1. android

1.1. In Android, there is the notion of API Level. Say if you agree with the following definition: “API Level is an integer value that uniquely identifies the framework API revision offered by a version of the Android platform”. Indicate in what way this affects the portability of the applications developed. Justify your answer

1.1.1. It’s defined when developed. takes into account the number of smartphones the application will be available on. e.g.: the API level associated with the Ice Cream Sandwich release of Android (version 4.0) is 14. Features can be discontinued or changed between version which mean that by knowledge of the changes we can know if the app works for previous and new API levels.

1.2. In Android, applications are built around several components. Mention two of such most important components (in addition to the component “service”) and provide their meaning.

1.2.1. Activities and Content Providers. Activities represents a screen with a visual user interface (Activity class). They dictate the UI and handle the user interaction to the smartphone screen. Content Providers enables applications to store and share data with other applications (ContentProvider class). They handle data and database management issues.

1.3. Consider the Android system. Why is this system needed and existing desktop OSs such as Unix or Windows or MacOS are not adequate? Relate your answer to the programmatic interface provided to app developers.

1.3.1. Different capabilities to that of a desktop and different challenges to overcome. Android is a Linux-based platform, It uses a heavily customized Linux kernel,It is not another flavor of Linux because:

- it does not support the complete set of standard GNU libraries, and
- it uses its own proprietary windowing system instead of X-Windows

1.4. In Android, consider the component service. Does this component have an interface to the user? Justify your answer.

1.4.1. No, its used for background tasks such as time intensive tasks or inter-application functionalities which do not require direct user interaction (Service class). they handle background processing associated with an application.

1.5. Consider the manifest.xml file attached to each Android application. Does this file specify the hardware and software services required and the external libraries that need to be linked with an application? Relate your answer with the scenario in which some software service is not referred to in that file.

1.5.1. Yes, it specifies the hardware and software services required and the external libraries that need to be linked with the application

1.6. Consider the mechanism of broadcast in Android that is represented as an Intent object. Does it specify a particular Activity object that will be triggered? What does the Intent object contain?

1.6.1. it only contains the message associated with the broadcast, and it does not specify any Activity object that has to be triggered.

1.7. Can an activity in Android start another activity that exists in another application on the device? Answer “yes” or “no” and justify with an example in any of the cases.

1.7.1. Yes,
you can define an intent to perform a "send" action and include some data, such as an email address and a message

- an activity from another application that declares itself to handle this kind of intent then opens
- the intent is to send an email, so an email application's "compose" activity starts (if multiple activities support the same intent, then the system lets the user select which one to use)
- when the email is sent, your activity resumes and it seems as if the email activity was part of your application
- even though the activities may be from different applications, Android maintains this seamless user experience by keeping both activities in the same task

1.8. Consider Android and the following sentence: “The activities are arranged in a stack (the back stack), in the order in which each activity is opened with a logic of first-in first-out”. Do you agree? Answer “yes” or “no” and justify.

1.8.1. "last in, first out" stack mechanism: • when the user is done with the current activity and presses the Back button, it is popped from the stack (and destroyed) and the previous activity resumes

1.9. Considering that in Android a task is a cohesive unit, w.r.t. foreground and background Activities, what happens when a user begins a new task or goes to the Home screen, via the Home button?

1.9.1. A task is a cohesive unit that can move to the "background" when users begin a new task or go to the Home screen, via the Home button

1.10. Does Android suggest application resources such as images and strings to be externalized from the code? If so, what is the reason?

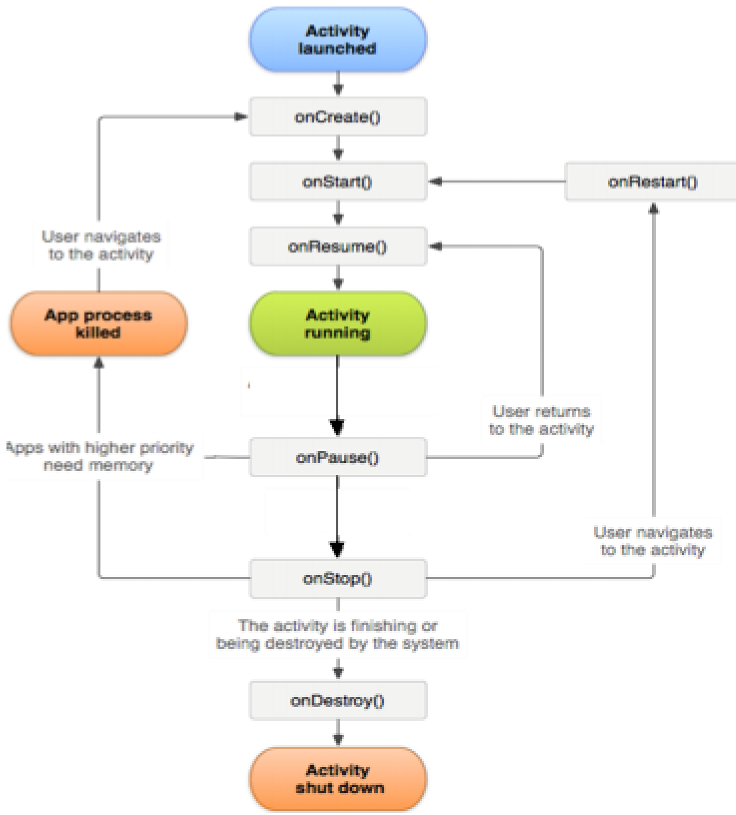
1.10.1. Yes, so that you can maintain them independently.

1.11. In Android, what are the three states in which an Activity can exist? State to what each one corresponds.

1.11.1. Resumed (or Running), the activity is in the foreground of the screen and has user focus
Paused, another activity is in the foreground and has focus, but this one is still visible

Stopped, the activity is completely obscured by another activity (the stopped activity is now in the "background")

1.12. Consider the figure describing an Activity lifecycle. Between which calls (to which functions) is an Activity visible? Between which calls (to which functions) is an Activity in the foreground?



1.12.1. Its visible from onCreate() until it moves to the background in onStop()

1.13. The Android system supports the mechanism designated AsyncTask (asynchronous task). What is the purpose of this mechanism? In your answer, provide an example of its usage.

