COMP327
Mobile Computing
Session: 2014-2015

Lecture Set 6 - Personal Area Networks and Wireless Connections

In this Lecture Set

- Wireless Connection Technologies
  - Wireless Personal Area Networks (WPAN)
    - InfraRed
    - Bluetooth
  - Wireless Local Area Networks (WLAN)
  - Sensors
    - RFID

Oranges are not the only fruit!

- Mobile Devices do more than just make calls
  - They interact with a number of local devices, forming a Personal Area Network (PAN)
    - Printers, Audio Equipment, Input Devices
  - They also connect to other non-telephony networks to get Internet Access, through Local Area Networks (LAN)
    - WiFi, or the 802.11 standards
  - They may also detect sensor nodes in the environment and act based on their discovery
   - Tagging

Master and Slave

- Mobile Phones can play both primary and secondary roles:

  - Primary Role

    - Other devices support the phone and its function

      - Output devices (e.g. Headsets, printers)
      - Input devices (e.g. keyboards, GPS devices, RFID tags)

  - Secondary Role

    - The phone acts as a comms device for another device

      - Modems (e.g. through tethering)
      - SMS transmitters/receivers (from a PC)

Peer relationships

- Mobile Phones can also have a peer-based relationship with other devices

  - Exchanging information

    - Typically with another user

      - Exchanging contact information, data, or multi-player games

  - Synchronising information

    - Typically with another device owned by the user

      - Address Books, Music, Images, Video

  - Receiving advertising

    - From wireless broadcast stations

      - Bluecasting!
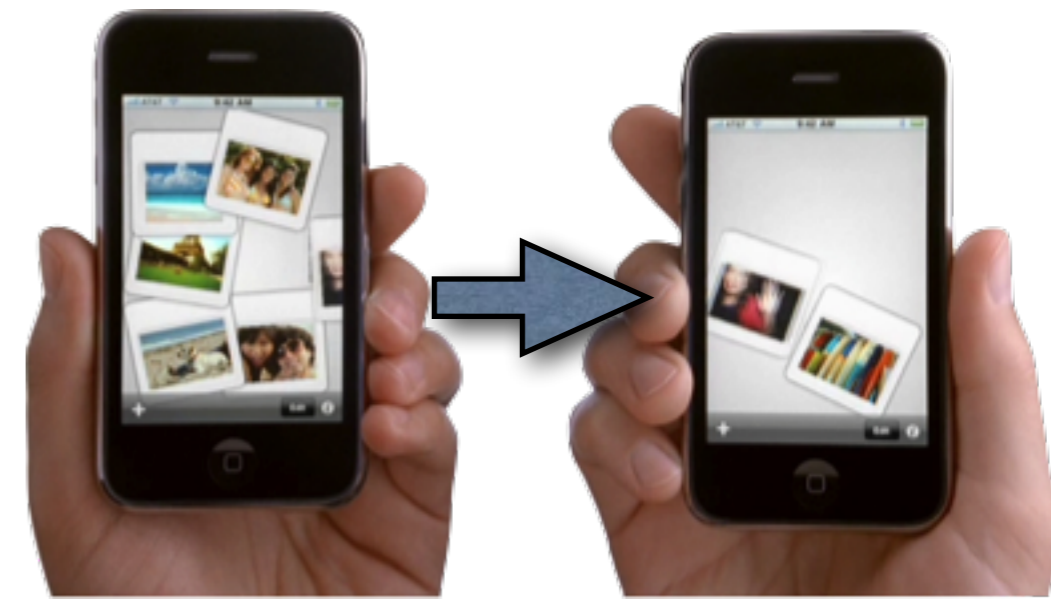
To see three iPhone Apps that share data, see
http://www.apple.com/iphone/gallery/ads/#share-large

The problem with wires

- Early mobile phone connectivity approaches used wired connections...

