Learning objectives of the subject:

The course gives a basic knowledge in QoS through metrics, algorithms, routing protocols and their application in the performance evaluation of communication systems. This course covers the principles and algorithms that arise in the QoS provision over different kind of networks, mainly in constrained wireless networks such as the infrastructureless ad hoc networks.

Learning results of the subject:
230616 - QSN - Quality of Service in Networks

- Knowledge of the main algorithms for packet forwarding and classification, scheduling, traffic shaping and policing, congestion control.
- Knowledge of the main architectures to provide QoS on the Internet.
- Ability to discuss and analyse the performance of different routing protocols.
- Ability to carry out performance evaluations of QoS-aware routing protocols in communication systems using the NS-2 simulator.
- Ability to discuss and analyse the results of a performance evaluation of routing protocols in communication systems using NS-2 simulations.
- QoS-aware routing protocols for MANETs (Mobile Adhoc Networks) and VANETs (Vehicular Adhoc Networks)
- Smart City applications involving VANETs and multimedia services.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Total learning time: 125h</th>
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</thead>
<tbody>
<tr>
<td>Hours large group:</td>
<td>26h</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>13h</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
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<tr>
<td>Self study:</td>
<td>86h</td>
</tr>
</tbody>
</table>
# Content

## 1. Introduction

**Learning time:** 9h  
Theory classes: 2h  
Laboratory classes: 1h  
Self study: 6h

**Description:**  
- Introduction. QoS architectures for the Internet: IntServ, RSVP, Diffserv.  
- Different classes of services and their QoS requirements (ftp, video-streaming).  
- Introduction to the practices to be done with the Network Simulator NS-2.

## 2. Algorithms to provide QoS

**Learning time:** 29h  
Theory classes: 6h  
Laboratory classes: 3h  
Self study: 20h

**Description:**  
- Traffic policing and traffic shaping algorithms. Leaky bucket algorithms.  
- Algorithms to provide QoS locally: Scheduling algorithms (FIFO, RR, WRR)  
- Queuing algorithms (RED, WRED, RIO, CBQ)  
- Introduction to simple network scenarios using NS-2.

## 3. Routing protocols and QoS

**Learning time:** 29h  
Theory classes: 6h  
Laboratory classes: 3h  
Self study: 20h

**Description:**  
- Classification of routing protocols in communication networks from the QoS perspective.  
- Routing protocols for ad hoc networks and QoS offered by each one: Terminology, basics and applications, characteristics of ad hoc communication, ad hoc routing protocols (AODV, OLSR, DSR, GPSR).  
- Simulation of network scenarios for different routing protocols.

**Learning time:** 32h  
- Theory classes: 8h  
- Laboratory classes: 4h  
- Self study: 20h

**Description:**  
- QoS parameters (delay, jitter delay, percentage of packet losses, throughput)  
- QoS metrics (distance, available bandwidth, delay, jitter delay, losses, load).  
- Advanced QoS metrics for ad hoc networks (path quality, link lifetime, battery lifetime, nodes' density, nodes' trajectory).  
- Measure of QoS parameters using real traces from simulations.  
- Performance evaluation of proposals of QoS-aware routing protocols compared to traditional routing protocols based only on the distance to destination.

### 5. Advanced QoS-aware routing protocols considering different QoS metrics.

**Learning time:** 26h  
- Theory classes: 4h  
- Laboratory classes: 2h  
- Self study: 20h

**Description:**  
- QoS parameters (delay, jitter delay, percentage of packet losses, throughput)  
- QoS metrics (distance, available bandwidth, delay, jitter delay, losses, load).  
- Advanced QoS metrics for ad hoc networks (path quality, link lifetime, battery lifetime, nodes' density, nodes' trajectory).  
- Confidence intervals of simulation results.
Planning of activities

LABORATORY

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 14h</th>
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EXERCISES

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>Exercises to strengthen the theoretical knowledge.</td>
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ORAL PRESENTATION

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>Presentation of a work group.</td>
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EXTENDED ANSWER TEST (FINAL EXAMINATION)

<table>
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<th>Description:</th>
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<tbody>
<tr>
<td>Final examination.</td>
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Qualification system

Final examination: 60%  
Individual assessment in the classroom: 10%  
Individual assessment in the laboratory: 30%

Bibliography

Basic:


Complementary:
