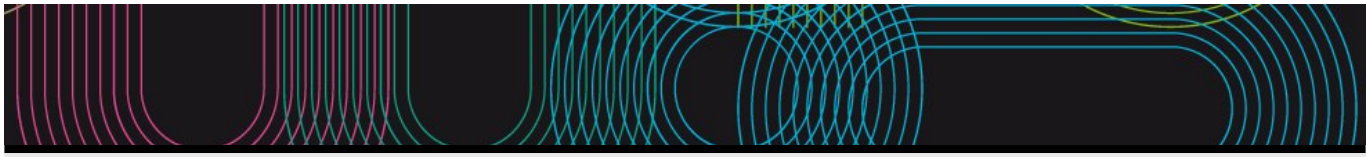

IDENTIFYING DATA				
Secure Communications				
Subject	Secure Communications			
Code	V05M175V01103			
Study programme	(*)Máster Universitario en Ciberseguridade			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Rodríguez Rubio, Raúl Fernando			
Lecturers	Fernández Iglesias, Diego Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando			
E-mail	rrubio@det.uvigo.es			
Web				
General description	This subject reviews the layers of the Internet communications architecture, showing its main weaknesses from a security point of view and providing the necessary techniques and tools to mitigate them. Students will acquire a detailed understanding of the network protocols that provide security for the transmission of information, and the implications derived from the place they occupy within the networking architecture.			

Competencies	
Code	
CB2	Students will be able to apply their knowledge and their problem-solving ability in new or less familiar situations, within a broader context (or in multi-discipline contexts) related to their field of specialization.
CB4	Students will learn to communicate their conclusions ---and the hypotheses and ultimate reasoning in their support--- to expert and non-expert audiences in a clear and unambiguous way.
CB5	Students will apprehend the learning skills enabling them to study in a style that will be self-driven and autonomous to a large extent.
CG1	To have skills for analysis and synthesis. To have ability to project, model, calculate and design solutions in the area of information, network or system security in every application area.
CG3	Capacity for critical thinking and critical evaluation of any system designed for protecting information, any information security system, any system for network security or system for secure communications.
CG5	Students will have ability to apply theoretical knowledge to practical situations, within the scope of infrastructures, equipment or specific application domains, and designed for precise operating requirements
CE1	To know, to understand and to apply the tools of cryptography and cryptanalysis, the tools of integrity, digital identity and the protocols for secure communications.
CE2	Deep knowledge of cyberattack and cyberdefense techniques.
CE4	To understand and to apply the methods and tools of cybersecurity to protect data and computers, communication networks, databases, computer programs and information services.
CE8	Skills for conceive, design, deploy and operate cybersecurity systems.
CT4	Ability to ponder the importance of information security in the economic progress of society.
CT5	Ability for oral and written communication in English.

Learning outcomes	
Learning outcomes	Competences
To know in depth the network protocols that provide security to the transmission of information, and the implications derived from the place they occupy within the networking architecture	CB5 CG1 CE1 CT4 CT5

To understand that other protocols, being auxiliary (not related to the world of security), present exploitable vulnerabilities; and will be able to describe the most common attacks that try to take advantage of them, and some possible countermeasures	CB5 CE4 CT4 CT5
Knowing which solution / protocol is appropriate to ensure a specific scene	CB5 CG1 CG3 CG5 CE1 CE2 CE4 CT4 CT5
To know the solutions providing security to certain network services and/or universally used applications	CB5 CE2 CE8 CT4 CT5
To be able to configure the tools (software packages) that the different operating systems / platforms provide to secure communications.	CB2 CB5 CG5 CT4 CT5
To acquire the ability to write technical reports justifying the suitability of a cybersecurity solution for a given problem or scene	CB4 CG1 CG3

Contents

Topic	
Internet architecture and protocols	Fundamental concepts
Link level security	Wired security/Ethernet networks: Access control and port-based authentication Confidentiality in Ethernet networks Wireless Security/WiFi networks: IEEE 802.11i IEEE 802.11w Passpoint / HotSpot2.0
Network level security	IPsec security protocols IPsec dynamic key management IPsec authentication mechanisms IPsec and NAT
Securing Internet infrastructure	Routing protocols security DNS security TCP security
Data transmission security	The TLS protocol Cryptographic suites WebPKI infrastructure Certificate validation HTTP Public Key Pinning
Mobile networks security	LTE system architecture Association and authentication of the user/terminal Privacy

