

Testing sub-rate data services



Application Note 1211-3

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APPLICATION          [ SUB RATE          ]
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BEARER RATE         [ 2Mb/s             ]
SUB RATE STRUCTURE  [ X.50 div 2         ]
DISPLAY             [ SUB RATE SET-UP]
PATTERN             [ 2^11-1           ]
CHANNEL AND RATE    [ 1602 ]   9.6kb/s
MAPPING
    1 - .....*.....*.....*.....*.....
    21 - .....*.....*.....*.....*.....
    41 - .....*.....*.....*.....*.....
    61 - .....*.....*.....*.....*.....

DESELECTED OCTETS   [ F0101010         ]
ERROR ADD           [ BIT ] [ SINGLE]
STATUS:
X.50   X.50   X.50   X.58
div 2  div 3  BIS
  
```

Private data networks are still heavily dependent on analog data modems for connecting devices such as terminals, printers and PCs, working at rates such as 2.4, 4.8 and 9.6 kb/s. It is rather inefficient to use a full 64 kb/s PCM voice channel to encode an analog modem signal which in turn carries the low-rate data stream.

Sub-rate services

As public networks become fully digital, we will see greater use of sub-rate data multiplexing where several low-speed data channels are combined in a single 64 kb/s circuit. Standards for this application are already recommended in CCITT X.50 and X.58, although variants of these are used in some countries at present. The European Telecommunications Standards Institute (ETSI) is

presently working on standards derived from CCITT X.58, X.51 and X.50 for crossconnection of sub-rate channels. Testing leased lines and digital crossconnect switches in the future will involve dealing with sub-rate multiplexing.

Why multiplexing?

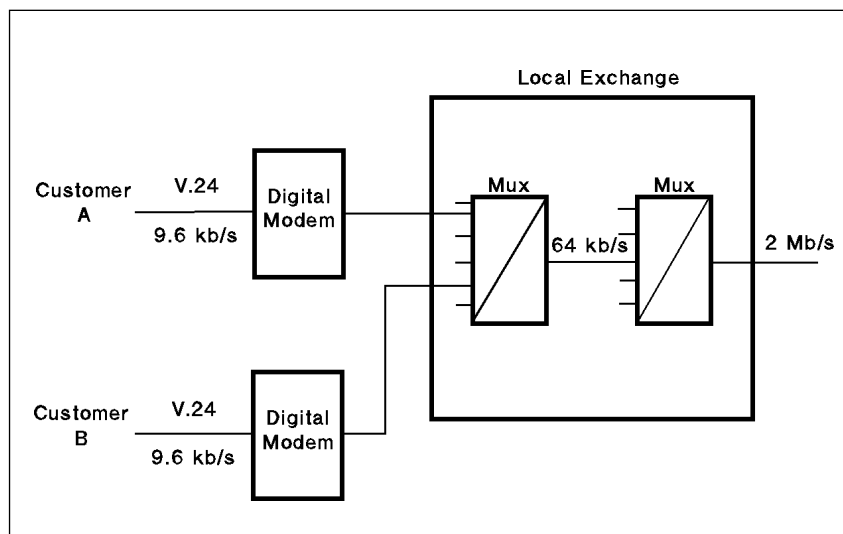
Multiplexing allows many circuits to share the same physical medium, saving material costs and allowing several customers to share bandwidth. Multiplexing requires framing which provides for in-service measurements as framing bits can be checked “on-line”.

Why sub-rate multiplexing?

Sub-rate multiplexing and framing allows a service provider to split up his bandwidth into even lower rate sections, that is, splitting a 64 kb/s signal, (codirectional or a timeslot within a 2 Mb/s signal) into lower rate sections. This makes better use of transmission facilities by packing several customers into one timeslot rather than allocating each a separate timeslot.

Prior to sub-rate data multiplexing, the choice was either low rate over analog lines via a modem or a full 64 kb/s digital signal. However, analog lines are expensive to maintain and are incompatible with the modern Integrated Digital Network. Also, they do not offer the quality of service offered by digital lines. Now, using sub-rate data multiplexing, a customer can have 0.6, 2.4, 4.8, 7.2, 9.6, 14.4, 19.2, 24, 32, 48, 56 kb/s or full 64 kb/s bandwidth.

Figure 1
X.50/X.58 Circuit



The physical interface, for sub-rate data, is either a timeslot within a 2 Mb/s bearer or a 64 kb/s codirectional signal. In the circuit shown (Figure 1), customers A and B “share” 64 kb/s bandwidth with 9.6 kb/s of data each. In turn their 64 kb/s signal becomes one timeslot of a 2 Mb/s signal. In practice, up to five customers with data at 9.6 kb/s would “share” one 64 kb/s signal. The remaining 16 kb/s is used for framing and control.

CCITT X.50

CCITT Rec. X.50 is the original sub-rate frame structure widely used in Southern Europe, Australia and the UK (“kilostream”). 25% of available bandwidth (16 kb/s) is used for network bits for framing and control, as shown in Figure 2.

X.50 defines three variants which are distinguished by the length of the framing pattern used: X.50 division 2 uses an 80-byte frame, while division 3 uses a 20-byte frame. X.50 bis has no framing structure as all octets are used to carry one 48 kb/s circuit.

