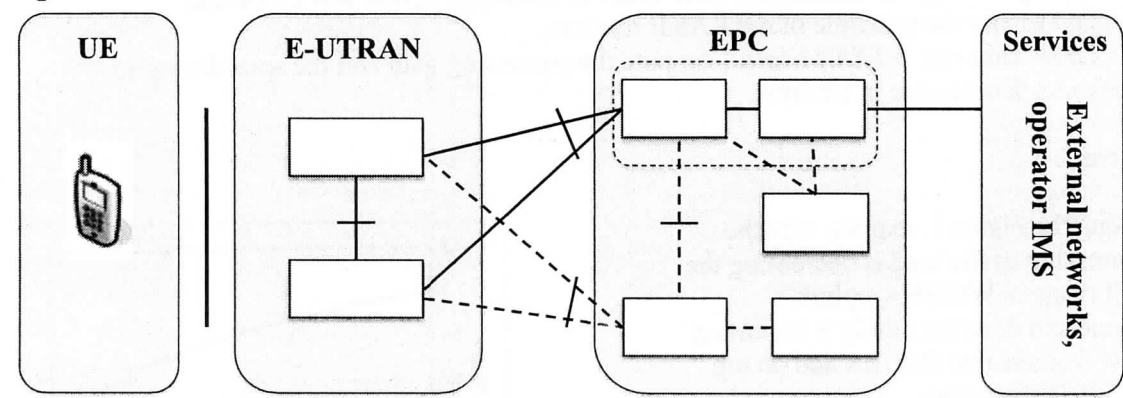


**Problem 4.** Write the abbreviations of the LTE network architecture elements in right places in the Figure 2. Then describe related functions of the elements (see guidance below). MME = Mobility Management Entity, S-GW = Service GateWay, P-GW = Packet data network GateWay, PCRF = Policy and Charging Resource Function, HSS = Home Subscription Server

Figure 2.



eNode B and MME: Describe main functions in details  
 S-GW, P-GW, PCRF, HSS: Describe main functions very briefly  
 Uu, X2, S1-U, S1-MME: Describe main functions very briefly

**Problem 5.** In Figure 3 (see page 3) the LTE link spectral efficiency is given as a function of Signal to Interference and Noise ratio. The curve with crosses (x) is related to 2x2 MIMO transmission while curve marked by circles (o) is related to 4x4 MIMO transmission. The LTE bandwidths and numbers of resource blocks for different band options are given in Table 1.

- Using Figure 3 define what is the maximum data rate (in bits/s) for 2x2 and 4x4 MIMO in 1.4MHz and 20MHz deployments.
- User with SINR = 12.5dB and 4x4 MIMO is served. How many RBs are needed when user data rate should be at least 10Mbit/s?
- Scheduler allocates for the user 4 RBs. What is the data rate of the user with 2x2 MIMO if SINR=7.5dB. How much rate is increased if 4x4 MIMO is used instead of 2x2 MIMO?

Bandwidth	1.4MHz	10MHz	20MHz
Total bandwidth for RBs	1.08MHz	9MHz	18MHz
Resource Blocks (RBs)	6	50	100

Table 1.