Evaluation procedure

A total of 100 points are awarded. They are distributed according to the following weighting:

Part 1 – Technical exercises

- Exercise 1	10 points
- Exercise 2	11 points
- Exercise 3	3 points
- Exercise 4	5 points
- Exercise 5	3 points
- Exercise 6	11 points
- Exercise 7	13 points
- Exercise 8	6 points
- Exercise 9	6 points

Part 2 – Soft skills

- Teamwork and presentation	32 points
	100 points

Presentations

Enter the awarded points in the fields directly under the exercise and also in the evaluation summary.

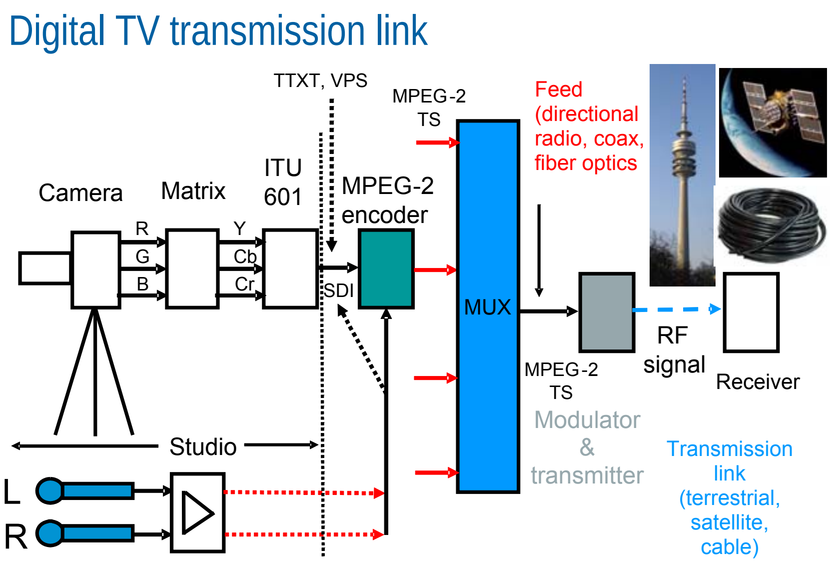
Each team has 15 minutes for the presentation. The presentation is not to be interrupted if the time limit is exceeded. In part 2 however, 0.5 points will be deducted for each extra minute.

PowerPoint or a flipchart/pin board can be used for the presentation. The groups are provided with adequate material (including paper and a presentation toolkit).

Part 1 – Technical exercises

Exercise 1 (10 points in total)

Exercise 1.1.



Block diagram, studio (2 points)
Encoder + multiplexer (2 points)
Transmission link (2 points)

Exercise 1.1.					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
6					

Exercise 1.2

Source coding methods (2 points):
Video: MPEG-1, MPEG-2 (H.262), MPEG-4 part 2 (H.263), MPEG-4 part 10 (H.264, AVC)
Audio: MPEG-1 layer I, II, III (MP3), MPEG-2 layer I, II, III, MPEG-2 AAC, MPEG4 AAC, Dolby Digital

Transmission standards (max. of 2 points for at least 4 standards):
DVB-C, DVB-S, DVB-T, DAB, ATSC, ISDB-T, DTMB, J.831B, DVB-S2, DVB-T2, DVB-C2

Exercise 1.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
4					

Exercise 2 (11 points in total)

Exercise 2.1

Interference (5 points for listing at least 5 types of interference):

- Additive interference (noise; narrowband and wideband, continuous and pulsed interference)
- Linear distortion (amplitude response and group delay)
- Nonlinear distortion
- Reflections, diversity
- Doppler effect

Exercise 2.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
5					

Exercise 2.2

Terrestrial (2 points):

- Diversity, therefore OFDM is used
- For mobile reception: Doppler effect, varying degree of fading
- Narrowband and wideband, continuous and pulsed interference

Satellite (2 points):

- Extremely nonlinear amplifiers
- Quasi-Gaussian channel, high attenuation of approx. 205 dB, therefore very poor signal-to-noise ratio

Cable (2 points):

