
Arquitecturas de Redes
MSC.Engenharia de Computadores e Telemática
1º ano, 1º semestre, 2023/2024
Rui L Aguiar, UA/IT

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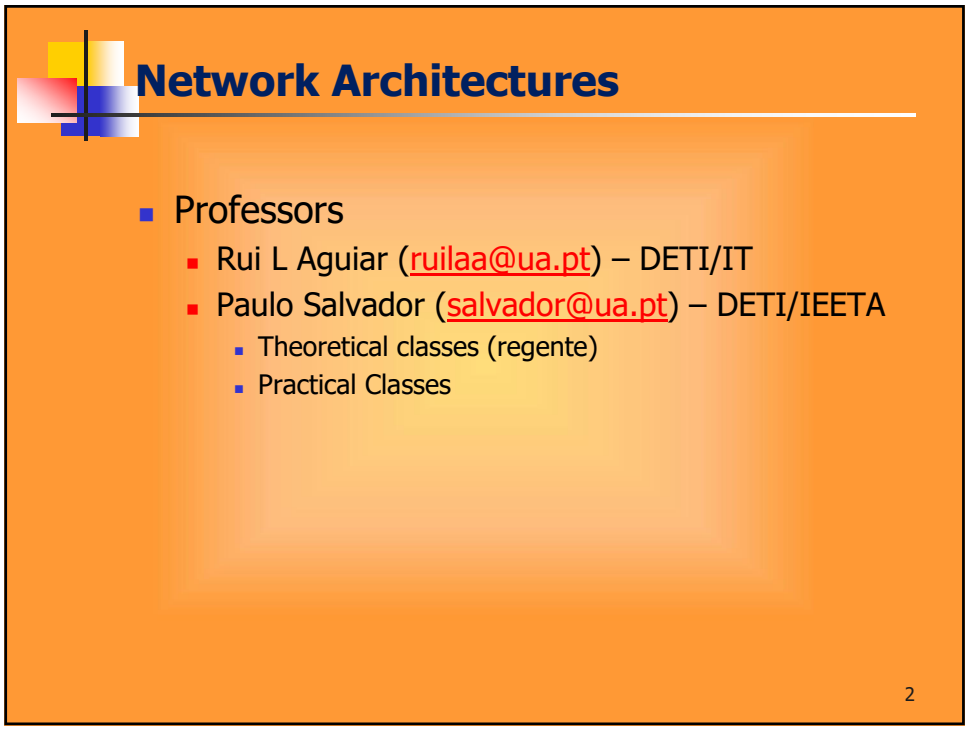
Network Architectures
Professors
Rui L Aguiar (ruilaa@ua.pt) – DETI/IT
Paulo Salvador (salvador@ua.pt) – DETI/IEETA
Theoretical classes (regente)
Practical Classes
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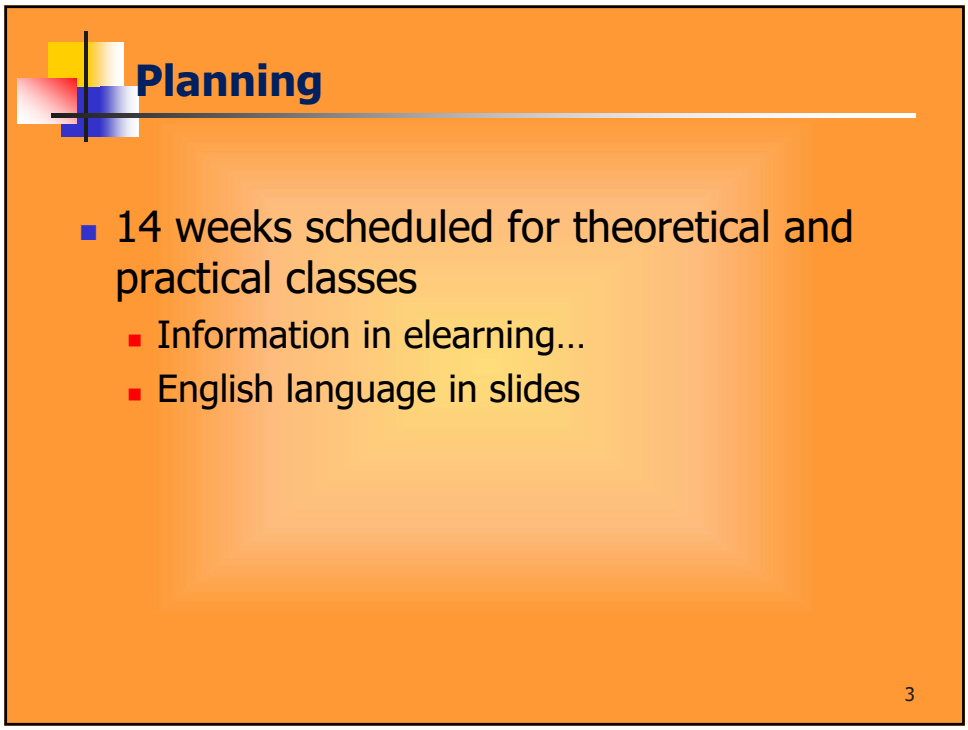
Planning
14 weeks scheduled for theoretical and practical classes
Information in elearning…
English language in slides