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	21	42
Laboratory practical	19	19	38
Autonomous practices through ICT	0	58	58
Essay questions exam	2	0	2
Practices report	0	10	10

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description

Lecturing	Master sessions follow the usual scheme for this type of teaching. In these sessions the CG3, CE1, CE2, CE4, CE8 competences are worked out
Laboratory practical	There will be several practical sessions guided by the teachers where the concepts learned in the theoretical classes will get entrenched. Such practices, will use network devices (routers and switches) and / or virtualization software that will allow students to learn and practice at home. The practices to be considered will be sized to be approachable during their respective classroom sessions; although any student that needs so will be able to reproduce them at home with free virtualization software that will allow them to virtualize the behaviour of the network hardware used in the laboratory. Optional exercises may also be proposed, which students can do during non-attendance hours, and may review individually during office hours. Students will acquire competencies CB2, CB4, CG1, CG3, CG5, CE1, CE4, CE8
Autonomous practices through ICT	Beyond the guided practices, the student will have to deploy / configure / implement some specific solutions, for certain scenarios, in an autonomous way. In these activities CB2, CB4, CB5, CG1, CG3, CG5, CE1, CE4, CE8 are worked out.

Personalized assistance

Methodologies	Description
Lecturing	During the office hours teachers will provide personalized attention to strengthen or guide students in the understanding of the theoretical concepts explained in the lectures or practical demonstration sessions; and to correct or reorient the small optional practical works derived from said laboratory classes.
Laboratory practical	This activity is interactive by definition, so it is expected that questions will flow naturally between teachers and students, and may involve other students in the answers.
Autonomous practices through ICT	Although the autonomous work is targeted to make students solve situations / challenges to be found in real systems on their own, during office hours, teachers will guide them by questioning the chosen solutions or suggesting alternative paths.

Assessment

	Description	Qualification	Evaluated Competencess			
Laboratory practical	They will be qualified as apt / unfit. Students will pass them if they attend all sessions of this type. If for some reason they miss any, they must do some complementary practical that teachers will establish. In some of the sessions / activities the student may be asked for an additional autonomous work (and its associated report) that will be quantitatively evaluated within the more general element called "Autonomous practices through ICT".	0	CB2 CB4 CB5	CG5	CE4 CE8	CT4 CT5
Autonomous practices through ICT	Students must perform, in presence of the teachers, a practical demonstration showing the resolution of the different technical challenges posed, and face questions about the adopted solutions and their degree of completeness. This defense/interview will take place, in a general way, after the delivery deadline of the last ordered task, and before the beginning of the official exams period in the corresponding call, and its definite date will be agreed on time between students and teachers. Every challenge or autonomous activity will require a written report, whose structure, composition and readability will affect final mark.	40	CB2 CB4 CB5	CG5	CE1 CE4 CE8	CT4 CT5
Essay questions exam	A written exam will be carried out at the end of the semester, where the theoretical concepts taught in the lectures are evaluated, as well as the practical foundations derived from the classes / practical work carried out.	60	CB4		CE1 CE2 CE4	CT4
Practices report	The student's autonomous work should be reported appropriately with pertinent docs whose evaluation will be part of the more general evaluation of the documented task.	0	CB4	CG1 CG3		CT4 CT5

Other comments on the Evaluation

The evaluation of the subject can either follow a continuous assessment strategy (EC) or a single assessment one (EU). The students choose EC if they deliver the solution to the first challenge or autonomous work that they must attend during the course. The percentages expressed in the previous section only reflect the maximum mark obtainable in each type of test in the EC modality; and they are only indicative. The detailed evaluation form is expressed below:
For EC (first call), the final grade will be the weighted geometric mean between the autonomous work grade (TA, 40%) and the corresponding grade for the essay questions exam (E, 60%). The grade of TA will be the arithmetic mean of the marks obtained in each of the challenges / autonomous practical that students have to solve during the semester.
FINAL GRADE (EC) = (TA ^ 0.4) × (E ^ 0.6)
If the laboratory practices assessment is unfit, the grade will be the minimum between the written test score (E) and 3.