1.13.1. asyncTask is designed to be a helper class around Thread and Handler and does not constitute a generic threading framework. AsyncTasks should ideally be used for short operations (a few seconds at the most.)

1.14. Consider the Android system. Is the Android UI toolkit thread-safe? Clarify your answer by indicating if you can manipulate the UI from a worker thread.

1.14.1. It is not Thread-safe. So, you must not manipulate your UI from a worker thread. You must do all manipulation to your user interface from the UI thread

2. put

2.1. According to Mark Weiser's vision, ubiquitous systems should be invisible. Does this mean that such a system should be pro-active? If so, on what

kind / type of information should (or could) a ubiquitous system be based upon? Provide a concrete example to illustrate your answer.

2.1.1. Yes it needs to be pro-active. The system must get all the context information to predict what the user wants and act accordingly. Context information includes many aspects; the most obvious is location to many others such as user's agenda, temperature, presence, etc...

2.2. Consider the notion of localized scalability:
i) explain what this notion is,
ii) provide a concrete example (i.e., refer to a scenario that currently does exist), and
iii) differentiate it from the classical notion of large-scale (distributed) scalability.

2.2.1. Localized scalability means that a system must scale in the local space: i.e., it must be able to handle a growing amount of devices and the resulting interaction

2.2.2. Such a room is also called a smart-space: • its "smartness" results from the existence of a large number of computing devices that, while being invisible, perform the work needed

2.2.3. Don't know, small room?

2.3. Point out a research challenge that applies strictly to pervasive computing and not to the so-called classic distributed systems and, while justifying, provide its definition.

2.3.1. In the literature, normally there is no distinction between ubiquitous and pervasive computing.
Pervasive computing implies the embedding of computing devices into everyday "stupid" objects: example a smart-mug that changes its color according to the temperature of the liquid it contains or a smart-chair that senses when someone sits on it

2.4. Consider the notions of pervasive computing and ubiquitous computing. Clearly state the difference between both and provide an example of a pervasive computing application / usage scenario.

2.4.1. Pervasive computing implies the embedding of computing devices into everyday "stupid" objects: example a smart-mug that changes its color according to the temperature of the liquid it contains or a smart-chair that senses when someone sits on it

2.5. In ubiquitous computing, there is the notion of smart spaces. What is a smart space? Provide a scenario in which a user enters a smart space and interacts with it.

2.5.1. Such a room is also called a smart-space: • its "smartness" results from the existence of a large number of computing devices that, while being invisible, perform the work needed. Music video moving room

3. context

3.1. What is the definition of context? Provide an example that illustrates the relevance of the information.

3.1.1. In the area of computer science, context was initially perceived as user location. But it has been enriched with other sources of information such as identity, activity, and state of people, groups, and objects.
Context is any information that can be used to characterize the situation of an entity:
an entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves

3.2. What is a context-aware system?

3.2.1. A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevance depends on the user's task.

3.3. There are three main features that context-aware systems may provide. Which are these?

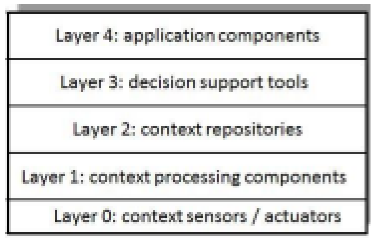
3.3.1. This results in three main features that context-aware systems may provide:

- presentation of information and services to a user
  - systems that provide information to the user augmented with contextual information (e.g., phone's contact list enhanced with location information) or that provide services based on the current user's context (e.g., show me restaurants nearby, free places in each restaurant);
- automatic execution of a service
  - systems that execute a service automatically based on the current context (e.g., automatically updating my status on a social network based on accelerometer data—sleeping, walking, and running);
- tagging of context to information for later retrieval
  - systems that are able to associate digital data with the user's context (e.g., virtual notes that are attached to certain locations, for others to see).

3.4. Regarding the categorization of the architectural options available to the application developer of distributed context systems, there are four layers: capture, infer, distribute, and consume. For layers capture and infer, provide a short description of each layer's functionality; also present a figure that illustrates how the four layers are layered.

3.4.1. The Capture layer is responsible for acquiring context data from the environment using sensors. The word "sensor" not only refers to sensing hardware but also to every data source which may provide usable context information: physical, and virtual.

It is responsible for reasoning and interpreting raw context information provided by sensors on the Capture Layer: for example end-user applications do not need to know the exact latitude and longitude of an entity, being much more interested in knowing the place (city, street, etc.) in which the entity is located



3.5. In context-aware systems, the word sensor not only refers to sensing hardware but also to every data source which may provide usable context information thus leading to physical and virtual sensors. Do you agree (answer “yes” or “no”)? Provide: i) the definition of each sensor type (physical and virtual), and ii) an example for a physical sensor and another for a virtual sensor.

3.5.1. Yes,
Physical sensors are hardware sensors capable of capturing physical data such as light, audio, motion, and location.
Virtual sensors acquire context data from software applications, operating systems, and networks.
Physical sensor for light level to adjust brightness, virtual checking electronic calendar for appointments.

3.6. Consider the following sentence: "For proactivity to be effective, it is crucial that a pervasive computing system tracks user intent." Do you agree with this sentence? Is the user intent the only relevant information for a system to be proactive? Justify your answer.

3.6.1. No, the user's intent can be crucial, but a smart mug that changes colour depending on the temperature does not need to know if the user wants to hold the mug. Depending on the pervasive computing system, different context information can be the most crucial.

3.7. Consider the need of a mobile/ubiquitous system to adapt automatically to the context. Present an example in which the high speed at which a system is capable to adapt is good and another example in which such high speed is not good.

3.7.1. High speed of adaptation can be good in case of environments or tasks that need rapid response to change. An example could be air conditioning that tries to keep the temperature stable in a room. An example where high speed adaptation is not good is:

3.8. In addition to the huge number of users and messages exchanged, context propagation creates unique challenges in the realm of distributed systems. What challenges are these? Provide examples that illustrate each challenge.

3.8.1. First there are different challenges for different types of distribution: from Centralized, partitioned and peer-to-peer. Partitioned - Delay +lack of redundancy, centralized is a single point of failure and thereby lacks robustness, its scalability is limited and it is not well fitted to scenarios where network connection is intermittent as it happens with mobile phones. Peer-to-peer has time necessary to propagate context may increase.

3.9. Where can the context-inference layer run? The location is intimately related to several properties of a context-aware system; which ones are these?

3.9.1. The Context-Inference layer is also known as the Preprocessing Layer.
Resourceful mashine(server)
Network bandwidth consumption
Complexity (CPU/memory consumption)
Reusability
Personalization

3.10. Regarding reusability, how does I evolve depending on the location of the inference layer?

3.10.1. It moves closer to the sensors and decreases towards the application

3.11. Regarding personalization, how does I evolve depending on the location of the inference layer?

3.11.1. It moves towards the application and increases towards the application

3.12. Context has to be distributed among the system components (sensors, middleware, application). Which approaches can be used? What are the main distinctive aspects for each one?

3.12.1. Centralised, partitioned and peer-to-peer

3.13. Regarding the consume layer, what are the several options and how they work?

3.13.1. Pull-based systems and Push-based systems

4. location

4.1. In the context of location systems, consider those systems based on signal strength fingerprinting, and that WiFi is used for that purpose. i) State what it consists of (i.e., the location system based on signal strength fingerprinting). ii) Assuming that the system is able to locate people/objects within 2 meters in 90% of the cases, state its precision and accuracy. iii) Point out two disadvantages of this kind of location solution.

4.1.1. 1

4.1.2. precision and accuracy

4.1.3. 2 disadvantages Scalability and The radio maps produced by the site surveys are brittle:
if an access point is moved, the map needs to be recollected for the space within range of this AP, even if the move is as insignificant as from the top of a filing cabinet to the desk beside it as a result, fingerprinting

systems are best suited for spaces in which some degree of control over the radio infrastructure can be maintained such as office spaces and other similar buildings or small campuses

4.2. In the context of location, what is the meaning of wardriving?

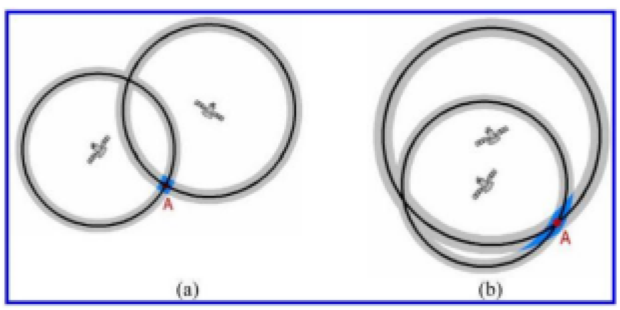
4.2.1. Wardriving is the act of searching for Wi-Fi wireless networks by a person in a moving vehicle, using a portable computer, smartphone or personal digital assistant (PDA).

4.3. Are light and sound the types of signals well suited for indoor location systems? Why?

4.3.1. Yes, These two types of signals are well suited for indoor location systems because they can determine which room a user is in with high accuracy.
Because Light and sound move freely in open space and are both largely blocked by the materials such as walls, curtains, and partitions that humans use to define the borders of their living spaces.

4.4. Consider the GPS for locating some users. How is the uncertainty area affected (increases or decreases) if the distance between the satellites increases? Present a figure that illustrates your answer.

4.4.1. The size of the uncertainty area where the receiver could be located decreases, as the distance between the satellites increases (see blue bands in the figure)



4.5. In the context of location systems, describe the notion of accuracy. Illustrate this notion with an example.

4.5.1. grain size is accuracy, how close we are to the real position

4.6. Consider the several techniques that can be used to provide location information. Provide a concrete example of a technology that can be used, classify it, and explain the notions of precision and accuracy.

4.6.1.

4.7. Consider an indoor location system based on infrared. What is one of the main disadvantages of this solution?

4.7.1. Infrared is easily blocked by fabric

4.8. Consider a GPS based location system. Such a system is made of three distinct components. Which components are these? What characteristics and function does each component have?

4.8.1. Satellites, receivers and ground stations. Satellites orbit earth and broadcast a continuous ranging signal. Ground stations responsible for monitoring satellite positions and providing satellites with clock corrections and satellite orbit updates. Receivers gets tracked by satellites and receive signals from them.

4.9. The GPS location system has some errors that are dealt with. What are these?

4.9.1. Ionospheric delay, Satellite coordinates, Satellite's atomic clocks are very stable but still can accumulate up to 17 ns of error per day.

4.10. What does Differential GPS takes advantage of? And how is that done?

4.10.1. Differential GPS takes advantage of the fact that, satellite clock and satellite coordinate errors, as well as ionospheric and tropospheric delays. Done by coordinating multiple GPS receivers that simultaneously track the same satellites, by having one or more GPS receivers fixed at known positions, the observed errors from those receivers can be transmitted to nearby roving GPS receivers and these roving units are then able to reduce their error in proportion to their proximity to the site at which the correction was measured.

4.11. The receiver's location in three-dimensional space (x, y, z) and receiver clock bias b is determined by solving the following equation for at least four satellites (just three satellites would be required with perfect clocks):

$R_i = \sqrt{(x_i - x^2) + (y_i - y)^2 + (z_i - z)^2} - b$ **Explain this formula.**

4.11.1.

4.12. Explain what is Real-time differential GPS (DGPS) and give some examples.

4.12.1. Real-time differential GPS (DGPS) is a relative positioning technique that provides sub-meter accuracy. the rover

4.13. What is a possible advantage of having several location systems similar to GPS?

4.13.1. Allows for customization depending on use, environment or other factors

4.14. How do you compare the several GPS-based systems regarding accuracy, coverage, cost of the infra-structure, per-client cost, and privacy? Explain your answer.

4.14.1.

