

Mobile Devices

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Objectives

- Identify mobile devices
- Learn how mobile devices obtain and transmit information
- Identify potential evidence that may be obtained from mobile devices
- Learn where data is stored

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Types of Devices

- Smartphones
- GPS
- Digital Cameras
- Beepers



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Types of Devices


- Game systems
- MP3 Players
- E-readers



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Types of Devices

- Calculator
- Personal Digital Assistant (PDA)
- Pager




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Processes

- Cellular network triangulation
- GPS trilateration
- Geotagging

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Smartphones



Simon

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Smartphones

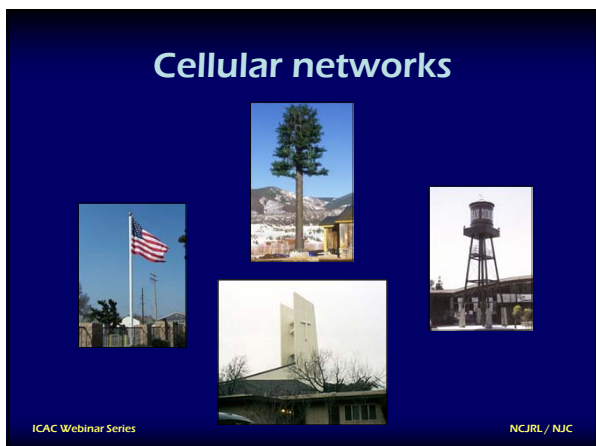
- Over 5.7 billion cell phones worldwide
 - 327 million in US
 - 103% of population
- 1.6 billion smartphones sold in 2010 alone

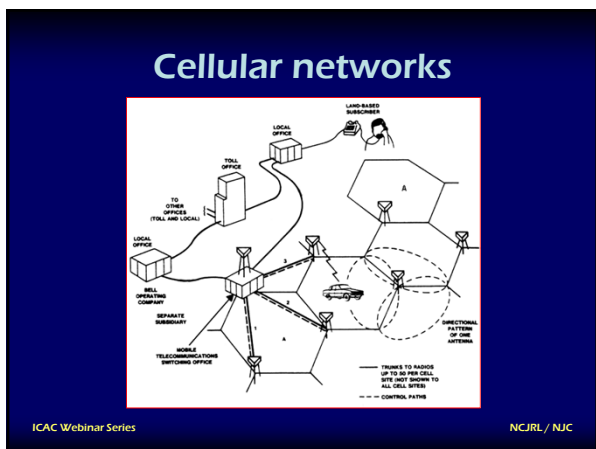
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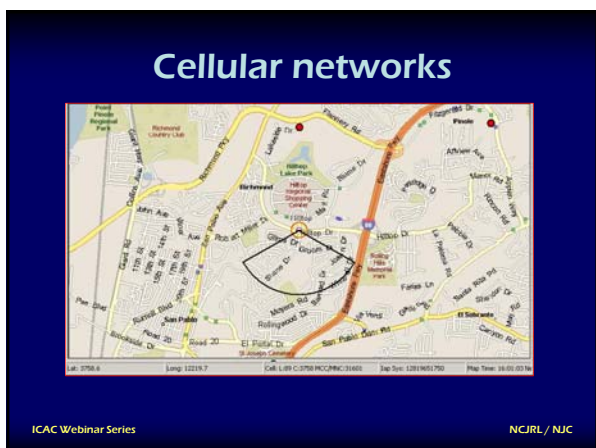
Cellular networks



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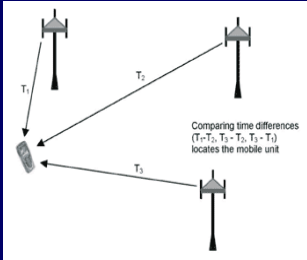






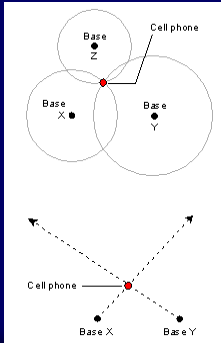
Triangulation

- Comparing signal strengths
 - Time delays
 - Angles of arrival
 - Three nearest towers



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Triangulation



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Cell Site Location Information

- Mobile switching centers may retain the location information in call detail records
 - At least for a period of time (e.g., 24 hours)
- Authorities can track subscriber's general movements by following sequence of towers contacted by the phone
- May also obtain last recorded location before signal or power lost

