Demonstration of Remote Wireless Access to a Database for Communicating Water Quality Data

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Outline

- Goals (of this presentation)
- Background/Networking
- Wireless Network Topology
- Security
- Mobile Devices
- Database Issues
- Building and Deploying a System
- Brief Proof-of-Principle Demonstration

Goals

- Introduction to wireless ideas as they relate to database access from field sites.
- Conditions to required to justify deployment of such ideas.
- Estimate of resources required to build, operate, maintain such a system.
- Get impression from people who might have to use these tools if they will reduce or increase effort.
- Demonstrate a rudimentary system assembled entirely with off-the-shelf consumer electronics.

Networking Technology

- Wireless “Networking”
  - Consumer Based:
    - Bluetooth
    - 802.11/.11g/.11g/.11a
    - WiFi
    - 1xRTT
      - Digital
      - Conventional dial-up using a cellular phone
  - Commercial Based:
    - PMRS

Bluetooth

- Technology standard developed by Ericsson, Intel, Nokia and Toshiba that specifies how mobile phones, computers and PDAs interconnect with each other, with computers, and with office or home phones.
  - Bluetooth would replace cable or infrared connections for such devices.
  - Radio transceiver operating in the 2.4 GHz range; Range is claimed to be about 10 meters, but longer distances are viable.
  - Throughput is ??
  - Up to seven simultaneous connections can established and maintained.

802.11b

- A Wireless local area network standard. (IEEE 802.11b).
  - 802.11b devices are radio transceivers that operate in the 2.4 GHz range.
  - Range is 30-75 meters, throughput declines as range is increased.
  - Throughput is 2.5-4Mbps; fast enough for most network applications and tolerable for file transfers.

802.11b/g/a

- 802.11b wireless network adapters can operate in two modes, Ad-Hoc and Infrastructure.
  - In infrastructure mode, all your traffic passes through a wireless ‘access point’(like hub or switch in conventional networking).
  - In Ad-hoc mode your computers talk directly to each other and do not need an access point at all (peer-to-peer networking).
- 802.11g wireless local area network standard.
  - 802.11g devices are radio transceivers that operate in the 2.4 GHz range.
  - Range is comparable to 802.11b
  - Throughput is 6-54Mbps

802.11b/g/a

- 802.11a wireless local area network standard
  - 802.11a devices are radio transceivers that operate in the 5.0 GHz range.
  - Range is comparable to 802.11b
  - Throughput is 20-25 Mbps
- WiFi is a nonprofit international association formed in 1999 to certify interoperability of wireless IEEE 802.11 specification products
  - Wi-Fi Alliance has 213 member companies from around the world, and 865 products have received Wi-Fi® certification since March of 2000.

1xRTT

- Short for *single carrier (**1x**) **r**adio **t**ransmission **t**echnology*, a 3G wireless technology based on the CDMA platform.
  - 1xRTT has the capability of providing ISDN-like speeds of up to 144 Kbps. 1xRTT is also referred to as *CDMA2000*.
  - Limited by cellular coverage (e.g. if you get signal, you get network access)
  - Throughput up to 2 Mbps.
  - CDMA– Code Division Multiple Access
  - 3G -- Wideband CDMA, also known as UMTS in Europe, is 3G standard for GSM in Europe, Japan and the United States.