  - RS232, through bespoke connectors

  - USB and Firewire cables

- However, this can limit connectivity, and contradicts the mobile wireless ethos

- Various wireless approaches have emerged to facilitate connection between the phone and other user devices

  - Wireless PAN - Personal Area Network

Personal Area Network

- Network for communicating between devices close to one's person
  - Range is typically a few meters
  - Wireless technologies now becoming ubiquitous:
    - IrDA - Infrared communication
    - Bluetooth Piconets

- Desirable requirements
  - "Plugging in" (automatic connection due to proximity)
  - Selective lock-out (prevent interference or unauthorised data access)

IrDA - Infrared Data Association

- Communicating data over infrared light

  - Short-range (< 1m), line of sight communication

    - Pair of LEDs focussed by a plastic lens into a narrow beam

    - Beam is modulated (switched on and off) to encode data

    - Filter is used to select rapid pulses and ignore ambient changes

    - Time Division Duplex Communication

      - Cannot transmit and receive simultaneously as receiver is blinded by the transmitter!

  - Full stack exists supporting comms up to IrLAN

    - including IrSimpleShot for camera phones!

  - Few security issues

    - no interference with other devices; works in "radio-noisy" environments

Bluetooth

- An open wireless protocol for exchanging data

  - Short range (1-100m) depending on class and power

  - Frequency hopping spread spectrum

    - Data is chopped up and transmitted as chunks over 79 separate frequencies.

- Designed as a "cable replacement" technology

  - Establishes piconet, with one master and up to 7 slaves

  - Scatternets form when two or more piconets share members

Bluetooth

- Dynamic discovery and connection mechanism
  - Security mechanisms employed through pairing
    - Uses the Service Discovery Profile (SDP)
    - Devices can be in discoverable mode
      - Transmits name, class, list of services and technical information
    - Paring is then performed using a link key (i.e. a shared code)
      - If stored by both devices, then they are bonded
    - Once pared, devices in range can be recognised and dynamically connected
  - Various security vulnerabilities have been identified
    - Bluejacking involves sending unsolicited messages to a device
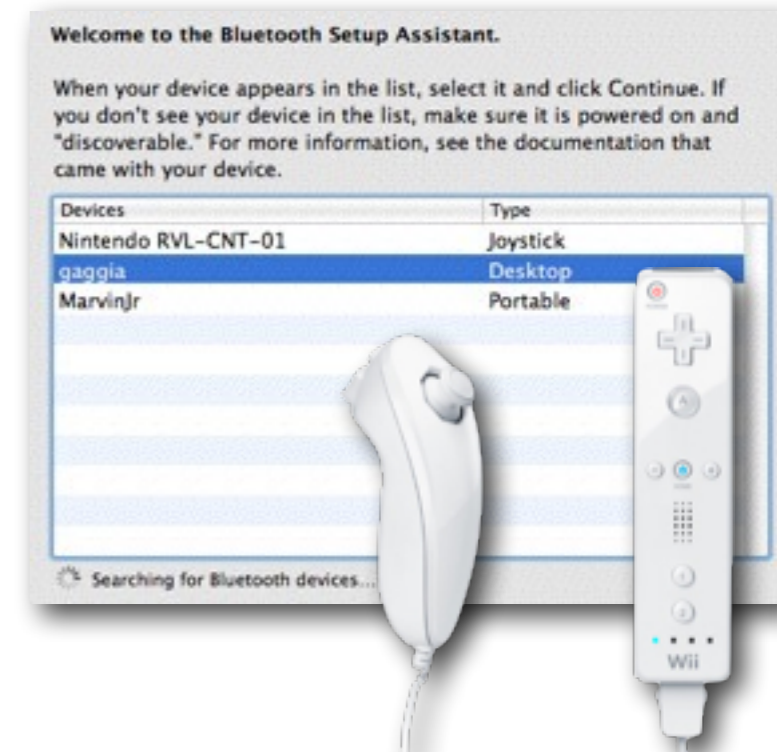   - Bluecasting is a variant, used for proximity marketing
      - e.g. Hypertag Ltd

