300041 - SAI - Audiovisual Services on the Internet

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 744 - ENTEL - Department of Network Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 4
Teaching languages: Catalan, Spanish, English

Prior skills

- Understand basic networking concepts such as protocol, protocol stack, network architecture, services, switching, multiplexing, network information, routing.
- Basic knowledge of IP protocols for streaming, IP telephony and video streaming over IP, which were taught in "Internet Architecture and Protocols".
- Be proficient in the use of protocol analyzers (Wireshark)
- Know and apply the principles of digital signals (sampling, quantization, coding), its parameters and its application to visual signals (sound and image).
- Knowledge of probability and stochastic processes: random variable, most common distributions (uniform, Gaussian, exponential ...)
- Knowledge of the Linux operating system at the user level and administrator: administration, software installation, system calls.

Requirements

Pre: Internet Architecture and Protocols (API)
Co: none

Degree competences to which the subject contributes

Specific:
1. CE 21 TEL. Capacidad para construir, explotar y gestionar las redes, servicios, procesos y aplicaciones de telecomunicaciones, entendidas éstas como sistemas de captación, transporte, representación, procesado, almacenamiento, gestión y presentación de información multimedia, desde el punto de vista de los sistemas telemáticos.(CIN/352/2009, BOE 20.2.2009.)

Generical:
3. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 2: Use the correct instruments, equipment and laboratory software for specific or specialized knowledge of their benefits. A critical analysis of the experiments and results. Correctly interpret manuals and catalogs. Working independently, individually or in groups, in the laboratory.

Transversal:
2. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
06 URI N2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.
### 300041 - SAI - Audiovisual Services on the Internet

#### Teaching methodology

The lectures consist essentially of magistral lessons (encouraging the active participation of the students), but also ask students to work certain parts of the course on their own (self-learning), from materials provided by the teachers (slides, use case documents / products, book chapters, etc.)

The theory concepts will be strengthened with exercises, which in many cases have the solution, thus providing a self-assessment of learning achieved in each unit and activity.

In laboratory sessions, students will have a guide for each activity in the digital campus Atenea, which must be prepared prior to the activity. The lab sessions will be conducted in the presence of the teacher.

Regarding the use of a third language (English) in the subject, it is expected to provide the material slides, documents, work practices and statements in English. The teacher's explanations in principle be given in Catalan / Spanish, but can be done in English in case of consensus with students. The subject will promote students to respond (in writing) in English, although it may do so in Catalan or Castilian.

#### Learning objectives of the subject

At the end of the course the student should be able to:
- Identify and describe the operation of the protocols, encoders and network scenarios for delivering audiovisual services over IP networks.
- Choose coders and protocols appropriate to each service (interactive and non-interactive services, in real time and non-real time, etc..) and configure their most important parameters.
- Know and understand the operating principles of lossless data compressors.
- Use software for audiovisual services (clients, servers), set it up, and configure it accordingly.
- Deploy and operate basic IP telephony services (including DNS, NATs, and interconnection with PSTN).
- Deploy and operate audio/video streaming services.
- Deploy and operate video distribution services and high quality TV over IP networks.

#### Study load

<table>
<thead>
<tr>
<th>Total learning time: 100h</th>
<th>Hours large group: 26h</th>
<th>26.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 13h</td>
<td>13.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 5h</td>
<td>5.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 56h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
Introduction to audiovisual services on the Internet

**Learning time:** 10h
- Theory classes: 2h
- Laboratory classes: 2h
- Self study: 6h

**Description:**
Summary of the course objectives and relationship with other subjects of the curriculum (0.5 h)
Review of knowledge seen in API - Internet Architecture and Protocols (1.5 hours):
- Taxonomy of Internet audio-visual services, interactive services versus broadcasting services
- Requirements network of audiovisual services: QoS (bandwidth, delay, jitter, loss)
- Protocols related multimedia: RTP, RTSP, SIP basics. NTP

**Conclusions**

**Related activities:**
- Theory: lecture (2 h) and independent learning (API review) (2 h)
- Practice: QoS and audiovisual services (2 hrs + Lab 4h independent learning - preliminary study and report)