Conventional Dial-Up

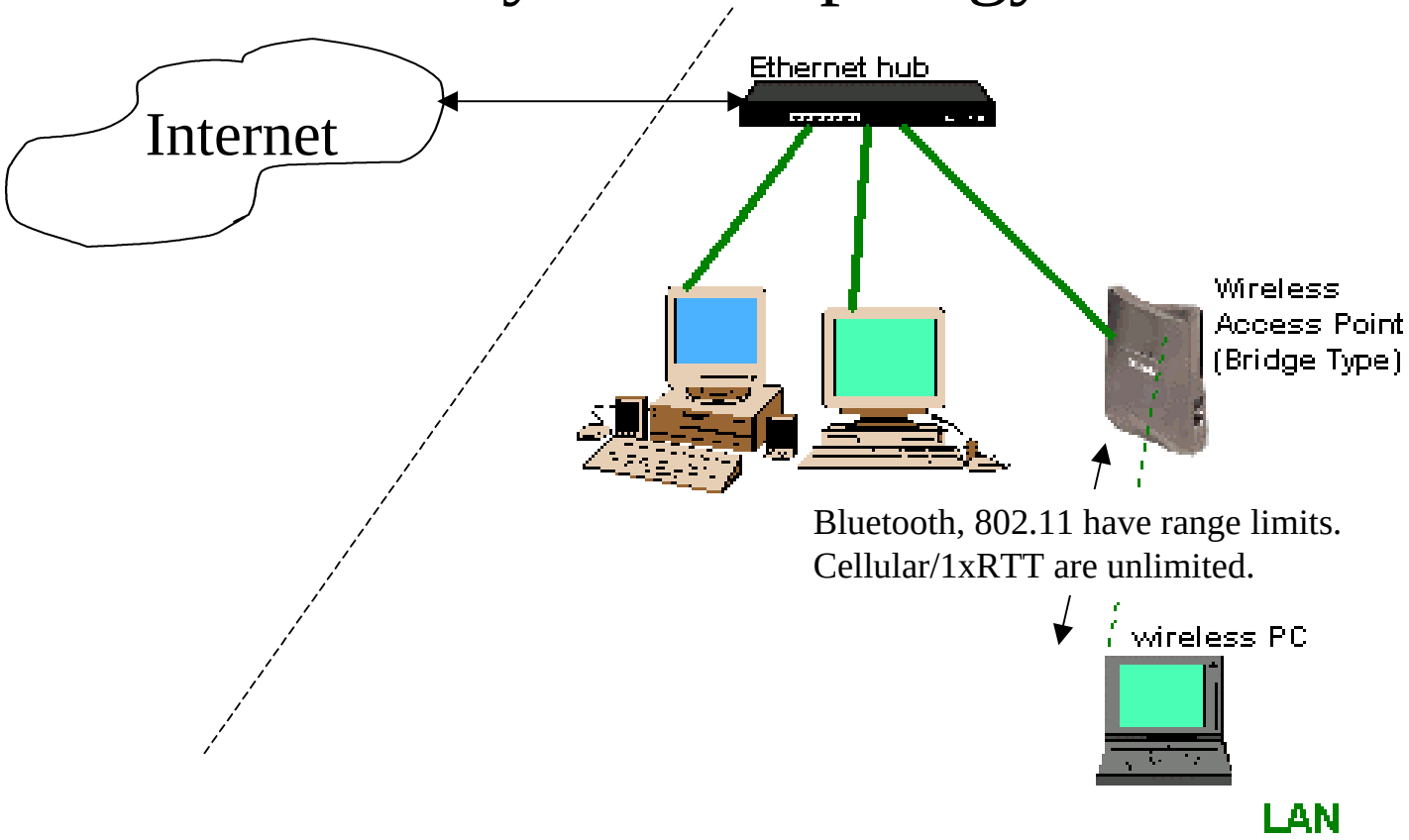
- Land-line (POTS)
  - Analog MODEM
  - DSL (Digital subscriber line)
- Cellular telephones
  - 1G – analog cellular phones
  - 2G – PCS
  - 3G – CDMA
  - All can transmit data the same way as dial-up (modem), but speeds vary.
    - Analog is 5.6Kbps, limited by FCC
    - PCS is about 11.4 Kbps, limited by carrier.
    - CDMA is 2 Mbps, currently limited by technology (This is 1xRTT; No modem)

PMRS

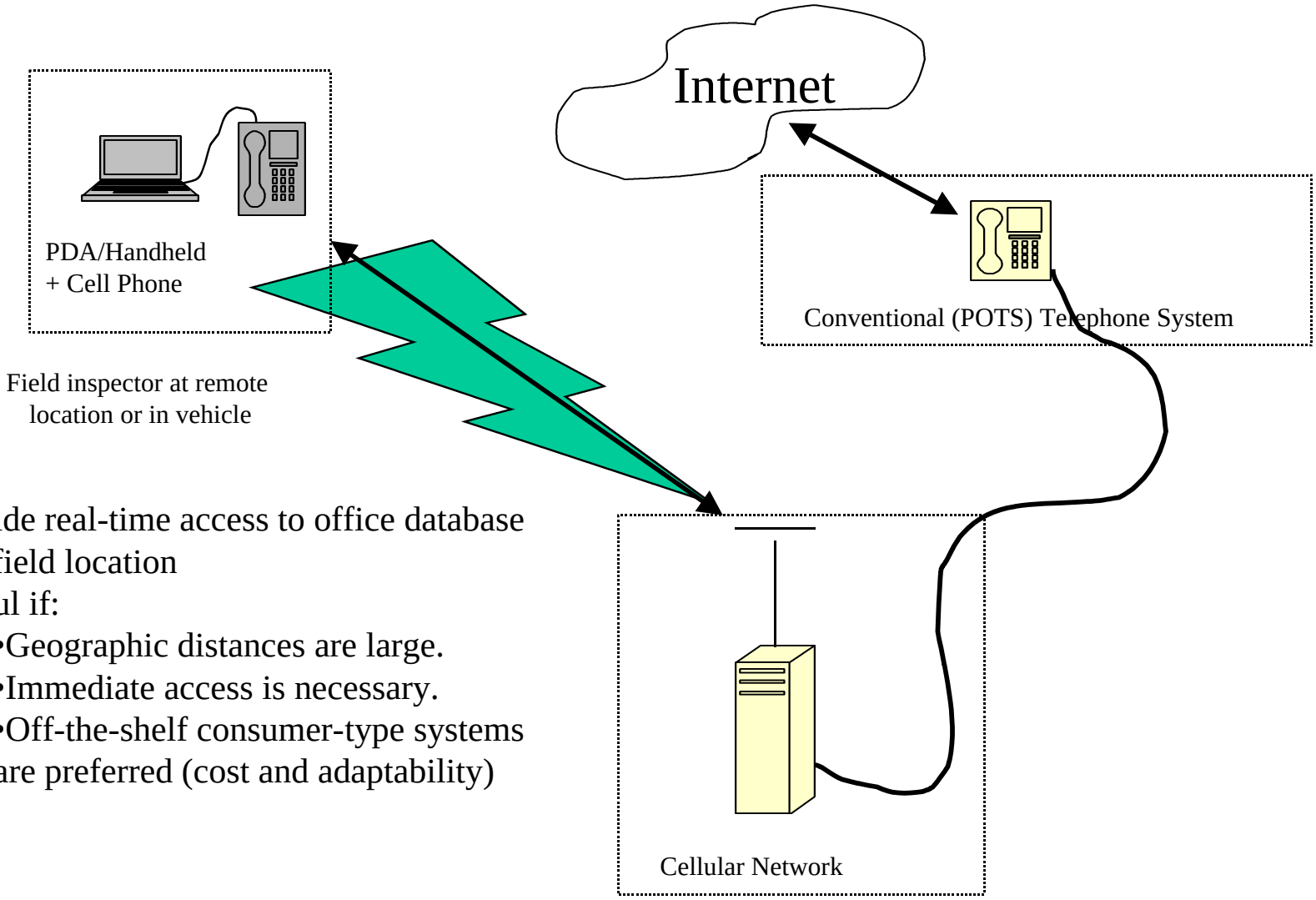
- Private Mobile Radio Service
  - Conventional police,fire, EMS dispatch uses this type of service.
  - Works same as wireless (radio transceivers), but user is also owner/operator of the communications network (as compared to cellular where the service provider owns the network, and we buy access).
  - PMRS is data capable if the owner/operator chooses necessary equipment.
  - Owner/operator has complete control of the system, reliability can be controlled by selection of repeater locations and emergency power supplies.