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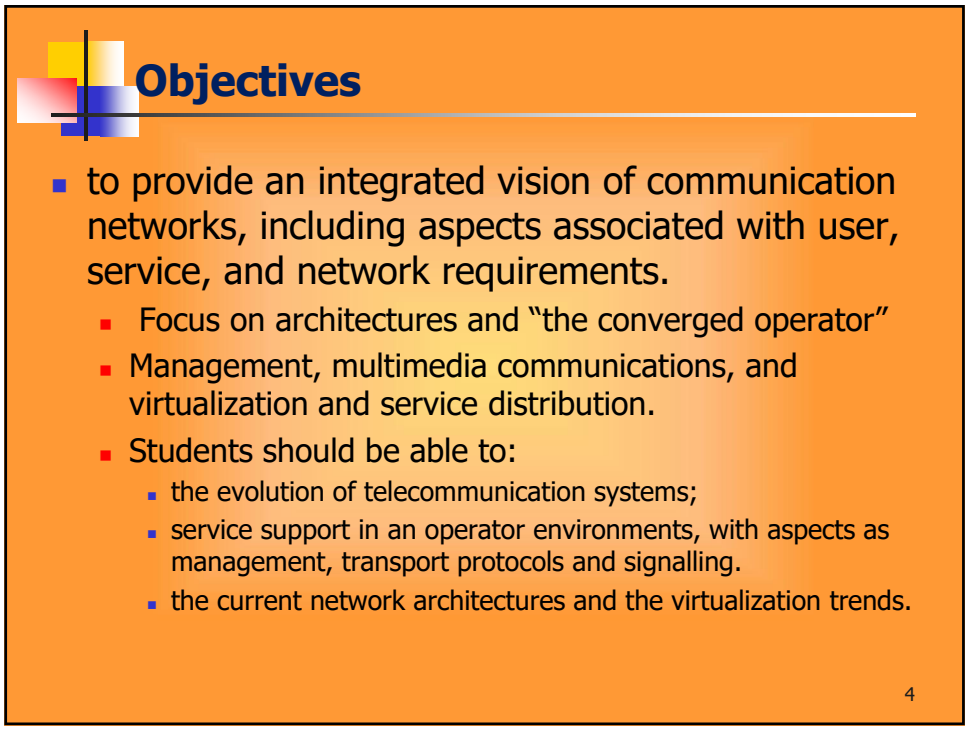
Objectives
to provide an integrated vision of communication networks, including aspects associated with user, service, and network requirements.
Focus on architectures and "the converged operator"
Management, multimedia communications, and virtualization and service distribution.
Students should be able to:
the evolution of telecommunication systems;
service support in an operator environments, with aspects as management, transport protocols and signalling.
the current network architectures and the virtualization trends.
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Program

