Казанский национальный исследовательский технический университет им. А.Н. Туполева-КАИ

Лекция 6
SDH продолжение

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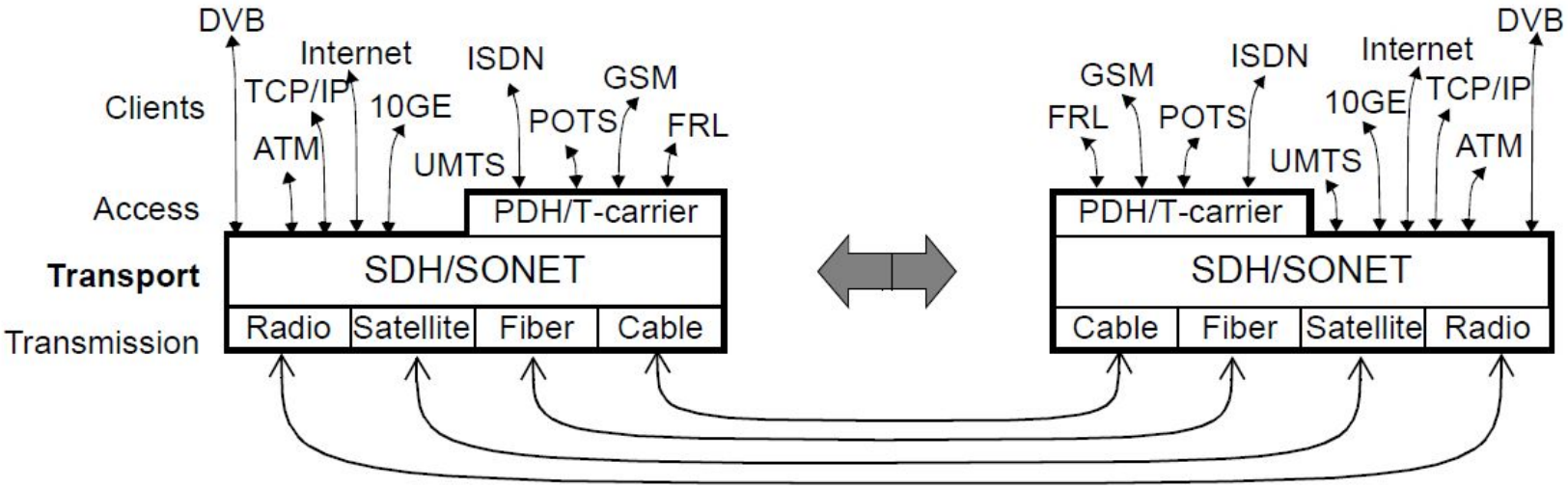
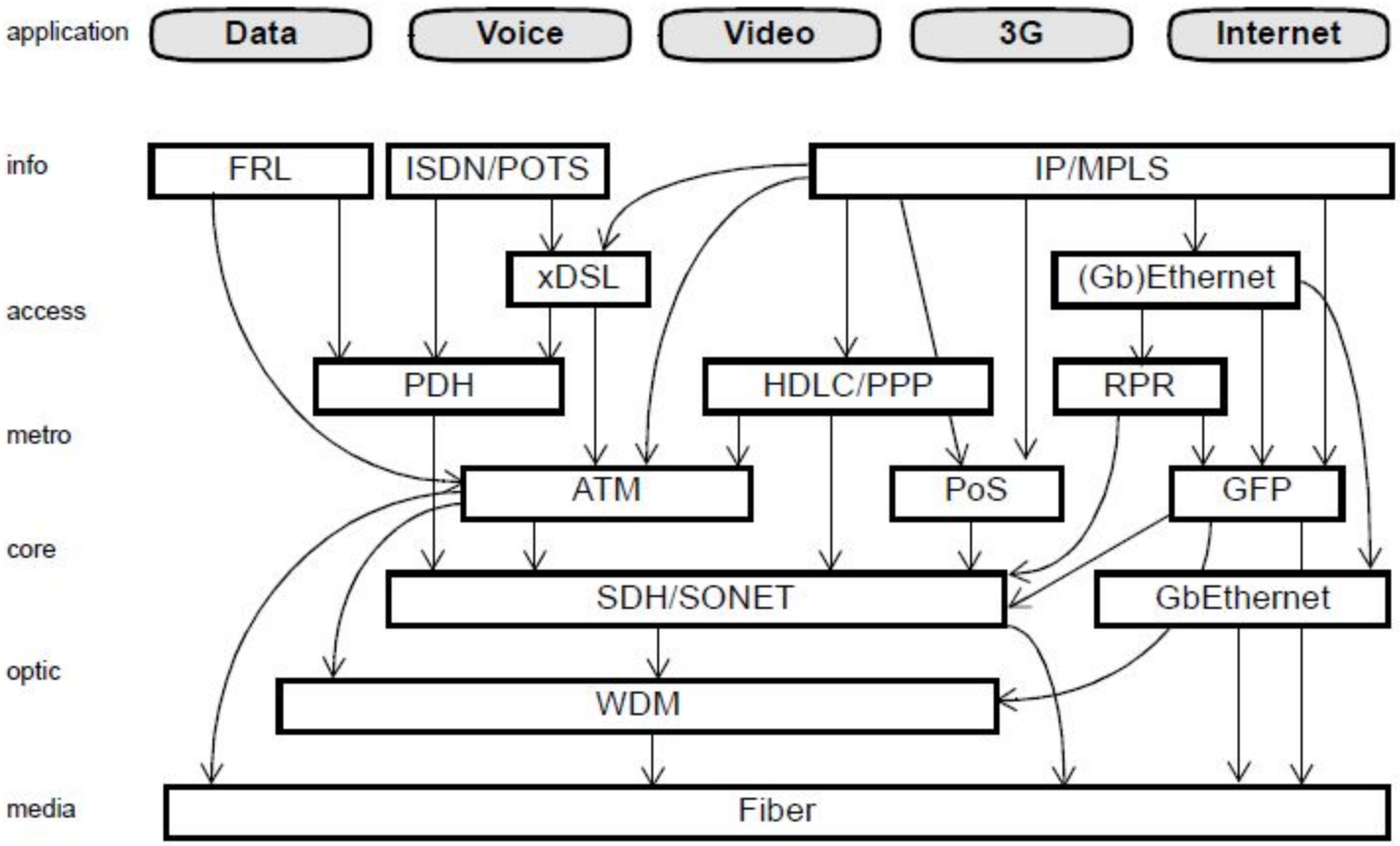
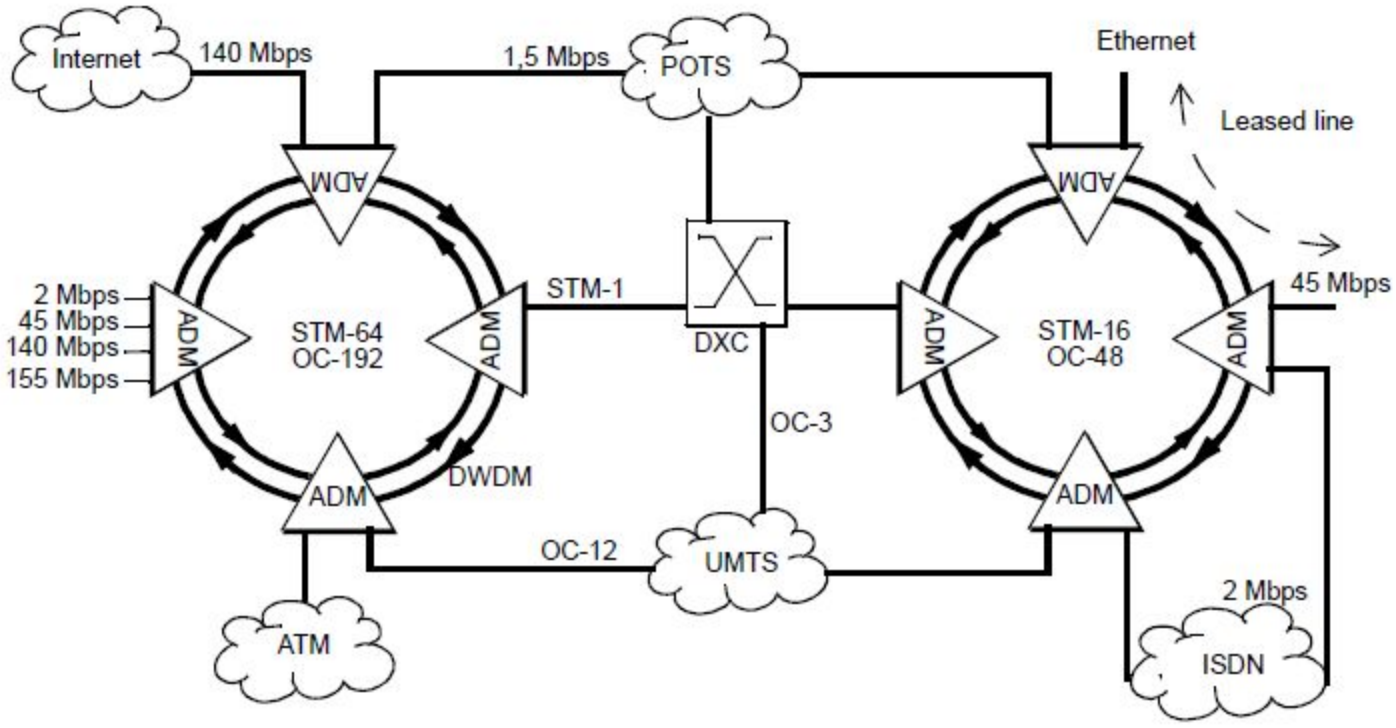
Применение технологии SDH



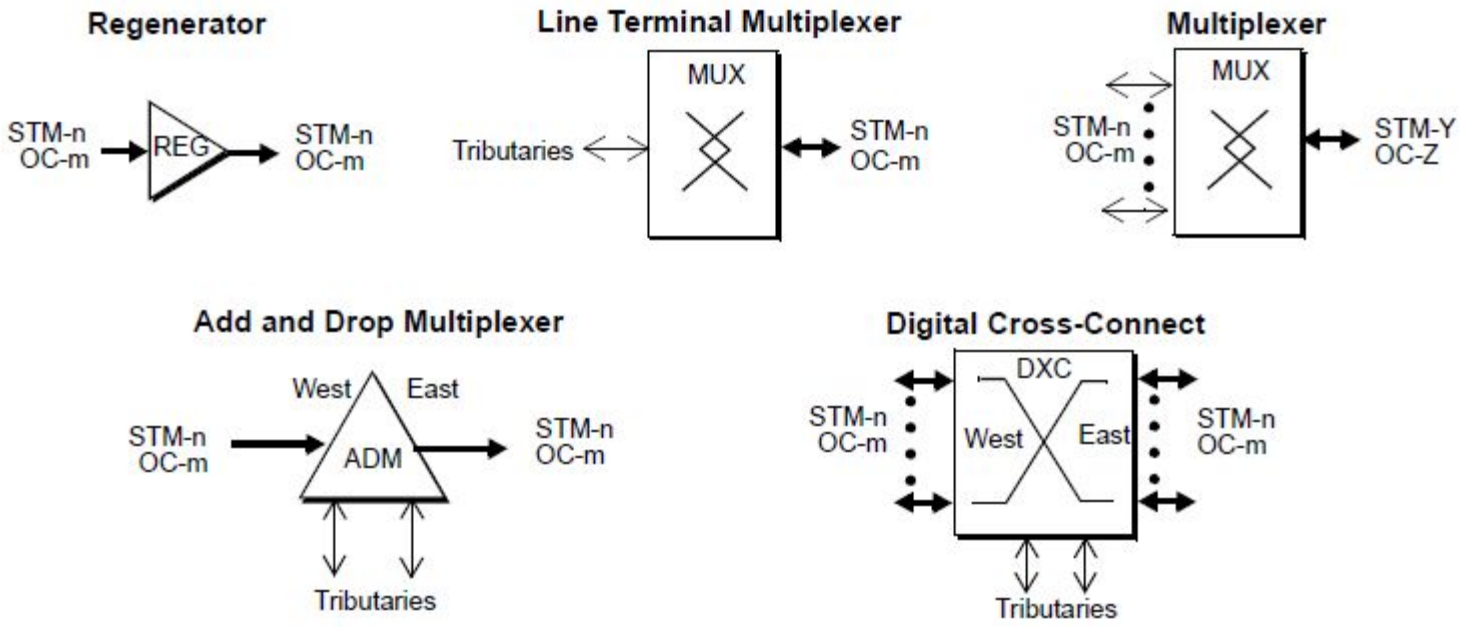
Next generation SDH



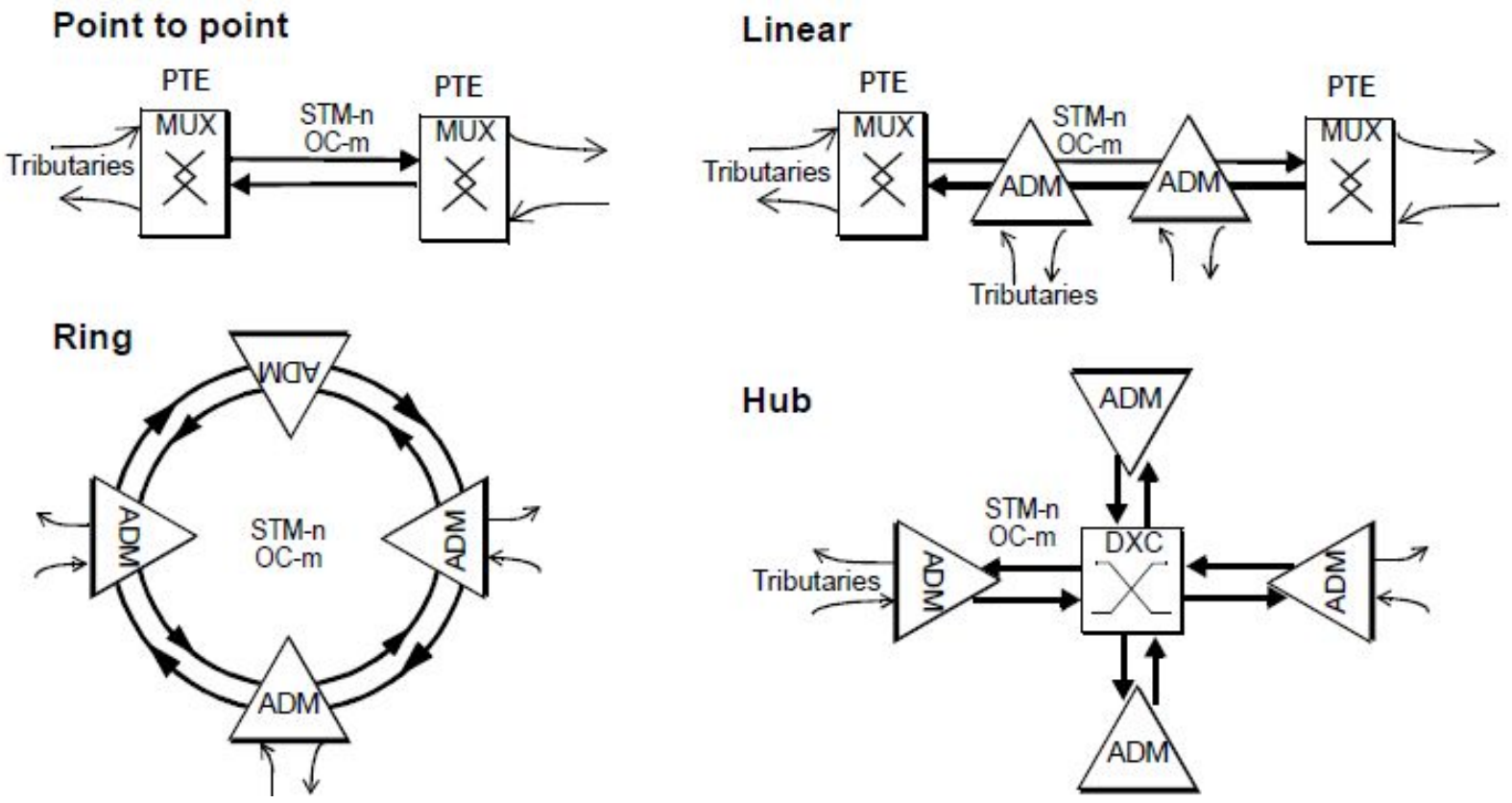
Основная цельSDH – транспорт для Других технологий