Hypertag®

Bluetooth Profiles

Minor Device Class for Audio/Video
Headset
Hands-free
Microphone
Loud-Speaker
Head Phones
Portable Audio
Car Audio
Set Top Box
HiFi Audio Device
VCR
Video Camera
Camcorder
Video Monitor
Video Display and Loud Speaker
Video Conferencing
Gaming/Toy

- Each profile corresponds to a class of devices, and defines:

  - Dependencies on other profiles

  - Suggested user interface formats

  - Parts of the Bluetooth stack used by the profile

- Several Major Device Classes, each with subclasses:

  - Computer: Desktops, Laptops, PDAs
  - Phone: Mobiles, Cordless, Payphones, Modems
  - LAN and Network Access Point
  - Audio: Headsets, Speakers and Stereos
  - Peripherals: Mouse, Joystick and Keyboards
  - Imaging: Printing, Scanner, Camera and Displays
  - Miscellaneous

Welcome to the Bluetooth Setup Assistant.

When your device appears in the list, select it and click Continue. If you don't see your device in the list, make sure it is powered on and "discoverable." For more information, see the documentation that came with your device.

Devices	Type
Nintendo RVL-CNT-01	Joystick
gaggia	Desktop
MarvinJr	Portable

Searching for Bluetooth devices...

A good list of up-to-date profiles with further details can be found at: http://en.wikipedia.org/wiki/Bluetooth_profile

Home and Health

- Entertainment:
    - Bluetooth is increasingly being used for
        - multi-player games
        - broadcasting music to speakers or headphones
- Lifestyle / Health:
    - Activity monitors allow users to track their lifestyle:
        - Jawbone's Up Wristband tracks activity, movement and sleep
    - Scales / Heart Rate / Blood Pressure monitors etc.

Bluetooth LE

- Reduced Power version of Bluetooth, targeted at the health / well being / sport and fitness market:

  - Smaller size and lower cost

  - Low power requirement aimed at months or even years of use on a button (battery) cell

- Several new profiles:

  - Health Care

    - Health Thermometer Profile

    - Glucose Profile

    - Etc

  - Sports and Fitness

    - Heart Rate

    - Cycle Speed

    - Etc

  - Proximity Sensing

    - Find me profile

    - Proximity profile

Wireless Local Area Network (WLAN)

- Spread spectrum RF technology for data comms

  - Range typically in tens of meters

    - range of a network can be extended using several access points

  - Fast data rate

    - 802.11g provides 54Mbit/s

      - 802.11n increases this to 155Mbits/s using multiple antennas (MIMO)

    - Shared-key Encryption mechanisms include:

      - Wired Equivalent Privacy (WEP)

      - Wi-Fi Protected Access (WPA, WPA2)

  - High adoption for home networks and HotSpots

    - Utilises unlicensed wavelengths

Wi-Fi Architectures

- Three typical architectures

  - Peer-to-peer

    - Two clients can communicate without the need for an access point

  - Bridge

    - Clients connect with Access point, which acts as a bridge / router to a wired ethernet

  - Wireless Distribution System

    - Multiple access points provide wider coverage without the need for wired backbone

      - Each access point is either a main, relay or remote base station
      - All nodes share same radio channel, and WEP or WPA keys

Wi-Fi Benefits

- **Convenience**
  - Provides network access from any location within range
    - Good as the number of home wi-fi gadgets increases
- **Mobility**
  - Users can browse outside home/work environment
    - Coffee Shops, Airports, Hotels
- **Productivity**
  - Employee can work from several locations without impediment

- **Deployment**
  - Initial setup requires single access point
- **Expandability**
  - Easy to add new clients without the need for additional infrastructure
  - WDS can be used to extend range
- **Cost**
  - Increase over a wired equivalent is modest

Wi-Fi Disadvantages

- **Security**
  - Poor antennas mean that signal propagate further than stated range
    - Can be intercepted by good antenna, and hence hacked
  - Encryption helps, but well known weaknesses exist in WEP