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Cell Site Location Information

- Most useful location information comes from initiation or receipt of a call or text
- A call data record (CDR) is kept for billing
 - Yield historical account of cell phone's locations
- Officers may also locate phone in "real time" while a call is in progress

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Enhanced 9-1-1

- FCC mandate of 95% of phones
- Locate phone location within 300 meters
- Within 6 minutes

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Smartphones

Modern cell phones have a variety of functions, including:

- SMS (short message service)
- MMS (multimedia message service)
- Phone Calls
- Cameras
- File Storage
- Internet Access (email, IM)



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Smartphones

SMS (short message service)

- 160 characters or less
- Sent from cell phone to cell phone by way of towers and servers
- If recipient phone is off, a message will be saved until the phone is turned on



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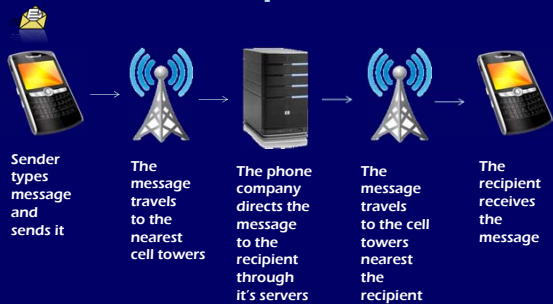
Smartphones

- Over 7 trillion text messages sent in 2011

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Smartphones



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Smartphones

MMS (multimedia message service)

- Like SMS, but allows sharing of pictures, video, and/or audio
- Usually an additional feature on phones

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Smartphones

Internet Access

- Email
- Social Media
 - Facebook, Twitter
- Chat & Instant Messaging
- Internet Browser



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Smartphones

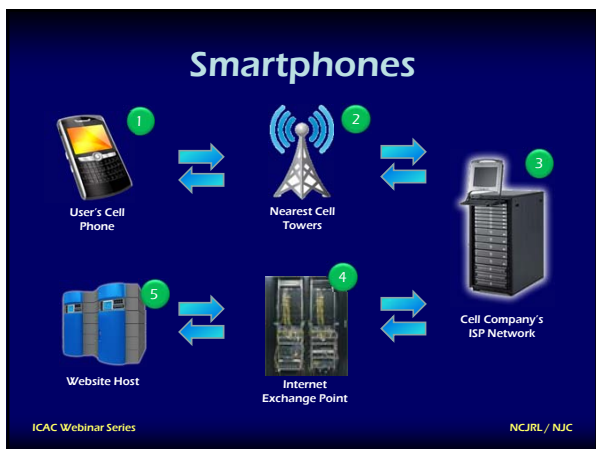
- Hybrid Browsing
 - Reduces download by compressing data – often by as much as 70%
- Essentially the same data stored on phone
 - Images in lower resolution
 - Record of access also on browser's server
 - In addition to the phone, ISP, and host's records

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Smartphones

- Internet Speed
 - 3G - 200 Kbps
 - 4G - 6.4 Mbps

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Smartphones

- GPS
 - Discussed in next section

The screenshot shows a GPS application interface. At the top, it displays 'AT&T', signal strength, Wi-Fi, and the time '2:15 PM'. Below that, there are 'Cancel' and 'Options' buttons and a timer '03:29'. The main area is a 3D map showing a route in orange and blue. A speed limit sign for '25' is visible. At the bottom, it shows '0 ft' and 'Madison St'.

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Smartphones

- Apps
 - Millions for nearly any purpose



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Smartphones

- Security
 - Apps can add encryption and better security



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Smartphones

- Therefore, cell phones contain lots of data:
 - Messages
 - Voicemails
 - E-mails
 - Pictures & Video
 - Location, trip data
 - Contacts
- However, some of this information may not be on the phone

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Smartphones

- For example, smartphones save little data related to social networks
 - Thus, opening Facebook on someone else's phone could be a violation of the SCA
- Applies to all data – depending on the app or phone model, the data may be saved on the phone and/or a remote server

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Smartphones

- Data may be stored internally or on a memory card
 - Usually MicroSD
- It can often be obtained even if the phone is locked
- Just like computers, deleted data may be recoverable



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Smartphones

- Other similarities with computers
 - Viruses
 - Hiding Tracks
 - Tor
 - VPNs
- Privacy Concerns

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QUIZ

Which of the following can be done with a cell phone?