- Groups of classes as theoretical and practical
  - Need to understand the class to close the practical works
  - Some classes will be mixed
  - Is it possible to change times for the classes?
    - 30 min later
    - Warnings on elearning
    - Some dates are a problem

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Program

2023			
1	14/09/2023	Introduction. Program and Rules.	
2	**21/09/2023**	BGP review and Advanced topics	TP: BGP (advanced topics)
3	28/09/2023		TP: BGP (advanced topics)
4	12/10/2023	IP-based QoS models: IntServ and DiffServ Architectures)	TP: DiffServ Architecture
5	*19/10/2023*		TP: DiffServ Architecture
6	26/10/2023	Network Monitoring and Management: basics and SNMP	TP: Management SNMP
7	**02/11/2023**		TP: Management SNMP
8	**09/11/2023**	Data centers: L2 overlay networks	TP: BGP EVPN
9	*16/11/2023*		TP: BGP EVPN
10	*23/11/2023*	Corporate networks: MPLS tunnels and VPNs	TP: MPLS tunnels
11	30/11/2023		TP: MPLS VPN
12	07/12/2023	Multimedia networks: interdomain and CDN	TP: CDN Routing with Conditional DNS
13	14/12/2023	Convergent telecom networks: interdomain, virtualization	minitest, demo discussion
14	21/12/2023		Project demo presentation

Exam – 12-Jan-2024, 10h00
Second phase – 01-Fev-2024, 10h00

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Evaluation criteria

- Theory: 50%
  - Single test.
  - Final exame (a.k.a. exame de recurso) will contain all subjects as well
- Practical: 50%
  - mini-test (practical material), 15%
  - Project Work: 30%,
    - including "presentation" and "reporting" (5%).

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Organization

- All information to be displyed in e-learning
  - Announcements
  - Classes handoout
  - Practical works
  - Evaluation and grades
- Summaries in paco.

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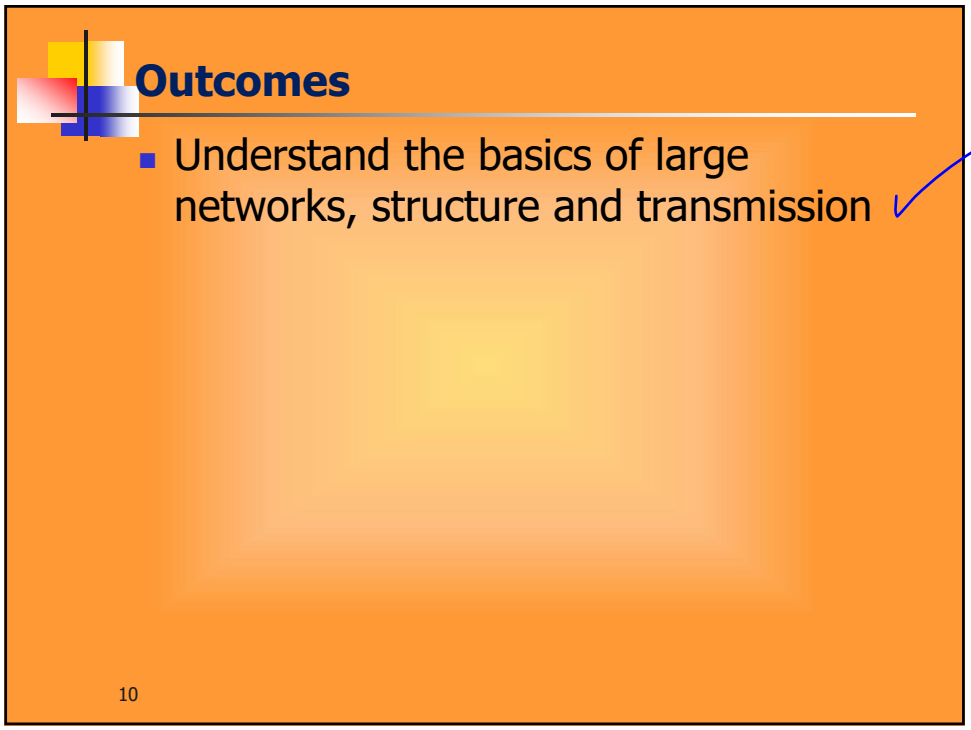
Outcomes
Understand the basics of large networks, structure and transmission
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The communication network