Digitization

**Learning time:** 9h 30m
- Theory classes: 3h
- Guided activities: 0h 30m
- Self study: 6h

**Description:**
Digitization. Uncompressed codecs (3 h):
- Image (BMP, GIF, TIFF)

**Related activities:**
- Theory: lecture (3h) and autonomous learning (theory, exercises) (6 h)
- Directed activity: questionnaire (0.5 h)
## Data compression

### Learning time: 10h 30m
- Theory classes: 4h
- Guided activities: 0h 30m
- Self study: 6h

### Description:
- Introduction to lossless compression. Information Theory (1h)
- Huffman code and variants (1h)
- Based dictionary. LZW (0.5h)
- Run-Length Encoding (0.5h)
- Introduction to lossy compression: limitations of the human eye and ear, compression techniques (1h)
- Conclusions

### Related activities:
- Theory: lecture (4h) and independent learning (theory, exercises) (6h)
- Directed activity questionnaire (0.5h)

## Audiovisual codecs

### Learning time: 32h
- Theory classes: 8h
- Laboratory classes: 5h
- Guided activities: 1h
- Self study: 18h

### Description:
- Introduction to lossy codecs
  - Audio (3h):
    - Codecs based on waveform prediction (DPCM, ADPCM)
    - Vocoder (GSM, G.723.1, G.728, G.729)
    - Perceptual Encoders: MPEG Audio systems HomeCinema
    - Transport of audio codecs over IP, streaming audio
  - Image (2.5 hours):
    - Transform DCT, JPEG codec.
    - Wavelet transform, JPEG 2000 codec.
    - MJPEG video. Digital cinema.
  - Video (2.5 hours):
    - Motion Compensation
    - Codecs H.261, MPEG-1/2, H.263, MPEG-4 part 2, H.264.
- Conclusions

### Related activities:
- Theory: lecture (8h) and independent learning (theory, case studies, exercises) (8h)
- Lab: Audio Coding (2h + 4h independent learning lab - preliminary study and report)
- Lab: image and video coding (3h + 6h independent learning lab - preliminary study and report)
- Directed activity: demo of audiovisual equipment (0.5h)
- Directed activity questionnaire (0.5h)
### Interactive services - IP Telephony

<table>
<thead>
<tr>
<th><strong>Learning time:</strong> 19h</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Laboratory classes: 3h</td>
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<tr>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td>Self study: 10h</td>
</tr>
</tbody>
</table>

#### Description:
- Introduction to IP Telephony (1 h)
  - Structure, numbering, signaling and transport of the analogue telephone service.
  - Introduction to SS # 7
  - DTMF
  - Why move to IP Telephony?
  - Codecs usual IP Telephony
  - Challenges in IP Telephony solution: transport, signaling connection with RTC. Mention briefly the solution of the ITU-T H.323.
- SIP architecture (2 h)
  - Introduction to SIP: features, functions and role of DNS.
  - Examples of complete calls
  - SIP Extensions (presence, instant messaging, etc).
  - Problems in networks with firewalls and NAT.
- Interconnection with the Switched Telephone Network (1 h)
  - Numbering: E.164, ENUM
  - Introduction to H.248.1/MeGaCo/MGCP protocols. Examples of calls to / from PSTN.

#### Related activities:
- Theory: lecture (4h) and independent learning (theory, case studies, Wireshark captures, exercises) (6h)
- Lab: IP Telephony (3h) + directed activity (1h) + independent learning (4h)
- Directed activity: Visit to UPC IP Telephony system (0.5 h)
- Directed activity questionnaire (0.5 h)
**300041 - SAI - Audiovisual Services on the Internet**

### Diffusion services: Digital TV and IPTV

<table>
<thead>
<tr>
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<th>Learning time: 18h</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
<td></td>
</tr>
<tr>
<td>Laboratory classes: 3h</td>
<td></td>
</tr>
<tr>
<td>Guided activities: 1h</td>
<td></td>
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<tr>
<td>Self study: 10h</td>
<td></td>
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</tbody>
</table>