Technology	GSM signal-strength fingerprinting	GSM TOF and signal-strength modeling	GSM/CDMA proximity	Assisted GPS (A-GPS)
Accuracy	★★★☆ 2D coordinates with 4 m median accuracy in dense cell environment	★★☆☆ 3D coordinates with 100 - 200 m accuracy	★☆☆☆ Accuracy dependant on cell tower density (150 m – 30 km)	★★☆☆ 3D coordinates with 10 -150 m accuracy depending on number of GPS satellites visible
Coverage	★★☆☆ Building to campus scale. Requires cell network coverage and radio map. Best accuracy when 3+ cells are visible	★★★☆ Areas with GSM coverage and radio map. Best accuracy when 3+ cells are visible	★★★★ Anywhere with cell coverage and cell-to-location map	★★★☆ Outdoors with 4+ GPS satellites or indoors with cell network support + view of 1+ GPS satellite
Infrastructure cost	★★★☆ No additional infrastructure is needed beyond cell network. Creating radio map is time intensive	★★★★ No additional infrastructure is needed beyond cell network and map of tower locations	★★★★ No additional infrastructure is needed beyond cell network and map of tower locations	★★★☆ Beyond GPS constellation, requires deployment of fixed GPS receivers
Per-client cost	★★★★ Software only solution	★★★★ Software only solution	★★★★ Software only solution	★★★☆ GPS antenna and chipset required for handset
Privacy	★★☆☆ Even if location is computed on client device, the network still tracks a handset's associated cell	★★☆☆ Even if location is computed on client device, the network still tracks a handset's associated cell	★★☆☆ Even if location is computed on client device, the network still tracks a handset's associated cell	★★☆☆ Even if location is computed on client device, the network still tracks a handset's associated cell
Well-matched use cases	Asset and personnel tracking in indoor environments, indoor mapping/navigation/tour guides	Social networking, emergency response, neighorhood-scale information access, fitness tracking, outdoor mapping / navigation	Regional information access (weather, traffic, etc.)	Emergency response, indoor/outdoor information/tour guide services, personnel/pet tracking, activity tracking, gaming

4.15. Globally, what kind of solutions can be devised for in-door location systems using infrared and/or ultrasound systems? What accuracy can be achieved approximately?

4.15.1. can use proximity or time-of-arrival or angle-of-arrival to determine the user's location within the room with room-5–10 cm accuracy

4.16. Explain how Active Badge work. What is its fundamental problem?

4.16.1. Active Badge sends a unique pulse-width modulated infrared code every 15 s. These codes are received by base stations. Base stations decode the received infrared signals and forward the decoded badge-IDs to a centralized location server. From this server can know what room badge is beaconing from. Problems: Stopped by cloth, obscured by objects, need infrastructure and users with badges.

4.17. Explain how Walrus/Cricket/ActiveBat work.

4.17.1. Bats are located by measuring the travel time of an ultrasonic pulse. Bats emit the ultrasonic pulses and receivers in the infrastructure listen for and time the pulse's travel.

4.18. How do you compare the several in-door systems based on infrared and/or ultrasound regarding accuracy, coverage, cost of the infra-structure, per-client cost, and privacy? Explain you answer.

4.18.1.

Technology	Infrared proximity (e.g., Active Badge)	Ultrasound proximity (e.g., WALRUS)	Ultrasound TOF (e.g., Active Bat)	Infrared triangulation (e.g., ALTAIR)
Accuracy	★★★☆ Room ID with high accuracy	★★★☆ Room ID with high accuracy	★★★★ 3D location with 5 cm accuracy	★★★★ 3D location with 9 cm accuracy
Coverage	★★☆☆ Indoor only in room fit with IR receiver/beacon	★★☆☆ Indoor only in room fit with ultrasonic beacons	★★☆☆ Indoor only in room fit with ultrasonic infrastructure	★★☆☆ Indoor only in room fit with infrared cameras
Infrastructure cost	★★☆☆ Infrared receiver or beacon required for each room	★★☆☆ 1 or more ultrasonic receiver or beacon required for each room	★☆☆☆ Requires dense array of ultrasonic receivers	★☆☆☆ Requires 2+ calibrated IR cameras per room
Per-client cost	★★★☆ Inexpensive IR badge/dongle required	★★★★ Software only solution on device with microphone	★★★☆ Inexpensive ultrasonic badge/dongle required	★★★☆ Inexpensive IR badge/dongle required
Privacy	★★★★ If localization is performed on the client. Otherwise ★★☆☆ Opt-out easy by removing badge	★★★★ Localization is performed by mobile client	★★☆☆ Localization is performed by infrastructure. Opt-out easy by removing badge	★★☆☆ Localization is performed by infrastructure. Opt-out easy by removing badge/dongle
Well-matched use cases	Asset and personnel tracking, indoor mapping/ navigation/tour guides	Asset and personnel tracking, indoor mapping/ navigation/tour guides	Asset and personnel tracking, tangible UIs, fine-grained info services	Asset and personnel tracking, tangible UIs, fine-grained info services

4.19. Broadly speaking, there are two big families of location solutions based on WiFi. What are these? Explain how each one works.

4.19.1.

4.20. Explain how Radar/ActiveCampus/PlaceLab work.

4.20.1. builds a map of the radio environment by collecting location-tagged “radio fingerprints”, and later use this map to perform localization of mobile 802.11 devices as most other similar systems, it uses the Euclidian distance in signal space as a measure of the similarity of the two radio scans

4.21. Regarding location solutions based on WiFi what can you say about its privacy?

4.21.1. The privacy of 802.11 location systems can be excellent if it is implemented entirely with passive radio reception and client-side computation. Palace lab

4.22. Please compare the several approaches based on WiFi location regarding accuracy, coverage, cost of the infra-structure, per-client cost, and privacy? Explain you answer.

4.22.1.

Technology	802.11 signal-strength fingerprinting (e.g., RADAR)	802.11 signal-strength modeling (e.g., Place Lab)	802.11 proximity (e.g., GUIDE)
Accuracy	★★★☆ 2D coordinates with 1-3 m median accuracy	★★☆☆ 2D coordinates with 10-20m median accuracy	★☆☆☆ Location accuracy dependant on AP density
Coverage	★★☆☆ Building to campus scale. Requires 802.11 coverage and radio map. Best accuracy achieved when 3+ APs are visible.	★★★☆ Areas with 802.11 coverage and radio map. Best accuracy achieved when 3+ APs are visible.	★★★☆ Anywhere with 802.11 coverage and an AP, location map.
Infrastructure cost	★★☆☆ No additional infrastructure is needed beyond 802.11 APs. Creating radio map is time intensive and new/moved APs require remap.	★★★☆ No additional infrastructure is needed beyond 802.11 APs. Creating radio maps is less work than for fingerprinting.	★★★★ No additional infrastructure is needed beyond 802.11 APs.
Per-client cost	★★★★ Software-only solution for devices with 802.11 NICs.	★★★★ Software-only solution for devices with 802.11 NICs.	★★★★ Software-only solution for devices with 802.11 NICs.
Privacy	★★★★ when localization is performed on the client. ★☆☆☆ when localization is performed in the infrastructure.	★★★★ when localization is performed on the client. ★☆☆☆ when localization is performed in the infrastructure.	★★★★ when localization is performed on the client. ★☆☆☆ when localization is performed in the infrastructure.
Well-matched use cases	Asset and personnel tracking in indoor environments, indoor mapping/navigation/tour guides	Social networking, tour guides, indoor/outdoor navigation/tour guides, fitness/activity tracking	Outdoor tour guides, nearby resource advertisement, activity tracking

4.23. What kind (big families) of location systems can be devised when these are based on cellular radio signals.

4.23.1.