What is then a network

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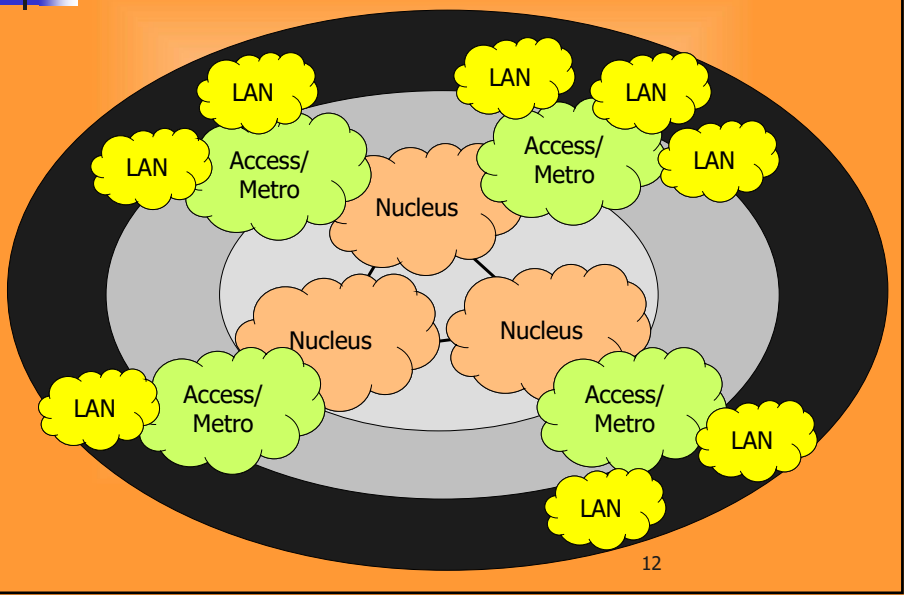
Network architecture



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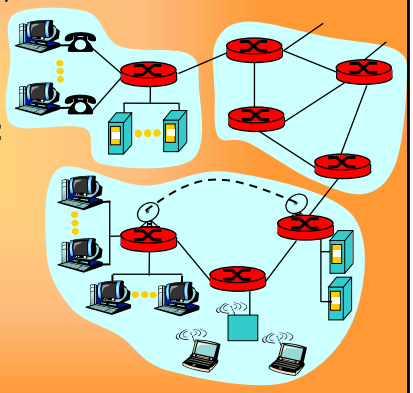
Networks: service vision

- Distributed communications infrastructure supporting applications, also potentially distributed
  - WWW, email, games, e-commerce, databases, voting
- Communications services supporting:
  - Connection-oriented
  - Connection-less
- Service platforms for millions of devices: *hosts, end-systems*
  - Pc's, workstations, servers
  - PDA's, phones, fridges...



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Network structure

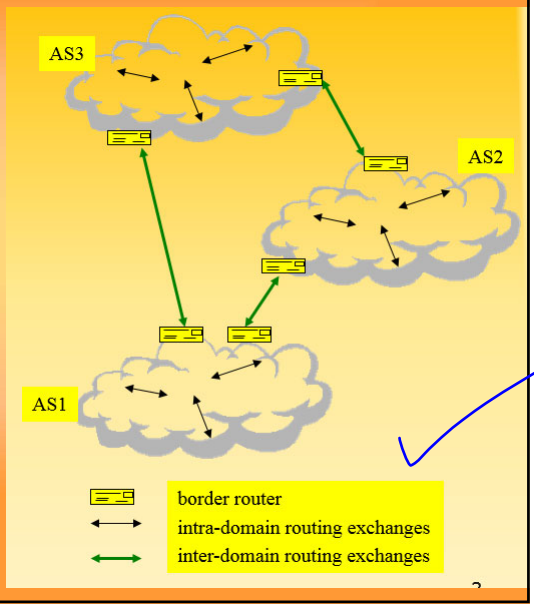
- Administrative borders define:
  - Autonomous systems(AS)
    - **Intradomain routing**
    - Internal policies
    - Different metrics can be used on different domains

    (connectivity protocols in Internet: RIPv2, OSPFv2)
  - Interconnection of ASs
    - **Interdomain routing**

    (Connectivity information protocols in Internet: BGP)

NOTE: this structure is for ALL NETWORKS

- But details presented are for ISPs.



