Your mobile phone company has been selected to build a CDMA (IS-95) network to cover urban and suburban areas. You may use the following data:

- BTS antenna gain: 16 dBi
- MS antenna gain: 0 dBi
- Receive Cable Connector loss: 2 dB
- Noise figure: 8 dB
- Grade of Service: 2%
- Maximum system temperature: 290° Kelvin
- No. of VLR within MSC area: 1
- Population growth rate per year: 0.04
- Roll out time in years: 6
- Your company’s market share: 40%
- Maximum power of terminal: 200 mw
- Maximum power of BTS: 20 W
- Allowable $E_b/N_0$: 5 - 7 dB
- Max. Rise: 5 dB
- 3-sector cell with sector efficiency: 0.85
- Allow 15% cell over-lapping for cell breathing

**Urban Area**

- Present population: $5 \times 10^6$
- Market penetration: 0.20
- One-way bandwidth: 5 MHz
- Average call holding: 100 seconds
- Average BHC rate: 1.0 call/subscriber
- One-km intercept: -120 dB/ mile
- Path-loss exponent: 3.63

**Suburban Area**

- Present population: $2 \times 10^6$
- Market penetration: 0.10
- One-way bandwidth: 5 MHz
- Average call holding: 120 seconds
- Average BHC rate: 0.6 call/subscriber
- One-km intercept: -110 dB/ mile
- Path-loss exponent: 3.84
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Max. Capacity</th>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSC</td>
<td>400 K BHC</td>
<td>8 BSCs</td>
</tr>
<tr>
<td>BSC</td>
<td>1000 E</td>
<td>80 BTSs</td>
</tr>
<tr>
<td>HLR</td>
<td></td>
<td>300 K customers</td>
</tr>
</tbody>
</table>

Note: Assume any other data and state all assumptions

Your design should include the following:
1. Number of BTS required in urban and suburban areas
2. Number of BSC required in urban and suburban areas
3. Number of MSC required in urban and suburban areas.
4. Number of HLR required

Refer: CDMA IS-95 and cdma2000 book
**APPROACH**

- The aim of the project is to design a CDMA (IS-95) system for a suburban and urban area. We also take into consideration the future growth and all parameters are found accordingly. We consider various concepts like link budgets, radio link capacity, facility engineering, boundary between two service providers and inter frequency handoffs.

- Design and planning a wireless network

  The planning of a wireless network is a multidiscipline task in which competing requirements are balanced. There are various trade-off which are delicately balanced to obtain the best results with the minimum cost. The designed system should also be reliable, robust and should have good QoS.

  The designed parameters should be such that future expansion in coverage area and increase in traffic along with increae in number of subscribers can be handled. Total area coverage and capacity objectives require a trade-off between the desired quality and overall network cost.

- RadioLink Design

  For any wireless communications system the first important step is to design the radio link. This determines base station density in different environments as well as the corresponding radio coverage. The transmit power of handsets will be the determining factor for a CDMA system with balanced up/down link power.

- Estimation of a cell count

  The total load of the system and load offered per user determines the total traffic. From the cell capacity and coverage area per cell, the total number of cell required for the system is determined.

  Various factors used to determine cell capacity are analytical formula’s, user information rate, QOS requirements and outage probability. Also various factors used to determine the maximum coverage of cell are the link budget, cable losses, antenna gains and the receiver noise figure. Soft handoff gain has a large impact on link budget.

  For the reverse link, the main factors to be considered is theload factor $\rho$ (in the link budget). Assymetric traffic load should be taken into consideration in link budget calculations. CDMA can trade the reverse link capacity for coverage. This is useful since usually the mobile transmission power limits the maximum cell range.
For detailed network planning, a network-planning tool should be used. A network planning has a digital map of the area to be planned.

To determine the size of a wireless network we need to know the following parameters:
1) Network Topology
2) Link Capacity
3) BSC sizing
4) MSC sizing

Cell and frequency planning in a wireless network involves:
1) Initial traffic estimation
2) Traffic growth plan
3) Initial design selection
4) Initial cell plan
5) Network expansion plan

To design a traffic plan for wireless network deals we must have information about:
1) The number of users
2) Users behavior i.e heavy users or light users
3) Busy traffic as a % of the total traffic
4) Users distribution over the service area
5) Division of the service area into zones of different traffic density

Growth of a wireless network involves:
1) Time to roll out the network
2) Requirements of additional cells