Mobile Computing - Introduction

- **Mobile Communication**: Mechanism of accessing a network without a wire
  - Wire is replaced by the transmission of electromagnetic waves through the ‘air’ medium
- Communication device exhibits one of the following characteristics:
  - **Fixed & Wired:** e.g desktop computer
  - **Mobile & Wired:** e.g laptop
  - **Fixed & Wireless:** e.g fixed networks, router, modem
  - **Mobile & Wireless:** e.g mobile phone, etc

Electronic Computing Devices & Technology Trends

- Advances in Technology
  - more computing power in smaller devices
  - flat, lightweight displays with low power consumption
  - user interfaces suitable for small dimensions
  - higher bandwidths
  - multiple wireless interfaces: wireless LANs, wireless WANs, home RF, Bluetooth
- New Electronic Computing Devices
  - small, cheap, portable, replaceable and most important of all USABLE!
- Technology Trends
  - devices are aware of their environment and adapt - “location awareness”
  - devices recognize the location of the user and react appropriately (e.g., call forwarding, fax forwarding)

Wireless and Mobile Communications

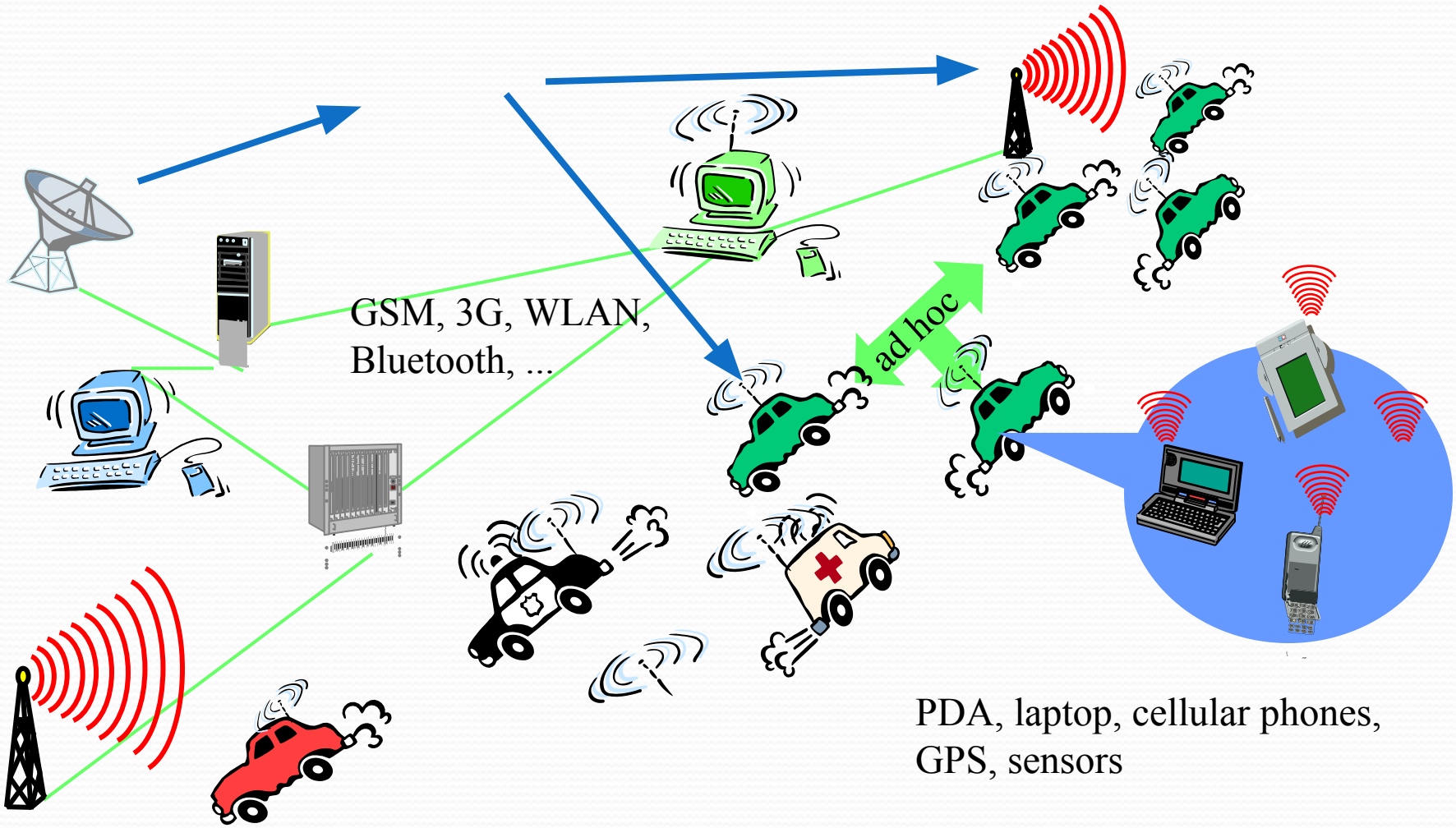
- Definition of mobility:
  - **user mobility**: users communicate anytime, anywhere, with anyone
    - E.g mobile phone, etc
  - **device portability**: devices can be connected anytime, anywhere to the network
    - E.g dongal, router, etc
- Definition of wireless:
  - Un-tethered, no physical wire attachment
- Wireless vs. Mobile Examples