- Extremely linear amplifiers
- For analog TV, intermodulation products visible on the screen
- Digital TV: quasi-Gaussian channel
- Only short-term echoes
- But some frequency bands are not usable (external radiation or prevention of emission, e.g. prevention of interference of airborne communications)

Exercise 2.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
6					

Exercise 3 (3 points in total)

Network-planning coverage model:

- Coverage using rooftop antenna with gain, approx. 20 dB to 30 dB (1 point)
- Coverage using external antenna, approx. 15 dB to 25 dB (1 point)
- Portable indoor reception, approx. 10 dB to 20 dB (1 point)

Exercise 3					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
3					

Exercise 4 (5 points in total)

Exercise 4.1

Net data rate: 13.2 Mbit/s, i.e. 4 programs per multiplex (2 points)

Exercise 4.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
2					

Exercise 4.2

B = 8 MHz (UHF);
SNR = 13 dB; (11 dB to 13 dB is OK)
Shannon limit from approx. 10 dB: C = 1/3 x B x SNR;
C = 1/3 x 8 x 13 Mbit/s = 34.7 Mbit/s

(3 points: correct bandwidth, correct signal-to-noise ratio, correct equation)

Exercise 4.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
3					

Exercise 5 (3 points in total)

Exercise 5.1

- Less expensive for network and service providers since multiple programs can be broadcast on one frequency channel. (1 point)

- Channel coding (error protection) improves quality of service. Even when subject to interference, clear TV reception is possible up to a certain limit (cliff effect). (1 point)

Exercise 5.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
2					

Exercise 5.2

- Use better source coding methods (MPEG-4 instead of MPEG-2) to improve quality (e.g. picture quality). Broadcast HDTV instead of SDTV. (1 point)

Exercise 5.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
1					

Exercise 6 (11 points in total)

Exercise 6.1

- Multiple inputs, transport streams or generic streams (more flexibility)
- New improved error protection (BCH and LDPC) (higher data rate)
- 256QAM (higher data rate)
- Rotated and Q-delayed constellation diagrams (less SNR needed under certain reception conditions)
- More OFDM modes (1K, 2K, 4K, 8K, 16K, 32K) (more flexibility – from good mobile reception to stationary reception at high data rates)
- Better interleaving (bit, cell, time and frequency interleavers), and therefore more resistant to burst errors and impulsive noise, better mobile reception
- PAPR reduction – reduction of the crest factor and therefore better energy efficiency, also better protection against flashover
- MISO, to prevent destructive notching during SFN operation

(Total of 8 points when an innovation plus a benefit are listed)

Exercise 6.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
8					

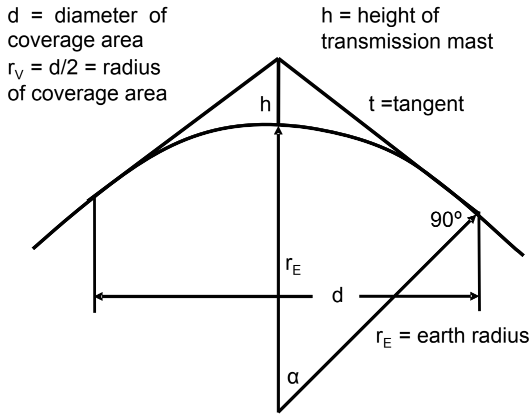
Exercise 6.2

Main arguments (3 points):

- Higher net data rate (30 % to 50 %)
- Better mobile reception possible when suitable modes are selected
- More flexibility

Exercise 6.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
3					

Exercise 7 (13 points in total)



Exercise 7.1

Derivation of the equation

Method 1: Assumption: Radius r_V of the coverage area is approximately as long as tangent t in the diagram. The antenna height h is much less than the earth radius r_E = 6370 km.

