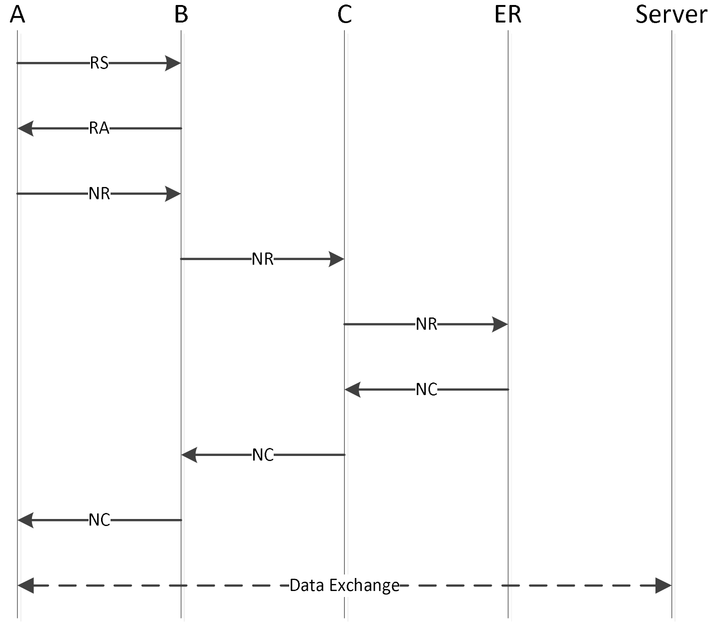
1.

a)
Router Discovery and Neighbor Registration Procedures.



b)
The prefix fe80::/10 is the link local prefix and thus can be elided. Since the interface identifiers are derived from the MAC addresses within the LoWPAN, they can also be elided.

c)
Since the communication is link-local, all that was written in b) also applies in the case of improved header compression, since it also supports stateless header compression.

2.
a)
Unlike the single carrier system, where the length of one symbol is inversely proportional to the total bandwidth B, OFDM divides the bandwidth B into N subcarriers of bandwidth $\frac{B}{N}$, demultiplexing the bitstream by those N narrowband subcarriers. An OFDM symbol corresponds to a set of N modulation symbols transmitted in parallel, one through each subcarrier. The length of these symbols (and hence the length of the OFDM symbol) corresponds to N times the length of the symbol of the single carrier system, being even longer if the cyclic prefix is taken into account. The additional length of the symbol allows multipath reflections of the previous symbol to be absorbed by a small fraction of the symbol energy in its beginning, thus mitigating ISI and improving the SNR.

b)
The duration of the OFDM symbol can be calculated as follows (assuming $r = 0$):

$$T_{OFDM} = \frac{N}{B} + Cp = 51.2\mu s + 8\mu s = 59.2\ \mu s$$

The number of single carrier symbols that fit in this duration is then:

$$M = \frac{59.2}{\frac{1}{B}} = 1184$$

c)
The cyclic prefix is added in the beginning of the OFDM symbol to help absorbing the multipath reflexions of the previous symbol. Since it is eliminated at the receiver, it is expected that a significant portion of ISI will be eliminated before demodulation, besides simplifying signal processing operations at the receiver (the cyclic prefix is a copy of the last part of the OFDM symbol, thus allows the treatment of the received symbols according to a cyclic convolution in the time domain = multiplication in the DFT domain).
The disadvantage of the cyclic prefix is the overhead, as can be concluded from b): the example OFDM system is able to transmits 1024 BPSK symbols in same time interval that could be used to transmit 1184 BPSK symbols with the single carrier system. Still, the overhead of OFDM pays off most of the time.

d)
OFDMA is similar to OFDM, but it allows groups of subcarriers to be assigned to different mobile stations, thus being a form of multiple access besides a modulation method.