☐	☐	stationary computer
☐	✔	notebook in a hotel
✔	☐	wireless LANs in legacy buildings
✔	✔	Personal Digital Assistant (PDA)

Applications

- Vehicles
  - transmission of news, road conditions, weather
  - personal communication using cellular
  - position identification via GPS
  - inter vehicle communications for accident prevention
  - vehicle and road inter communications for traffic control, signaling, data gathering
  - ambulances, police, etc.: early transmission of patient data to the hospital, situation reporting
  - entertainment: music, video

Highway Scenario



Mobile Workers (Emergencies & Business)

- Mobile workers
  - collaborative work environments
  - access to email and voice messages
- Replacement of fixed networks
  - remote sensors, e.g., weather, environment, road conditions
  - flexible work spaces
  - LANs in legacy buildings

Entertainment, education, etc

- Entertainment, education, ...
  - outdoor Internet access
  - intelligent travel guide with up-to-date location dependent information
  - ad-hoc networks for multi user games

Location Dependent Services

- Location aware services
  - services, e.g., printer, fax, phone, server etc. exist in the local environment that can be used by the user (security and authentication)
- Follow-on services
  - automatic call-forwarding, transmission of the actual workspace to the current location
- Information services
  - push: e.g., current special offers in the supermarket
  - pull: e.g., where is certain location/place
- Support services
  - caches, intermediate results, state information, etc., *follow* the mobile device through the fixed network
- Privacy
  - who should gain knowledge about the location of the user/device

