Problem 1:

One application of wireless which I think can be extremely useful and interesting around year 2030 is detecting the vital signs like respiration rate and heartbeat of people through wireless microwaves radar sensors. Let's say we want to detect human life are at an earth quake site and there are people who have got stuck inside the rubble. Its working principle is very simple. It works in a way that when a microwave beam of certain frequency is aimed at a portion of rubble (or) collapsed building under which a person has been trapped, the microwave beams penetrates through the rubble and then are reflected back. These reflected waveforms are modulated due to human heart beat and human rate. Now, if we correctly demodulate the waves, we can check that if a living person exists in the proximity or not. Also, the effect of waves reflected back from the rubble or any other non living human being needs to be cancelled during demodulation for proper detection purpose. Research is going on, on the algorithmic side on this type of application but physical implementation of such devices is difficult and is achieved by very few firms. Through these microwaves non contact sensors can also be used to keep track of patient's vital signs.

Problem 2:

Main Features and Key differentiators:

1G:

* Introduced in early 1980s.
* 1G technology was only able to transfer voice data using analog transmission techniques and only landlines were used at that time. Analog devices were heavy, power inefficient and expensive.
* Uses the standards like AMPS, NMT and TACS. All of these standards are frequency modulation techniques for data/voice transfer.
* Network was divided into small cell and each cell had different frequency. This is the reason why frequency could be reused and this increased system capacity.
* Spectrum was divided into number of channels and each user was allotted a separate channel that is why this generation supported only 1 user/channel.
* Large guard bands were used to avoid interference.

2G:

* Introduced in early 1990s.
* 2G technology used digital data transmission. This enabled voice data to be compressed and hence resulted in more voice capacity. Digital devices were light, power efficient, cheap and the data was more secure.
* Uses Standards like TDMA and CDMA. In TDMA same frequency is used by the cells but the time slots are divided. In CDMA same frequency and time slots are used but the data transmitted by the base station is multiplied by some code. Now only that user can access this code who has got the same code as with the data is coded. When 2G got a little advanced, GPRS was introduced. With the advent of GPRS, packet switching was introduced which made the access of internet easier, which was not possible with circuit switched networks.
* This network supported more than one user per channel.
* Mobile voice service and other simple data services to more people were provided with less number of base stations.
* Large guard bands were still used to avoid interference.

3G:

* Introduced in early 2000s.
* It's a combination of wireless and internet. One network for voice and other for IP was used. Used standard like CDMA2000/EV-DO,WCDMA/HSPA+, TD-SCDMA.
* Data rate was optimized. Data transfer rate was at least 200kbit/s. Later 3G was further transformed and supported data rates of several Mbit/s. 3G allowed users to access even more advanced services and application with higher capacity.
* Due to higher order modulation enabled packing of data 50% more into packages.
* Channels of higher data rates were aggregated and this increased peak data rates.

4G:

* Introduced in early 2010s.
* It is based on standards like LTE and LTE advanced. Connects a user faster and in real time.
* Key technologies used were MIMO(multiple antennas at the receiving and transmitting end) and OFDM(manages channel distortion and ISI). Due to these two technologies >100Mbit/s of broadband data is provided to mobile users and is still evolving for data capacity by enhancing Shannon's law.
* 4G is boosted 3G. It is based on UMTS 3G technology.
* Due to MIMO spatially separated paths are created and then channels are aggregated for higher data rates.