Wireless Network (Digital)

- All have essentially same topology



Wireless Dial-Up



- Provide real-time access to office database from field location
- Useful if:
  - Geographic distances are large.
  - Immediate access is necessary.
  - Off-the-shelf consumer-type systems are preferred (cost and adaptability)

Security (General)

- Security issues are a major concern for wireless LANs.
  - WEP Wireless Equivalent Privacy. Considered easy to compromise because keys are common and static. Compromise means an unauthorized person can access the wireless network and use unsecured resources.
  - The Data Encryption Standard, or DES, was the first official U.S. government cipher intended for commercial use. DES is the most widely used cryptosystem in the world.
  - AES Advanced Encryption Standard is the U.S. government's next-generation cryptography algorithm, which will replace DES and 3DES.

Security (Data)

- Current wireless is less secure than wired.
- Access points can be hacked in a few hours; an unauthorized user can then browse the LAN.
- The data itself can be kept relatively secure by requiring user/password challenges to use databases within the LAN.
- Main issue for sys-admin to be sure their access points issue userid/password challenges (just like conventional wired networks).

Mobile Devices

- Current project was to provide access to a database via a wireless connection from the field using mobile computing equipment.
- Mobile computers
  - Laptop PC
    - Windows 98/Me/NT/2000/XP
    - Linux/UNIX
  - PDA (Portable Digital Assistant)
    - Windows CE/PocketPC/.NET
    - Linux
    - Palm OS

Mobile Devices

- Mobile PCs:

Laptop

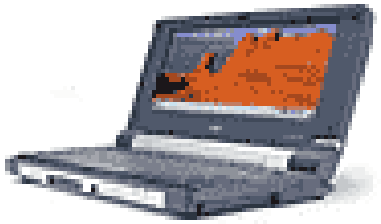
Tablet

Mobile Devices

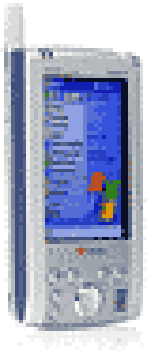
- PDAs

Handheld (Win)

Handheld (PalmOS)



Sub-Notebook (Win)



Integrated PCS

Sub-Tablet (Linux)

Database/Interface Issues

- Three essential functions:
  - View data in the database
  - Edit existing data
  - Create new data
- Concurrency
  - If there are multiple copies of a database, which is correct?
  - Usually resolved by a master database, and human intervention to decide how to resolve concurrency.

Database Issues

- Concurrency matters (in this project) because there are several ways to handle a field portable database.
  - Supply copies of the entire database to laptop users each day, then synchronize changes each night.
  - Supply subsets, then synchronize.
  - Provide authenticated access to the master (one and only) database.

Interface Issues

- Interface (in this context) refers to program that allows the remote user to enter and retrieve data in the database from different devices.
  - Desktop
  - Laptop
  - PDA
- Interface design.
  - Communications dictates how to handle interfaces.
  - Device form factor impacts ease of use.
  - Web browser is simplest cross-platform approach.

Field Portable Access

- Three conditions that justify remote wireless access:
  - Need to access/update data while in the field.
  - Large geographical area (if you are thinking about a single building or inter-connected campus of buildings, consider 802.11-type methods).
  - Need to make changes in near real-time.