- A. Instant Messaging
- B. MMS
- C. Internet Browsing
- D. International Phone Calls
- E. All of the above

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QUIZ

Which of the following generally is not involved in the transmission of text messages?

- A. Cell Phones
- B. DSL Modem
- C. Cell Service Providers' Servers
- D. Phone Towers

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Beepers

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Beepers

- Requires "tailing"
 - Antenna used to track radio signals
 - Up to 5 miles
- Placed on car or package
 - 1"x2" to 3"x5"
- Does not store information

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Beepers

- Use beeps and/or lights to indicate
 - Direction (but not very well)
 - Distance

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GPS

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GPS

- Global Positioning System
- Developed by US government for military purposes
 - Cost unknown, but EU's competing system expected to cost around \$25 billion
 - Still operated by the military

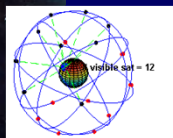

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GPS

- Three Components
 - Satellites
 - 24 operational, 3 backups
 - Any point on earth can "see" at least 6 at all times
 - Each knows its distance from the center of the Earth
 - Ground Stations
 - 11 around the globe
 - Receivers
 - Calculate their distance from the satellite

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GPS



Satellites

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GPS

Ground Stations

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GPS

Receiver

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2-D Trilateration

- Involves a bunch of difficult calculations
- Instead of learning that, let's use pictures

$$\hat{e}_x = \frac{P2 - P1}{\|P2 - P1\|}$$

$$i = \hat{e}_x \cdot (P3 - P1)$$

$$\hat{e}_y = \frac{P3 - P1 - i \hat{e}_x}{\|P3 - P1 - i \hat{e}_x\|}$$

$$\hat{e}_z = \hat{e}_x \times \hat{e}_y$$

$$d = \|P2 - P1\|$$

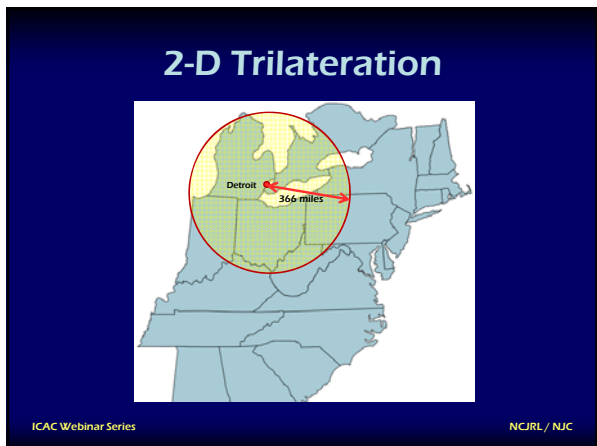
$$j = \hat{e}_y \cdot (P3 - P1)$$

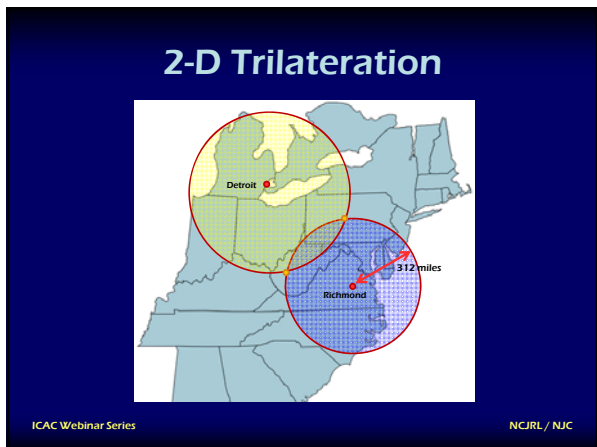
i, d, and j

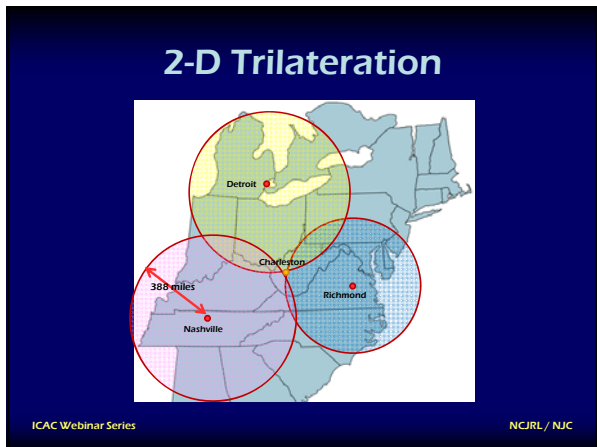
$$\vec{p}_{1,2} = P1 + x \hat{e}_x + y \hat{e}_y \pm z \hat{e}_z$$