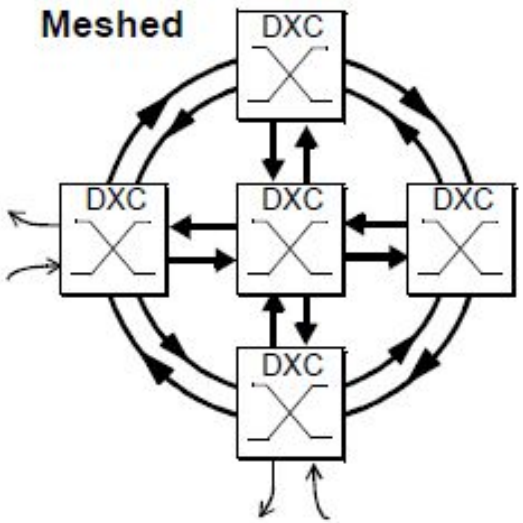
Сетевые элементы SDH

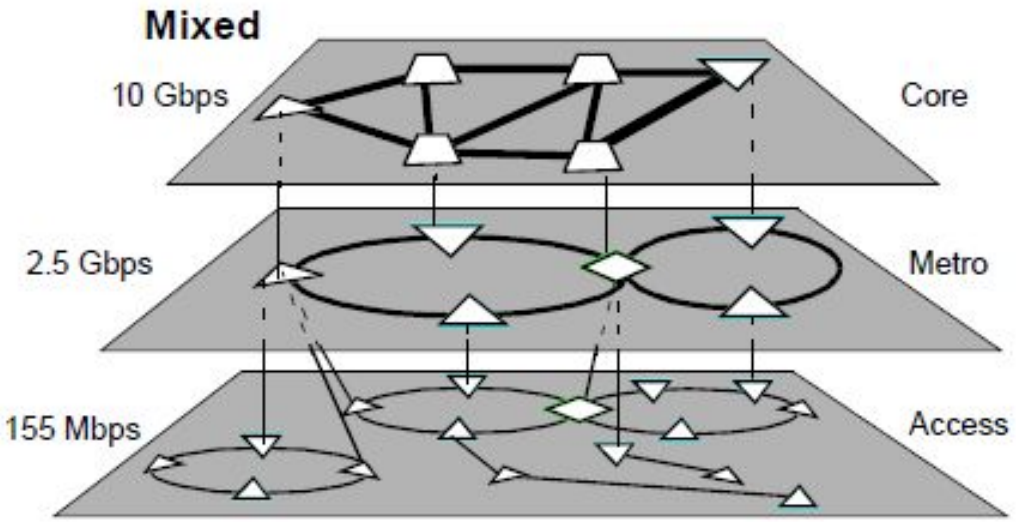


Топология сети SDH



Топология сети SDH





Уровни SDH

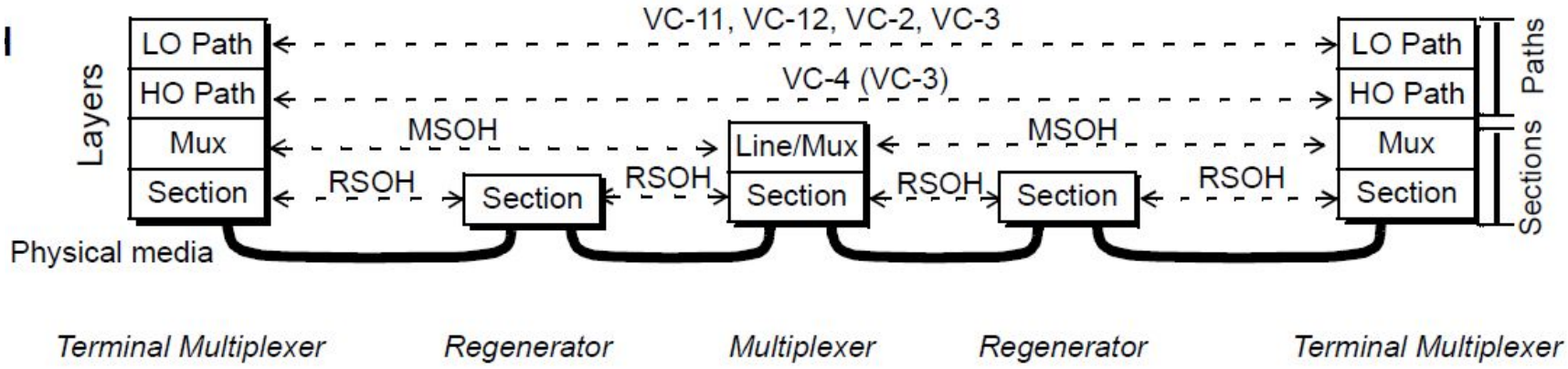
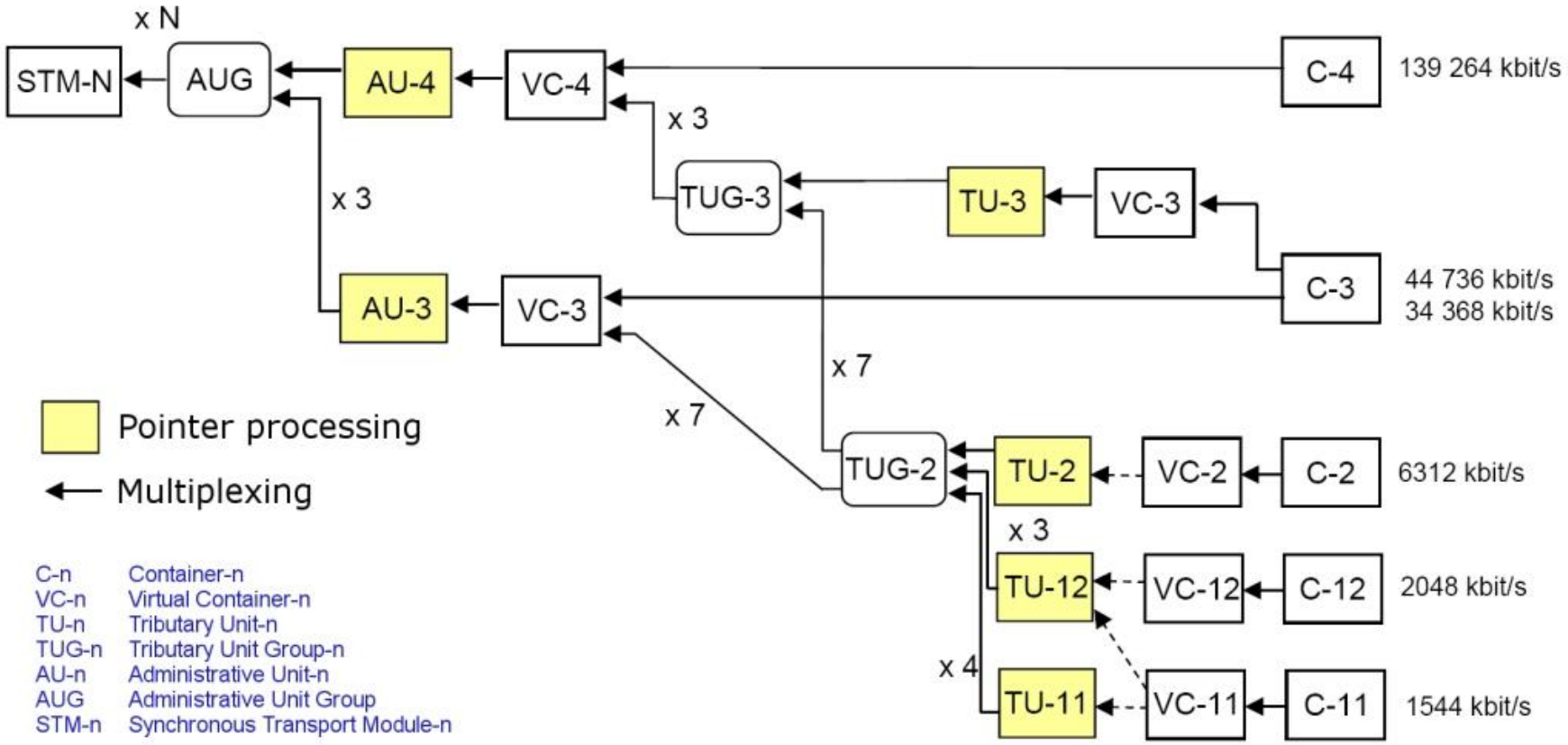
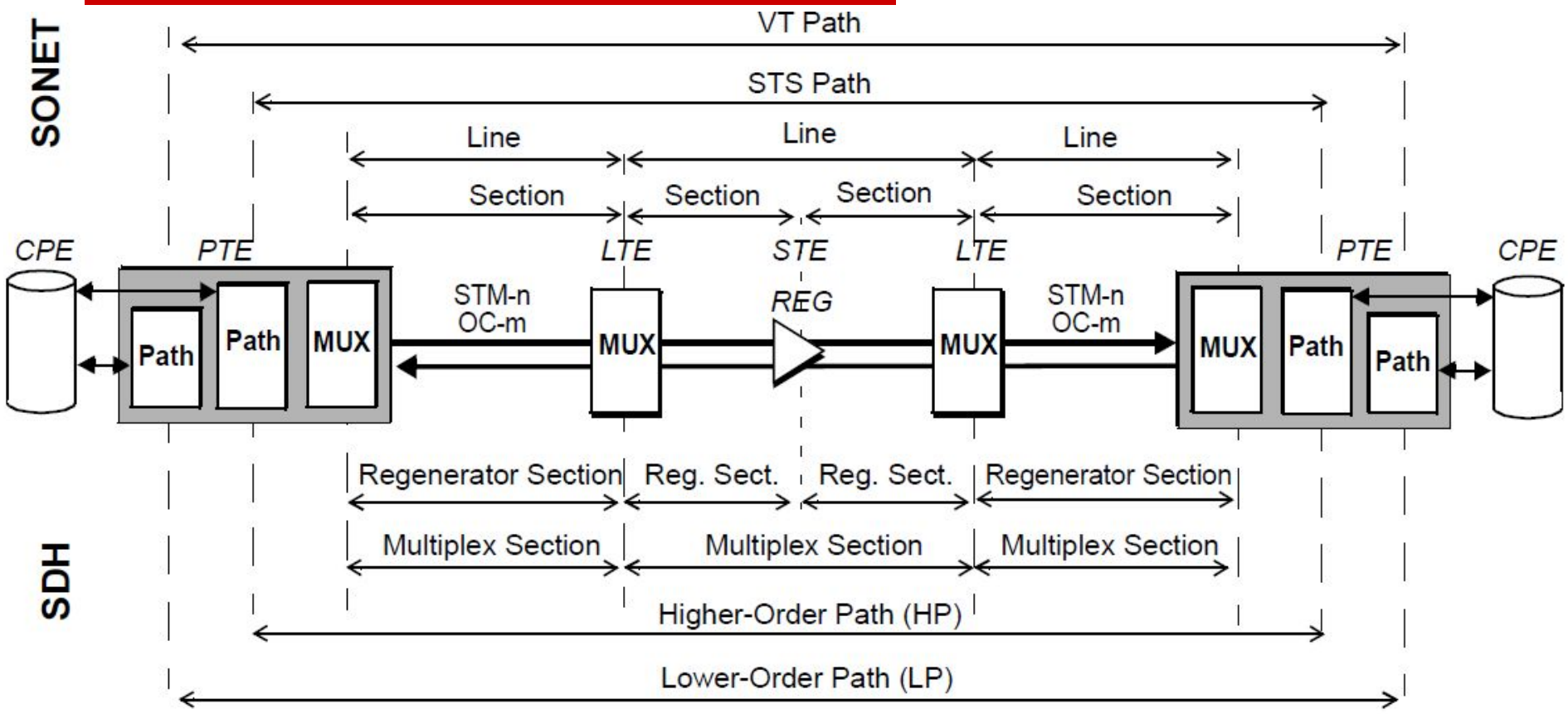
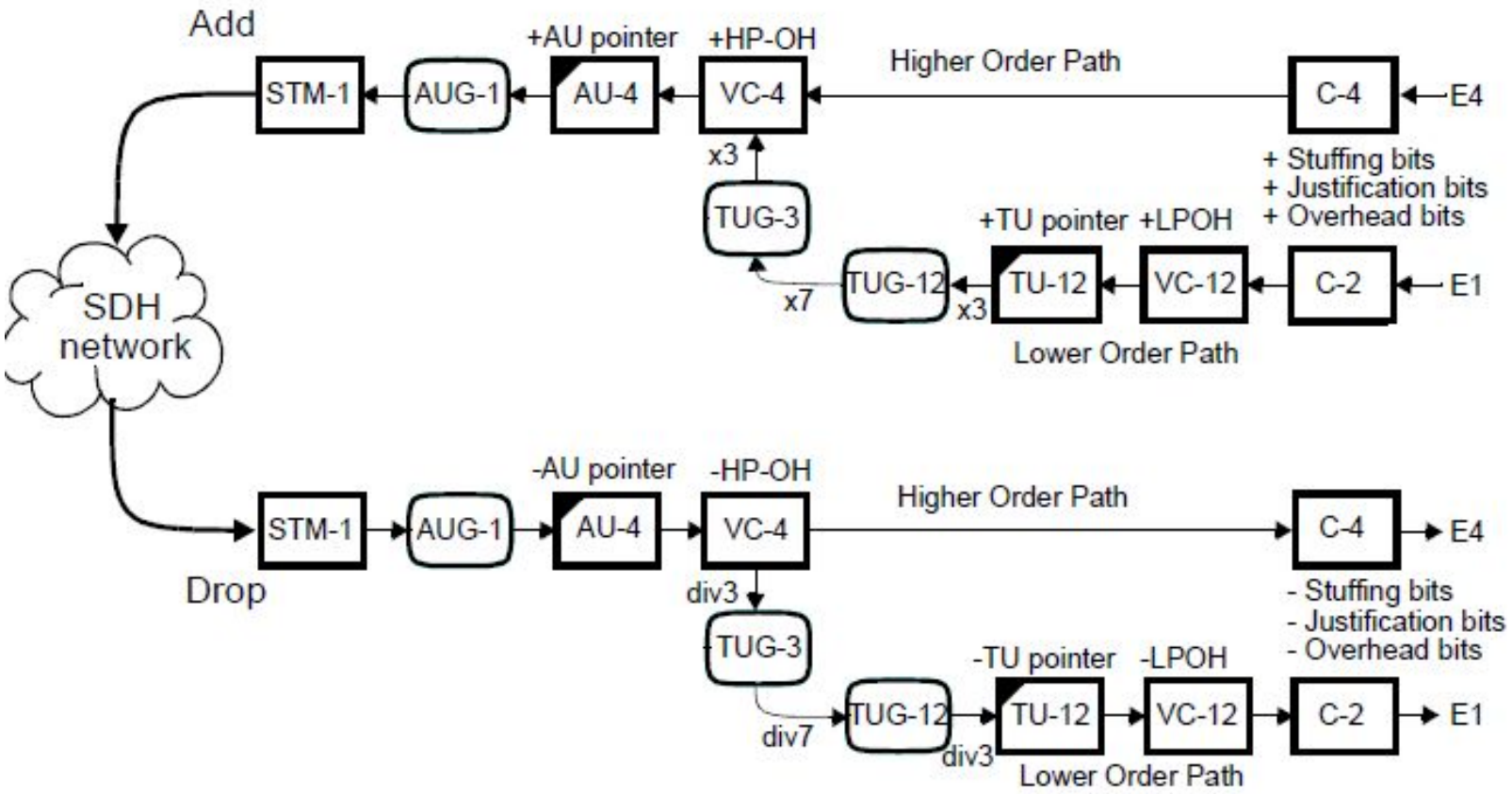

