An adaptable military communication system

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Summary This article deals with the flexible military line-of-sight communication system installed on the Falkland Islands, which provides a network covering both East and West Falklands. Emphasis is given to the use of containerization as a means of providing a complete communication system, and its special relevance in the harsh conditions experienced in the Falkland Islands is discussed.

Introduction

The Falkland Islands Trunk System (FITS) is the static telecommunications system for the British forces on the Islands. Supporting both operational and administrative traffic, it enables the garrisons, bases and outposts to be interconnected with a very high-quality communications service. Moreover it satisfies the essential military requirements for secure transmission, survivability, and flexibility.

The FITS technical characteristics were derived by the Royal Signal's Communications Projects Division at Blandford in Dorset, England. These reflected the logistic and environmental circumstances particular to the Falklands as well as the most modern military thinking on static trunk communications for effective Command and Control (C^2).

In 1983, Marconi Communication Systems Limited was selected by the Ministry of Defence (MOD) to be the Prime Contractor for the FITS digital 'line-of-sight' radio network. The initial contract was for the supply of all the microwave radio stations to be installed in the network and a sophisticated computer-based management system to enable the entire network to be controlled from a central area.

Background

The Falkland Islands are characterized by their rugged and inhospitable terrain, and by the fierce, chilling winds that blow for most of the year. Gusts approaching 300km/h have been experienced on some sites.

With few roads outside the Port Stanley and Mount Pleasant areas, the military forces have to rely on occasional sea transport to the nearest accessible harbours, and helicopter airlifts – weather permitting – to move stores to their sites. There are few available local resources, even for the most elementary requirements.

Prior to the implementation of the FITS project, Royal Signals provided a limited trunk communications service based on the Marconi-supplied Triffid tactical radio-relay equipment. However this arrangement was clearly temporary because of the high demands on skilled manpower to attend to the tactical communication complex, and because of the limited user facilities which could be provided to the islands' new defence infrastructure. Also the logistics cost of maintaining manned relays on remote hilltops, subject to the most appalling weather conditions, was unacceptable. An alternative solution was essential, and required quickly. Hence the Army raised an Urgent Operational Requirement and the FITS concept was born.

FITS consists of a ring of microwave radio stations covering the East and West Falkland Islands. Two links also cross the ring to enhance network survivability in the event of one or more stations being damaged. The ring serves as the backbone transmission bearer system for a number of digital telephone exchange and subscriber apparatus circuits located throughout the islands, together with data and telegraph facilities. A schematic diagram of the network concept is shown in figure 1.

The FITS requirements

The MOD instructed Marconi to design and supply the complete

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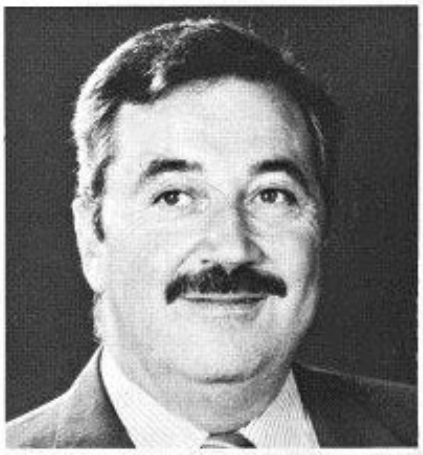
Mr Brick joined the Marconi Company in 1968 as a Systems Engineer for troposcatter and line-of-sight radio systems. In 1973, he was attached to an overseas military organisation on a C^3I system design consultancy project.

Returning to the UK in 1975, he transferred to Transmission Systems Sales Department and was primarily involved with North Sea Oil, tactical tropo, and defence-orientated business. He is currently a Sales Manager in the Space and Broadcast Division.



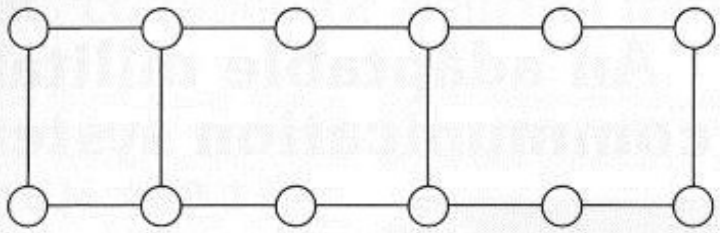


Fig.1. Network configuration providing alternative traffic paths to reduce the risk of a break in communications in the event of damage

microwave radio stations. Full consideration was given to the following points:

Fast installation

The electronic equipment was to be accommodated in high-quality factory-installed shelters which would be shipped complete to the Islands and then helicopter-lifted to the final sites. The Falklands weather-window limited planned helicopter freight lifts to a few months of the summer only. On-site civil works were to be minimized because of the difficulty of getting building materials to site. For similar weather reasons and because of the military nature of the system, on-site setting-up and commissioning times also were to be minimized by the design.