Field Portable Access

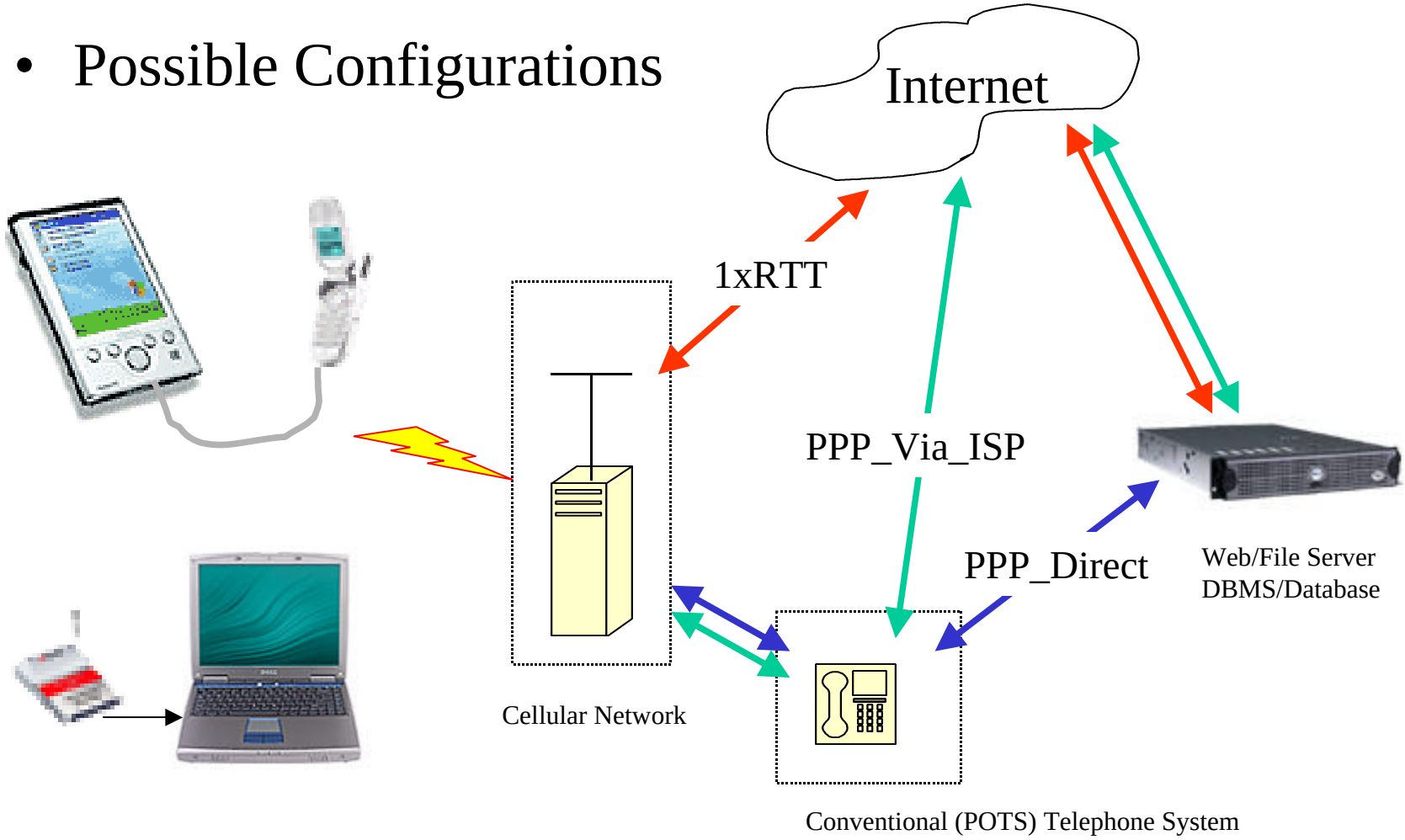
- If near-real-time access is not necessary, then consider a synchronization approach:
  - Issue PDA/Laptops to those who need the data.
  - Start of each day, they synchronize their copies/subsets with the master database.
  - End of each day, they synchronize their changes.
  - Database administrator reviews changes and resolves concurrence issues.

Building/Buying a System

- Hardware:
  - Server
  - PDAs/Laptops
  - Cellular phones (or 1xRTT cards)
  - Cellular service (1 line per connection)
- Software
  - Web server
  - DBMS
  - Interface (CGI-Bin; ASPs) etc.