VC-11, VC-12, VC-2, VC-3
VC-4 (VC-3)
MSOH
MSOH
RSOH
RSOH
RSOH
RSOH
Layers
LO Path
HO Path
Mux
Section
Line/Mux
Section
Section
Section
LO Path
HO Path
Mux
Section
Paths
Sections
Physical media
Terminal Multiplexer
Regenerator
Multiplexer
Regenerator
Terminal Multiplexer

Схема мультиплексирования данных SDH

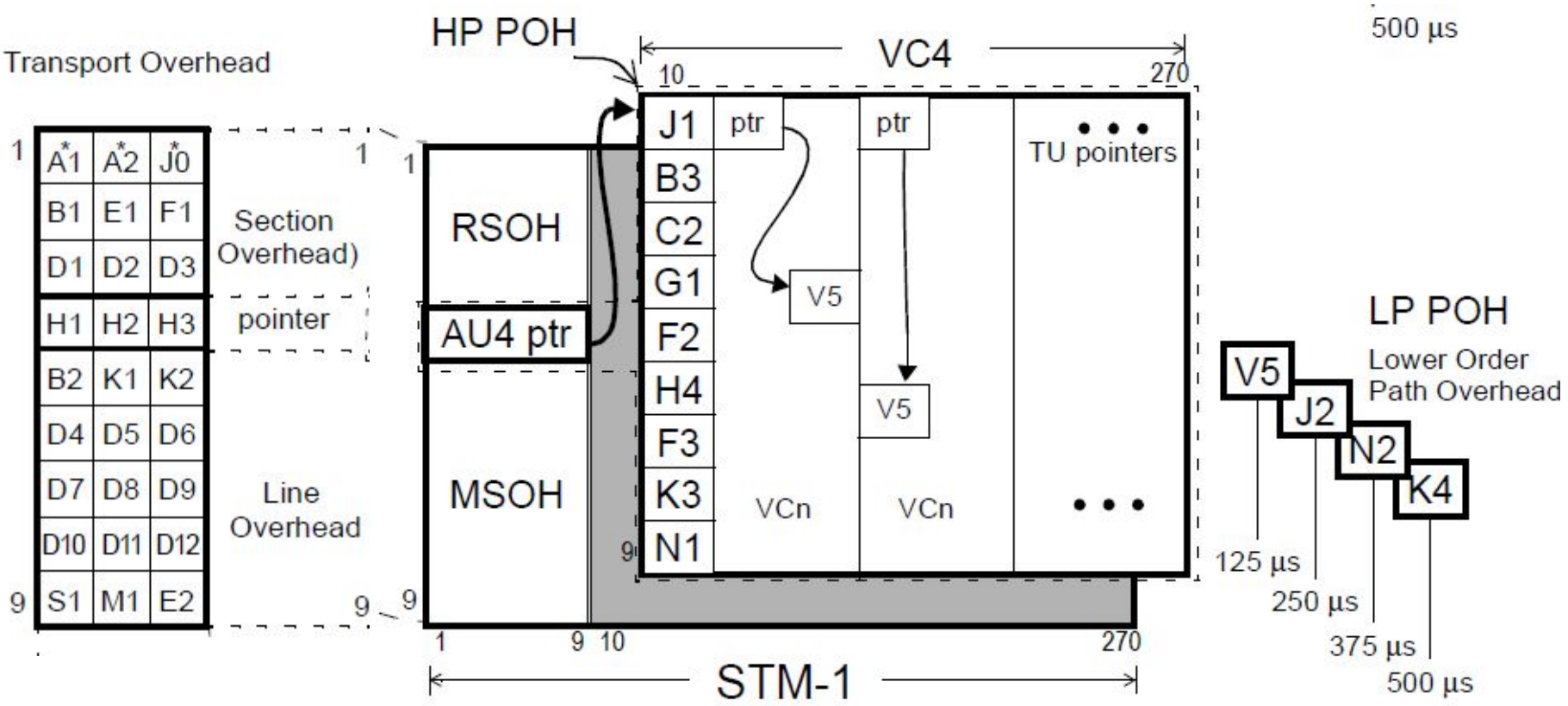


Уровни SDH


SONET
SDH
VT Path
STS Path
Line
Line
Line
Section
Section
Section
Section
CPE
PTE
LTE
STE
LTE
PTE
CPE
Path
Path
MUX
STM-n
OC-m
MUX
REG
MUX
STM-n
OC-m
MUX
Path
Path
Regenerator Section
Reg. Sect.
Reg. Sect.
Regenerator Section
Multiplex Section
Multiplex Section
Multiplex Section
Higher-Order Path (HP)
Lower-Order Path (LP)


Add
+AU pointer
+HP-OH
Higher Order Path
STM-1
AUG-1
AU-4
VC-4
C-4
E4
x3
+ Stuffing bits
+ Justification bits
+ Overhead bits
TUG-3
+TU pointer
+LPOH
SDH
network
TUG-12
TU-12
VC-12
C-2
E1
x7
x3
Lower Order Path
-AU pointer
-HP-OH
Higher Order Path
STM-1
AUG-1
AU-4
VC-4
C-4
E4
Drop
div3
- Stuffing bits
- Justification bits
- Overhead bits
TUG-3
-TU pointer
-LPOH
TUG-12
TU-12
VC-12
C-2
E1
div7
div3
Lower Order Path

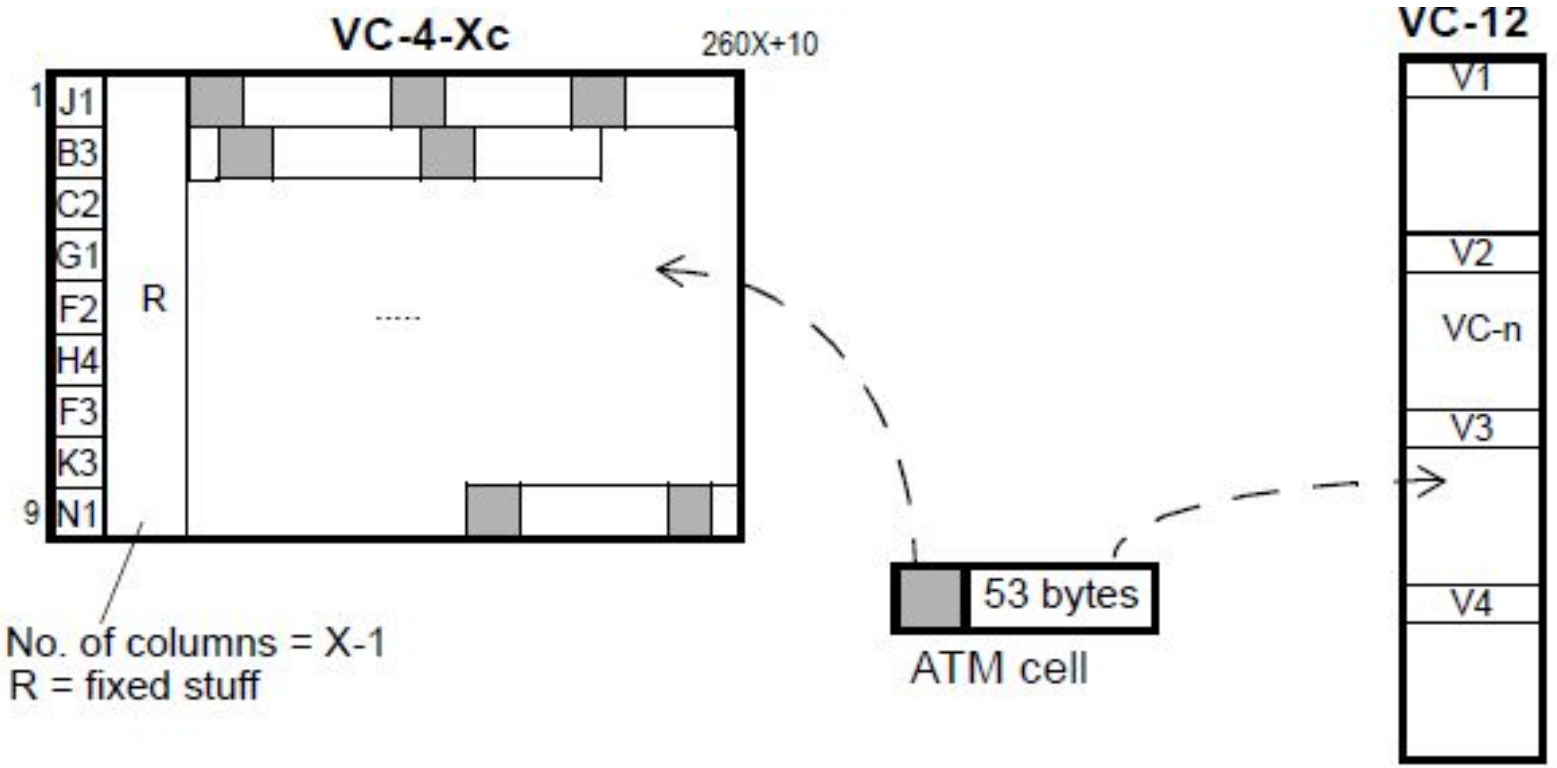
Уровни SDH


Transport Overhead
HP POH
VC4
500 µs
A1 A2 J0
B1 E1 F1
D1 D2 D3
H1 H2 H3
B2 K1 K2
D4 D5 D6
D7 D8 D9
D10 D11 D12
S1 M1 E2
Section Overhead)
pointer
Line Overhead
RSOH
AU4 ptr
MSOH
J1
B3
C2
G1
F2
H4
F3
K3
N1
ptr
ptr
V5
V5
VCn
VCn
TU pointers
LP POH
Lower Order Path Overhead
V5
J2
N2
K4
125 µs
250 µs
375 µs
500 µs
STM-1

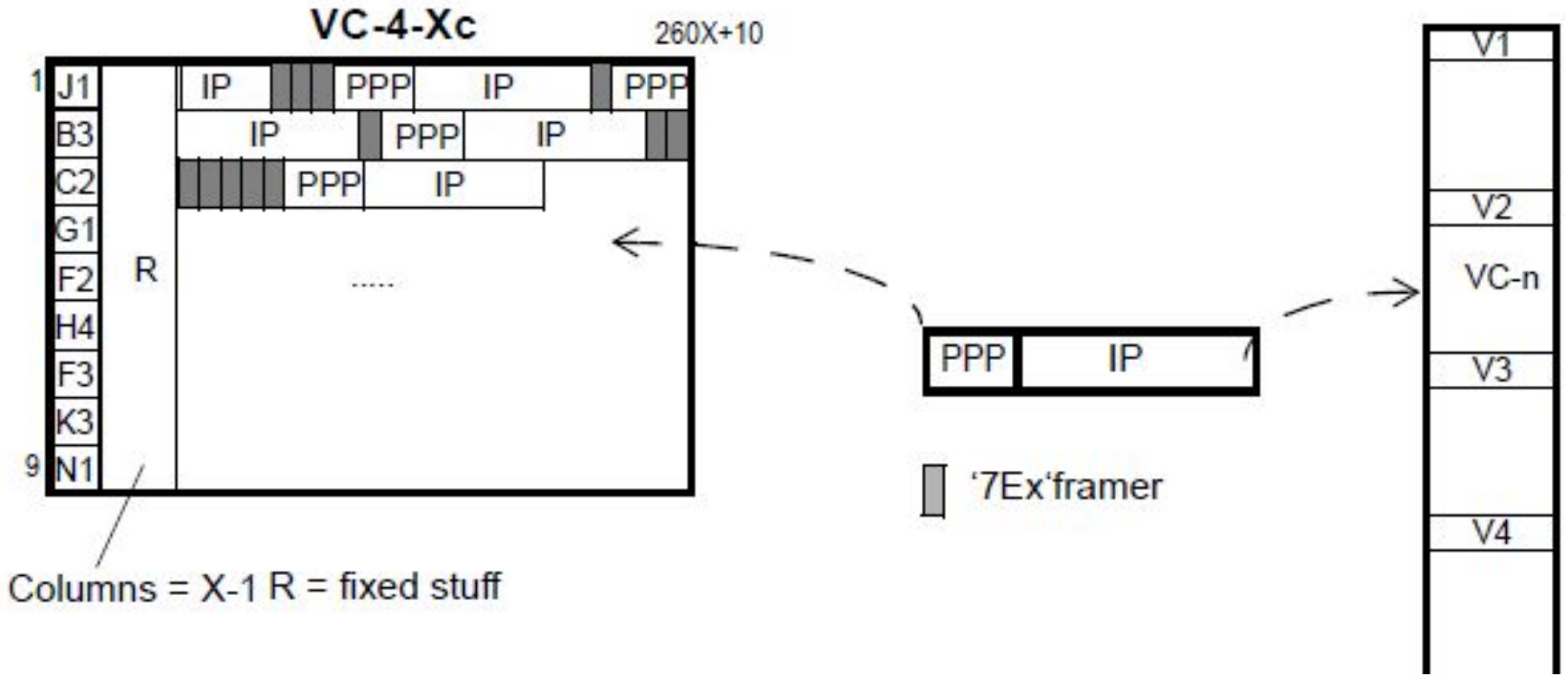
Типы VC и их пропускная способность

SDH	*SONET*	*Bandwidth*	*Payload*
VC-11	VT 1.5 SPE	1,664 Kbps	1,600 Kbps
VC-12	VT 2 SPE	2,240 Kbps	2,176 Kbps
VC-2	VT 6 SPE	6,848 Kbps	6,784 Kbps
VC-3	STS-1 SPE	48,960 Kbps	48,384 Kbps
VC-4	STS-3c SPE	150,336 Kbps	149,760 Kbps
VC-4-4c	STS-12c SPE	601,344 Kbps	599,040 Kbps
VC-4-16c	STS-48c SPE	2,405,376 Kbps	2,396,160 Kbps
VC-4-64c	STS-192c SPE	9,621,504 Kbps	9,584,640 Kbps
VC-4-256c	STS-768c SPE	38,486,016 Kbps	38,338,560 Kbps