X.50 division 2 has 80 framing bits. Within the X.50 framing bits, certain bits carry network information. These are bits A to H. Currently, only the A bit has been assigned a meaning (“alarm”) by the CCITT.

X.50 division 3 has 20 frame bits with only one bit carrying network information. This is bit A which, like bit A in division 2, is used to convey alarm information.

Customer circuits and rates of 600 b/s to 9.6 kb/s are carried in 64 kb/s X.50 signals as follows:

Rate	Number of customers	Number of octets each
600 b/s	80	1
2.4 kb/s	20	4
4.8 kb/s	10	8
9.6 kb/s	5	16
48 kb/s	1	80

The X.50 division 2 frame is divided into 5 phases as shown in Figure 3, which also shows how 5 customers each with 9.6 kb/s bandwidth (one phase) share a 64 kb/s line.

Alternatively one of these 5 phases can be shared by two customers with data at 4.8 kb/s, or 4 at 2.4 kb/s and so on.

Figure 4 shows the set-up display for testing phase 2 at 9.6 kb/s with the Hewlett-Packard 37722A digital telecom analyzer or HP 37732A telecom/datacom analyzer.

CCITT X.58

CCITT recommendation X.58 defines another variation in the frame structure for sub-64 kb/s data

multiplexing. The data bandwidth “lost” in X.58 framing is far less than that for X.50 framing. There are 4 frame bytes and there are 4 bytes used to carry network information, distributed across the 80-byte structure. The A, B, C, D, E, F, G and H bits, in this case, make up the first network control byte and the three remaining control bytes are reserved for national use. They are set to one on an international link. Customer rates offered with X.58 are the same as for X.50 plus 14.4 kb/s and 19.2 kb/s.

Figure 2
X.50 Byte Format

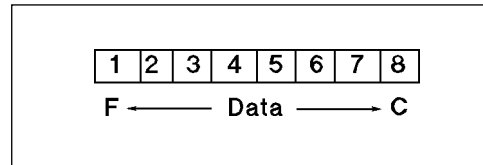
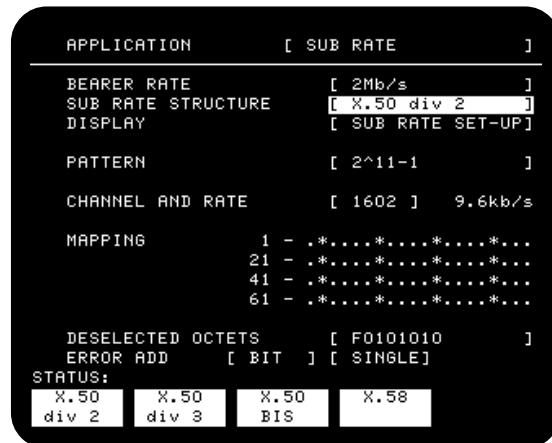


Figure 3
Customer circuits in X.50 division 2 signals – 9.6 kb/s

Phase	Octet															
1	1	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76
2	2	7	12	17	22	27	32	37	42	47	52	57	62	67	72	77
3	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78
4	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

Figure 4



New variant of X.58

ETSI are defining a new version of X.58 which only loses 2.5% of the available bandwidth to framing and control bits. It also provides a larger selection of customers' rates. In addition to the rates offered by CCITT recommendations X.50 and X.58, X.58 ETSI defines 7.2, 14.4, 16, 24, 32, 48 and 56 kb/s.

Testing X.50 and X.58 links

Testing sub-rate data services falls into two categories: in- and out-of-service. In both cases, test equipment must be capable of generating and recognizing the sub-rate frame structure used on the link under test.

Out-of-service testing involves generating a pattern (a pseudo random binary sequence, PRBS, or a user-definable pattern) with the relative framing, in a selected customer circuit and comparing it with the received signal at the input. The resulting measurement is the bit error rate. In-service testing involves monitoring the framing bits within the digital signal.

Both in- and out-of-service testing can be combined to test the performance of individual channels. One sub-rate channel can be taken out-of-service while the remaining channels continue carrying revenue-earning traffic. The standard PRBS generation and pattern/error detection tests can then be carried out on the one channel. Figure 5 shows the HP 37722A/37732A display for setting a 16-bit user-word to be generated in one customer's six 4.8 kb/s X.58 octets.

Applications

Examples of applications where sub-rate data multiplexing is used are low-speed, widely-distributed data networks, such as ATMs (automatic teller machines, bank terminals) and EFTPOS (electronic fund transfer at point of sale) which need little bandwidth to service each customer, and it is unlikely that their services will ever require extra bandwidth. For many such applications, 64 kb/s bandwidth is too large.

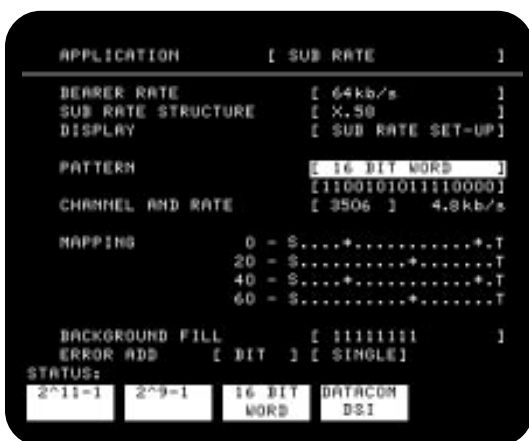


Figure 5

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