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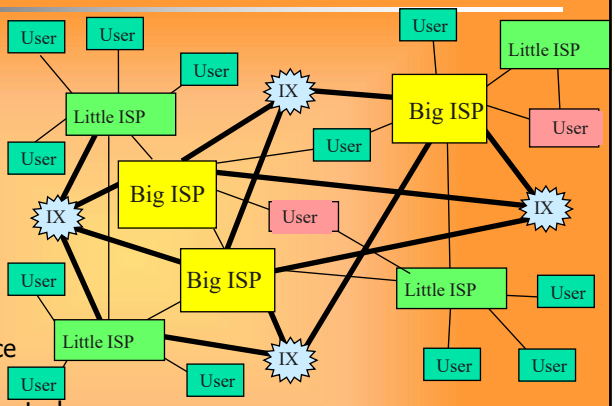
Real structure



- **TIER** concept:
Apparently hierarchical (**bold** lines)
  - Backbone ISP provides service a ISPs increasingly smaller
  - Smaller ISPs eventually providing service end users.
- But hierarchy is not respected
  - Private connection agreements
  - Mechanisms for improvement of the network
  - All companies provide service to (some) users – Corporate users are different in structure
  - Service providers connect to multiple connection provider
  - Users connect to multiple ISPs

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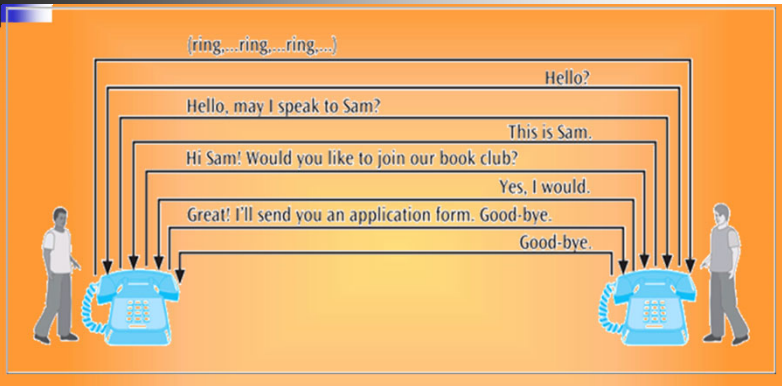
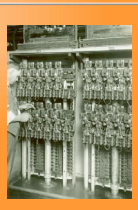
Connection-oriented versus Connectionless





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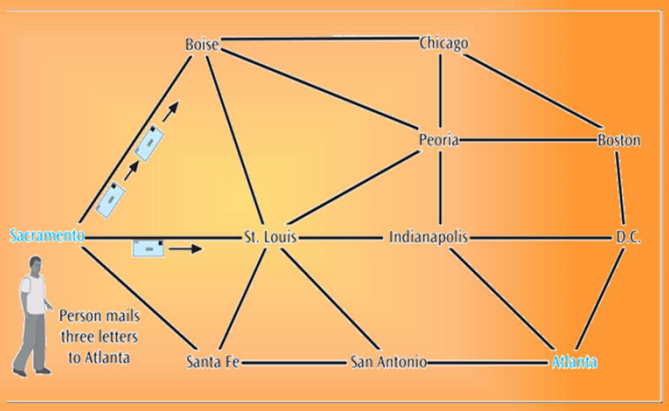
Connection-oriented versus Connectionless



In a given communications today, most probably we are using **at the same time** technologies that are connection-oriented and connectionless. At each technology level, the most efficient and cost effective method is used.

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Connection-oriented versus Connectionless

- A connection-oriented application can operate over both a circuit switched network or a packet switched network.
- A connectionless application can also operate over both a circuit switched network or a packet switched network but a packet switched network may be more efficient.