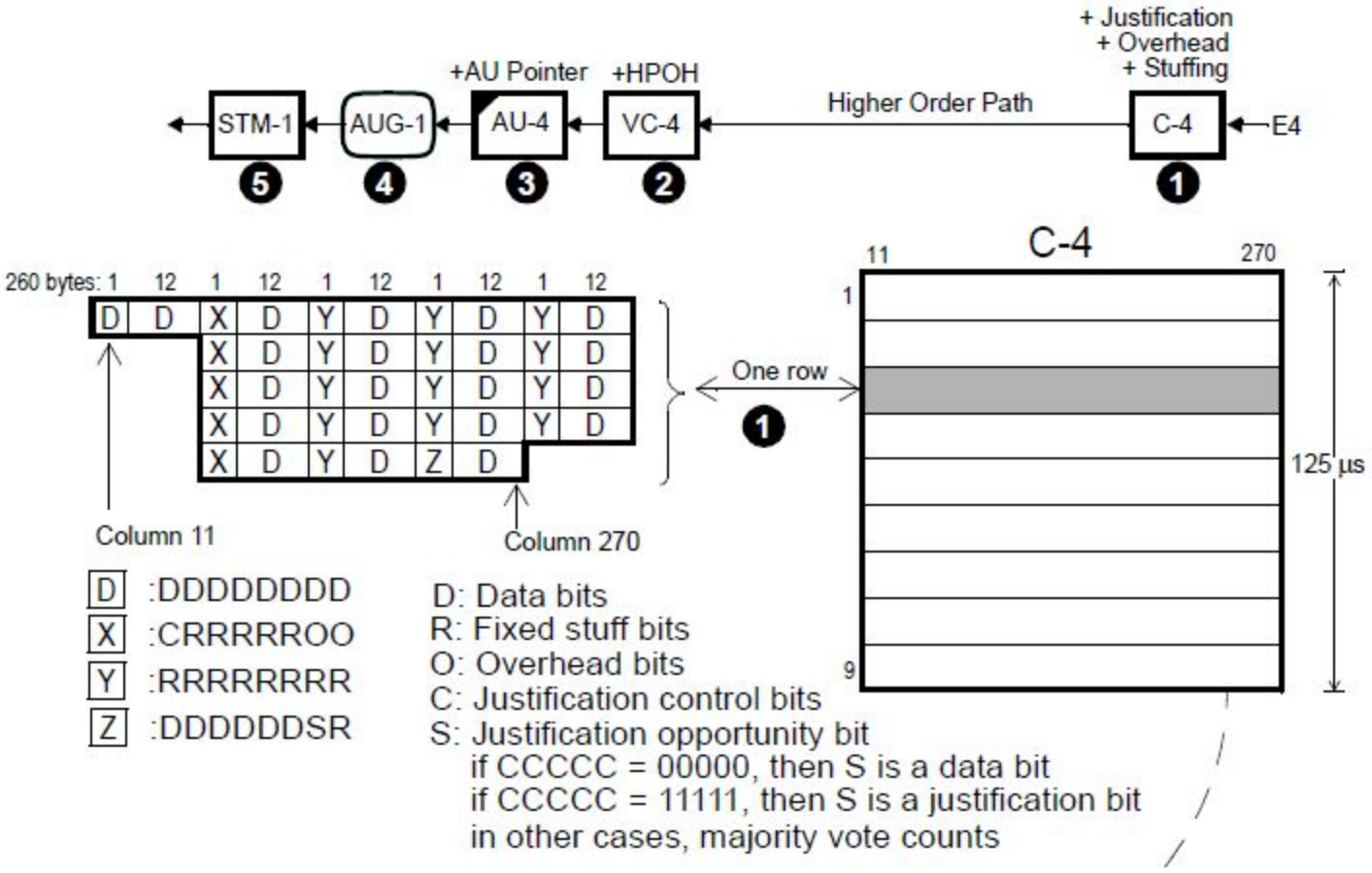
ATM over SDH


VC-4-Xc
260X+10
1
J1
B3
C2
G1
F2
H4
F3
K3
9
N1
R
.....
No. of columns = X-1
R = fixed stuff
53 bytes
ATM cell
VC-12
V1
V2
VC-n
V3
V4

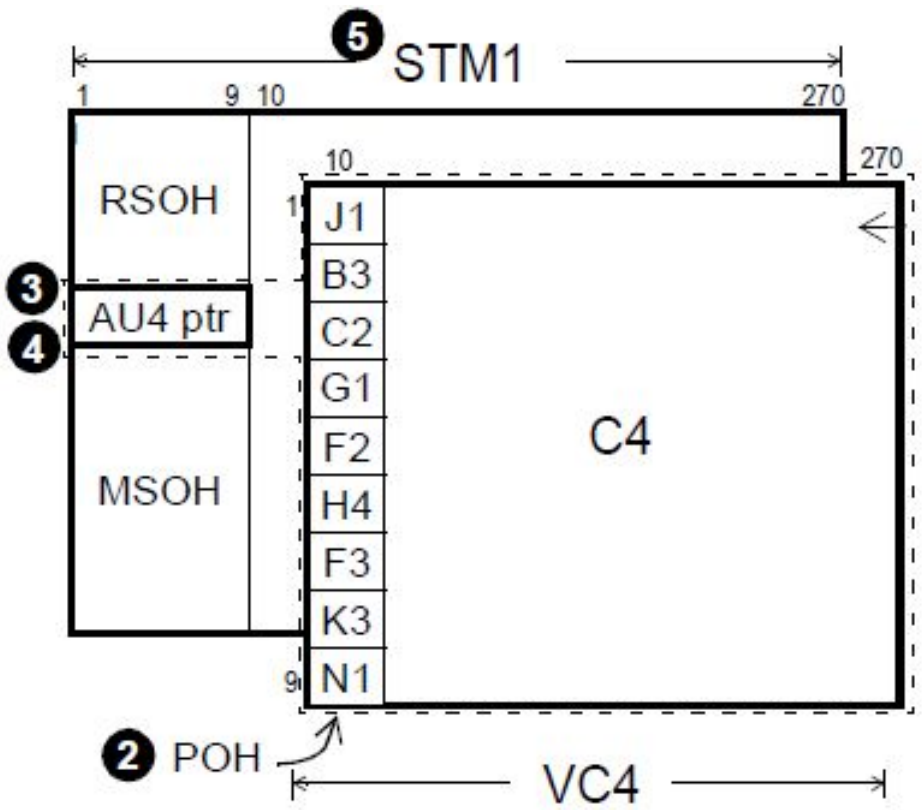
IP over SDH


VC-4-Xc
260X+10
1
J1
B3
C2
G1
F2
H4
F3
K3
9
N1
R
IP
PPP
IP
PPP
IP
PPP
IP
PPP
IP
.....
PPP
IP
'7Ex'framer
V1
V2
VC-n
V3
V4
Columns = X-1 R = fixed stuff

Отображение асинхронного потока E4 на STM-1



Отображение асинхронного потока E4 на STM-1



VC4 = C4 + POH

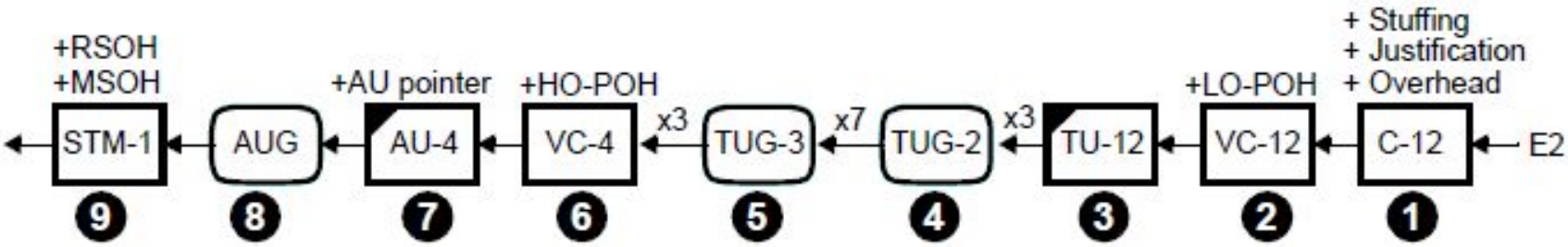
AUG-1 = AU4 ptr + VC4

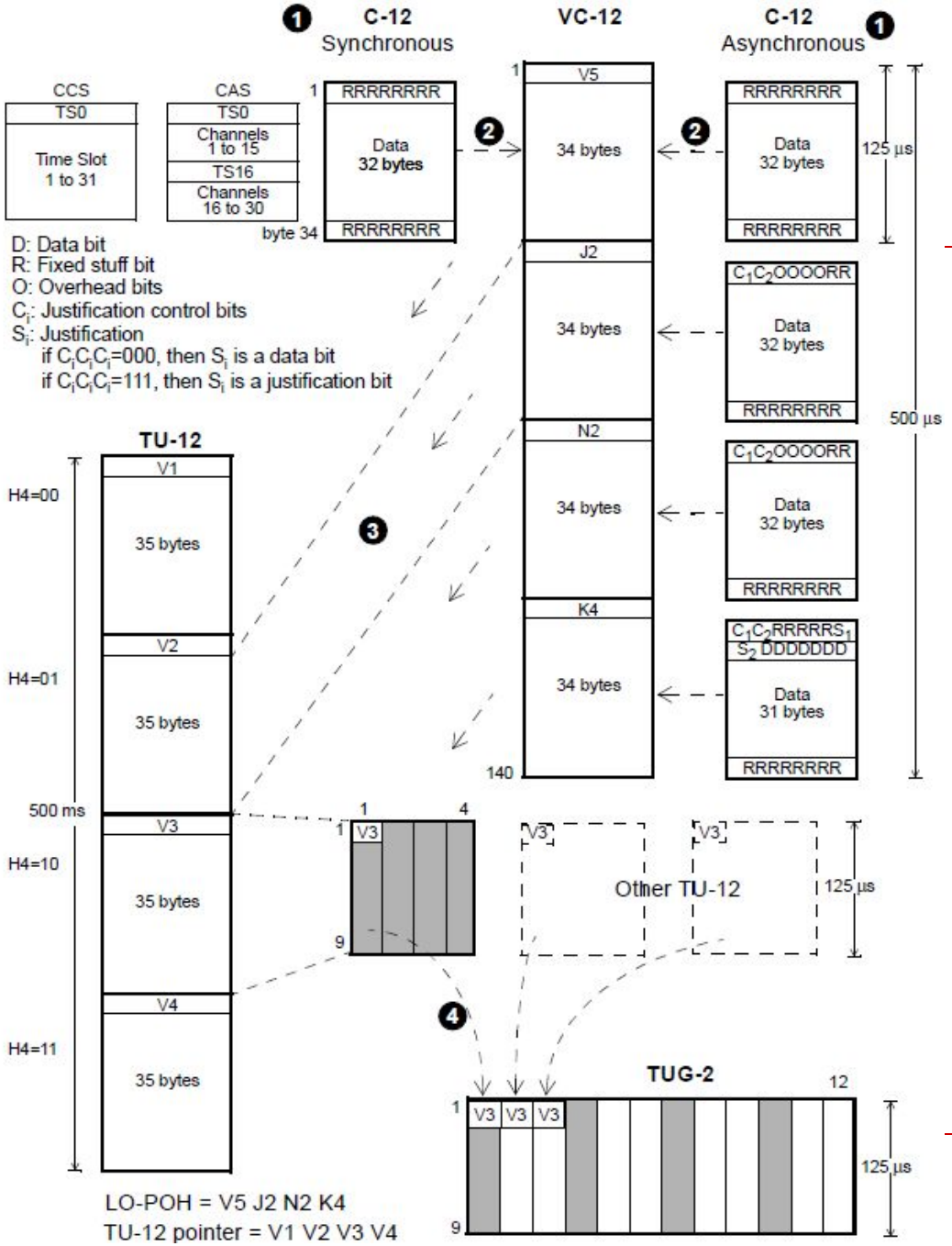
STM-1 = AUG + RSOH + MSOH

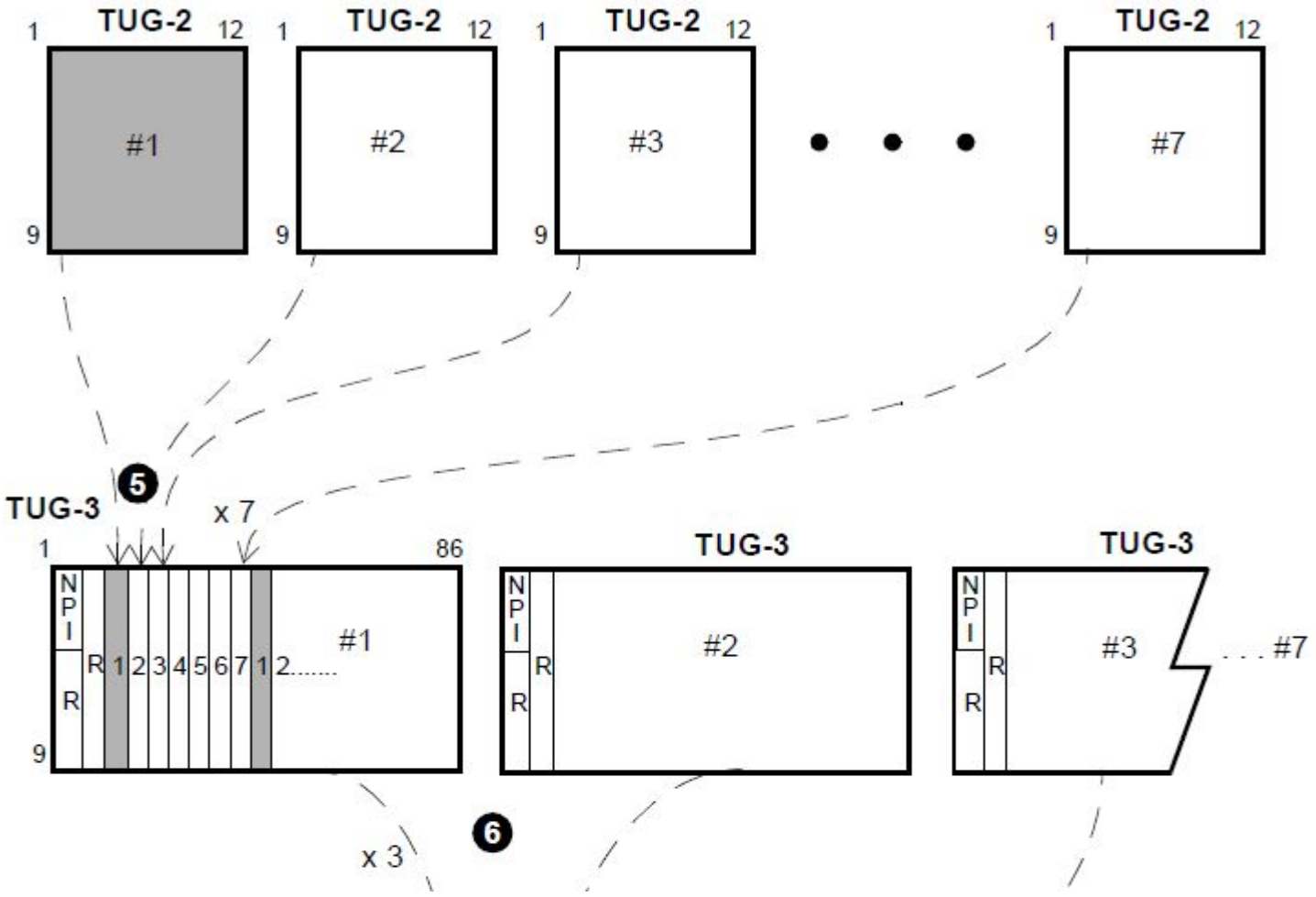
RSOH: Regenerator section overhead
MSOH: Multiplex section overhead