Pythagorean theorem:

$(h + r_E)^2 = t^2 + r_E^2$;

Solved for t:

$$t = \sqrt{(r_E + h)^2 - r_E^2} = \sqrt{r_E^2 + 2r_E h + h^2 - r_E^2} = \sqrt{h(h + 2r_E)};$$

Since h<< r_E, the equation can be simplified:

$$t \approx \sqrt{2hr_E};$$

It can then be further simplified:

$$r_V \approx t \approx \sqrt{2hr_E};$$

Method 2:
Circumference of the earth = 2 π r_E;
r_V = (circumference of the earth) * α / 360;
cos α = r_E / (r_E + h);

r_V = (2 π r_E) * arccos (r_E / (r_E + h));

(6 points: derivation and diagram; other methods are allowed; points deducted for unclear or inaccurate derivation)

Applying methods 1 and 2: when h = 300 m, r_V = 61.8 km; d = 123.6 km (1 point)

Exercise 7.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
7					

Exercise 7.2

Plus second rooftop antenna triangle: 11.3 km, therefore r_V = 61.8 km + 11.3 km = 73.1 km; d = 146.2 km (1 point)

Propagation time: t = x / c; if c = 3 * 108 m/s; t = 61800 m / c = 206 µs, or 73100 m / c = 244 µs (1 point)

Exercise 7.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
2					

Exercise 7.3

The distance between transmitter sites is typically in the range of 50 km to 60 km. For DVB-T, the width of the guard interval of ¼ was selected so that SFN-operated transmitter networks can be implemented for this transmitter spacing. The guard interval protects neighboring OFDM symbols against intersymbol interference caused by diversity. DVB-T2 allows much longer guard intervals, which enables the setup of nationwide single-frequency networks. (4 points)

Exercise 7.3					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
4					

Exercise 8 (6 points in total)

Exercise 8.1

- Scenario 1: Countries in which DVB-T was introduced some time ago (1 point)
- Scenario 2: Countries in which DVB-T was recently introduced (1 point)
- Scenario 3: Countries that still use terrestrial analog TV (1 point)

Exercise 8.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
3					

Exercise 8.2

- Solution to scenario 1: Attract viewers with new DVB-T2 applications (e.g. HDTV, digital audio broadcasting). (1 point)
- Solution to scenario 2: This is the most difficult scenario; there is a risk that subscribers will be annoyed or confused which would be detrimental to the changeover to digital television. Changeover, e.g. in 5 years, use new applications to attract subscribers. (1 point)
- Solution to scenario 3: This is the easiest case; these countries should make a direct change from ATV to DTV. (1 point)

For solutions 1 to 3, other creative ideas can also be awarded points.

Exercise 8.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
3					

Exercise 9 (6 points in total)

- The S/N for a DVB-T network designed for portable indoor reception (e.g. Germany) is approx. 11.6 dB (in line with the DVB-T standard). (1 point, 11 dB to 14 dB is OK)

- The noise level N at the receiver input can be determined from the following physical relationship:
  - N[dBW] = –228.6 + 10 × log(b/Hz) + 10 × log((T/°C + 273)) + F;
  - B = bandwidth in Hz;
  - T = temperature in °C;
  - F = noise figure of receiver in dB;

  The constant –228.6 dBW/K/Hz in the equation is the Boltzmann constant.
  Assume:
  - Ambient temperature T = 20 °C;
  - Tuner noise figure F = 7 dB;
  - Receiver bandwidth B = 8 MHz;

    N[dBW] = –228.6 + 10 × log(8000000/Hz) + 10 × log((20 / °C + 273)) + 7;
    0 dBm at 50 Ohm = 107 dBµV;
    0 dBm at 75 Ohm = 108.8 dBµV;
    (Derivation or equation: 2 points)

  - N = –98.1 dBm = –98.1 dBm + 108.8 dB = 10.7 dBµV; (at 75 ohms)
    (1 point, 2 dB more or less makes no difference)

    Under these conditions, the noise level at the receiver input is 10.7 dBµV.

  - For 16QAM, the minimum receiver input level needed is S = S/N [dB] + N [dBµV] = (11.6 + 10.7) [dBµV] = 22.3 dBµV; (1 point, 2 dB more or less makes no difference)

Exercise 9.1					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
5					

Exercise 9.2

Benefit: higher data rate: approx. 20 Mbit/s instead of 13.27 Mbit/s
(1 point, 1 Mbit/s more or less makes no difference; important is the assertion that a higher data rate is possible)

Exercise 9.2					
Max. no. of points	Team 1	Team 2	Team 3	Team 4	Team 5
1					