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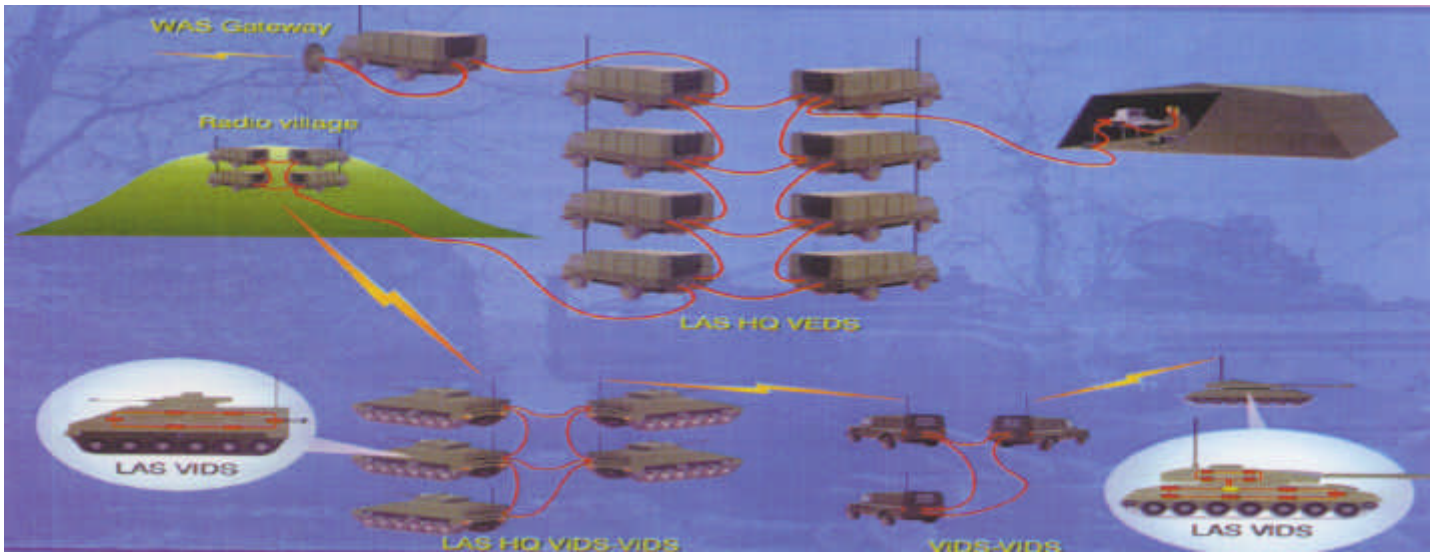
Fibre Optics in a Tactical Environment



Picture suplied by HUNTING ENGINEERING LTD.

The communication of data within a tactical battlefield environment has always proven problematic. When considering copper as the preferred format, the drawbacks include:

?? EW radiation
?? Weight
?? EMP susceptibility
?? Band width limitations

With the advent of fibre optic technology, primarily driven by the commercial data transmission market, many of these problems have been alleviated.

EMI radiation - As the transfer media is light through glass, the escape of signals is indictable. Therefore, this would enable secure data to be transmitted with a high confidence factor. In fact, interception of a signal would require the fibre to be physically compromised and hence detection of such incursions would be highly probable.

Weight - The weight of fibre, compared to that of a copper transmission line with comparable data capacity, is much reduced, even in the tactical environment. This scenario requires the use of kevlar and sheathing materials, to provide sufficient crush strain relief, to survive in harsh environments. The reduction in weight also brings about associated gains as the deployment of fibre systems allows an individual to connect an information system over a wider area, and with less mechanical assistance than a copper laying counterpart. All of these factors would reduce 'set up' and 'tear down' times, assisting with 'life cost' reduction.

EMP susceptibility - As with EMI radiation, the absence of conductive material ensures a virtually impregnable system, to both natural and man made sources of attack. This is particularly important where long lengths of cable are laid in exposed areas. The risks in using a copper system in this situation would require serious consideration to cable screening and EM' protection devices. Fibre, by comparison, would be far more resistant to soft attack.

Band width - Even the simplest of optic cable has the band width of all but the most sophisticated and expensive of copper cables. With the increased requirement for data transfer, band width takes on higher priority when it comes to system design. This factor is an obvious concern for the military system designer, and also the major reason for promoting such media in the commercial world. However, optic based systems may fall into difficulty from a previously unencountered source.

TREE (Transient Radiation Effects on Electronics) - The nuclear age has a particularly marked effect, when considering the employment of an optic system.

GAMMA radiation - The emission of gamma radiation in a post nuclear scenario has two attack mechanisms - dose rate and total dose. The gamma dose rate will cause an increase of minority carriers, in p.n. junctions of semiconductor material. These minority carriers allow the flow of stray currents in these materials, known as primary photocurrents. Data storage or flow may be corrupted by the appearance of spurious data signals or signal 'latch up', potentially caused by primary photocurrents. In more serious cases, these uncontrolled currents will damage the power supply through excessive demand. Generally, circumvention is a two pronged defence, the first being to select less susceptible materials, which will minimise the initial effects. Secondly as photo currents require an external feed to do real damage, a gamma detection and power down circuit should be employed so that the latch up effects may be negated and the resulting hardware reset.

Total gamma dose is a major down fall of optical fibre systems, when compared to survival in a post nuclear situation. Exposure to gamma radiation will increase losses in the fibre, particularly at the blue end of the spectrum. The infra red end is affected to a much lesser extent, but the cost of these optical transmitters and receivers (in the 1300m to 1550mm range), is higher than the more commercially available 850mm counterparts, which may cause the initial project evaluation to be declared cost prohibitive.

Deterioration of the fibre performance is not permanent and recovery will be relative to dosage, time and ambient temperature. The net effect is that the system will be inoperable immediately after the nuclear event, for a time scale based on the fibre recovery factors and the amount of optical difference between transmitter power and the receivers sensitivity and in this case should also be considered after any degradation of the devices, resulting from gamma dose rate and neutron fluence. When specifying the preferred recovery time and anticipated dosage, a conservative approach may render the optic either uneconomic or developmental, an early consideration of these issues would therefore be prudent.

Neutron fluence - The effects that Neutron bombardment has on data transmission systems is similar to that of Gamma dose rate. Its primary areas of interference are the semiconductor materials, which will convert to and from optic signals. Unlike the Gamma dose rate however, the Neutron effects will be permanent. The lattice structure will be broken down, causing deterioration of the overall gain of amplifiers and other sensitive electronic devices. This effect would occur irrespective of power state, so circumvention is limited to the selection of radiation hardened materials and circuit design, incorporating a low dependency on high gain, high performance devices.

Where the benefits of fibre systems initially appears as a major advantage over copper fed counterparts, careful consideration is required for the overall system reliability, particularly when the specification of TREE recovery performance will have such dramatic effect on COTS availability and cost.