

Distributed Systems

Academic Year 2022-23

+ Faculty

■ José María Foces Morán

■ *Part I (Architecture of Distributed Systems, Sept-Nov)*

■ **Contact:**

■ **For administrative matters:** chema.foces@unileon.es

■ **For technical matters (Doubts, difficulties with the material):** *Course Forum (agora)*

■ Technology II bldg., office 363, phone ext. 5390

■ Tutor assistance hours:

■ Habitually, office hours will be held on tuesdays from 11:30 thru 12:30

■ Office no. 363/Lab B6

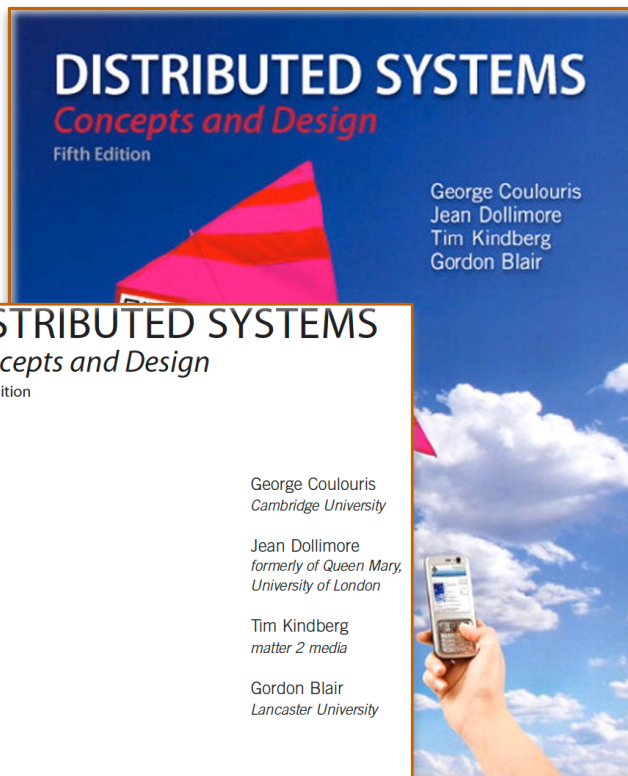
■ Notes, presentations, past exams, exercises, etc: Available Mondays and Tuesdays, in Lab sessions only:

■ <http://paloalto.unileon.es/ds>

■ Antonio Sánchez Vargas

■ *Part II (Hadoop, Nov-Jan (2022))*

+ Main Reference books



DISTRIBUTED SYSTEMS
Concepts and Design
Fifth Edition

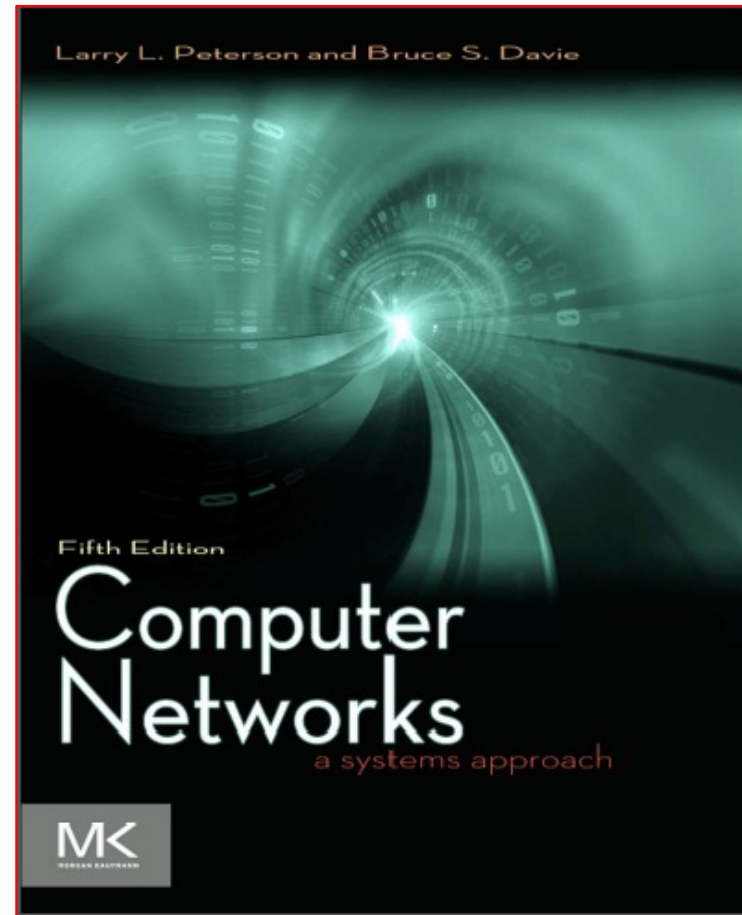
George Coulouris
Cambridge University

Jean Dollimore
*formerly of Queen Mary,
University of London*

Tim Kindberg
matter 2 media

Gordon Blair
Lancaster University

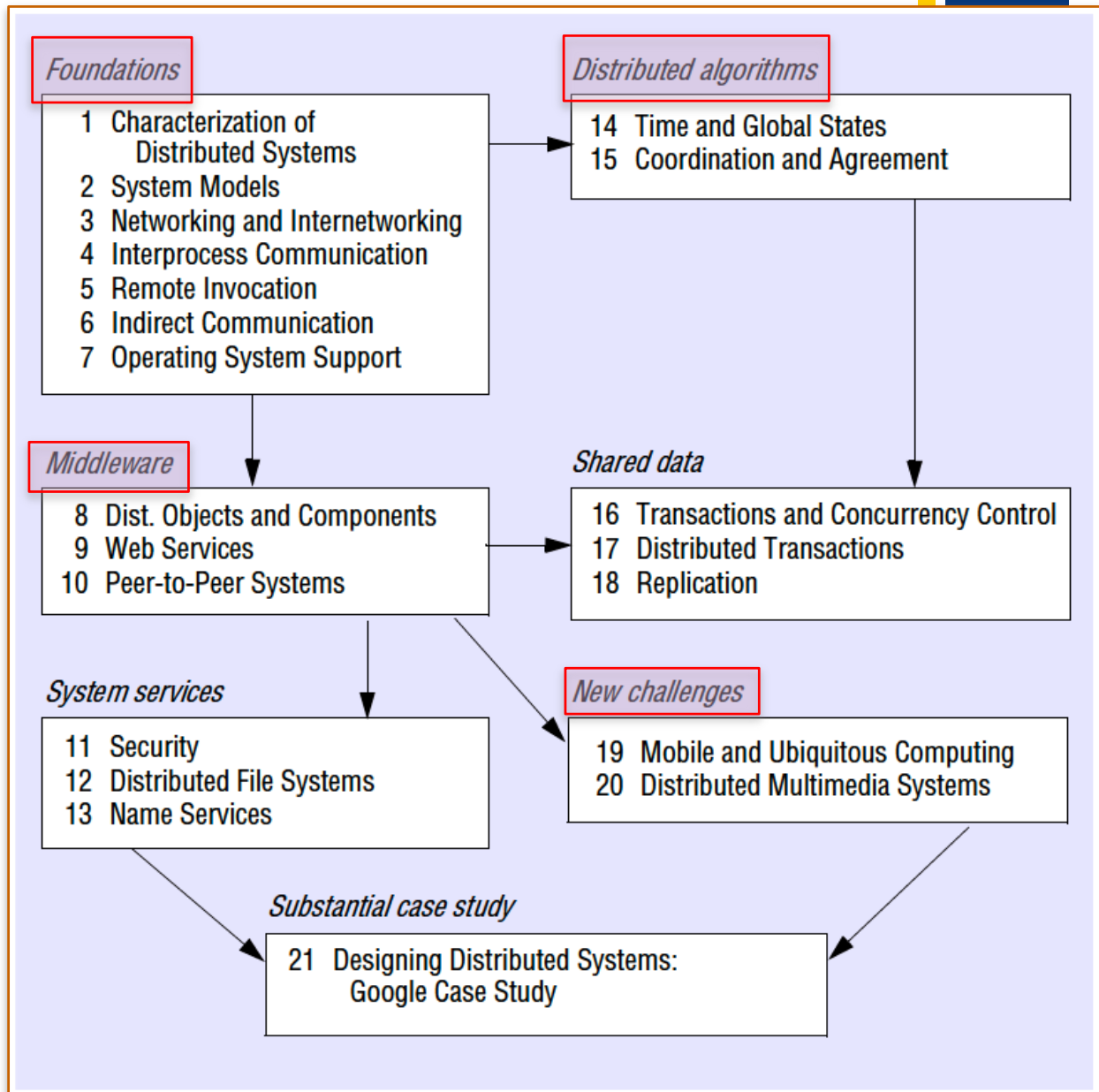
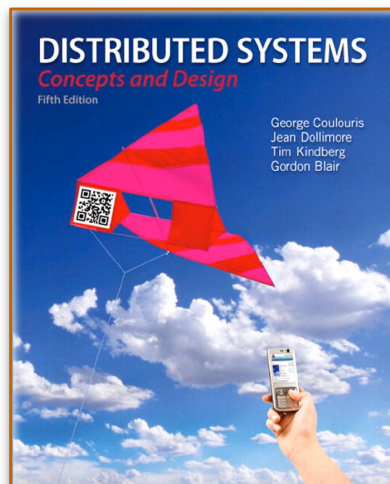
Addison-Wesley
Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montreal Toronto
Delhi Mexico City Sao Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo



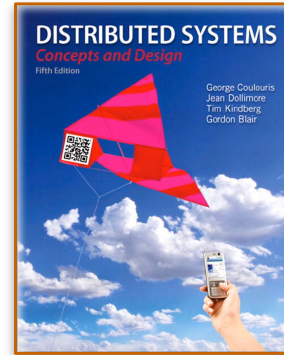
+ Course contents

■ Main blocks

1. Foundation
2. Architecture of DS
3. Middleware
4. Distributed computing with Hadoop, etc.



+ Course contents



5

1. Foundation

- a) Networking summary
- b) Faults in distributed systems: Reliable transmission with TCP
- c) Socket programming
- d) Clocks and states: Cristian's algorithm, clock synchronization with ICMP and NTP, Lamport clocks

2. Architecture of DS

- a) Layered and tiered models
- b) The C/S and peer-to-peer models

3. Middleware, general RPC:

- Java RMI
- Distributed objects

4. Distributed computing technologies (Hadoop and others)

- a) Concepts and possibilities of today's distributed system technologies

+ Exams and homework

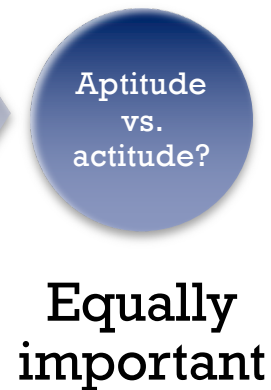


- Participation
- Note taking
- Attendance to lectures AND labs!

- Exams**
- **Term Exam 1 (TE1)**
 - 21/Nov/2022
 - **TE2**
 - 9/Jan/2022



- Homework**
- Weekly questionnaires
 - Questionnaire solutions published shortly after Q. pub. date
 - Set of exercises (Homework#1)
 - Final practice (DSPro Homework#2)
 - Lab Book (Homework #3)



+ Chapters of each book

4 Advanced Internetworking

Problem: Scaling to Billions	307
4.1 The Global Internet	308
4.1.1 Routing Areas	310
4.1.2 Interdomain Routing (BGP)	313
4.1.3 IP Version 6 (IPv6)	324
4.2 Multicast	338
4.2.1 Multicast Addresses	340
4.2.2 Multicast Routing (DVMRP, PIM, MSDP)	341
4.3 Multiprotocol Label Switching (MPLS)	354
4.3.1 Destination-Based Forwarding	355
4.3.2 Explicit Routing	362
4.3.3 Virtual Private Networks and Tunnels	364
4.4 Routing among Mobile Devices	369
4.4.1 Challenges for Mobile Networking	369
4.4.2 Routing to Mobile Hosts (Mobile IP)	372
4.5 Summary	379
What's Next: Deployment of IPv6	380
Further Reading	381
Exercises	382

7 End-to-End Data

Problem: What Do We Do with the Data?	579
7.1 Presentation Formatting	581
7.1.1 Taxonomy	583
7.1.2 Examples (XDR, ASN.1, NDR)	587
7.1.3 Markup Languages (XML)	592

5 End-to-End Protocols

Problem: Getting Process to Communicate	391
5.1 Simple Demultiplexer (UDP)	393
5.2 Reliable Byte Stream (TCP)	396
5.2.1 End-to-End Issues	397
5.2.2 Segment Format	400
5.2.3 Connection Establishment and Termination	402
5.2.4 Sliding Window Revisited	407
5.2.5 Triggering Transmission	414
5.2.6 Adaptive Retransmission	418
5.2.7 Record Boundaries	422
5.2.8 TCP Extensions	423
5.2.9 Performance	425
5.2.10 Alternative Design Choices	428
5.3 Remote Procedure Call	431
5.3.1 RPC Fundamentals	431
5.3.2 RPC Implementations (SunRPC, DCE)	440
5.4 Transport for Real-Time Applications (RTP)	447
5.4.1 Requirements	449
5.4.2 RTP Design	452
5.4.3 Control Protocol	456
5.5 Summary	460
What's Next: Transport Protocol Diversity	461
Further Reading	462
Exercises	463

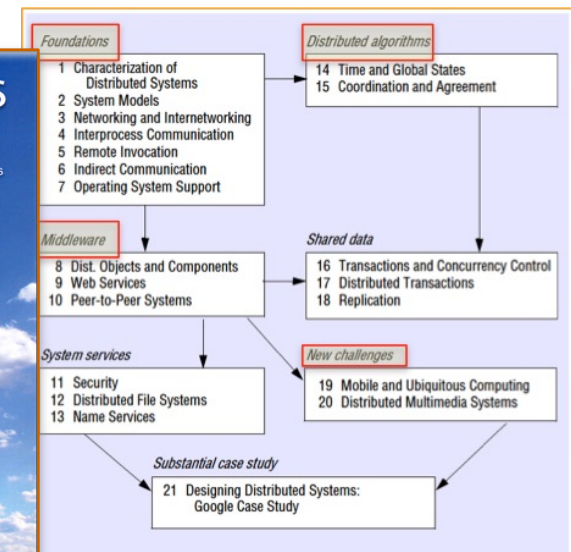
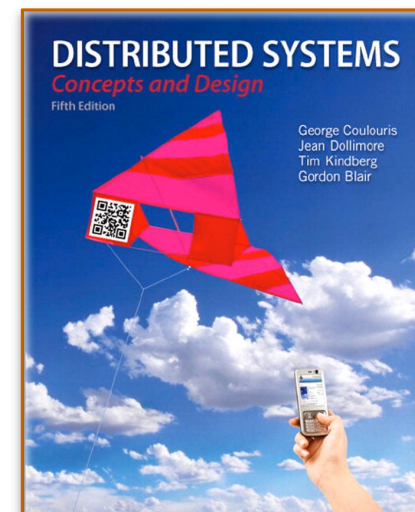
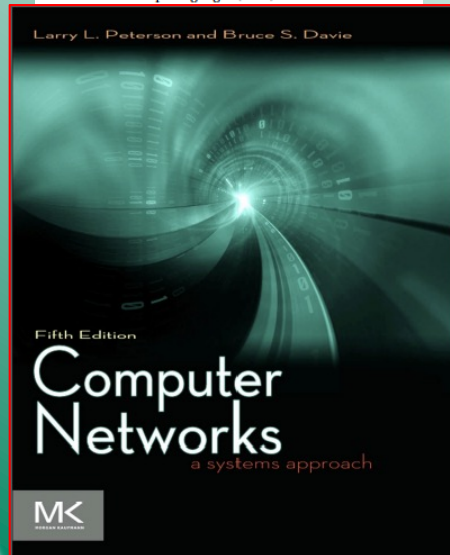
9 Applications

Problem: Applications Need their Own Protocols	697
9.1 Traditional Applications	698
9.1.1 Electronic Mail (SMTP, MIME, IMAP)	700
9.1.2 World Wide Web (HTTP)	708
9.1.3 Web Services	718
9.2 Multimedia Applications	727
9.2.1 Session Control and Call Control (SDP, SIP, H.323)	728
9.2.2 Resource Allocation for Multimedia Applications	739
9.3 Infrastructure Services	744
9.3.1 Name Service (DNS)	745
9.3.2 Network Management (SNMP)	756
9.4 Overlay Networks	759
9.4.1 Routing Overlays	762
9.4.2 Peer-to-Peer Networks	769
9.4.3 Content Distribution Networks	783
9.5 Summary	789
What's Next: New Network Architecture	790
Further Reading	791
Exercises	793

Topic blocks:

1. Foundations
2. Architecture
3. Middleware
4. Distributed computing

We will inform you about the book section relevant to each book chapter



+ Languages and OS for practicals

- **Linux (Preferrably Ubuntu or Debian) or UNIX (OS-X)**
- **Windows** ≈
- **C and Java SE**
- **Lab B6 (Networks and Distributed Systems)**
 - Raw and Berkeley Sockets
 - Client/Server with Sockets and RMI (Remote Method Invocation)
 - Remote Objects, concurrency
 - Protocol Analysis for DS (Distributed Systems)
 - IP, TCP, UDP, http, NTP
 - Real-time clock synchronization with Raw Sockets
- **Lab B3 (ATC)**
 - Distributed Programming with Hadoop



Schedule and locations

- **Lectures: A single, on-site attendance group (A)**
 - **Classroom Building, classroom no. 18**
 - **Mondays 10:00 – 12:00**

- **Problem and exercises sessions (B1)**
 - **Embedded in Lab sessions (B3)**

- **Lab Practices (B3)**
 - **Technology II bldg., Lab B6**
 - **4 groups every week**
 - G1 (Mondays) 12:00 – 14:00
 - G2 16:00 – 18:00
 - ~~■ G3 18:00 – 20:00~~
 - G4 (Tuesdays) 13:00 – 15:00

+ Assessment

■ Term Exam 1

- Passing this exam is a **necessary condition** for passing the course

■ Term Exam 2

- Passing this exam is a **necessary condition** for passing the course

■ *If both exams are passed:*

- Exams weight is 72%
- Regular lab attendance + LabBook: 15%
- Final Practice (DSPro): 10%
- Other: 3% (Attendance, etc)

+ Questions?