4.24. Mention some of the other location approaches and compare them regarding accuracy, coverage, cost of the infra-structure, per-client cost, and privacy? Explain you answer.

4.24.1.

4.25. Regarding indoor location techniques (signal properties), there are several solutions based on the arrival of the signal that is propagated to the receiver. Which solutions are these and how is the distance calculated?

4.25.1.

4.26. Regarding indoor location techniques (location techniques), there are several solutions based on different location algorithms. Which algorithms are these and how is location determined in each one?

4.26.1.

4.27. Regarding indoor location techniques (signal properties), describe how the solution RSSI works.

4.27.1.

4.28. Regarding indoor location techniques and in particular signals properties and location algorithms (signal property), how do you compare AOA and TOA with respect to the measurement metric, and their pros and cons?

4.28.1.

4.29. Regarding indoor location techniques and in particular signals properties and location algorithms (signal property), how do you compare TDOA and RSSI with respect to the measurement metric, and their pros and cons?

4.29.1.

4.30. Regarding indoor location techniques and in particular and signals properties and location algorithms (positioning algorithm), how do you compare triangulation and trilateration with respect to the signal property, and their pros and cons?

4.30.1.

4.31. Regarding indoor location techniques and in particular and signals properties and location algorithms (positioning algorithm), how do you compare proximity and scene analysis/fingerprinting with respect to the signal property, and their pros and cons?

4.31.1.

4.32. Regarding indoor location techniques, what are the indoor location technologies used?

4.32.1.

5. adaptability

5.1. Consider the notion of adaptability. Present its definition and give some examples.

5.1.1. Adaptability is a feature of a system or of a process. quality of being adaptable; a quality that renders adaptable. variability in respect to, or under the influence of, external conditions. Adapting to a slow internet connection.

5.2. **It is well known that static partitioning fails to account for the variability inherent in mobile and pervasive computing environments. Present five cases that justify the previous sentence.**

5.2.1. Static partitioning fails to account for the variability inherent in mobile and ubiquitous/pervasive computing environments:
• wireless network quality can change by one or more orders of magnitude as users move
• mobile devices may become disconnected from the fixed infrastructure
• shared computational resources in the cloud may become overtaxed
• nearby computational resources may become available for opportunistic usage
• resources available to different mobile devices can vary substantially from platform to platform
• battery/energy/cellular bandwidth are limited resources and may need to be consumed within a budget
• application demand and user workloads may change over time

5.3. **Consider the need of a mobile/ubiquitous system to adapt automatically to the context. Present an example in which the high speed at which a system is capable to adapt is good and another example in which such high speed is not good.**

5.3.1. Changing lightlevel, conection to server is unsable and app stops working when connection is lost

5.4. **Consider the notions of mobile-transparent and mobile-aware applications and the following sentence: "This approach aims to enable applications to actively adapt to the conditions of mobile environment". To what notion (from the previous two) does this sentence applies? How is transparency achieved if the other notion is followed?**

5.4.1.

5.5. **Consider a system that, for adaptability purposes, supports computation offloading from a mobile device to a server on the cloud in run-time, i.e. while an application is running. Assuming that the application is written in Java, can this be done without modifying the java virtual machine?**

5.5.1. Java Virtual Machines and other managed run-times are designed to be portable across many different types of computer hardware

5.6. **For service discovery, the SLP (Service Location Protocol) is a possible solution. What is the mechanism that is used to deal with misbehaved service agents that do not unregister the service when it is no longer offered?**

5.6.1.

5.7. **Consider the following statement: "Applications can be automatically adapted to the varying conditions of mobile environments by exclusively fine-tuning the operating system; thus, no changes are required to the source code of applications." Do you agree with this statement? Illustrate your viewpoint with an example.**

5.7.1. oblivious to application semantics • global/equal solutions to all • implications with OS portability • no application awareness

5.8. A possible solution to deal with the lack of networking while allowing the user to keep on working with his mobile device is provided by the system Rover. a. What are the two most relevant techniques proposed by Rover? How do they work? b. Does Rover handle conflicts? Describe a scenario in which such a conflict situation may arise and explain how Rover deals with it.

5.8.1.

5.9. What type of variations in the resources must be taken into account?

5.9.1. qualitative (e.g., network connection or disconnection, specific devices such as printers in the device neighborhood, consistency and security constrains), or • quantitative aspects (e.g., amount of usable bandwidth, memory available)

5.10. What resources should a system be made adaptable to?

5.10.1. system: network, energy, CPU, memory, etc. • environment: luminosity, temperature, etc.

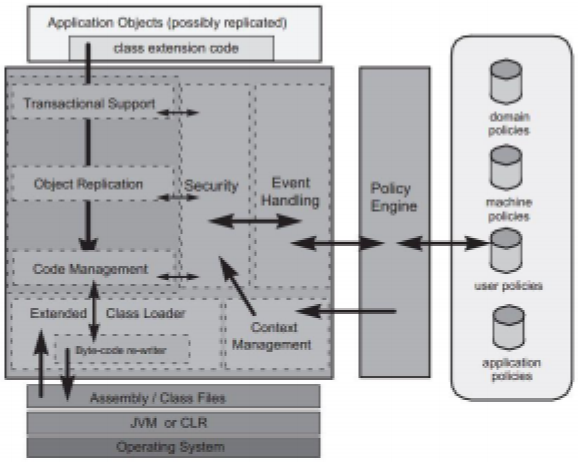
5.11. How can we measure the effectiveness of adaptability mechanisms? Explain what each one is.