Students who choose EU must take a final exam consisting of three parts: a written test analogous to the continuous assessment test (E), a proficiency test in the laboratory and one or more practical tasks (T). The final grade, in this case, is the weighted geometric mean between the theory grade (E, 80%) and practical work (T, 20%), with the condition that the aptitude test is passed. For any student that fails the aptitude test, the final grade will be the minimum between E and 3.
FINAL GRADE (EU) = (T ^ 0.2) × (E ^ 0.8)
Finally, for the second call (June / July), students will be able to continue with the evaluation mode that they had already chosen (keeping the mark of the part -E or TA / T- that they had passed), facing only the failed part - though with possible modifications in the specifications of the practical works; or they may choose to follow EU doing just a final exam as the one just described. The aptitude test will only be necessary if they did not attend all laboratory sessions.

Sources of information

Basic Bibliography

I. Ristic, **Bulletproff SSL and TLS, ser. Computers/Security**, London: Fesity Duck, 2015

A. Liska and G. Stowe, **DNS Security: Defending the Domain Name System**, Boston: Syngress, 2016

Yago Fernández Hansen, Antonio Angel Ramos Varón, Jean Paul García-Moran Maglaya, **RADIUS / AAA / 802.1x**, RA-MA Editorial, 2008

Graham Bartlett, Amjad Inamdar, **IKEv2 IPsec Virtual Private Networks: Understanding and Deploying IKEv2, IPsec VPNs, and FlexVPN in Cisco IOS**, CISCO PRESS, 2016

Complementary Bibliography

D. J. D. Touch, **Defending TCP Against Spoofing Attacks**, IETF, 2007

R. R. Stewart, M. Dalal, and A. Ramaiah, **Improving TCP□s Robustness to Blind In-Window Attacks**, IETF, 2010

D. J. Bernstein, **SYN cookies**,

P. McManus, **Improving syncookies**, 2008

C. Pignataro, P. Savola, D. Meyer, V. Gill, and J. Heasley, **The Generalized TTL Security Mechanism (GTSM)**, IETF, 2007

D. J. D. Touch, R. Bonica, and A. J. Mankin, **The TCP Authentication Option**, IETF, 2010

S. Rose, M. Larson, D. Massey, R. Austein, and R. Arends, **DNS Security Introduction and Requirements**, IETF, 2005

R. Arends, R. Austin, M. Larson, D. Massey, S. Rose, **Resource Records for the DNS Security Extensions**, IETF, 2005

R. Arends, R. Austein, M. Larson, D. Massey, S. Rose, **Protocol Modifications for the DNS Security Extensions**, IETF, 2005

Cloudflare Inc., **How DNSSEC works**,

P. E. Hoffman and P. McManus, **DNS Queries over HTTPS (DOH)**, IETF, 2018

E. Jones and O. L. Moigne, **OSPF security vulnerabilities analysis**, IETF, 2006

M. Khandelwal and R. Desetti, **OSPF security: Attacks and defenses**, 2016

J. Durand, I. Pepelnjak, and G. Doering, **BGP operations and security**, IETF, 2015

R. Kuhn, K. Sriram, and D. Montgomery, **Border gateway protocol security**, NIST, 2007

C. Pelsser, R. Bush, K. Patel, P. Mohapatra, and O. Maennel, **Making route flap damping usable**, IETF, 2014

Y. Rekhter, J. Scudder, S. S. Ramachandra, E. Chen, and R. Fernando, **Graceful restart mechanism for BGP**, IETF, 2007

IEEE 802.1 Working Group, **IEEE Std 802.1X - 2010. Port-Based Network Access Control**, IEEE Computer Society, 2010

Security Task group of IEEE 802.1, **IEEE Std 802.1AE. Medium Access Control Security**, IEEE Computer Society, 2018

S. Kent, K. Seo, **Security Architecture for the Internet Protocol**, IETF, 2005

S. Kent, **IP Authentication Header**, IETF, 2005

S. Kent, **IP Encapsulating Security Payload**, IETF, 2005

C. Kaufman, P. Hoffman, Y. Nir, P. Eronen, T. Kivinen, **Internet Key Exchange Protocol Version 2 (IKEv2)**, IETF, 2014

J. Cichonski, J. M. Franklin, M. Bartock, **Guide to LTE Security**, NIST Special Publication 800-187,

Recommendations