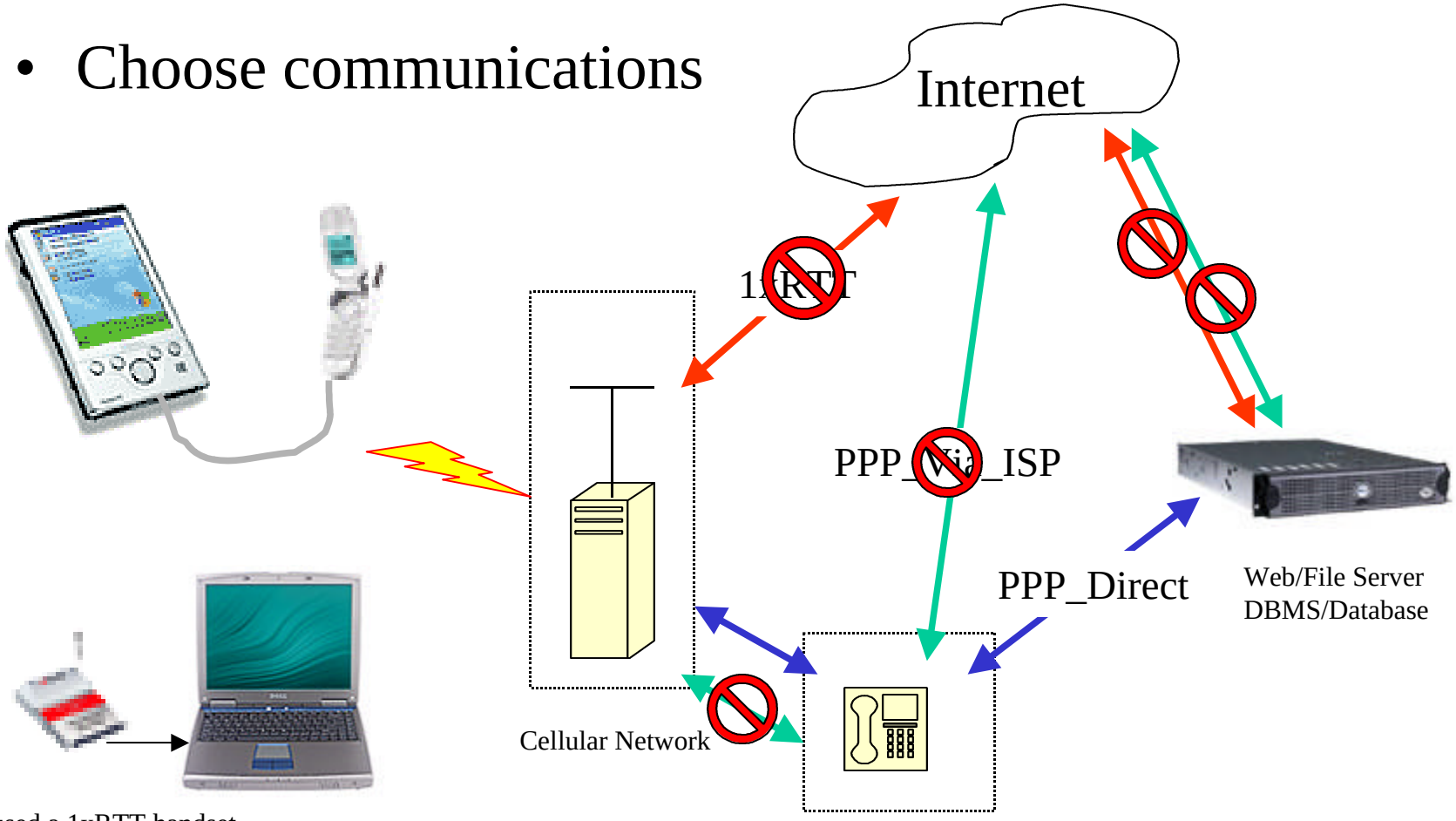
Building/Buying a System

- Possible Configurations



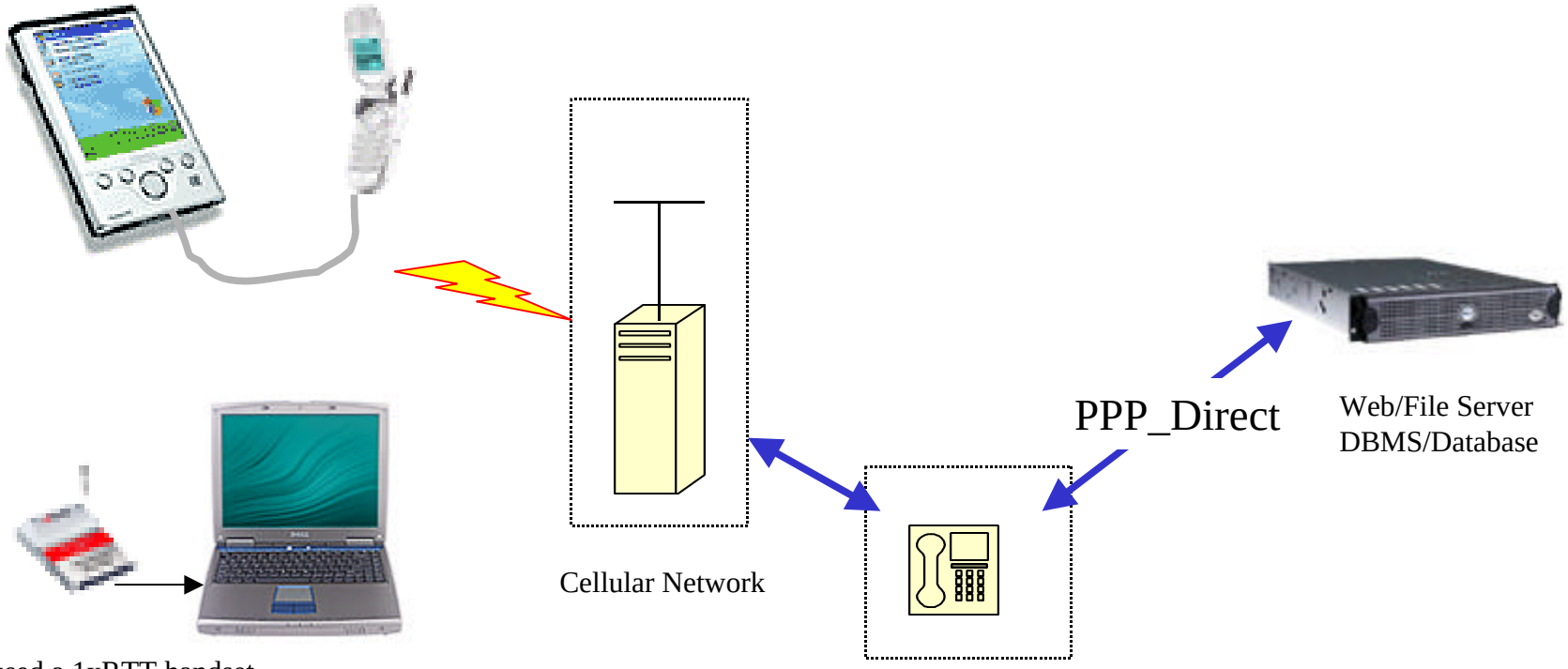
Building/Buying a System

- Choose communications



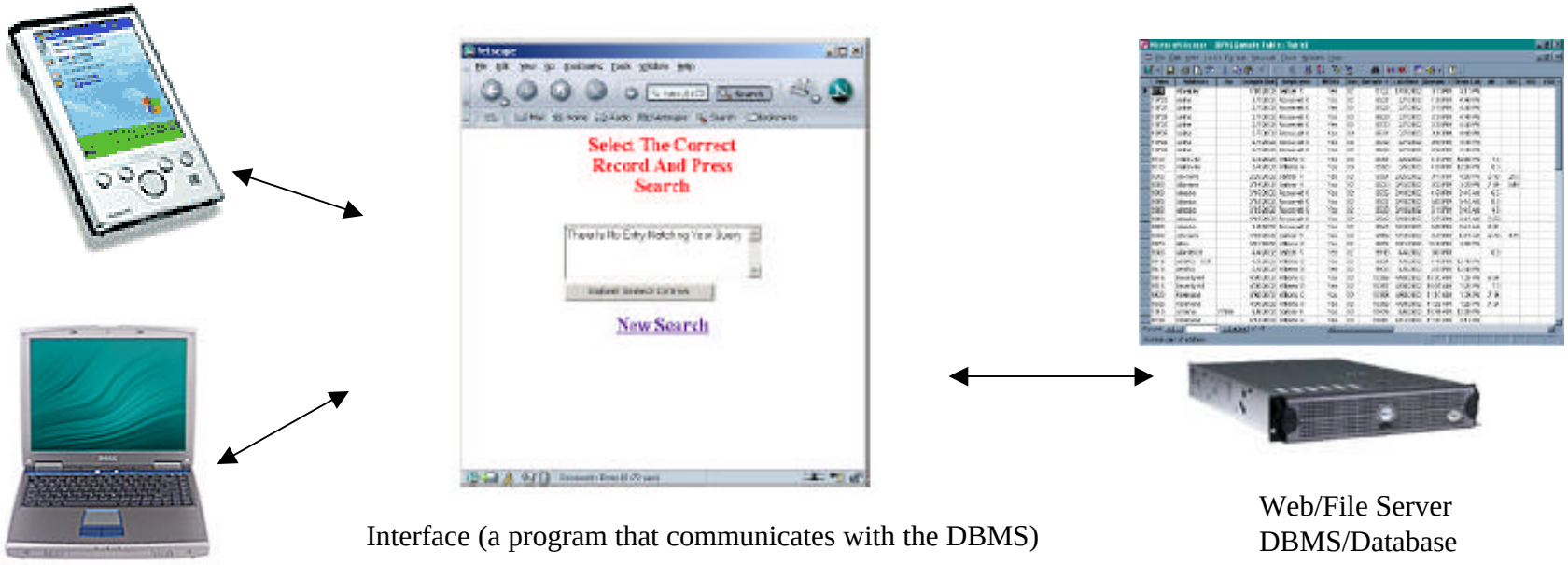
Building/Buying a System

- Communication (DHHS Example)



Building/Buying a System

- Develop Interface
  - Look and work the same on PDA and PC
  - Used a web-browser interface



Interface (a program that communicates with the DBMS)

Web/File Server
DBMS/Database

Conventional (POTS) Telephone System

Building/Buying a System

- Deploy the system
  - Need feedback to improve interface so that actual users are satisfied.
  - Expect months to work out interface problems.
  - Maintain the database, hardware and interface.
- What we developed is for routine use. Emergency use may not be reliable, so don’t depend on a cellular wireless system for critical applications.
  - 09-11-01 Cellular system was overloaded.
  - 08-16-03 Power failure; Cellular towers lose power.