Off-the-shelf equipment

The urgency of the project dictated that the equipment proposed must be readily available. This policy also had a potential cost advantage. Moreover, the selected equipments were to conform to civilian rather than to military engineering standards since they would be installed professionally by Marconi in high-quality containers having a controlled environment. Shock-mounting would be necessary, however, in order to protect the equipments during transit, particularly for the helicopter freighting stages when the incessant winds could make gentle lifts and drops difficult.

System Characteristics

Digital microwave transmission

The main transmission bearer is an 8Mbit/s microwave system for supporting 120 telephone channels. Digital transmission enables a superior level of encryption to be applied to security-sensitive circuits, and the transmission quality is not significantly impaired by repeaters and digital circuit patching.

The 2GHz frequency band was preferred to higher frequency bands because it places less demands on antenna mast stability in view of the expected winds and the military environment. Also it enables solid coaxial feeder cables rather than bulky waveguides to be used, which makes field connection easier for Service personnel.

Pulse code modulation multiplexers

Standard CCITT 30-channel p.c.m primary multiplexers at 64kbit/s per channel are employed. These are grouped to the 8Mbit/s transmission rate by 2nd-order multiplexers. Extensive digital and audio patching arrangements are incorporated

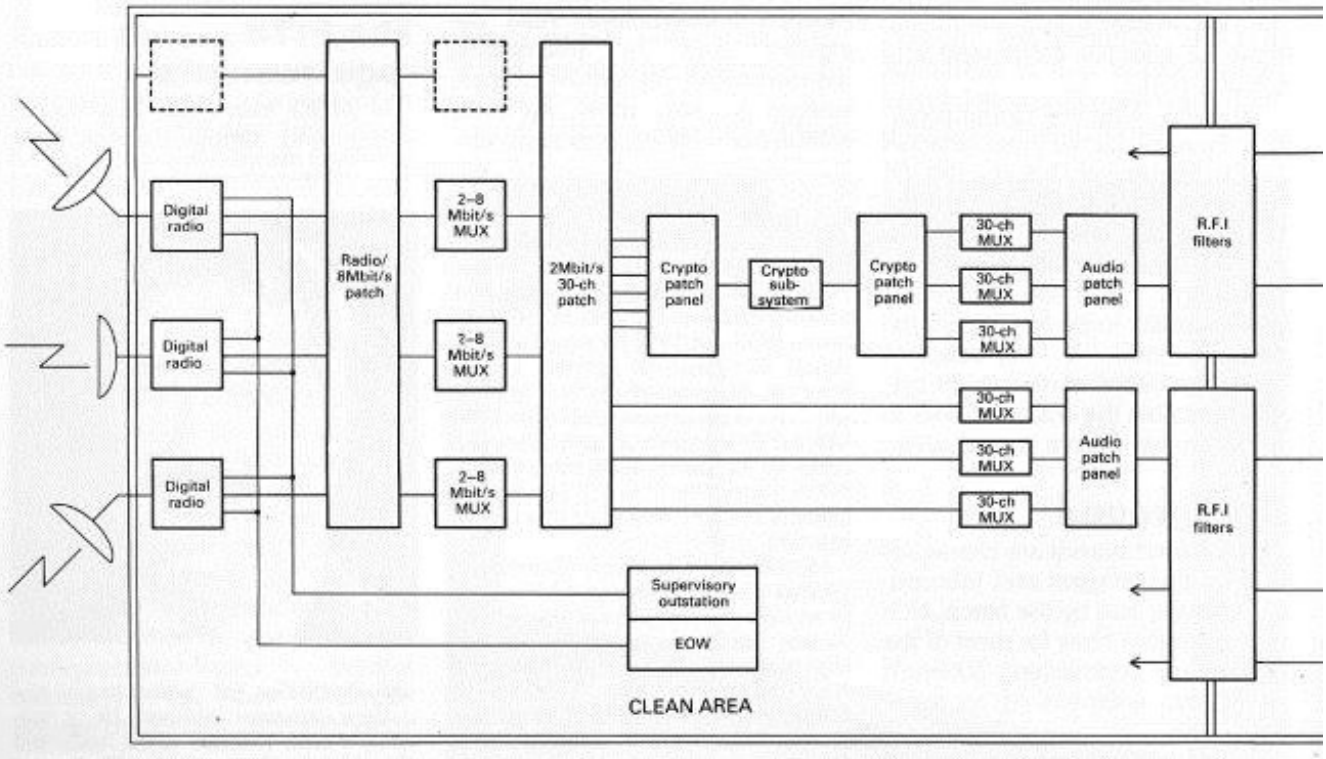


Fig.2. Equipment content in a typical FITS radio shelter

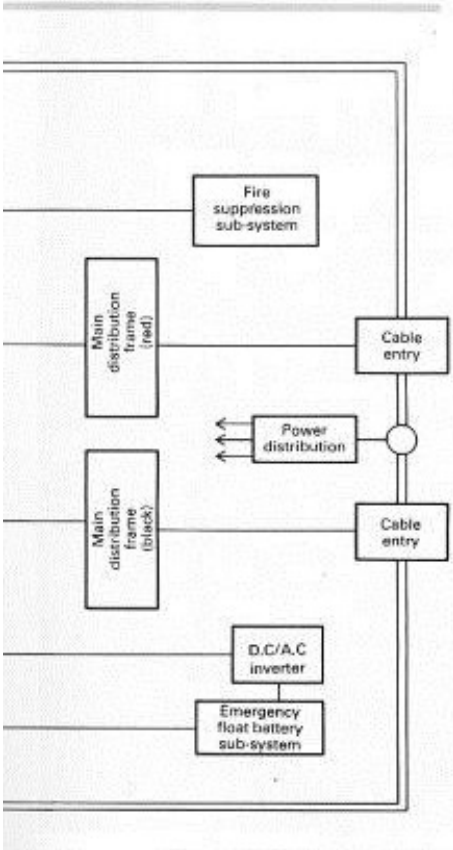
so as to provide a maximum traffic and equipment re-routing capability.

Management

Each station has a comprehensive alarm monitoring system which feeds back to Port Stanley by two independent routes for survivability. The large volume of information needs a computerized data handling system which is capable of one-man operation.

Nodal flexibility

Depending on the location within the network, each station can have between one and four links emanating from it. Rather than have each shelter individually wired for its nodal network function, a standard shelter design capable of accommodating up to four complete terminals was required, equipped only with the number of radios and multiplexers necessary for the particular site (figure 2). Hence if a shelter is damaged, a spare shelter fitted with the requisite modules can be flown in very quickly to replace it. This important concept also makes network reconfiguration possible.



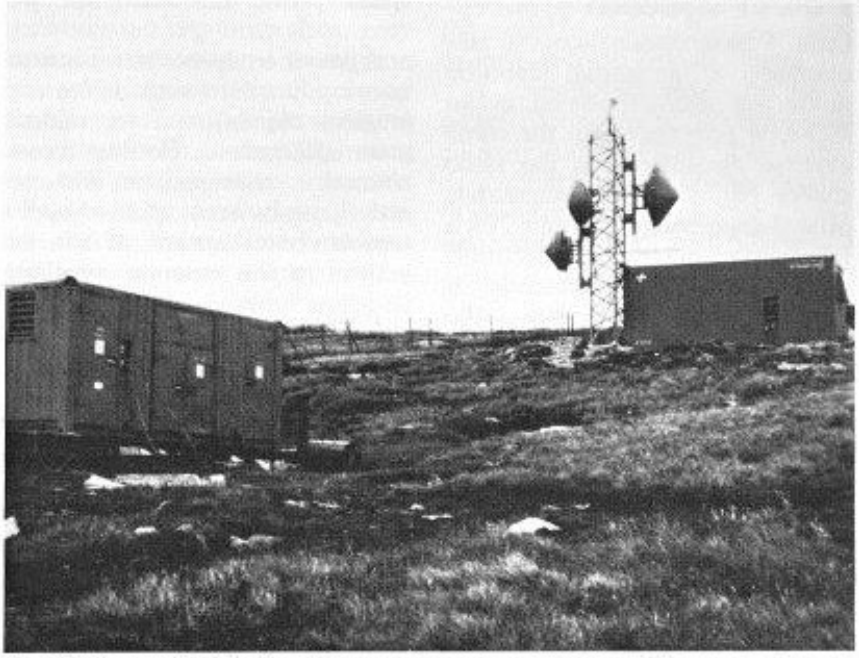


Fig.3. Remote FITS site with generator container on left mounted on grillage

RFI protection

The stations are capable of operating in environments subject to severe radio frequency interference (RFI) (for example, adjacent to high-power radar or h.f installations).