Mobile & Wireless Devices

Pager
- receive only
- tiny displays
- simple text messages

PDA
- simple graphical displays
- character recognition
- simplified WWW

Laptop
- fully functional
- standard applications

Sensors, embedded controllers

Mobile phones
- voice, data
- simple text displays

Palmtop
- tiny keyboard
- simple versions of standard applications

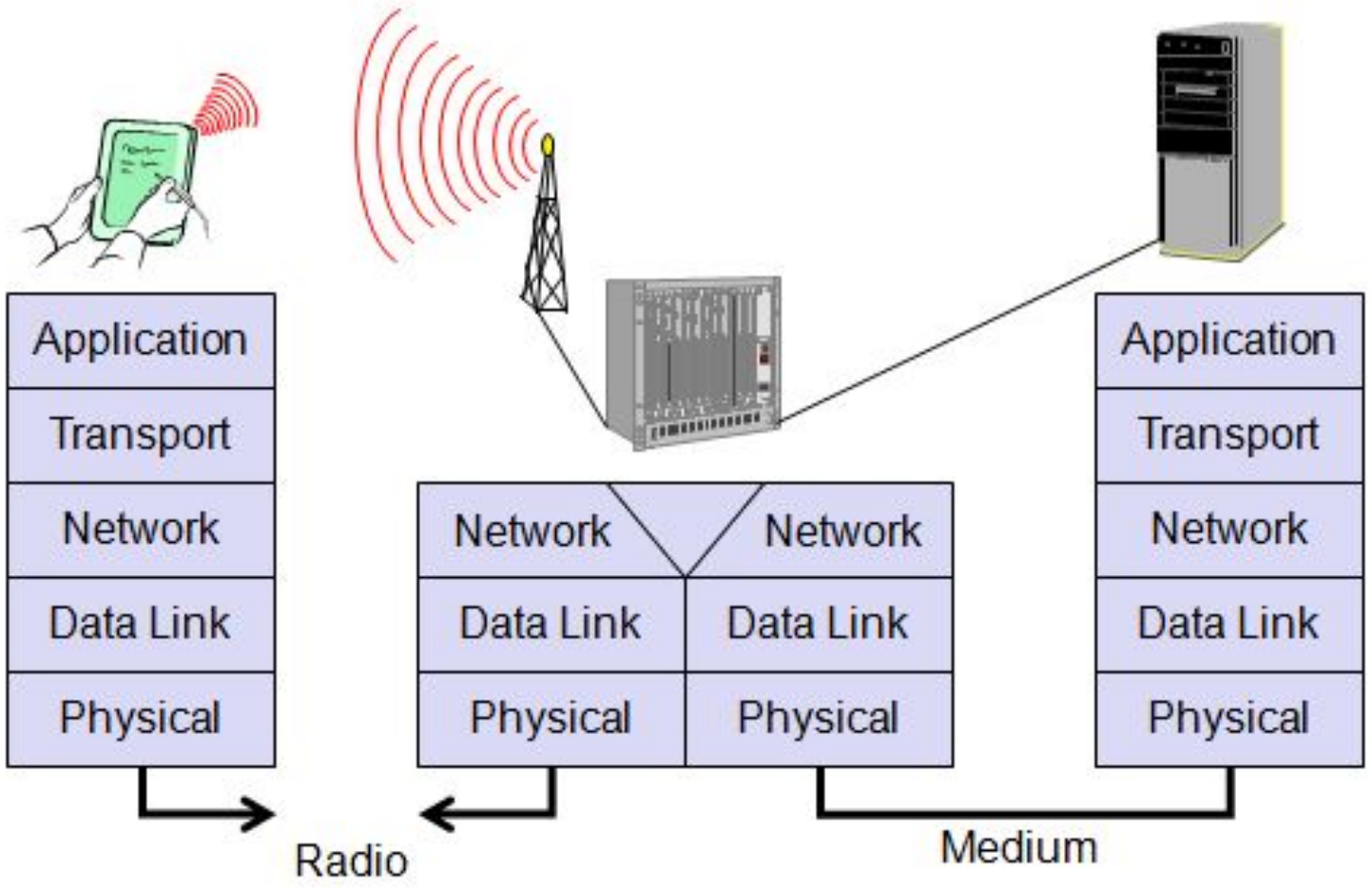
Impact of Portability on Device Design/Functionality

- Power consumption
  - battery capacity - limited computing power, low quality/smaller displays, smaller disks, fewer options (I/O, CD/DVD)
- Device vulnerability
  - more rugged design required to withstand bumps, weather conditions, etc.
  - theft
- Limited/Simpler User Interfaces
  - display size
  - compromise between comfort/usability and portability (keyboard size)
  - integration of character/voice recognition, abstract symbols
- Limited memory
  - memory limited by size and power
  - flash-memory or ? as alternative

Wireless Networks Compared to Fixed Networks

- Higher loss-rates due to interference
  - other EM signals, objects in path (multi-path, scattering)
- Limited availability of useful spectrum
  - frequencies have to be coordinated, useful frequencies are almost all occupied
- Low transmission rates
  - local area: 2 – 11 Mbit/s, wide area: 9.6 – 19.2 kbit/s
- Higher delays, higher jitter
  - connection setup time for cellular in the second range, several hundred milliseconds for wireless LAN systems
- Lower security, simpler active attacking
  - radio interface accessible for everyone
  - base station can be simulated, thus attracting calls from mobile phones
- Always shared medium
  - secure access mechanisms important

Simplified Reference Model



Communication Layers

Application layer	❑ service location ❑ new applications, multimedia ❑ adaptive applications
Transport layer	❑ congestion and flow control ❑ quality of service
Network layer	❑ addressing, routing, device location ❑ hand-over
Data link layer	❑ authentication ❑ media access ❑ multiplexing ❑ media access control
Physical layer	❑ encryption ❑ modulation ❑ interference ❑ attenuation ❑ frequency