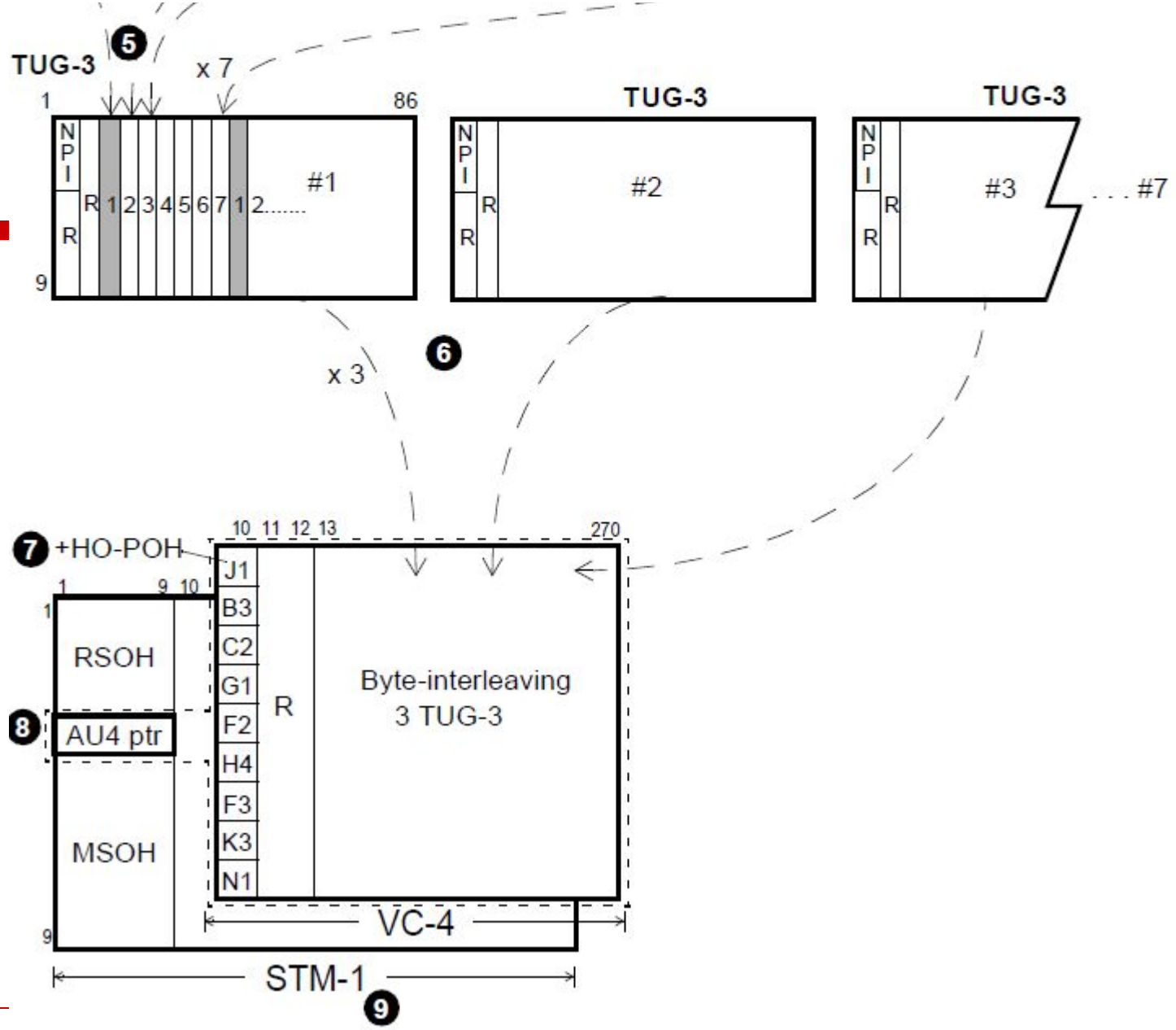
AU ptr: Administration unit pointer
POH: Path overhead
VC4: Virtual container 4
STM: Synchronous transport module

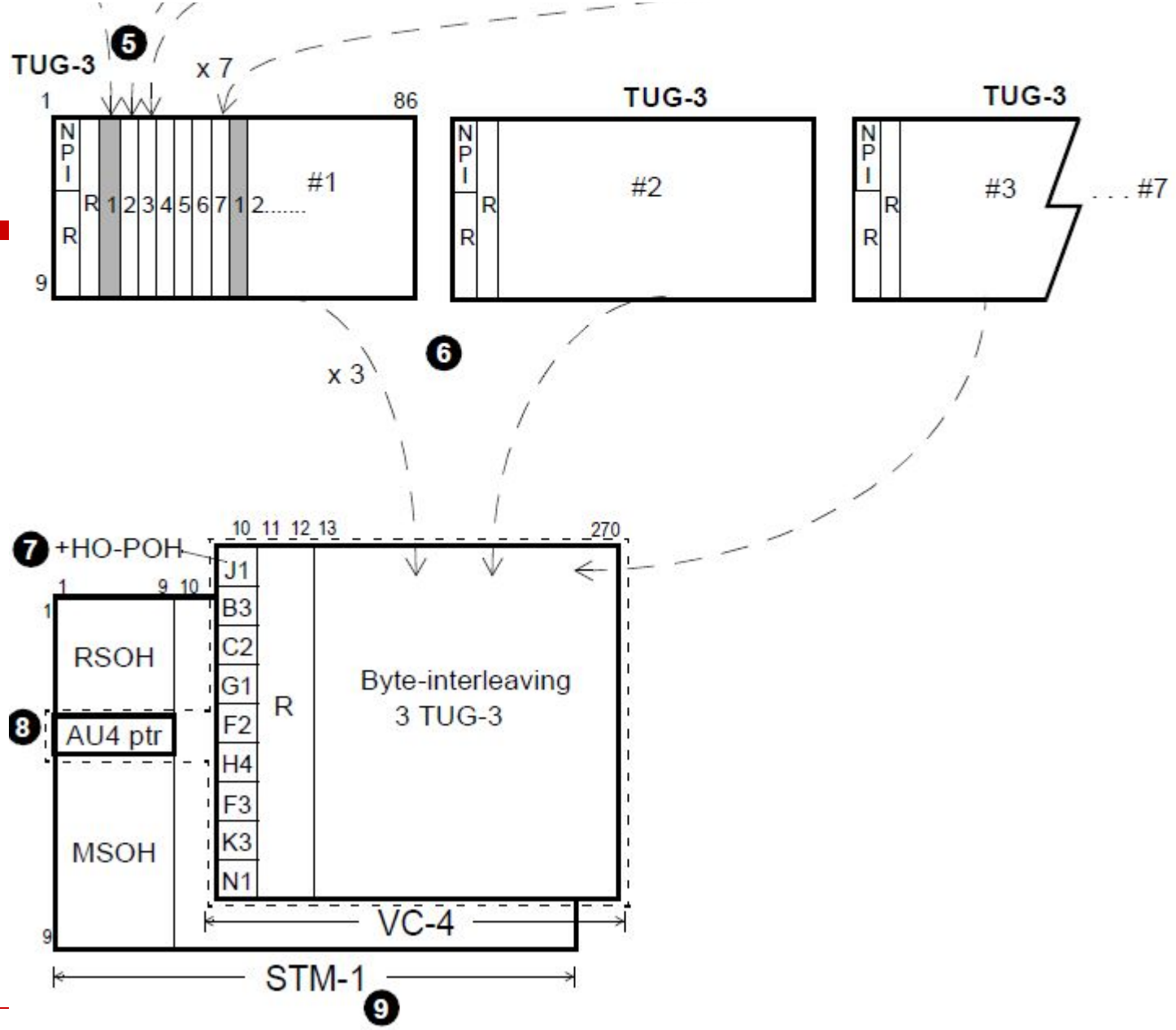
E1 – STM 1

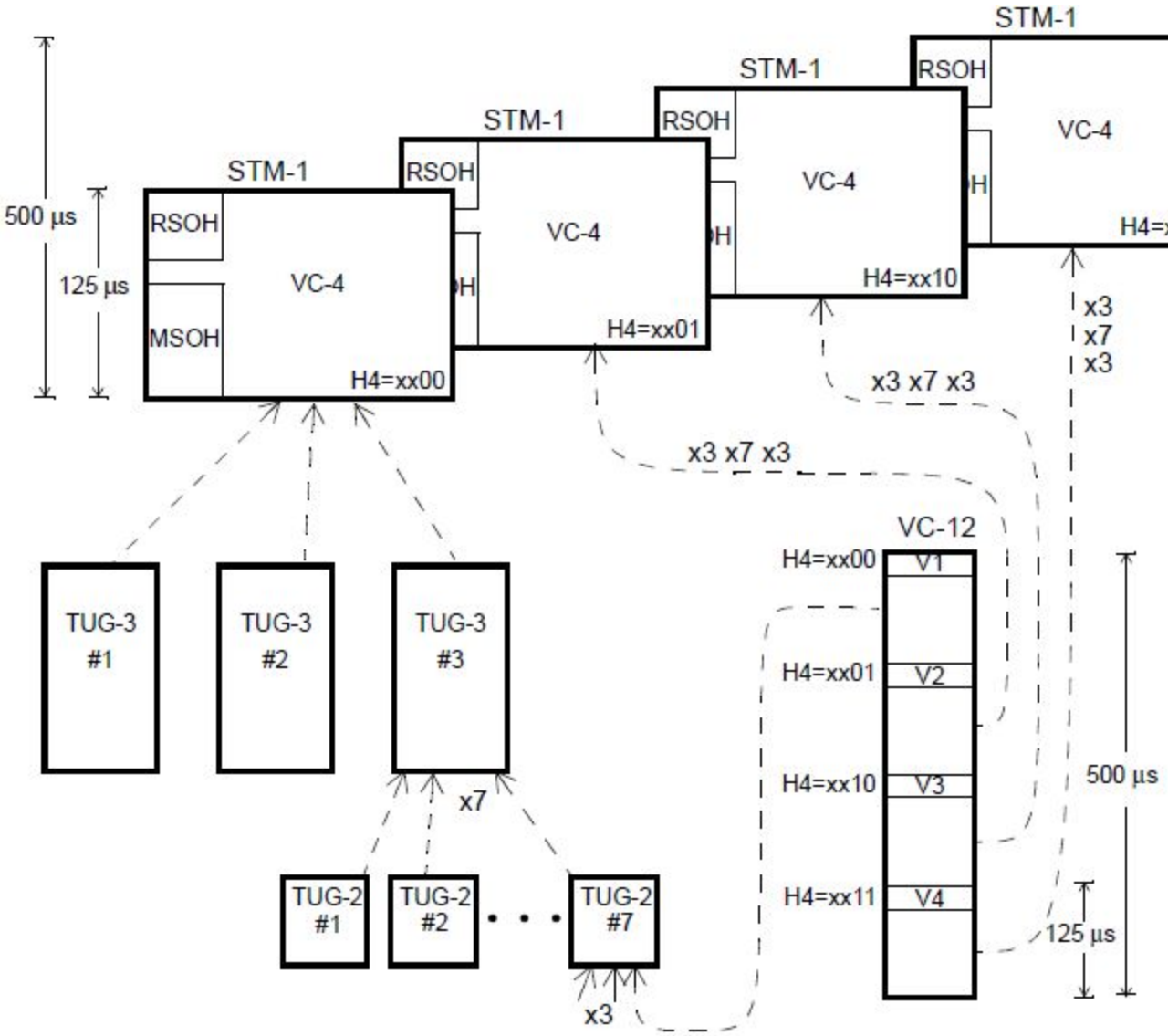

+RSOH
+MSOH
STM-1
9
AUG
8
+AU pointer
AU-4
7
+HO-POH
VC-4
6
x3
TUG-3
5
x7
TUG-2
4
x3
TU-12
3
+LO-POH
VC-12
2
+ Stuffing
+ Justification
+ Overhead
C-12
1
E2


C-12
Synchronous
VC-12
C-12
Asynchronous
CCS
TS0
Time Slot
1 to 31
CAS
TS0
Channels
1 to 15
TS16
Channels
16 to 30
byte 34
RRRRRRRR
Data
32 bytes
RRRRRRRR
V5
34 bytes
J2
34 bytes
N2
34 bytes
K4
34 bytes
140
RRRRRRRR
Data
32 bytes
125 µs
RRRRRRRR
C_1C_2OOOORR
Data
32 bytes
RRRRRRRR
500 µs
C_1C_2OOOORR
Data
32 bytes
RRRRRRRR
C_1C_2RRRRRS$_1$
S_2 DDDDDDD
Data
31 bytes
RRRRRRRR
D: Data bit
R: Fixed stuff bit
O: Overhead bits
C_i: Justification control bits
S_i: Justification
if $C_iC_iC_i$=000, then S_i is a data bit
if $C_iC_iC_i$=111, then S_i is a justification bit
TU-12
H4=00
V1
35 bytes
H4=01
V2
35 bytes
500 ms
H4=10
V3
35 bytes
H4=11
V4
35 bytes
1
4
1
V3
9
V3
V3
Other TU-12
125 µs
TUG-2
12
1
V3 V3 V3
9
125 µs
LO-POH = V5 J2 N2 K4
TU-12 pointer = V1 V2 V3 V4