- **Range**
  - Suitable only for small areas
  - Metropolitan coverage can be costly

- **Reliability**
  - Signal quality affected by interference from devices on similar wavelengths

- **Speed**
  - Reasonably slow compared to wired connections
  - Faster than most wireless counterparts

- **Radio Emission**
  - Can affect nearby devices
  - Questionable affect on human health

WiFi vs UMTS

- WiFi is often perceived as better than UMTS...
  - Wifi is not always faster
    - *"WiFi hotspots offer up to 54Mbit/s but early UMTS R99 offers only 3Mbit/s"*
  - Wifi often limited by backhaul link to the Internet
    - DSL limits downlink speed to 1-8Mbit/s; uplink to < 1Mbit/s
    - UMTS has large coverage, with GPRS fallback
      - WiFi covers small area, limiting roaming ability
  - UMTS has a well-established billing solution
    - Payment for commercial Wifi access is ad-hoc
      - Scratch cards, online Credit-card payment, or billing through subscription

WiFi vs UMTS

- Technical realisation of lawful interception
  - Well established for Telecommunications
  - Still evolving for Wifi access
- Wifi designed for small coverage
  - WDS can extend coverage, but with limitations
    - Handover problematic when roaming to a new area
  - UMTS designed for national coverage
    - Seamless roaming over long periods at high speed (<500km/h)
- Security
  - UMTS through SIM encryption & key management
  - Wifi exposes IP subnet, and key handling can be combersome

WiFi vs UMTS

- Telephony and VoIP

  - UMTS provides circuit switched links for voice

    - IMS architecture supports VoIP

  - VoIP clients exist over WLAN

    - Quality of Service can be poor; uplink speeds problematic

- Mobile Phones are increasingly appearing with both WiFi and UMTS capability

  - WiFi used when available, but fallback to UMTS (and GSM) when roaming

Sensors: RFID

- Radio-frequency Identification (RFID) uses a tag with a unique ID for tagging "things"
  - Three tag types
    - Passive: no battery - coiled antenna induces current which powers the tag and and encoded information is transmitted
    - Active: battery operated - can transmit signals autonomously
    - Battery Assisted Passive: requires external power to wake, but has greater range
  - Used mainly in inventory and supply-chain management
    - Increasing used in:
      - Contactless Mobile Payment (e.g. Nokia's RFID shells)
      - Location-based services (e.g. in museums)
      - Bar code replacement
    - Can be used as external cues by mobile devices
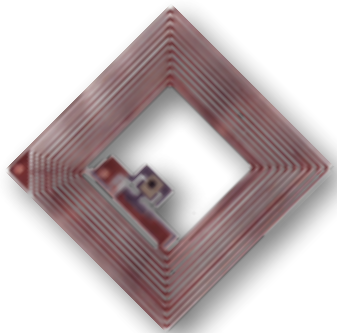
Exercises...

- If periodic, peer-to-peer transmission of data is required between two devices (e.g. a camera-phone and a printer), which of the following technologies would you use: IrDA or Bluetooth?
  - Explain why, and the limitations of each approach for this application.
- Discuss ethical issues of Bluecasting and Bluejacking
- Compare and contrast the use of WiFi technology with 3G standards, and illustrate two scenarios where one may be better than the other.

To Recap...

- In this lecture set, we covered:
    - The notion of Personal Area Networks
        - Discussed why these should be wireless
        - How such technologies are used by Mobile Phones
    - Wireless Local Area Networks
        - How Wifi compares to 3G technology
    - Sensing using RFID

Further Reading

- ***Ubiquitous Computing: Smart Devices, Environments and Interactions***
  Stefan Poslad (Wiley, 2009)
  - Chapter 11

- ***Communication Systems: for the Mobile Information Society***
  Martin Sauter (Wiley, 2006)
  - Chapters 4, 5 and 6

- ***Wikipedia !!!***