SHALL WE DUPLEX C^2 AND C^3?

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I. Separate C^2 and C^3 Fibers.

Present plans call for the use of two separate fibers for C^2 and C^3. Each of these is provided with a 10:1 splitter, used by C^2 to combine incoming signals, and by C^3 to divide outgoing ones. Since the fibers are available, it has seemed the simplest way to go.

However, there is a disadvantage to this process which has perhaps not been fully taken into account. It is cost. If we use separate fibers for C^2 and C^3, we must supply separate optical make-and-break connectors for them. If, as now appears, these cost about $5K each, then using separate fibers requires a total of 30 connectors, costing $150K, a very substantial sum.

II. Duplexing C^2 and C^3.

An alternative is duplexing C^2 and C^3 on a single fiber. The two links can be on different wavelengths, in which case the duplexing is not difficult to achieve. A similar proposal, I find, has already been considered in some detail by O'Connor and Harris in their paper "Design of Long Haul Telemetry for the DUMAND Phase II Undersea Array." Fig. 1, taken from that paper, illustrates the combined $C^2 + C^3$ link. This alternative gets rid of 10 fiber-optics connectors.

There is one possible difficulty with the proposed solution. It requires a shore-based DFB laser at 1550 nm with a power output of 5-10 mw. At the time the paper was written (11/89) no such laser was known to the authors. This point requires further study. (This laser would also be required for C^3 even if no duplexing were undertaken.)

III. Elimination of the C^2 Optical Connectors.

There is a third alternative, which may warrant closer inspection. It is to have all the C^2 signals to shore duplexed, at their respective SBC's, via high-speed modem, on the umbilical power cables. (A variant of this procedure provides a separate signal pair for C^2, but requires multi-wire underwater connectors instead of single-wire; these are said to be available.) The junction box must then contain an encoder which combines all the C^2 signals, and drives a single laser transmitter which is directly connected to the C^2 fiber to shore. This alternative eliminates the ten optical fiber connectors and avoids the duplexing problems, and it also replaces ten laser transmitters in the SBC's and JBEM by a single one in the JB or JBEM. However, it adds an active element to the junction box node, thus introducing an undesirable element of possible failure of the entire C^2 link. To be sure, spares can be provided; but this disadvantage needs to be carefully weighed against the gain in eliminating 10 optical connectors and 10 laser transmitters,

This system is not compatible with the combined C^2–C^3 system described above, but is an alternative to it.

Having thus reduced the number of underwater optical make-and-break connectors from 30 to 20, we ask whether we can use the same trick to get rid of the ten optical connectors for C^3. Since these carry very high-speed (nanosecond) signals, there appears to be no simple way in which such signals can be transmitted by wire from the JB to the SBC's. The required bandwidth is in the range 250–500 Mhz. In principle one could modulate a SHF microwave oscillator at this rate, and send the signal by coax cable over the 200m umbilical cable path; but then we would need much auxiliary equipment and underwater coax connectors, and the whole approach loses its attraction – especially in view of the previous alternative.

IV. Duplexing C^3 and Data Fibers.

One final possibility needs to be looked at. Can the C^3 data possibly be duplexed on the data fibers with the data back to shore? At first sight, this seems plausible, since the data fibers are used only for sending data to shore, and not for sending data to the array. By converting the data fibers to duplex operation, we can save the ten optical connectors C^3 requires on the junction box. In conjunction with the elimination of the C^2 connectors, as discussed above, we could go down to only 10 underwater make-and-break optical connectors, a saving of $100K.

Unfortunately, we have already used both available wavelengths for transmission of data to shore. The C^3 link would thus have to use a wavelength already in use in the opposite direction. This is not possible at

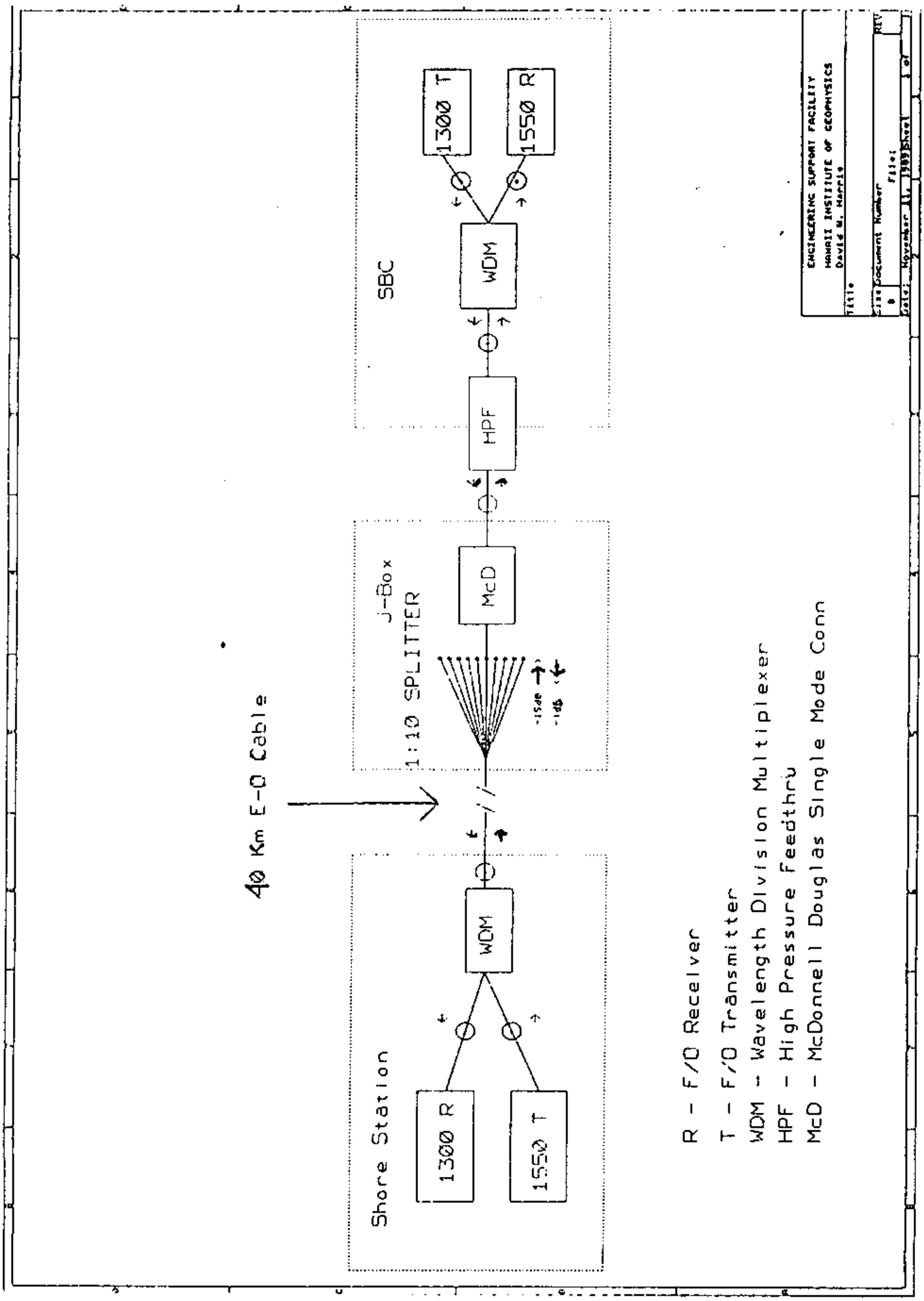

Fig. 1. Schematic of combined C^2 and C^3 communication link.