5.11.1. User satisfaction •
“Dirac/Spike” changes on resources availability •
Speed to react •
System stability •
Portability of the solutions •
Resource usage of the adaptability solutions

5.12. At what level should the adaptability solution be implemented? What are the pros and cons of each one?

5.12.1. Operating system:
• oblivious to application semantics
• global/equal solutions to all
• implications with OS portability
• no application awareness
Middleware:
• common mechanims can be reused
• interaction with applications to be semantic aware
• portable
Application:
• semantic aware
• specific for each application
• not portable for different applications

5.13. Describe the following figure (possible generic Architecture for Adaptability) and explain its components.



5.13.1.

5.14. What kind of policies can be envisaged? Explain each one.

5.14.1. Replication and transactions/sessions

5.15. Why is the term "sessions" used instead of "transactions"?

5.15.1. Given that mobile environments are highly dynamic nodes enter and leave network communication links are more prone to failures, and disconnections are frequent. No longer typical transactions. We call it sessions.

6. Cyberforaging

6.1. What is cyber-foraging? Give examples.

6.1.1. Cyber foraging is a pervasive computing technique where resource-poor mobile devices offload some of their heavy work to stronger surrogate machines in the vicinity. Phone connecting to server to do resource intensive task like a big query from a database

6.2. Explain what are the concepts behind the notions of thin-client and thick-client.

6.2.1. Thin-client mode:
• all computation/data access is performed at the fixed infrastructure
• the mobile device operates only as a terminal
Thick-client (or fat) mode:
• the computation/data are hosted on the mobile device
• wireless networks are used only to fetch inputs not available locally

6.3. What are the potential benefits of cyber-foraging? Explain each one carefully.

6.3.1. There are many reasons why an application may benefit from:
• executing a computation or storing data on remote infrastructure instead of or in addition to the mobile computer on which it is currently executing
• better performance, more storage, less battery used, app fidelity

6.4. Taking into account the concept of cyber-foraging, present the definition of fidelity.

6.4.1. the degree to which the results produced by an application match the highest quality results that would be produced given ample computational resources

6.5. In the scope of cyber-foraging, complete the following table using only: "High", "Low", "Large", "Small", or N/A.

Factor	Favorable for remote execution	Favorable for local execution
Network bandwidth		
Network latency		
Disparity between compute resources		
Granularity of computation		
Parallelism in computation		
Memory/storage requirements		
Size of inputs/outputs		
Load on remote computers		
Wireless network power		
Sensitivity of activity		

6.5.1.

6.6. Consider a cyber-foraging scenario in which the computation is not asynchronous and is on the critical path of the application. When is performance improved?

6.6.1. Unless the computation is asynchronous and not on the critical path of the application, performance is improved only if the:
- time saved by performing the computation remotely is greater than
- the time spent communicating inputs and outputs at the start and end of the computation

6.7. Consider the several offloading solutions from a mobile device to the cloud, to support augmented execution for mobile phones: a. What augmented execution refers to? b. One of the solutions is called background augmentation: i) describe what it consists in, and ii) provide an example illustrating its usefulness.

6.7.1. Augmented Execution is the technology which focuses on alleviating the limitations of resource-constrained smartphones by using the method of computation offloading.

6.8. Consider an application P running on mobile device A. Take into account the mechanism that supports the partitioning of P in such a way that, when P is running, some of P's objects are relocated to another computer B in the cloud. What is the main concern (related to object invocation) that we must have so that the partitioning has a minimum negative performance impact on P?

6.8.1.

6.9. What is partitioning?

6.9.1. Given a specific application state and a specific computational environment, which portions of the application should run on the mobile computer and which should run on remote infrastructure?

6.10. When partitioning, after choosing the metrics and constraints that express the goals for partitioning, what must be done? What are the restrictions for partitions?

6.10.1.

6.11. Give examples of partitioning.

6.11.1.

6.12. Regarding managing issues of cyber-foraging, mention the factors that impact the location decision. What are the several options regarding location?

6.12.1. network latency and bandwidth, ease-of-management, cost, and privacy concerns
deploying surrogates as close to the edge of the network as possible, • use of dedicated computers in a data center, and • opportunistic use of computers in a data center

6.13. Provide examples in which the latency of the network is relevant and makes the option for having the code close to the edge a good option.

6.13.1. Online games

6.14. Cyber-foraging systems measure network supply (i.e., the available bandwidth and latency) through a variety of strategies. Which are these ones? Explain each one.

6.14.1. active measurement,
passive measurement, or
a combination of the two
passive measurements observe traffic sent over the network for other purposes:
• they do not inject additional traffic
• this conserves both battery energy and cellular network usage
• however, passive measurements may become stale if the mobile computer does not send or receive data for a time
Active measurements:
• inject traffic into the network solely for the purpose of measuring the network performance
• provide more recent data

6.15. In cyber-foraging, the Network Measurement and Estimation has several challenges. Say what these are and describe them.

6.15.1. First challenge - measuring CPU supply and demand: • such measurements must be performed on both the mobile computer and the remote server(s) used in cyber foraging
Second challenge - arises from the distributed nature of cyber foraging • The partitioning decision is made on one computer (often, but not always the mobile computer) using as an input the CPU load of other computers •

Thus, when a partitioning decision arises: • the cyber foraging system could potentially query all other computers that might participate in the computation for their current CPU load • Unfortunately, this involves a network round trip: • if the computation being considered is relatively small, the extra time to perform the query of remote state could add an unacceptable overhead relative to the compute time • the opposite is also true: if the computation is long-running, then the relative overhead of a network round-trip may be insignificant

6.16. Say if you agree with the following sentence and justify: ”The supply of battery energy is one of the simplest resource values to measure and estimate while the demand for battery energy is one of the most difficult”. Justify your answer.

