Department of Computing

**Hong Kong Polytechnic University**

**Comp 5527 Mobile Computing and Data Management**

**Tutorial One Sample Solutions**

Q1: Sample Solutions:

* ***Mobile*** is the ability to be on the move (without be constrained to a fixed location). A mobile device is anything that can be used on the move, ranging from laptops to mobile phones. Mobile doesn’t only mean being remote.
* ***Wireless*** refers to the transmission of voice and data over radio waves. It allows an entity to communicate with other entities in the network without requiring a physical connection to the network. Wireless devices include anything that uses a wireless network to either send or receive data.
* Wireless networks can be accessed from mobile devices as well as in fixed locations. In most cases, *wireless is a subset of mobile*.

*Mobile and wireless* applications must be tailored to the characteristics of the device and the environment that they run on, which include mobility, limited resources and power, low network bandwidth, intermittent connectivity, and reduced security.

*Wireless applications that are not mobile* use fixed wireless networks, which provide network access in a fixed environment. WLAN is an example, which is often used by business and home users to avoid having to install network cables throughout their buildings. Another example is network access via satellites.

On the other side, we have *applications that can be mobile without being wireless*. They can be used on the move and do not have wireless connectivity. For these mobile applications, data is often synchronized using a fixed connection and stored on the device for use at a later time. It is worthwhile to note that even though these applications do not require wireless connectivity, they can often benefit from it when it is available.

* **Pervasive computing** (also called ubiquitous computing) refers to a computing environment *saturated* with computing and communication capability, while at the same time gracefully integrated with human users so that it becomes invisible and “disappear”.

There are many critical elements of pervasive computing, including handheld and wearable computers, wireless networks, devices to sense and control computing equipment, and human-computer interactions. In particular, *mobile computing is essential for pervasive computing*. Since motion is an integral part of everyday life, pervasive computing must support mobility; otherwise, a user will be acutely aware of the technology by its absence when he/she moves. Therefore, the research agenda of pervasive computing subsumes that of mobile computing, but goes further (see reference paper posted on the WebCT home page).

Q2: Sample Solutions:

* Bluetooth is a WPAN technology providing universal radio interface for ad-hoc wireless connectivity. It is used for interconnecting computer and peripherals, handheld devices, PDAs, cell phones – replacement of IrDA. It has the following features:
  + Short range (<10 m),
  + Low cost (US$5 /device)
  + Low power consumption,
  + License-free 2.4 GHz ISM,
  + Voice and data transmission,
  + Approx. 1 Mbit/s data rate
* A **piconet** is an ad hoc connection of Bluetooth devices which are synchronized to the same hopping sequence. One device in the piconet can act as *master* (M), all other devices connected to the master must act as *slaves* (S).
  + Each piconet has 1 master and up to 7 simultaneous slaves. *Why eight active devices*? – 3 bit *active device address* assigned by the master.
  + In addition to active devices, two additional types of devices exist: *parked devices* (P) can not actively participate in the piconet (i.e., they do not have a connection), but are known and can be reactivated; *stand-by devices* (SB) do not participate in the piconet.
  + > 200 devices could be *parked*. If a parked device wants to communicate and there are already 7 active slaves, one slave has to switch to park mode.
* Bluetooth uses *FHSS / time-division* – each device performs frequency hopping with 1600 hops/s in a pseudo random fashion; within each slot the master or one out of slaves may transmit data in an alternative fashion. Each piconet has a unique hopping pattern among 79 channels, each of 1MHz bandwidth (2.402 GHz, 2.403 GHz, …, 2.480GHz). All active devices in the piconet share the same 1 MHz channel. Participation in a piconet means the synchronization to the hopping sequence. *The master determines hopping pattern, slaves have to synchronize to this pattern*.
* Initially all devices are stand-by before a piconet is formed. All devices have the same networking capabilities, i.e., they can be master or slave. The device establishing the piconet automatically becomes the master, all other devices will be slaves.
  + The master sends its device ID and clock to slaves.
  + The hopping pattern is determined by the device ID (48 bit MAC address, unique worldwide)
  + The phase in the hopping pattern is determined by the master’s clock (28bit, frequency of 3.2 kHz, 24 hours per cycle). After adjusting the internal clock according to the master, a device may participate in the piconet.
  + The master and a slave communicate by sending message alternatively. A slave can send message only after it receives a message from the master (i.e., the master allocated time slots to slaves using polling).
  + All active devices are assigned a 3-bit active member address (AMA).
  + All parked devices use an 8-bit parked member address (PMA).
* Many piconets with overlapping coverage can exist simultaneously and form a scatternet. All piconets in the same scatternet use a different hopping sequence, always determined by the master of the piconet. If a device acts as masters in two piconets, it would lead to identical behavior as both piconets would have the same hopping sequence – consequently the communications of the two piconets will cause conflict to each other.

If a device acting as slave in one piconet wants to participate in another piconet, it simply starts to synchronize with the hopping sequence of the piconet it wants to join. After synchronization, it acts as a slave in this piconet and no longer participates in its former piconet (Why, as it has only one transceiver). Before leaving one piconet, a slave informs the current master that it will be unavailable for a certain amount of time. A master can also leaves its piconet and acts as a slave in another piconet. A soon as the master leaves its piconet, all traffic within this piconet is suspended until the master returns.

Communication between piconets is achieved through devices jumping back and forth between the piconets.