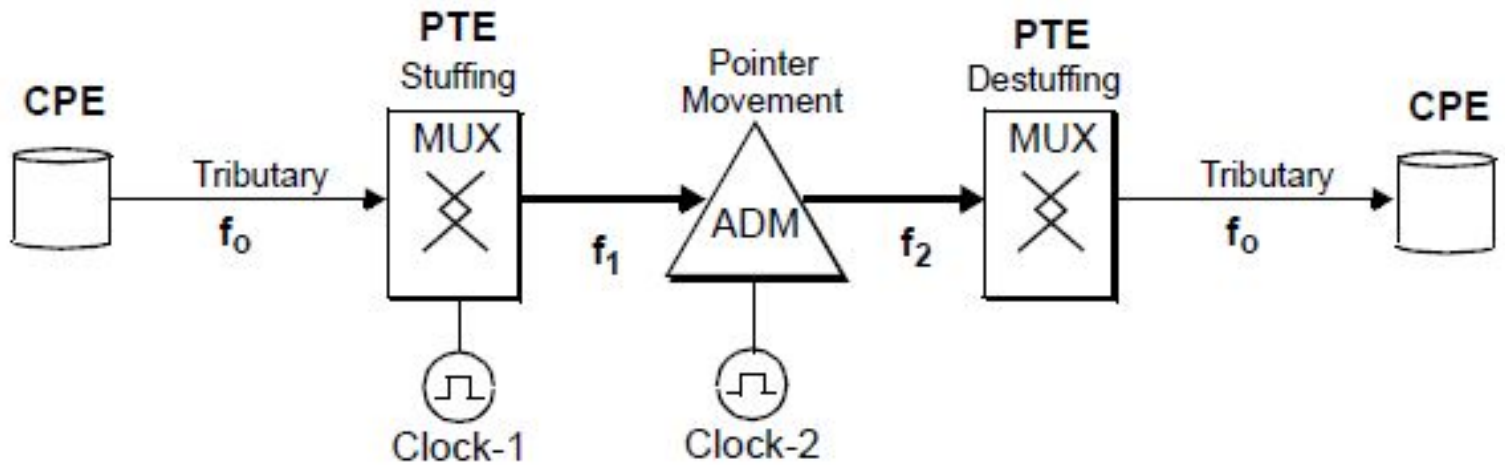

TUG-2
1
12
9
#1
#2
#3
#7
5
TUG-3
x 7
86
NPI
R
1 2 3 4 5 6 7 1 2.....
#1
#2
#3
. . . #7
6
x 3

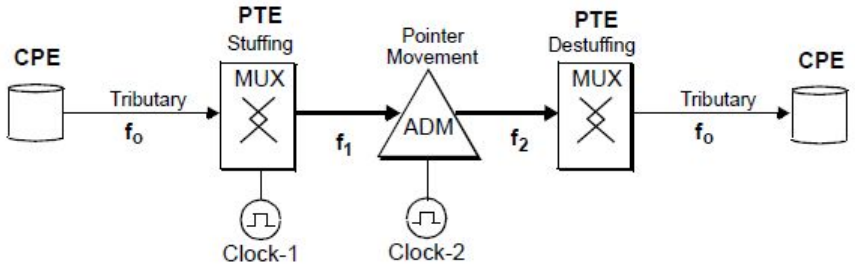

TUG-3
5
x 7
1
86
NPI
R
1 2 3 4 5 6 7 1 2.....
#1
9
TUG-3
#2
TUG-3
#3
. . . #7
x 3
6
7 +HO-POH
10 11 12 13
270
J1
B3
C2
G1
F2
H4
F3
K3
N1
R
Byte-interleaving
3 TUG-3
1
9 10
RSOH
8
AU4 ptr
MSOH
9
VC-4
STM-1
9

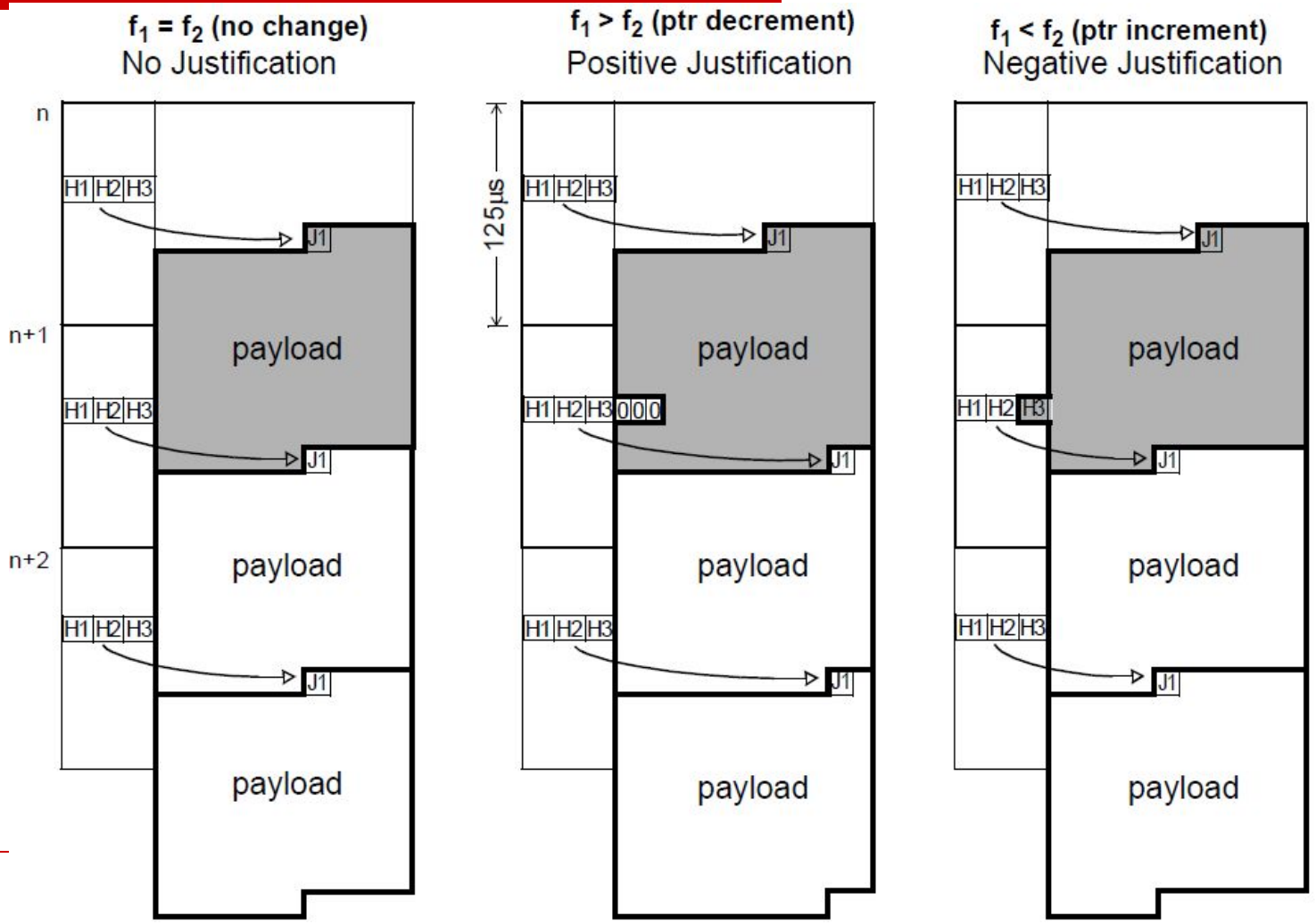

TUG-3
5
x 7
1
86
NPI
R
1 2 3 4 5 6 7 1 2.....
#1
9
TUG-3
#2
TUG-3
#3
. . . #7
x 3
6
7 +HO-POH
10 11 12 13
270
J1
B3
C2
G1
F2
H4
F3
K3
N1
R
Byte-interleaving
3 TUG-3
1
9 10
RSOH
8
AU4 ptr
MSOH
9
VC-4
STM-1
9

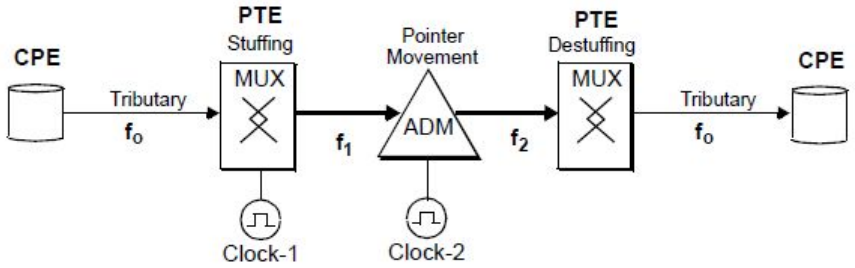

STM-1
RSOH
VC-4
H4=xx11
STM-1
RSOH
VC-4
H4=xx10
STM-1
RSOH
VC-4
H4=xx01
STM-1
RSOH
MSOH
VC-4
H4=xx00
500 µs
125 µs
x3
x7
x3
x3 x7 x3
x3 x7 x3
VC-12
H4=xx00
V1
H4=xx01
V2
H4=xx10
V3
H4=xx11
V4
500 µs
125 µs
TUG-3
#1
TUG-3
#2
TUG-3
#3
x7
TUG-2
#1
TUG-2
#2
TUG-2
#7
x3

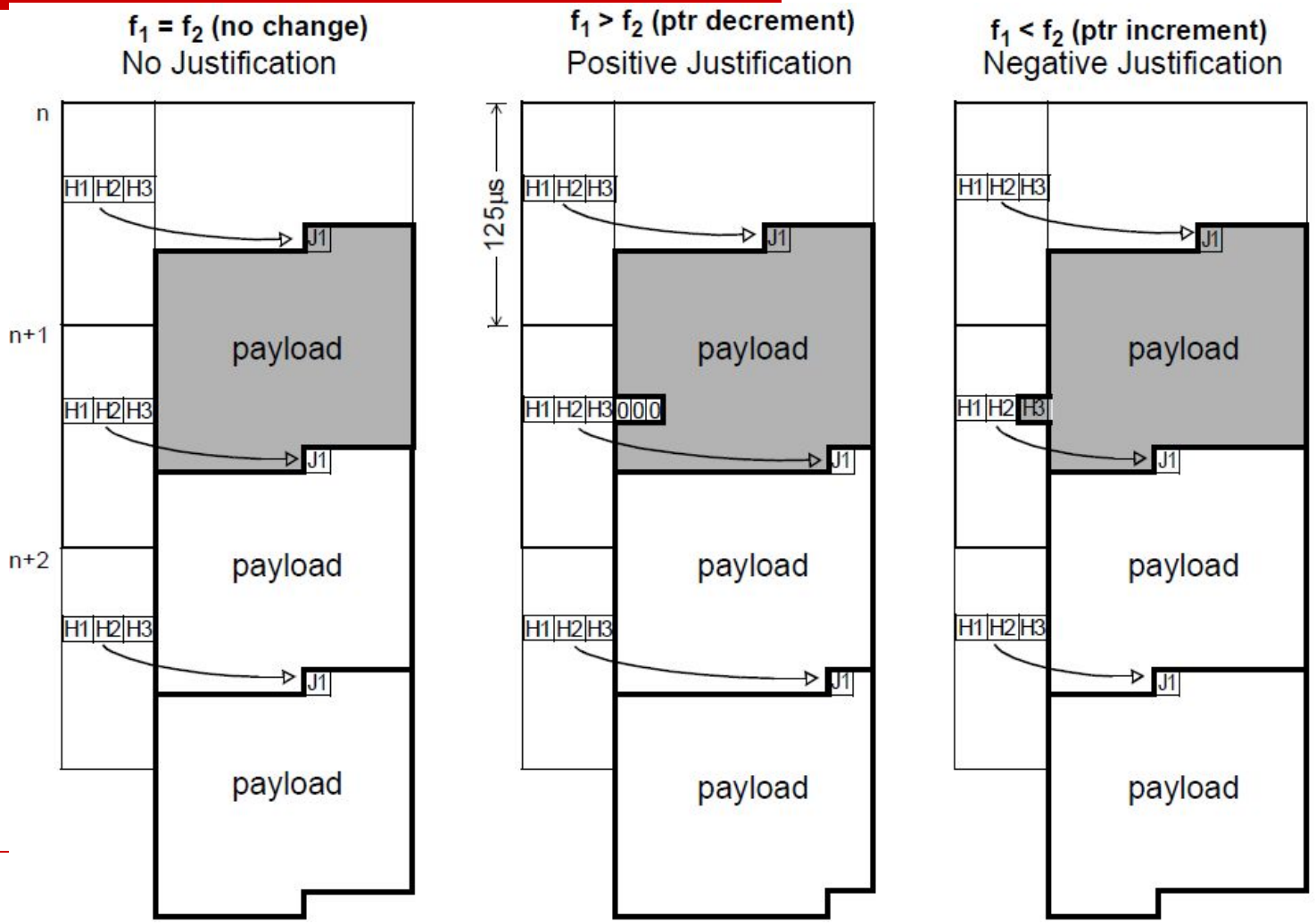
POINTERS AND TIMING COMPENSATION




CPE
Tributary
f_o
PTE
Stuffing
MUX
f_1
Pointer
Movement
ADM
f_2
PTE
Destuffing
MUX
Tributary
f_o
CPE
Clock-1
Clock-2


$f_1 = f_2$ (no change)
No Justification
$f_1 > f_2$ (ptr decrement)
Positive Justification
$f_1 < f_2$ (ptr increment)
Negative Justification
n
n+1
n+2
125µs
H1 H2 H3
J1
payload
0 0 0


CPE
Tributary
f_o
PTE
Stuffing
MUX
f_1
Pointer
Movement
ADM
f_2
PTE
Destuffing
MUX
Tributary
f_o
CPE
Clock-1
Clock-2