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The bits must go on

MULTIPLEXING AND TRANSMISSION - ELECTRICAL

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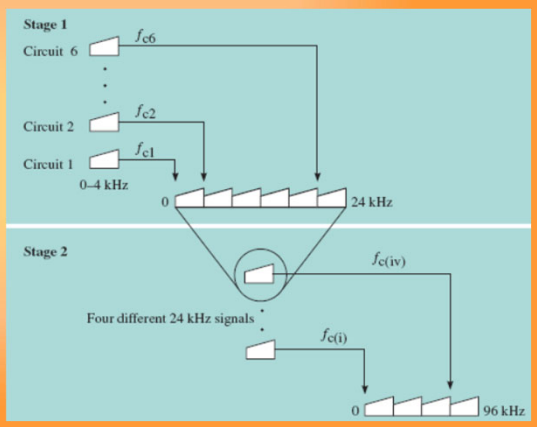
History of Multiplexing

- Synchronous digital hierarchy (SDH) is a world-wide standard for digital communication network.
- Two other systems were before it:
  - the plesiochronous digital hierarchy (PDH) and
  - frequency division multiplexing (FDM).
- ***Frequency division multiplexing*** (FDM):
  - a number of signals share a medium that has a much larger bandwidth.
  - Support of many stages



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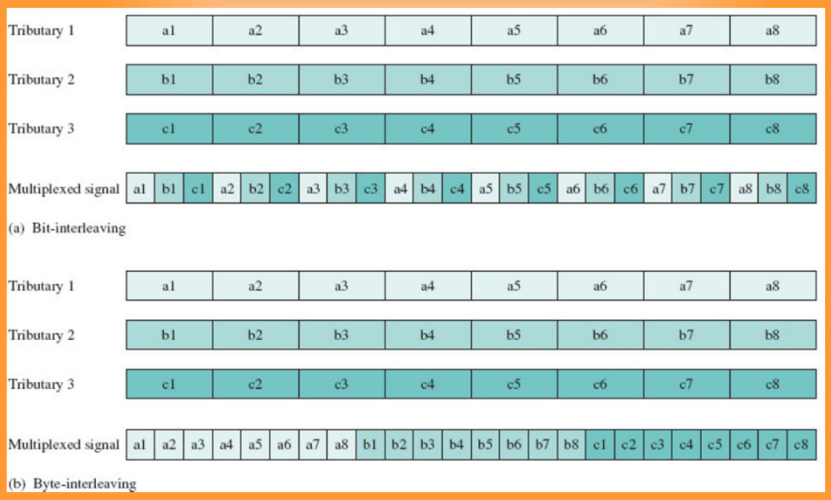
Time Division Multiplexing (two ways)



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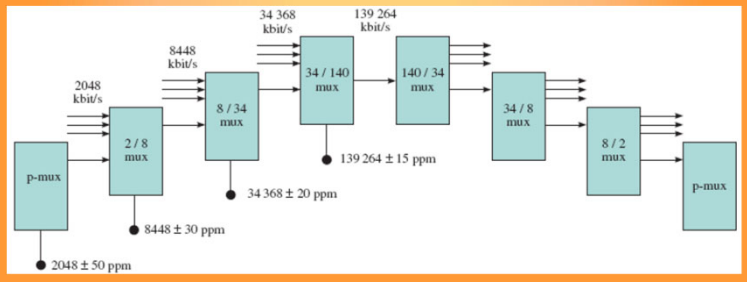
Plesiochronous Digital Hierarchy

- PDH basic data transfer rate is 2048 Kbps
- It is broken in
  - 30 x 64Kbps
  - 2 x 64Kbps (synchronization and signaling)
- The exact frequency of the 2Mpbs is controlled by a clock with some percentage +/- %0.005
- **Justification or Stuffing**
  - Extra bits that are need to reconstruct correctly



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SONET / SDH

- What is SONET / SDH?
  - **S**ynchronous **O**ptical **Net**work – ANSI (US)
  - **S**ynchronous **D**igital **H**ierarchy –ITU-T Europe
  - Similar and compatible
  - A standard to be used for fibre optics
  - Recommendation for FOTS equipment
    - Fibre Optic Transmission Systems
  - Can carry incompatible DS-0, DS1 (Asyn)