3.
a)
The figure presents the number of calls that took place during one hour, as well as the sum of the respective durations. The asked quantities can thus be easily derived:

$$\lambda = \frac{97}{60} \approx 1.62\ calls/minute$$

$$h = \frac{294}{97} \approx 3.0\ minutes$$

b)
In a non-blocking scenario, the offered traffic is the same as the placed traffic. Based on this assumption:

$$A = \lambda \cdot h = 4.86\ Erlang$$

c)
With $P = 0.01$, the carried traffic would be:

$$C = (1 - P)A = (0.99)4.86 \approx 4.81\ Erlang$$

d)
The system would require 20 channels, which is able to support 9.41 Erlang.

e)
A single cell with N channels is able to support an offered traffic that is more than the double of that supported by a single cell with $\frac{N}{2}$ channels.

4.
a)
The answers will be based on the following expressions:

$$Footprint\ Diameter = \theta_{div} \times d$$
$$G_{(1pl\quad)}[\text{dBi}] = 10 \cdot log_{10}(2\pi/\theta_{div})$$

The altitude of GEO satellites is approximately 35786 km. As such:

$$\theta_{div}^{GEO} = \frac{8000}{35786} \approx 0.22\, rad$$
$$\mathrm{G}_{1plan}^{GEO}\ [dBi] \approx 14.49\, dBi$$
$$G^{GEO}[dBi] = 2 \times \mathrm{G}_{1plane}^{GEO}[dBi] \approx 28.97\, dBi$$

In a similar way, for MEO:

$$\theta_{div}^{MEO} = \frac{8000}{10000} = 0.8\, rad$$
$$\mathrm{G}_{1plan}^{MEO}\ [dBi] \approx 8.95\, dBi$$
$$G^{MEO}[dBi] = 2 \times \mathrm{G}_{1plane}^{GEO}[dBi] \approx 17.90\, dBi$$

b)
In order to simplify the calculations, the conditions of the problem allow us to consider the crude approximation that the distance between a ground station and a satellite is more or less constant (assume that the footprint diameter is not significant in comparison with the satellite's altitude) and equal to the altitude of the satellite.
In the case of GEO satellites, two hops are enough: GS to satellite and Satellite to GS. In case the distance between the GS and the satellite was 0, the delay of one hop would correspond to the transmission delay, i.e., the time interval between the beginning of transmission of the first bit, until the end of the reception of the last bit, which only depends on the number of message bits and the bitrate. Since the GS and satellite are far away, we must also sum a propagation delay component, which depends on the altitude and speed of light. The total delay for the GEO configuration is thus:

$$T^{GEO} = 2 \times \left(\frac{100 \times 8}{20000} + \frac{35786}{300000}\right) \approx 319\, ms$$

For the considered MEO system, transmission between two GSs (GS1 and GS3) located 8000 km appart, entails 4 hops: GS1 to satellite1, satellite1 to GS2, GS2 to satellite2 and satellite2 to GS3. For each hop, we have similar considerations as for the GEO case, but now we must consider the MEO altitude:

$$T^{MEO} = 4 \times \left(\frac{100 \times 8}{20000} + \frac{10000}{300000}\right) \approx 293\ ms$$

c)

In case inter-satellite links are considered, the hops involving GS2 can be replaced by one hop between the satellites. However, the distance between the satellites must now be calculated. It is said that the MEO system has global coverage around the equator and the distance between GSs is 4000 km. It is also easily deduced from the picture that the number of satellites is the same as the number of GSs. We will thus start by calculating the number of satellites of the MEO constellation, dividing the perimeter of the Earth my the distance between GSs:

$$N = \left\lceil \frac{2\pi \cdot 6371}{4000} \right\rceil = 11$$

The arc and chord between the two satellites can then be calculated:

$$\alpha = \frac{2\pi}{11}\ rad \approx 0.57$$

$$c = 2 \times r \times \sin\left(\frac{\alpha}{2}\right) \approx 9224.49\ km$$

The total delay is thus:

$$T^{MEO} = 2 \times \left(\frac{100 \times 8}{20000} + \frac{10000}{300000}\right) + \left(\frac{100 \times 8}{20000} + \frac{9224.49}{300000}\right) \approx 217\ ms$$