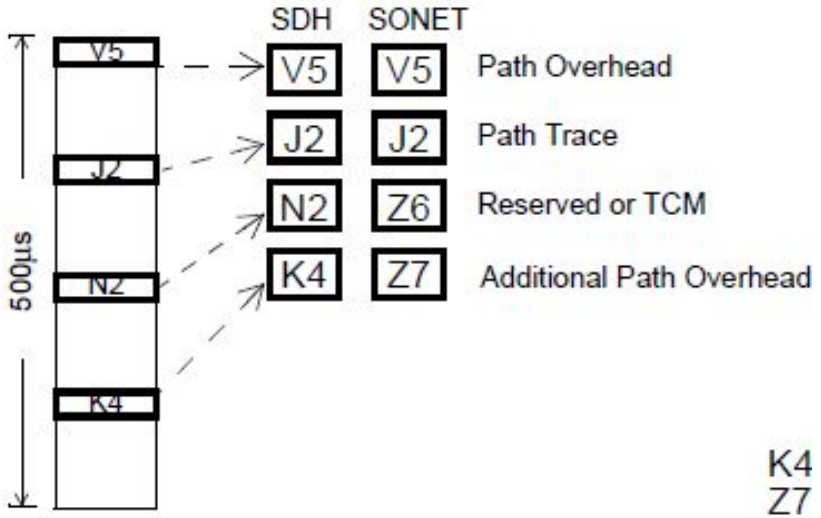

$f_1 = f_2$ (no change)
No Justification
$f_1 > f_2$ (ptr decrement)
Positive Justification
$f_1 < f_2$ (ptr increment)
Negative Justification
n
n+1
n+2
125µs
H1 H2 H3
J1
payload
0 0 0

Структура заголовков

Nine-byte Path Overhead (POH)

SDH	SONET	
J1	J1	Path trace, message with CRC
B3	B3	BIP-8 parity control
C2	C2	Signal label (mapping)
G1	G1	Path status
F2	F2	Path user channel (voice or data)
H4	H4	Position and sequence indicator
F3	F3	Path user channel (voice or data)
K3	Z3	Automatic Protection Switch
N1	Z4	Tandem Connection Monitoring

Four-byte Path Overhead (POH)



Структура заголовков

STS-1/STM-0

1	A1*	A2*	J0*
	B1	E1	F1
	D1	D2	D3
	H1	H2	H3
	B2	K1	K2
	D4	D5	D6
	D7	D8	D9
	D10	D11	D12
9	S1	M1	E2

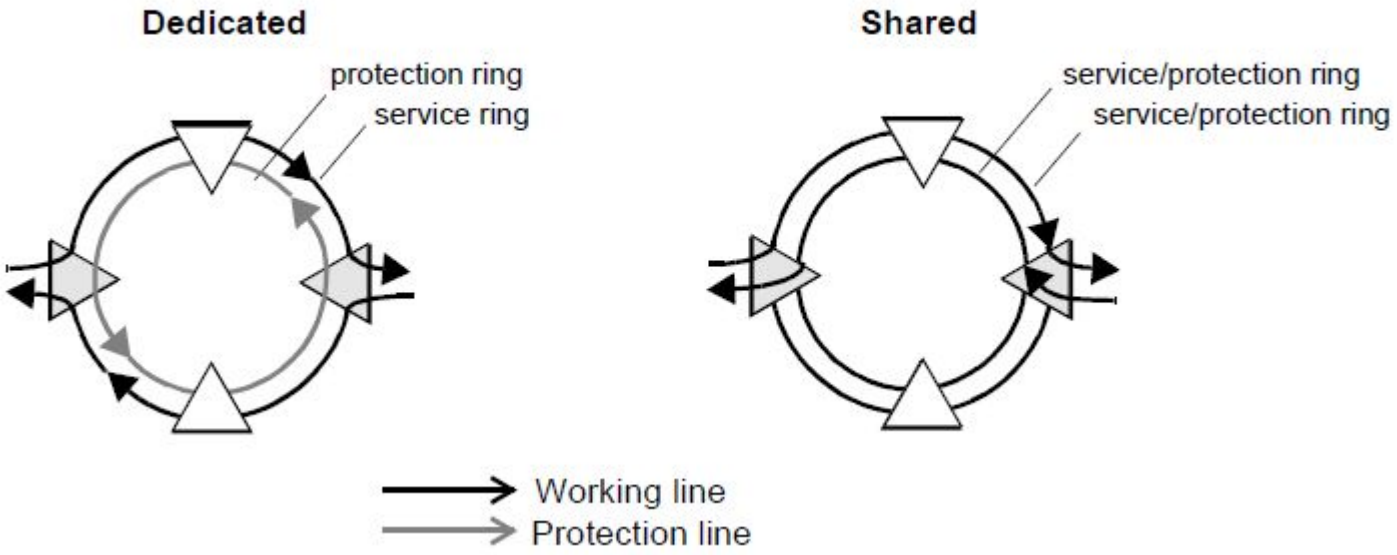
STM-1/STS-3/OC-3

1									9
1	A1*	A1*	A1*	A2*	A2*	A2*	J0*	X*	X*
	B1	^	^	E1	^		F1	X	X
	D1	^	^	D2	^		D3		
	Pointer (s)								
	B2	B2	B2	K1			K2		
	D4			D5			D6		
	D7			D8			D9		
	D10			D11			D12		
9	S1					M1	E2	X	X

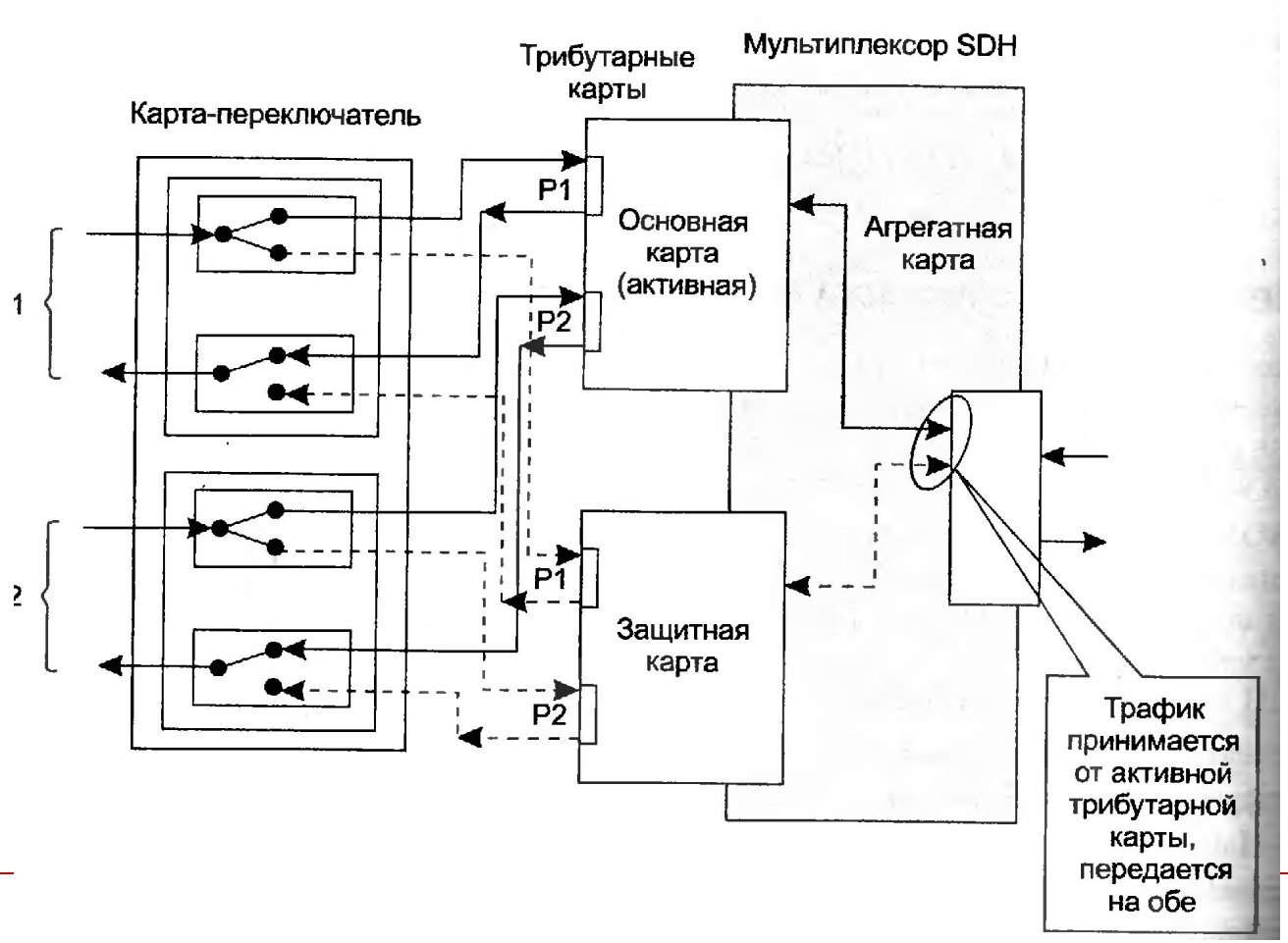
J0: Section Trace
A1= 11110110, A2= 00101000: Frame Alignment
B1: Section Parity Code BIP-8
B2: Bit interleaved parity,
D1-D3: 192-Kbps OA&M data
D4-D12: 576-Kbps OA&M data
E1, E2: 64-Kbps orderwire channels
F1: 64-Kbps user channel
H1, H2, H3: pointer bytes
K1, K2: Request /answer APS channels
F1: 64-Kbps user channel
M0, M1: Resending of B2 errors
Z0: reserved