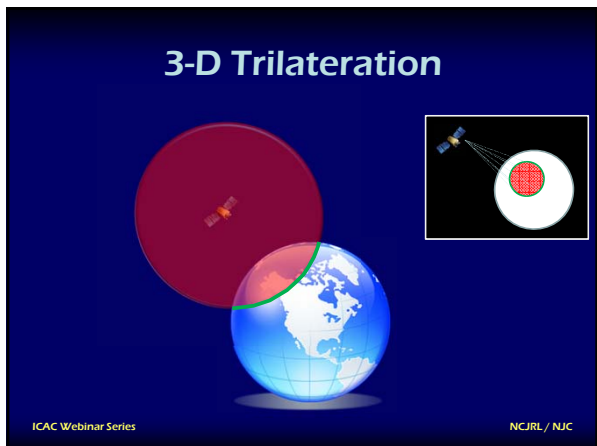
\hat{e}_x , \hat{e}_y , and \hat{e}_z

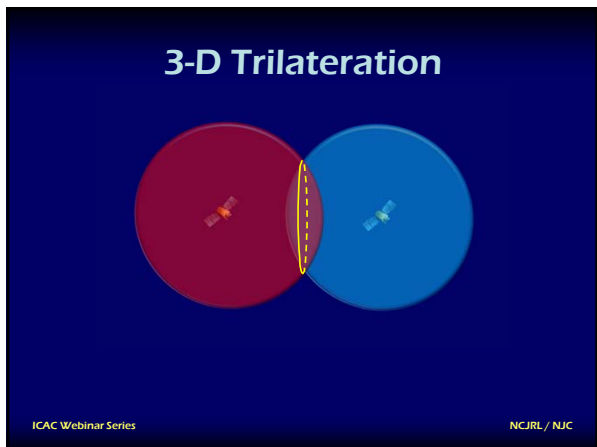
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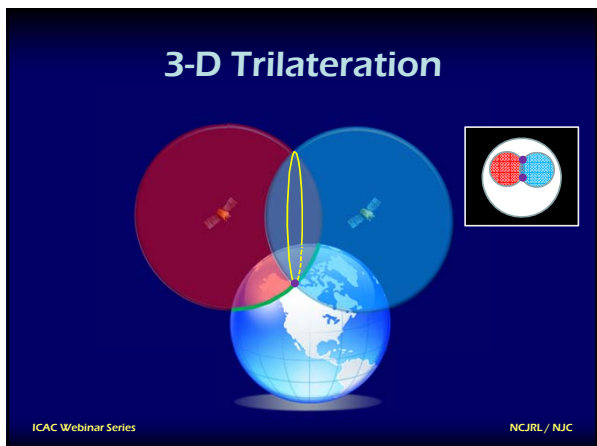