6.16.1. The supply of battery energy is one of the simplest resource values to measure and estimate: • the supply of battery energy is just the amount of charge remaining in the battery • most mobile computers provide standard interfaces for querying this value • The demand for battery energy is one of the most difficult: • it is the amount of battery energy consumed by a particular computation

6.17. Direct measurement of battery usage has two main drawbacks. Say what these are and justify.

6.17.1. Direct measurement has two drawbacks:

• if more than one activity occurs simultaneously, it is difficult to separate the energy cost of each activity

• Spectra adjusts for this issue by discarding all energy demand measurements in which operations executed concurrently

• many mobile computers do not provide fine-grained measurements of battery capacity

6.18. Many cyber-foraging systems use a model-based approach to estimate energy demand. Explain what this is.

6.18.1. Many cyber foraging systems use a model-based approach to estimate energy demand: • executes a series of micro benchmarks on the mobile computer in a laboratory setting • while an external power measurement device measures how much energy the computer expends executing those benchmarks • an energy model is constructed using the results of these experiments

6.19. Regarding cyber-foraging, there are also other aspects to consider when talking about resource estimation such as File Cache Measurement and Estimation, Errors During Partitioning, and Replication. Explain what these are.

6.20. What kind of tasks are the best suited for cyber-foraging?

6.20.1. The tasks best suited for cyber foraging are compute-intensive • Such tasks benefit most from remote execution, and they therefore offer the best opportunity to recoup the costs of sending state over the wireless network

6.21. **Regarding cyber-foraging, the location of surrogates can be where?**

6.22. **Regarding cyber-foraging, what is a cloudlet? What can it provide? What is the underlying vision and where could it be deployed?**

6.23. **Regarding cyber-foraging, w.r.t. security, the isolation of operations is of paramount relevance. How is this typically done?**

6.24. **Regarding cyber-foraging, what is sandboxing, what are its functions and its goals?**

6.25. **Regarding isolation in cyber-foraging, there are process isolation, application VM, and hardware VM. Compare them regarding safety, flexibility, transparency, overhead, and start-up time.**

6.26. **Explain and describe the concept of data staging.**

7. Replication

7.1. **The replication model differs from device-side caching in a number of key ways. Mention two of them and explain their meaning.**

7.1.1. a whole or partial data collection is copied onto a device at one time, rather than as individual objects are accessed, and explicitly refreshed periodically through a synchronization protocol
• attempts to read a data object fail if the data is not resident on the accessing device, rather than resulting in a cache miss and a remote access to the master
• data objects are implicitly added to a device's replica when new objects become part of the replicated data collection
• when a device deletes a replicated object, that object is removed from the data collection and all of its other replicas, rather than simply being discarded from the device's local storage

7.2. **Give some examples of applications that illustrate the use of replication.**

7.2.1. Offline Google drive, offline spotify,

7.3. **Compare the approaches of "Remote Data Access" and "Master Replication".**

7.3.1. Remote data access:
• information on a server machine from which it can be remotely fetched by mobile and wireless devices (thin-client)
Master replication:
• authoritative copy resides on a master site
• caching or replication is used

7.4. **In a master replication model, what component is responsible for detecting when two devices produce conflicting updates? Can all such conflicts be solved automatically?**

7.4.1. in some cases, the master may be able to automatically resolve conflicts that arise, whereas in other cases, such conflicts may require human attention

7.5. **How do you compare the several solutions for accessing data (remote access, device caching, master replication, etc.) with respect to devices, data, reads and updates?**

7.6. **In a replicated system, what is consistency?**

7.6.1. Having things be the same as the state in master.

7.7. **Regarding consistency, what is the notion of: weak/best effort/eventual/causal /bounded/VFC/session?**

7.7.1. Algorithms

7.8. **As introduced by Bayou, what is a session? Does a session correspond to an atomic transaction?**

7.8.1. A session is an abstraction for the sequence of read and write operations performed during the execution of an application. Sessions are not intended to correspond to atomic transactions that ensure atomicity and serializability

7.9. **Consider the session guarantee Monotonic Writes/or any other of those presented. At what instants (Write or Read operation) is the session state: i) updated, and ii) checked. Justify your answer.**

7.9.1.

7.10. **Take into account the notion of best effort consistency. Indicate four situations in which, even with reliable delivery, replicas will not converge.**

7.10.1. updates are performed differently at different replicas (i.e., the application of an update is not deterministic)
• updates are applied in different orders at different replicas and are not commutable
• replicas have different conflict resolution policies
• metadata, such as deletion tombstones, are discarded too early
• replicas lose or corrupt data, such as when a replica is restored from an old backup
• the system is improperly configured, such as when the synchronization topology is not a well-connected graph

7.11. **Consider the various session guarantees that are possible under a distributed system with a database replicated on multiple servers (e.g. Bayou). Such system is used in a scenario of a company that sells several models of tires and whose sellers, each one using a mobile device, can connect to any server at any moment:**
- there is a table in the database where each record is related to a tire model and its characteristics;
- each record corresponds to a specific tire model; - each field of each record in the table corresponds to a product characteristic (e.g. price, existing units, etc.);
- each one of the vendors sells only one tire model which is distinct from the others;
- the database is modified by the various vendors, such that it reflects the number of units already sold, i.e. each seller decrements/increments the

number of existing units taking into account the units sold/bought of the tire model for which he is responsible.

Which session guarantee should be applied in order to ensure that each seller always knows the exact value of existing units of the model he sells? Indicate the less demanding guarantee and justify your answer.

7.11.1.

7.12. Consider the following sentence and say if you agree (or not) and why: “Eventually consistent systems make no guarantees whatsoever about the freshness of data returned by a read operation”. Give an example that illustrates your answer.

7.12.1. readers are simply assured of receiving items that result from a valid update operation performed sometime in the past • e.g. a person might update a phone number from her cell phone and then be presented with the old phone number when querying the address book on her laptop

7.13. Consider the following sentence and say if you agree: the session guarantee "Read your Writes" guarantees that, in every copy of the database, Writes made during the session are ordered after any Writes whose effects were seen by previous Reads in the session. Justify your answer.

7.13.1. This guarantee ensures that: • the effects of any Writes made within a session are visible to Reads within that session • thus, Reads are restricted to copies of the database that include all previous Writes in this session. RYW-guarantee: • if Read R follows Write W in a session, and • R is performed at server S at time t, then • W is included in DB(S,t) • Applications are not guaranteed that: • a Read following a Write to the same data item will return the previously written value • in particular, Reads within the session may see other Writes that are performed outside the session

7.14. Consider a user editing a replicated file in his laptop. When a file is saved, it is stored at a server; then, the system is responsible to propagate the new file version to other servers. The system should ensure that if the user saves version N of the file and later saves version N+1, then version N+1 will replace version N at all servers. Thus, the following situation must be prevented: version N is written to some server and version N+1 is written to a different server, and both versions get propagated such that version N is applied after N+1. What is the most adequate session guarantee?