Estimated Costs

- Hardware
  - Server $ 500
  - PDA (Dell Axim) $200
  - DPC (digital phone card) $ 120
  - Handset (~$20)
- Software (licenses)
  - Win2K Server ($600 retail, $148 DIR)
  - MS Office (?? Retail, $48 DIR)
- Development (Interface programming)
  - 200 hrs (@$15.00/hr = $3000) (Student labor rate; Included working out communications issues and hardware configuration)

Estimated Cost

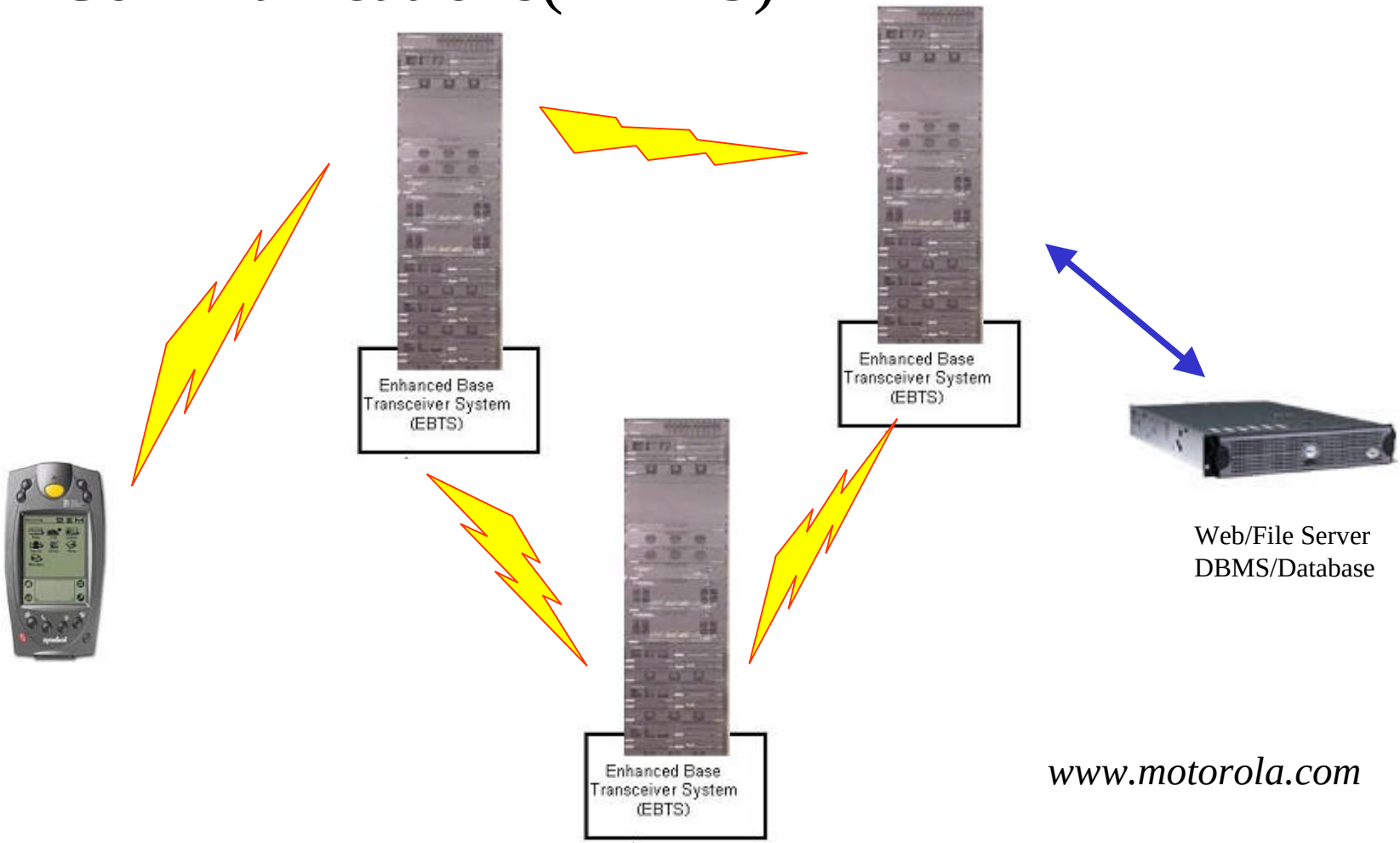
- Communications
  - ~$75/mo. Per communications channel. Includes state and federal communications taxes
  - Add ~$80/mo. For unlimited data access and true 1xRTT speed

Estimated Cost

- Personnel (to maintain)
  - Database manager (est. 16 hrs. per week); Interface programmer (est. 20 hrs. per week)
  - Skill level: A typical sys. admin (MSCE, CCNA,etc.) with some network and programming experience should be able to handle the job. It would be helpful of this person has some knowledge of the actual data meaning. The two “jobs” can be vested into the same person.
- Personnel (to operate)
  - Skill level: If the programmer and database administrator do their job, then anyone who can log-on to a network computer and use a web browser should be able to use such a system. Expect steep learning curve before system becomes accepted. The interface programmer needs to work closely with the pilot users to get the interface inot a really useful product.