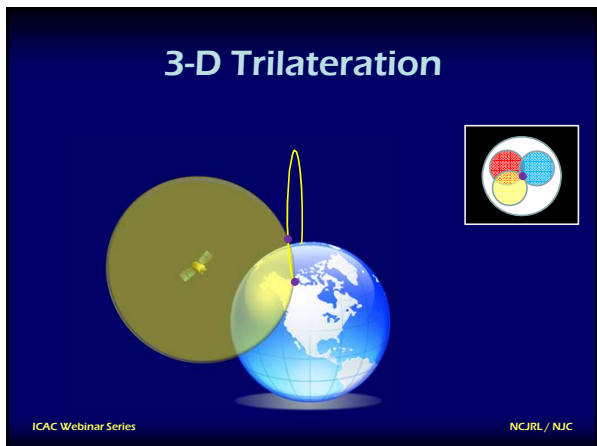


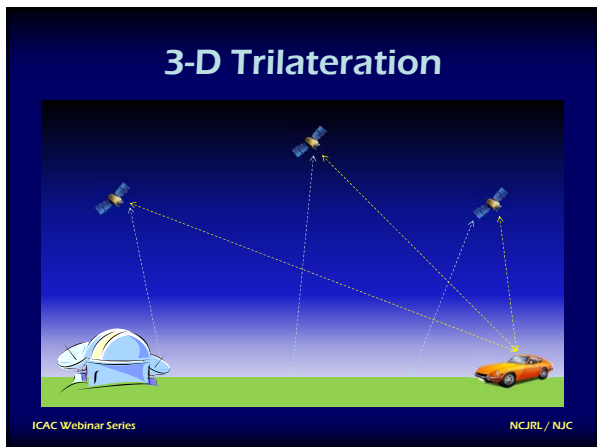


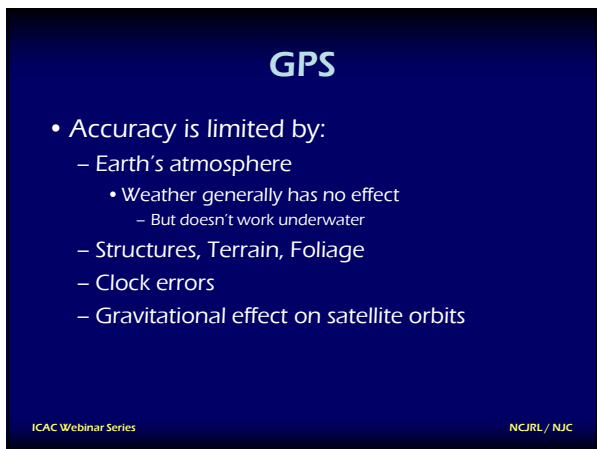












GPS

- Generally, accurate to 15 meters
- Receivers use "Differential GPS" to calculate error
 - Makes measurement accurate to 10 meters, but possibly up to 10 centimeters

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Assisted GPS (A-GPS)

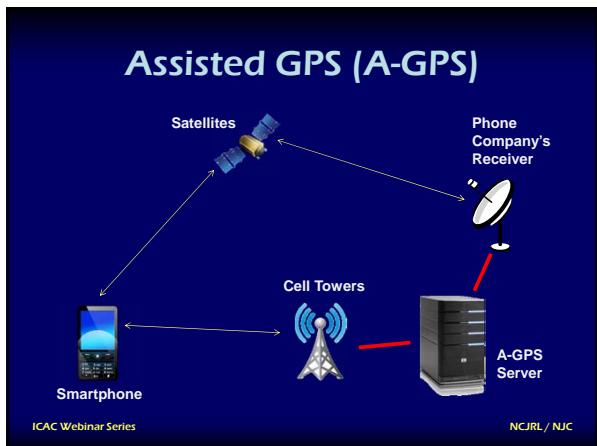
- Uses an assistance server to more rapidly or accurately obtain a location
 - Can be used in lieu of a fully functional GPS receiver or can be used to enhance the accuracy of a location
- If the GPS receiver has trouble determining a location, A-GPS can make a connection using the cell network to send data

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Assisted GPS (A-GPS)

- Many cell phones use A-GPS, cell site triangulation and other technology to determine location
- Other benefits
 - Uses less battery power
 - Less time to get a fix
 - Better coverage
 - System can be upgraded at network level

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- ### GPS Data
- Data that may be located on the GPS receiver includes:
 - Device information
 - Owner information
 - Waypoints
 - Home location
 - Points of interest (POI)
 - Deleted locations
 - Last fix
 - Routes/Journeys
 - Track logs
 - Favorites
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QUIZ

Which of the following is not necessary in determining location using GPS?

- A. Satellite
- B. Ground station
- C. Cell phone towers
- D. Receiver

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QUIZ

At least how many satellites can “see” your location from anywhere on Earth?

- A. Three
- B. Four
- C. Five
- D. Six
- E. Seven

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Digital Cameras

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Digital Cameras

- Pictures and video, of course
 - Geotagging
 - Especially in smartphones



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Geotagging

- Adds latitude and longitude coordinates to pictures and video
 - Stored in metadata; not visible in the image
- Usually derived from GPS
 - Camera must have a built-in GPS receiver
- Can also be used with text messages, social networking updates, and blog posts

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Geotagging



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The Future

- 5G smartphone Internet connections
- Multiple "GPS" services

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Legal Issues

- Search & Seizure
 - Search Incident to Arrest
 - Inventory
 - Consent
- Wiretap / Stored Communications Act
- Evidence Authentication
- Privacy
 - Carrier IQ
 - Location tracking

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