Question 1: Fundamental Problems

Describe the fundamental challenges of pervasive positioning and discuss them in relation to solutions presented during the course.

- **Adequately, Anything, Anywhere, Anytime**
  - Tracking humans (phones) vs tracking fish or cows
  - Under water, in buildings, in the desert
  - During business hours, at night, cloudy, fire
- **Quality attributes** (CARE)
  - Coverage - refer to Place Lab (4.5% GPS coverage)
  - Accuracy - gps, wifi, magnetic field
  - Responsiveness - gps vs a-gps
  - Energy efficiency - EnTracked
- **Privacy**

Question 2: Pervasive Positioning Applications

Describe how pervasive positioning applications can be classified
Discuss the classification in relation to existing applications on common mobile phones (iphone, android, …)

- **Application categories** (navigation, emergency response, social network, fitness)
- **Positioning type**
  - Signal-strength based → WiFi, GSM
  - Time-of-arrival based → GPS, A-GPS, Ultrasound, UWB
  - Location fingerprinting → WiFi
  - Intertial measurements (sensor fusion) → Accelerometer
- **Positioning methods**
  - Proximity
  - Lateration
  - Angulation
  - Pattern Recognition
  - Dead Reckoning
- **Categorizing location-based service**
  - Reactive → proactive
  - Self-referencing → cross-referencing
  - Single-target → multi-target
  - Content-oriented → Application-oriented

Question 3: Pervasive Positioning

Describe evaluation criteria, architectural properties and positioning methods and discuss dependencies between them when designing positioning systems (e.g. as in project 1)

- Evaluation criteria
    - **Quality attributes** (CARE)
        - Coverage
        - Accuracy
        - Responsiveness
        - Energy efficiency
    - **Krumm's evaluation criteria**
        - Resolution
        - Infrastructure requirements (Cost)
        - Privacy
        - Accuracy
        - Coverage
        - Spectral requirements
        - Location System Type
- **Architectural properties**
    - Client-based A device computes its own location
    - Network-based Network infrastructure calculates the position of a device
    - Network-assisted Device and infrastructure compute location coopetatively
- **Positioning methods**
    - Proximity
    - Lateration
    - Angulation
    - Pattern Recognition
    - Dead Reckoning
- Dependencies - tradeoff (draw graph, coverage vs accuracy)

Question 4: Applying Techniques I

Explain the technique of location fingerprinting and discuss issues when applying the technique as you did in mandatory project 1.

- Technique
    - **Training phase** (offline phase) to build radiomap
        - Radio map consists of signal strenghts
    - **Real-time phase** (online phase)
        - Measure AP signal strengths
        - Choose nearest neighbor in signal space
            - K-nearest neighbors
- **Issues**
    - Time consuming
    - AP relocation
    - Orientation (refer to RADAR)
    - Obstructions (meatbags, environmental changes)
- **Model-based approach**
    - Alleviates time consumingness
    - Requires floorplans and building materials
    - Still problem with obstructions (aka. meatbags)

Question 5: Applying Techniques II

Explain techniques for efficient position updating and discuss issues when applying the techniques as you did in mandatory project 2.

- **Periodic** approach Many fixes, many uplinks
- **Distance** based Many fixes, few uplinks
- **Bounded speed** Fewer fixes (short distance left ⇒ many fixes), few uplinks
- **Accelerometer** Fewest fixes (removes problem), few uplinks

- If the server provides an on-demand service
    - Move (some) responsibility from device to server
        - If data is queried once a day, no need to update every 50 meters
    - Combined **querying / reporting**
- **EnTracked**
    - Power off, power on delays
    - Cold starts vs hot starts

Question 6: Evaluation I

Discuss the evaluation of pervasive positioning systems and relate the discussion to your own evaluation in mandatory project 1

- **Quality attributes** (CARE)
    - Coverage
    - Accuracy (Discuss both empirical and model based approach)
    - Responsiveness
    - Energy efficiency

    - **Krumm's evaluation criteria**
        - Resolution
        - Infrastructure requirements (Cost)
        - Privacy
        - Accuracy
        - Coverage
        - Spectral requirements
        - Location System Type
- **Evaluation**
    - Simulation
    - Emulation
    - Experimentation

Question 7: Evaluation II

Discuss the evaluation of pervasive positioning systems and relate the discussion to your own evaluation in mandatory project 2

- **Quality attributes** (CARE)
    - Coverage
    - Accuracy (Discuss all four strategies)
    - Responsiveness
    - Energy efficiency (Discuss all four strategies)

    - **Krumm's evaluation criteria**
        - Resolution
        - Infrastructure requirements (Cost)
        - Privacy
            - Positioning is done locally so we own the position
        - Accuracy
        - Coverage
        - Spectral requirements
        - Location System Type
- **Evaluation**
    - Simulation
    - Emulation
    - Experimentation