1. In broadcast and select network (i.e., broadcast star) capacity can be allocated dynamically. The efficiency of channel allocations depends on the structure of the nodes and the allocation scheme that is used. Consider a 4-node FT-TT network with fixed frame length. The queue in each node contain 4 frames which are:

   - Node 1 – $[1,2]_1, [1,3]_1, [1,2]_2, [1,3]_2$
   - Node 2 – $[2,4]_1, [2,3]_1, [2,4]_2, [2,4]_3$
   - Node 3 – $[3,1]_1, [3,4]_1, [3,1]_2, [3,3]_1$
   - Node 4 – $[4,1]_1, [4,2]_1, [4,1]_2, [4,3]_1$

   (in the shown order). Find out the schedules for

   (a) Tell-and-go capacity allocation; when a node has something to send, i.e., queue is non-empty, it first send a message (through a separate signalling channel) to all destination stations and then, without waiting a reply, it sends the frame in first free slot. If there is more than one frame destined to a particular destination station at the same time slot, it can tune only to a single wavelenght and receive a single frame. How many frames are lost?

   (b) Lossless scheduling; conflicts are avoided by using reservations, i.e., only one source can send a frame to a particular destination in each time slot. The First Come First Served (FCFS) queue dicipiline is maintained, i.e., the frames have to be sent in order.

   (c) Perfect scheduling; FCFS is not maintained but there is one queue for each destination in each source station and the frames can be sent out of order.

2. Consider embedding a 8-node ShuffleNet (slides 12-46 - 12-49) in a uni-directional ring WRN instead of bi-directional one.

   (a) Find a suitable wavelength assignment that enables the connectivity required by the SuffleNet topology. How many wavelengths are required?

   (b) Compare the average path lengths (hop counts) in uni- and bi-directional rings. What is the value of the spectrum reuse factor?

3. Compare two approaches in upgrading an existing single channel SDH transmission system. One approach is to install new fiber and new single channel SDH transmission systems in parallel, i.e., one channel per fiber. Another approach is to use installed fiber and upgrade its capacity using WDM technology. As there is an existing infrastructure (e.g., cabinets for repeaters or amplifiers), only the fiber installation and equipment costs have to be considered.

   Assume that installation of new fiber cable costs 1,500 euro/km and the price of the cable is 2 euro/m for 8-pair cable and 3 euro/m for 16 pair cable. Furthermore, each single channel SDH transmission line requires a repeater after each 25 km fiber span. Assume that a repeater costs 7,000 euro.

A WDM transmission system requires at each end of the system one multichannel WDM (de)multiplexer and for each channel one transponder (a WDM transponder, placed before WDM multiplexer, converts the optical signal in to a form that is suitable for WDM network), e.g., 8 transponders for 8 channel system. Furthermore, an EDFA is required after each 50 km fiber span. Assume that one transponder costs 12,000 euro and one amplifier costs 90,000 euro. The costs for 8- and 16-channel WDM (de)multiplexers are 60,000 and 110,000 euro, respectively.

Draw figures showing the logical structure of both transmission systems. At which transmission line length it becomes cheaper to install WDM based system (consider both 8 and 16 channel cases)?