/countries
- Privacy friendly
 - With Location on Demand™ users control their location at all times