* Nonscrambled bytes
X bytes reserved for national use
^ Media-dependent bytes

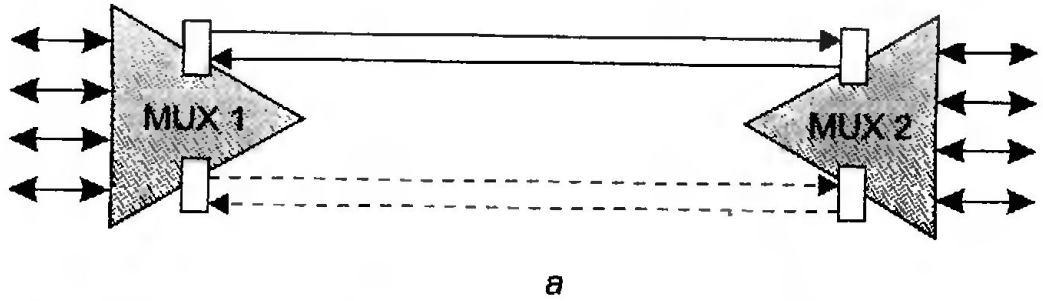
Защита в сетях SDH



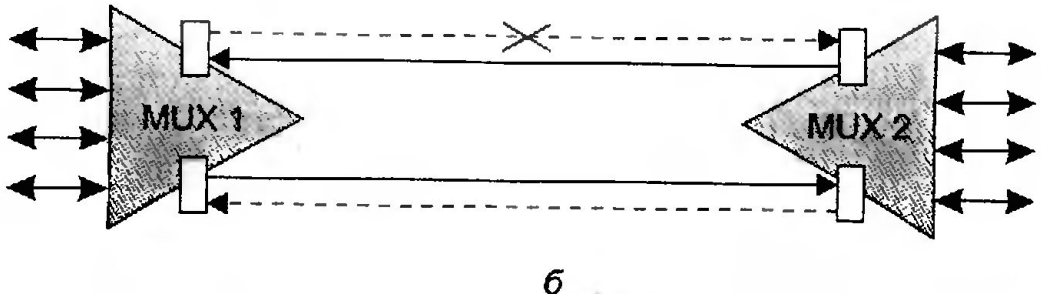
Методы обеспечения живучести сети SDH



Защита мультиплексной секции

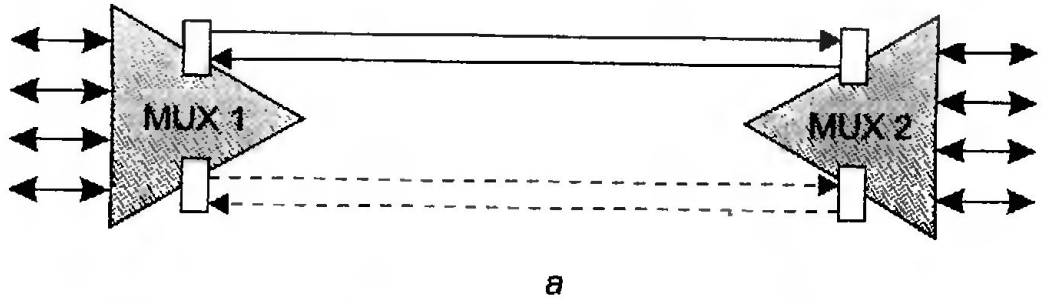


а



б

Защита мультиплексной секции



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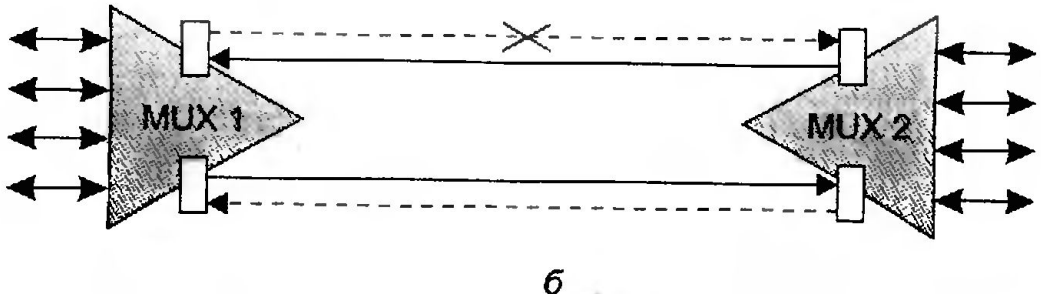
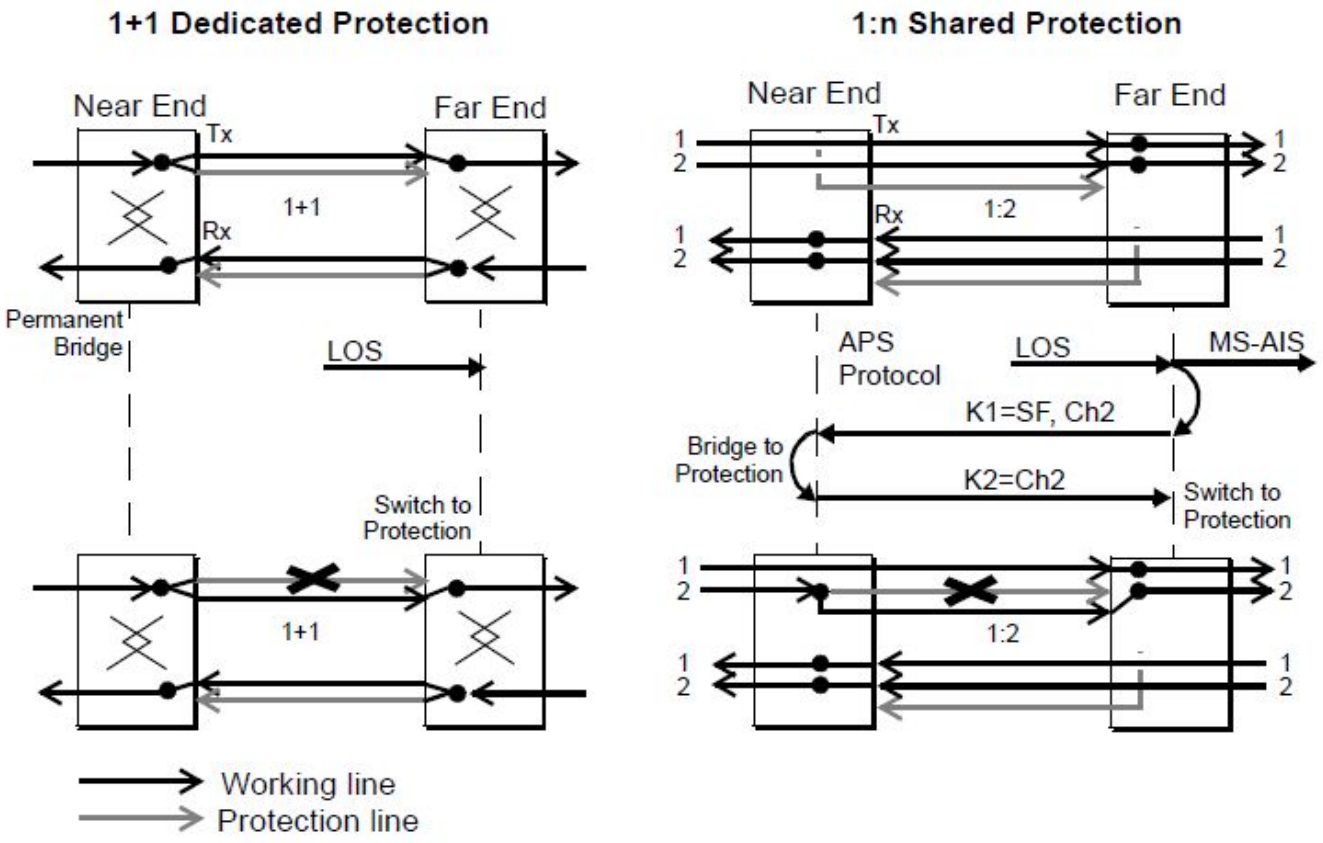
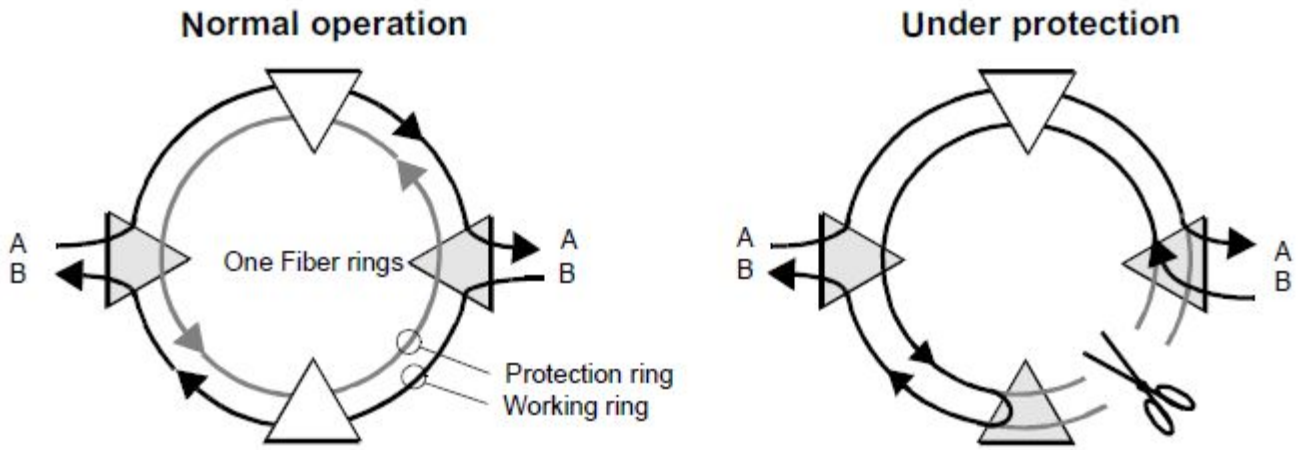


б

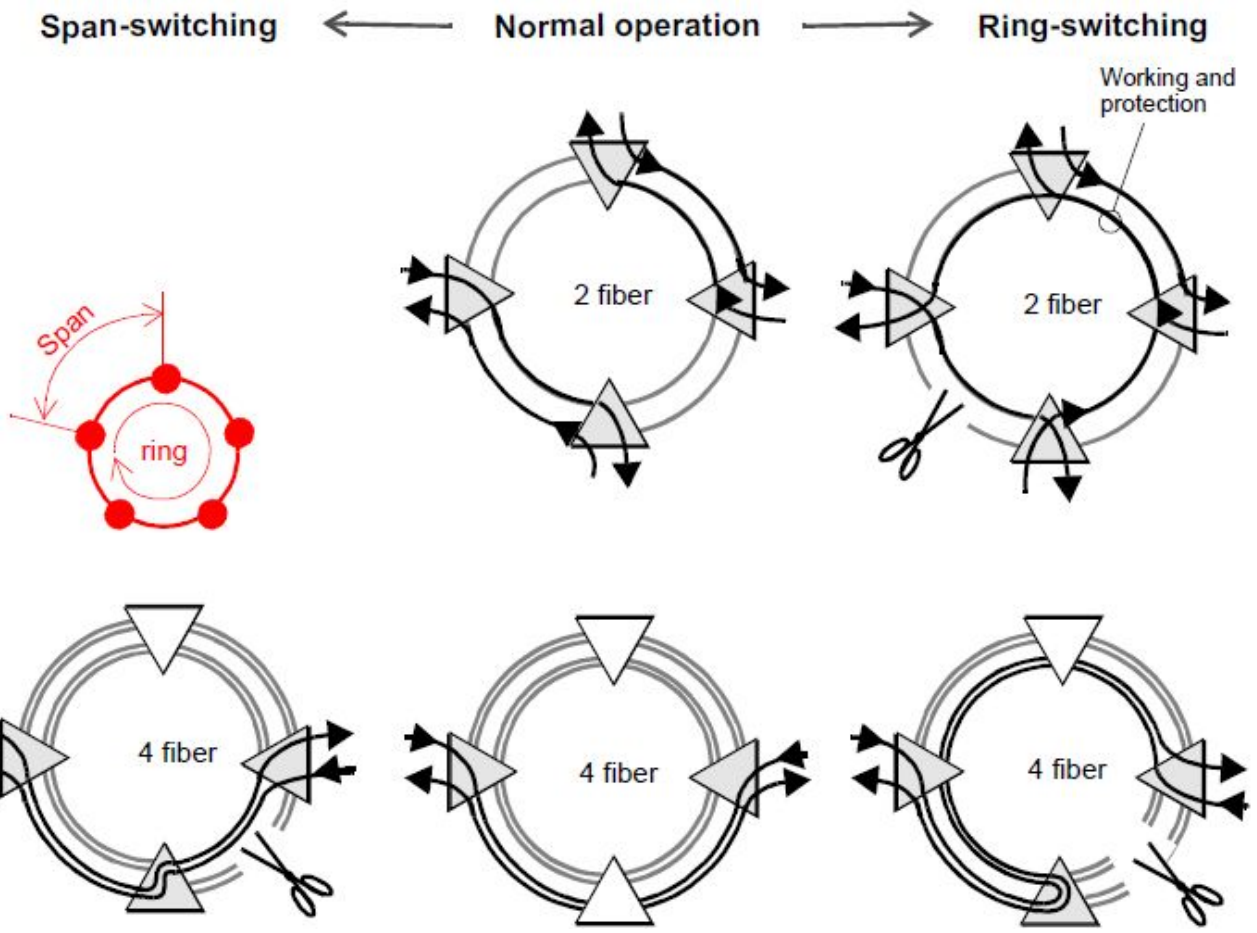
Защита в сетях SDH



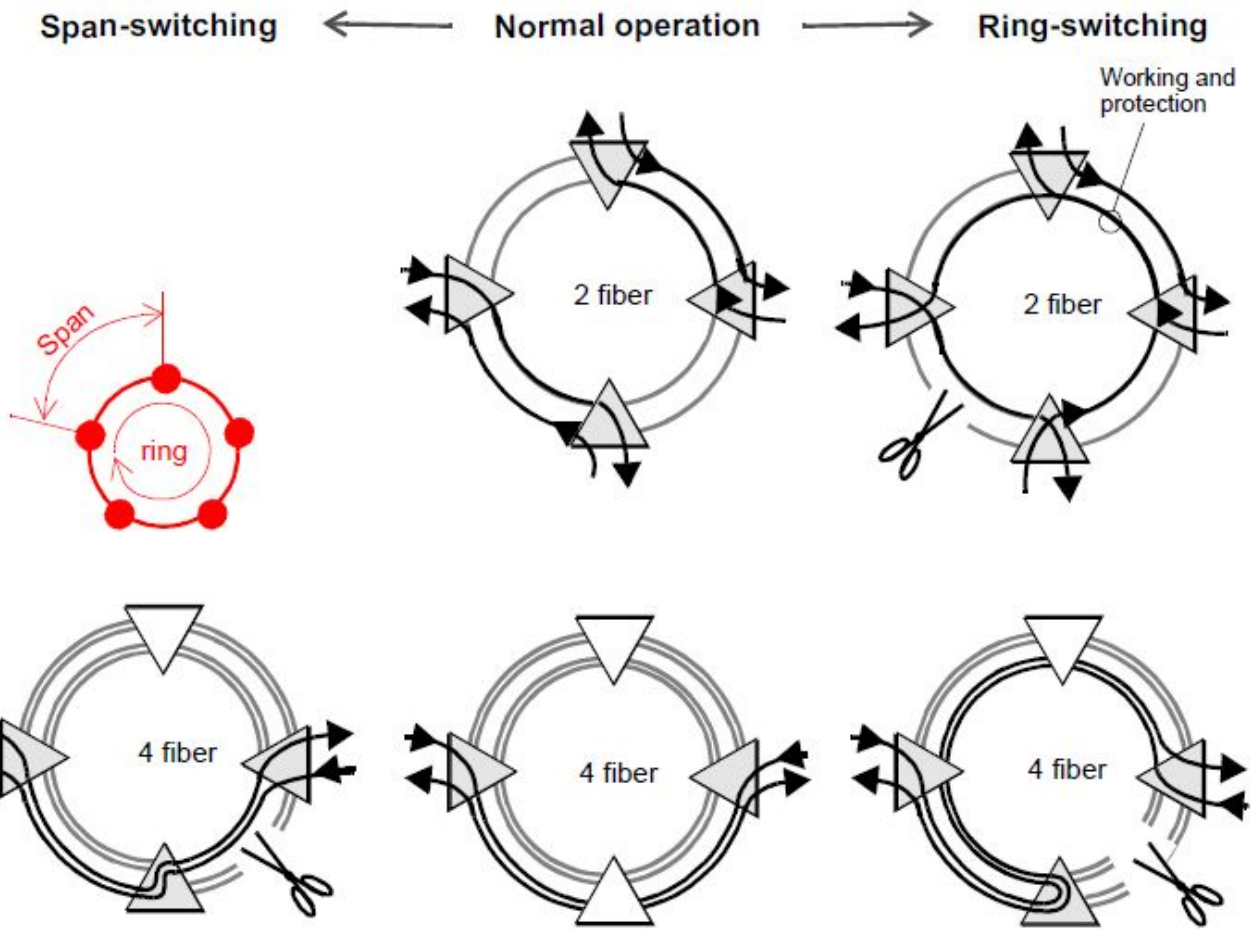
Защита в сетях SDH



Защита в сетях SDH



Защита в сетях SDH



Next Generation SDH

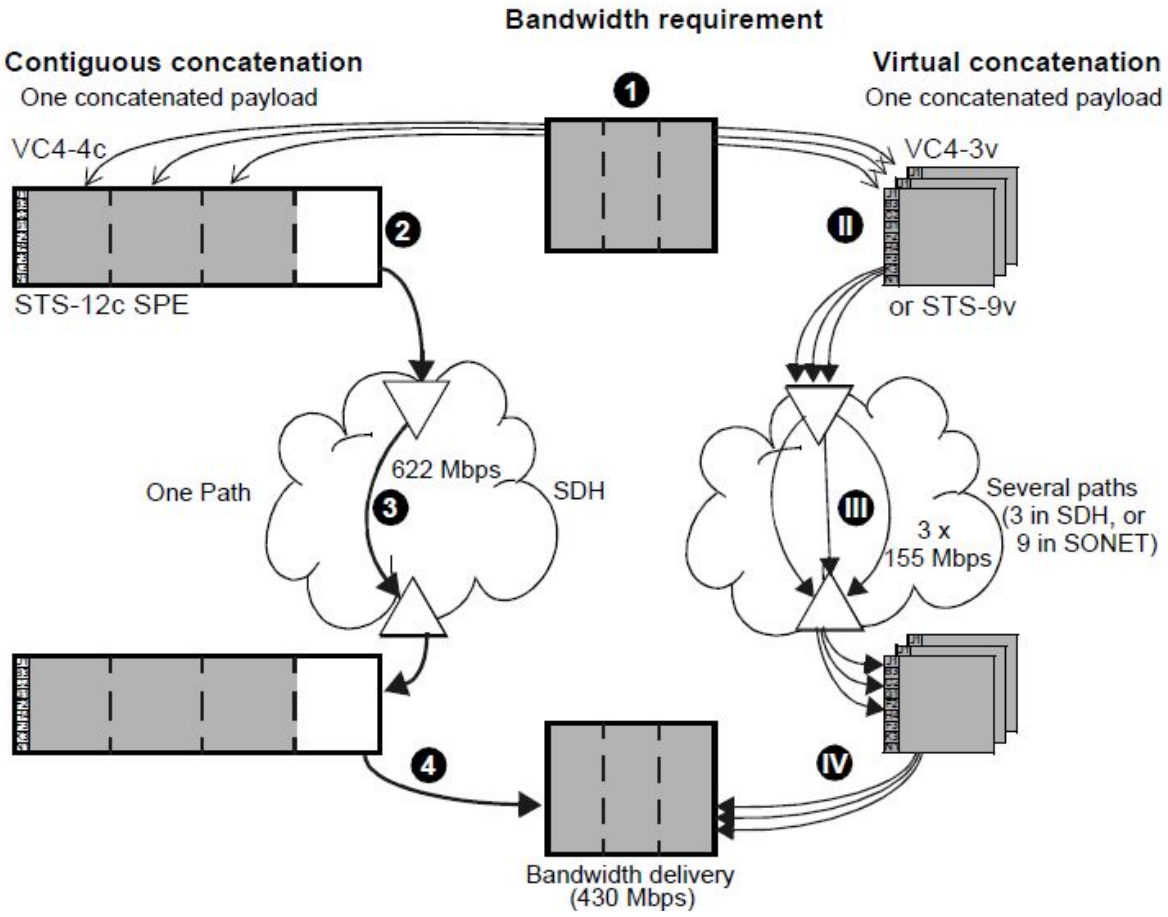
Новое поколение протоколов SDH

Виртуальная конкатенация (VCAT)

Схема динамического изменения пропускной способности (LCAS)

Общая процедура инкапсуляции данных (GFP)

Concantation



Virtual CONCATENATION