PMRS Alternative

- Communications(PMRS)



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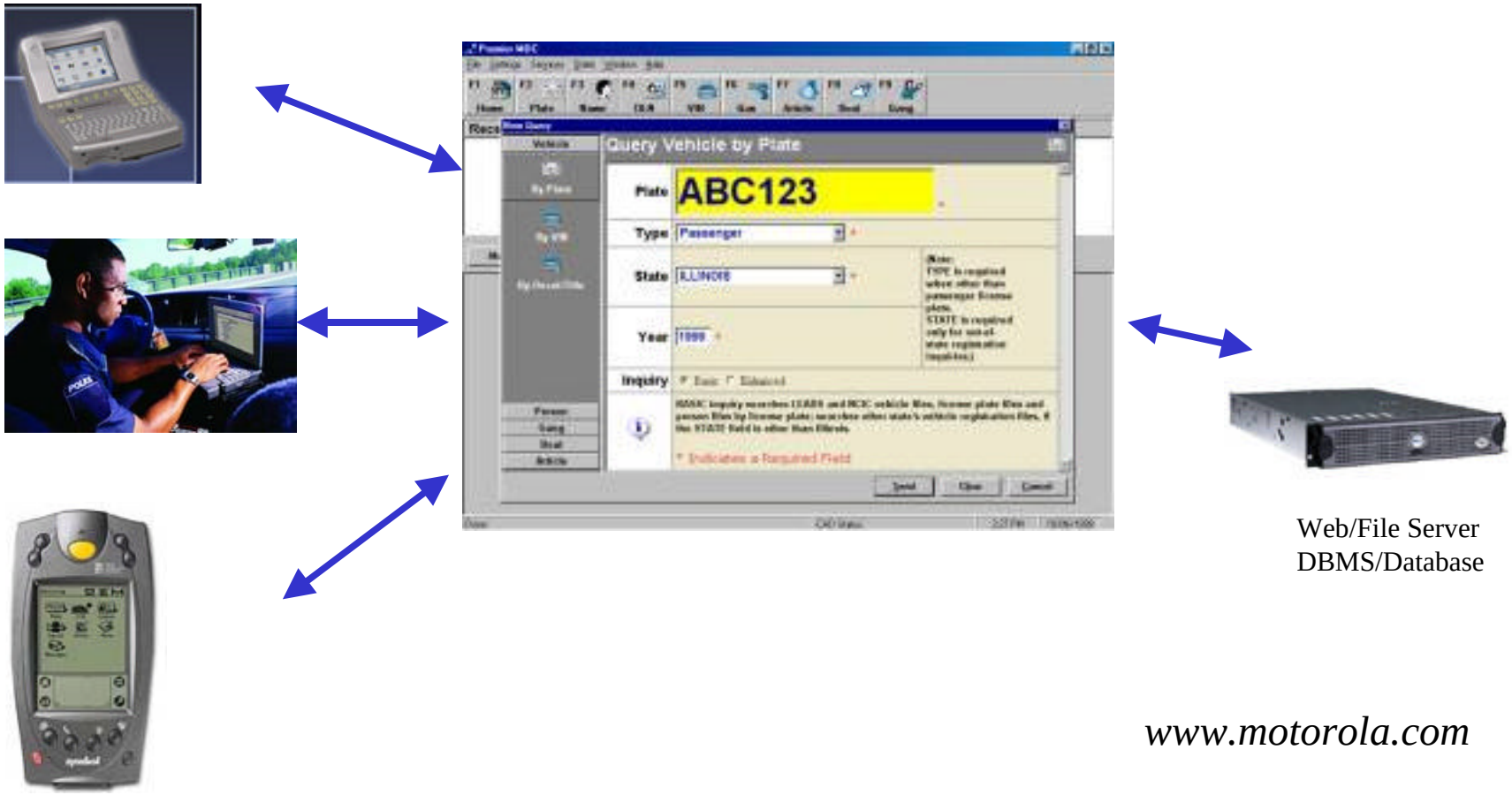
Building/Buying a System

- Interface (PMRS)



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Building/Buying a System

- For Emergency use consider a PMRS based approach
  - As owner/operator need FCC license to operate the system, and skilled radiotelephone technicians
  - Or enter into long term lease agreement with independent owner/operator who provides the service under their license (this is how cellular works).
  - Repeater location will require further leasing arrangements (to lease the roof space for the repeaters).
  - These systems can be very secure!