### Description:
- Introduction
- MPEG Systems Layer (1.5h)
  - Elementary Streams, Program Stream, Transport Stream
  - MPEG transport over DVB - Digital TV
  - MPEG transport over IP / RTP
- IPTV services (1.5h)
  - Introduction: services, architecture, protocols
  - Architecture of IPTV over managed networks: DVB-IP
  - Architecture of IPTV over unmanaged networks: OTT (over-the-top)
  - Advanced topics: CDNs, HbbTV, adaptive streaming (DASH)
- IP networks in television production (1h)
  - Cases of TV3, BBC, Tele5

### Related activities:
- Theory: lecture (4h) and independent learning (theory, case studies, Wireshark captures, exercises) (5h)
- Lab: IPTV (3h) + directed activity (0.5h) + independent learning (5h)
- Directed activity: information search (0.5 h)
- Directed activity: questionnaire (0.5 h)

### Course conclusions and future trends

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 1h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 1h</td>
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</table>

### Related activities:
- Lecture (1h)
### Planning of activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(ENG) PRÀCTICA QOS I SERVEIS AUDIOVISUALS</strong></td>
<td>2h</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td><strong>(ENG) QÜESTIONARI CONTINGUT 2: COMPRESSION DE DADES</strong></td>
<td>0h 30m</td>
<td>Guided activities: 0h 30m</td>
</tr>
<tr>
<td><strong>(ENG) PRÀCTICA COMPRESSION D’ÀUDIO</strong></td>
<td>1h</td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td><strong>(ENG) PRÀCTICA COMPRESSION D’ÀUDIO</strong></td>
<td>6h</td>
<td>Laboratory classes: 2h, Self study: 4h</td>
</tr>
<tr>
<td><strong>(ENG) PRÀCTICA COMPRESSION D’IMATGE I VÍDEO</strong></td>
<td>9h</td>
<td>Laboratory classes: 3h, Self study: 6h</td>
</tr>
<tr>
<td><strong>(ENG) QÜESTIONARI CONTINGUT 3: CODIFICADORS AUDIOVISUALS</strong></td>
<td>0h 30m</td>
<td>Guided activities: 0h 30m</td>
</tr>
<tr>
<td><strong>DEMO OF AUDIOVISUAL EQUIPMENT</strong></td>
<td>0h 30m</td>
<td>Guided activities: 0h 30m</td>
</tr>
</tbody>
</table>

**Description:**
Demo of audiovisual equipment

**Support materials:**
Guide

**Descriptions of the assignments due and their relation to the assessment:**
There can be questions about the activity at the questionnaires

**Specific objectives:**
Getting in touch with real equipment.
# Practice 1: Telephone IP

**Description:**
Visit/talk/demo of the UPC IP Telephony system

**Support materials:**
Guide/Talk

**Descriptions of the assignments due and their relation to the assessment:**
Questions can be asked in the questionnaires

**Specific objectives:**
Getting in touch with real equipment

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<tbody>
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<tr>
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<td>1h</td>
</tr>
<tr>
<td>Self study</td>
<td>4h</td>
</tr>
</tbody>
</table>

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# Practice 2: IPTV

**Description:**
Activity about search of information in generic searchers and specialized databases. The topic may change but will be related to Digital TV and/or IPTV

**Support materials:**
Guide/Talk

**Descriptions of the assignments due and their relation to the assessment:**
Questions can be asked in the questionnaires

**Specific objectives:**
Getting in touch with real equipment

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<table>
<thead>
<tr>
<th>Activity</th>
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<tbody>
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<td>Laboratory classes</td>
<td>3h</td>
</tr>
<tr>
<td>Guided activities</td>
<td>1h</td>
</tr>
<tr>
<td>Self study</td>
<td>4h</td>
</tr>
</tbody>
</table>

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**Search of information**

**Hours:**
- Guided activities: 0h 30m

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- **Hours:**
  - Guided activities: 0h 30m
The rating of the course will consist of:
- Midterm exam (15%)
- Final exam (25%)
- Laboratory: (30%)
- Directed activities (25%)
- Attitude and participation (5%)

For the student to be evaluated and practices directed activities, attendance is mandatory. Absences must be justified.

Exams and directed activities will be carried out individually. Lab sessions will be carried out in groups of 2 and 4 students, in the form of previous report, the work done in the lab, and a report.

**Bibliography**

**Basic:**


**Complementary:**