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SONET / SDH

- What is SONET / SDH?
  - Single reference clock
    - synchronize transmissions
  - Predictability
  - Powerful frame – Transmission envelope
    - Multiplex channels
  - Multiplexed transport mechanism
    - Optical based Carrier System
  - Self healing ring topology
  - Consolidate and segregate traffic from different end-points
  - Extensive integrated OAM&P
  - Backward compatibility

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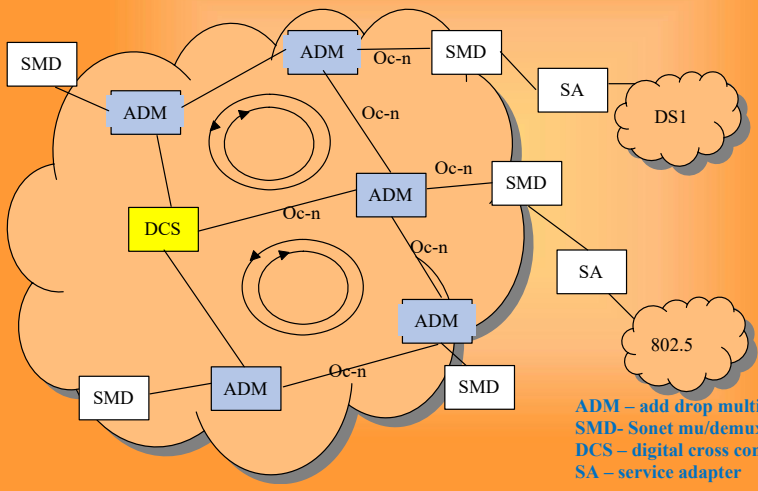
SONET / SDH topology



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SONET structure

- Signal Hierarchy
  - STS – Synchronous Transport Signals
    - support a certain base data rate- 51.84Mbps
    - STS 1 – STS 192 – different hierarchies
  - Corresponding carrier System
    - Optical Carrier – OC-1, OC-3, OC-12, OC-48
  - SDH – STM – Synchronous Transport Module
    - STM 1 = STS 3
- SONET/SDH is *channelized*.
  - STS-3 consists of 3 STS-1 streams, and each STS-1 consists of a number of DS-1 and E1 signals.
  - STS-12 consists of 12 STS-1 streams
- *Concatenated structures* (OC-3c, OC-12c, etc)
  - The frame of the STS-3 payload is filled with ATM cells or IP packets packed in PPP or HDLC frames.
  - Concatenated SONET/SDH links are commonly used to interconnect ATM switches and IP routers (Packets over SONET).

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The SONET/SDH hierarchy

Optical level	SONET level (electrical)	SDH level (electrical)	Data rate (Mbps)	Overhead Rate (Mbps)	Payload rate (Mbps)
OC-1	STS-1	-	51.840	1.728	50.112
OC-3	STS-3	STM-1	155.520	5.184	150.336
OC-9	STS-9	STM-3	466.560	15.552	451.008
OC-12	STS-12	STM-4	622.080	20.736	601.344
OC-18	STS-18	STM-6	933.120	31.104	902.016
OC-24	STS-24	STM-8	1244.160	41.472	1202.688
OC-36	STS-36	STM-12	1866.240	62.208	1804.932
OC-48	STS-48	STM-16	2488.320	82.944	2405.376
OC-96	STS-96	STM-32	4976.640	165.888	4810.752
OC-192	STS-192	STM-64	9953.280	331.776	9621.504
OC-768	STS-768	STM-256	39813.120	1327.104	38486.016
OC-N	STS-N	STM-N/3	N*51.840	N*1.728	N*50.112

x3

x3

x3

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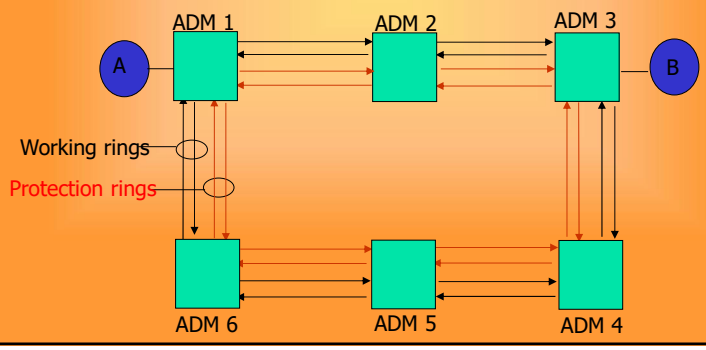
SONET/SDH protection