7.14.1.

7.15. One of the possible techniques to deal with network connection loss (or weak connectivity) is based on replication and it is designated staging. Taking into account this technique, how much does it depend on the correctness of the working set that is replicated? How does this technique deal with the case in which the user tries to access a file that is not staged? Describe what security aspects are considered and how they are dealt with.

(Draw a figure that shows how the system works to better explain your answer.)

7.15.1.

7.16. Consider the technique designated hoarding which is applied in the following scenario: a user carries his laptop to a place where either the network is non-existent, too expensive, or too slow, and he still wants to continue the work he was doing immediately before leaving his office (where his laptop was well connected to the fixed network). In this scenario, how effective would be a hoarding solution that is based on the last recently used policy?

7.16.1.

7.17. Consider the session guarantee Read Your Writes. Does this session guarantee affect the users outside the session under consideration?

7.17.1.

7.18. Consider the following scenario. A user's appointment calendar is stored online in a replicated database where it can be updated by both the user and automatic meeting schedulers. The user's calendar program periodically refreshes its display by reading all of today's calendar appointments from the database. If it accesses servers with inconsistent copies of the database, recently added (or deleted) meetings may appear to come and go unless a session guarantee prevents that from happening. What is the weakest session guarantee that should be used?

7.18.1.

7.19. Consider the four session guarantees presented from Bayou. Explain each one and provide an example.

7.19.1.

7.20. To ensure that the Bayou guarantees are meet, what can the servers do?

7.20.1.

7.21. In the Bayou system do you agree with the following? "The term database is not meant to imply any particular data model or organization, nor are the techniques specific to any data model". Justify your answer.

7.21.1. The term "database" is not meant to: imply any particular data model or organization, nor are the techniques specific to any data model
A database is simply a set of data items, a data item can be anything from a conventional file to a tuple in a relational database

7.22. Bayou assumes that the underlying replicated system provides eventual consistency and thus includes mechanisms to ensure two properties. What properties are these?

7.22.1. We assume that the replicated system provides eventual consistency and thus includes mechanisms to ensure these two properties as follows:
• Writes are propagated among servers by a process called anti-entropy, also referred to in some papers as rumor mongering, lazy propagation, or update dissemination

• anti-entropy ensures that each Write is eventually received by each server

• i.e, for each Write W there exists a time t such that W is in DB(S,t) for each server S

7.23. The implementations of the session guarantees require only minor cooperation from the servers that process Read and Write operations. Specifically, what information must a server be willing to provide?

7.23.1. Specifically, a server must be willing to return information about the:
• unique identifier (WID) assigned to a new Write,
• the set of WIDs for Writes that are relevant to a given Read, and
• the set of WIDs for all Writes in its database

7.24. For each session, the session manager maintains two sets of WIDs; which sets are these?

7.24.1. read-set = set of WIDs for the Writes that are relevant to session Reads
write-set = set of WIDs for those Writes performed in the session

7.25. Regarding the support for "Read your Writes", there are two basic steps. Which are these two? Where could these checks be done?

7.25.1. • whenever a Write is accepted by a server, its assigned WID is added to the session's write-set • before each Read to server S at time t, the session manager must check that the write-set is a subset of DB(S,t)

7.25.2. on the server by passing the write-set to it, or • on the client by retrieving the server's list of WIDs

7.26. Regarding the support for "Monotonic Reads", there are two basic steps. Which are these two?

7.26.1. before each Read to server S at time t, the session manager must ensure that the read-set is a subset of DB(S,t)
• after each Read R to server S, the WIDs for each Write in RelevantWrites(S,t,R) should be added to the session's read-set

7.27. Regarding the support for "Writes Follows Reads", there are two basic steps. Which are these two?

7.27.1. • each read R to server S at time t results in RelevantWrites(S,t,R) being added to the session's read-set
• before each Write to server S at time t, the session manager checks that this read-set is a subset of DB(S,t)

7.28. Regarding the support for "Monotonic Writes", there are two basic steps. Which are these two?

7.28.1. • in order for a server S to accept a Write at time t, the server's database DB(S,t) must include the session's write-set
• also, whenever a Write is accepted by a server, its assigned WID is added to the write-set

7.29. What is a version vector?

7.29.1. A version vector is a sequence of pairs, one for each server

7.30. What version vector is maintained in each server?

7.30.1. Each server maintains its own version vector with the following invariant:

• if a server has in its version vector, then it has received all Writes that were assigned a WID by server S before or at logical time C on S's clock

7.31. How can a set of WIDs be replaced by version vectors?

7.31.1. Replacing set of WIDs by Version Vectors

• To obtain a version vector V providing a representation for a set of WIDs, Ws:

• set V[S] = the time of the latest WID assigned by server S in Ws (or 0 if no Writes are from S)

• To obtain a version vector V that represents the union of two sets of WIDs, Ws1 and Ws2:

• first obtain V1 from Ws1 and V2 from Ws2 as above

• then, set V[S] = MAX(V1[S], V2[S]) for all S

• To check if one set of WIDs, Ws1, is a subset of another, Ws2:

• first obtain V1 from Ws1 and V2 from Ws2 as above.

• then, check that V2 "dominates" V1, where dominance is defined as one vector being greater or equal to the other in all components

• With these rules, the state maintained for each session compacts into two version vectors:

• one to record the session's Writes, and

• one to record the session's Reads

7.32. Describe how a client can find a suitable server?

7.32.1. To find an acceptable server:

• the session manager must check that one or both of these session vectors are dominated by the server's version vector

• Which session vectors are checked depends on the operation being performed and the guarantees being provided within the session

• Servers return a version vector along with Read results to indicate the relevant Writes:

• in practice, servers may have difficulty computing the set of relevant Writes

• 1) determining the relevant Writes for a complex query, such as one written in SQL, may be costly

• 2) it may require servers to maintain substantial bookkeeping of which Writes produced or deleted which database items