- Features (Four-fiber bidirectional line switched ring)
  - Two working rings and two protection rings.
    - The two working rings transmit in opposite directions, and each is protected by a protection ring which transmits in the same direction.
  - Advantage: it can suffer multiple failures and still function.
    - Deployed by long-distance telephone companies in regional and national rings.



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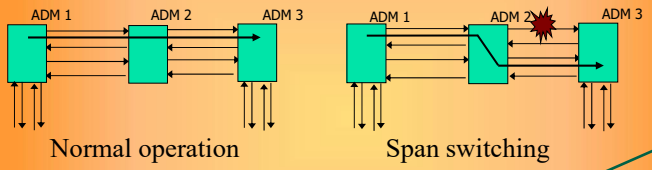
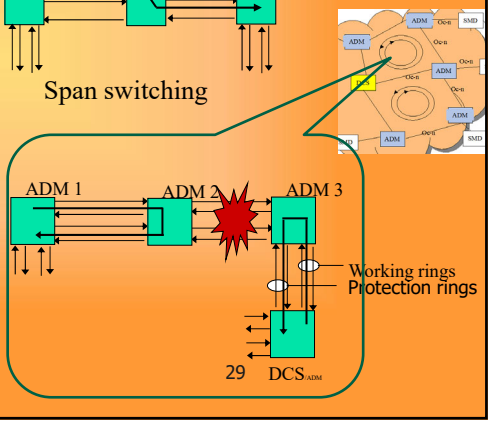
Self-healing operation

- *span switching:* If a working fiber fails, the working traffic will be transferred over its protection ring.



- *ring switching*: the working and protection fibers are part of the same bundle of fibers. When the bundle is cut the traffic will be switched to the protection fibers.



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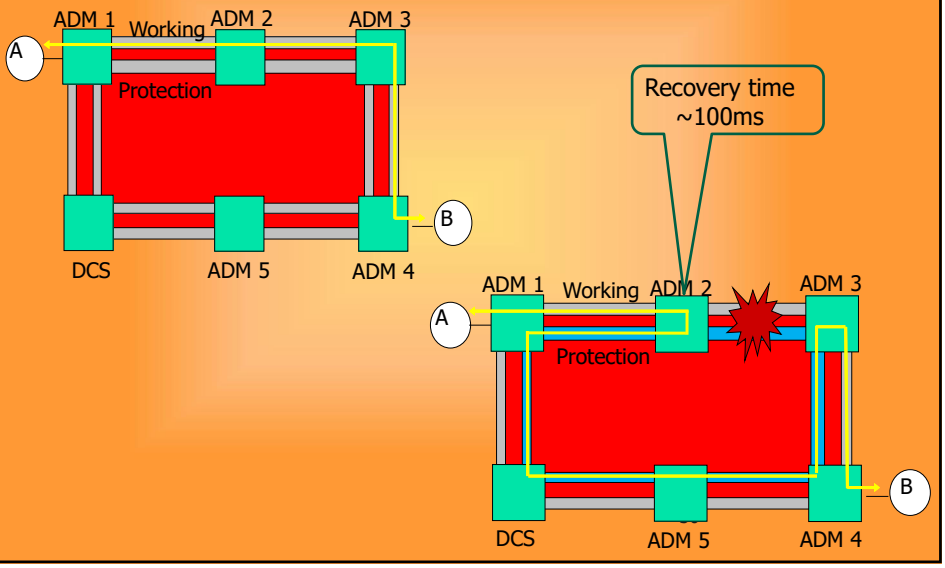
Ring switching: Rerouting a connection



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