Radio shelters

To minimize weight, aluminium-clad containers were selected. These are nominally 6m in length with standard ISO corners and end dimensions to simplify loading and transportation by commercial carriers.

Each shelter is divided into two separate compartments connected by a door. The inner compartment is arranged as an electrically 'clean area' and accommodates the radio, multiplex, electronic and audio/digital jackfields and other electronic equipment. All connections to the 'clean area' first pass through RFI suppression filters. The outer compartment accommodates the power distribution, emergency batteries, and other non-sensitive equipment.

The shelter size was dictated by the quantity of equipment to be accommodated and the maximum lift capacity of the helicopters. It was desirable to allow sufficient floor space for up to two technicians to sleep should they be isolated on site by severe weather conditions.

Since the system normally operates unattended, a fire detection and non-toxic Halon gas fire suppression system is incorporated. In addition, a comprehensive environmental control arrangement is provided to enhance equipment reliability and life.

The shelters rest on concrete pads and are guyed to the ground to prevent high winds either shifting them or – in the extreme – rolling them over. Where good foundations cannot be obtained, the shelters rest on metal grillages.

Cable entry facilities for up to 240 channels are provided to permit connection to the exchanges and to other systems.

Antenna system

At the majority of sites, 6m antenna masts of triangular cross-section are attached to the end walls of the shelters. With this arrangement, mast base foundations and special guying procedures are not required (figure 3).

Heights had to be limited for stability purposes and to minimize wind vibrations being transmitted into the shelter.

The antennas are standard parabolic dishes with diameters of 1·2m to 2·4m as the system performance requires.

Power system

Dual, 7·5kW diesel alternator sets operating in a mutual stand-by mode are accommodated in an ISO-type container with the same external dimensions as the radio shelter (figure 3). Approximately 50% of the capacity is required for a full complement of electronic equipment and the remainder is allocated to charging the emergency battery system located in the radio shelter.

Routine change-over between working and standby sets is accomplished from Port Stanley using remote-control circuits over the network.

A bulk-fuel tank is also accommodated in the power container together with an enlarged lubrication oil reservoir system, and these have capacity for over three months unattended operation.

The majority of the electronic equipments operate from −48V d.c, and items which do not are fed from an inverter. A float-battery system supplies the d.c and has an average capacity for between 12 and 24 hours emergency operation (dependent on the number of equipments installed in the shelter). Hence, even if both engines fail, network integrity is maintained whilst a power technician is flown in and implements a repair.

The management system

The FITS management system incorporates a computer-controlled supervisory system and the engineering order wire (e.o.w).

The supervisory system comprises two reconfigurable master stations (network monitors) communicating with outstation equipment located in the radio shelters (site monitors). One master station is accommodated in a Marconi-supplied System Control Container – SYSCON – located in the headquarters at Port Stanley. The other is located on a different site and acts as a standby to the SYSCON equipment. The entire FITS network is capable of being managed, controlled and monitored from SYSCON.

The outstations each monitor up to 80 alarms and also have up to eight remote-control points. The alarm points are used for the remote monitoring of the electronic and power equipments, for housekeeping functions such as fire and intruder alarms, and for various external functions. Routine diesel-alternator change-over and resetting can be accomplished by the remote-control system as can the control of the antenna mast obstruction lights.

Data is obtained from the outstations by interrogating or 'polling' each one in turn from the master station via alternative transmission routes through the network. If a station in the ring is damaged, the master station will still have a path to stations beyond the damaged one by the alternative route.

The master stations include a v.d.u/keyboard operator's interface, a printer to record all supervisory events, and a bubble memory database for the system. It is software controlled and is capable of expansion both for the number of outstations which can be supervised and in the comprehensive range of utilities it provides the operator.

An omnibus e.o.w system covers the total network and has alternative traffic routes back to the H.Q. Since the network is specifically designed for unmanned operation, an omnibus e.o.w is perfectly adequate for the infrequent usage it will have.

Implementation

Marconi shipped the majority of the FITS equipment during mid-1984 in time to meet the South Atlantic weather window. Additional equipment has been installed in the UK for Ministry of Defence training and modification design purposes.

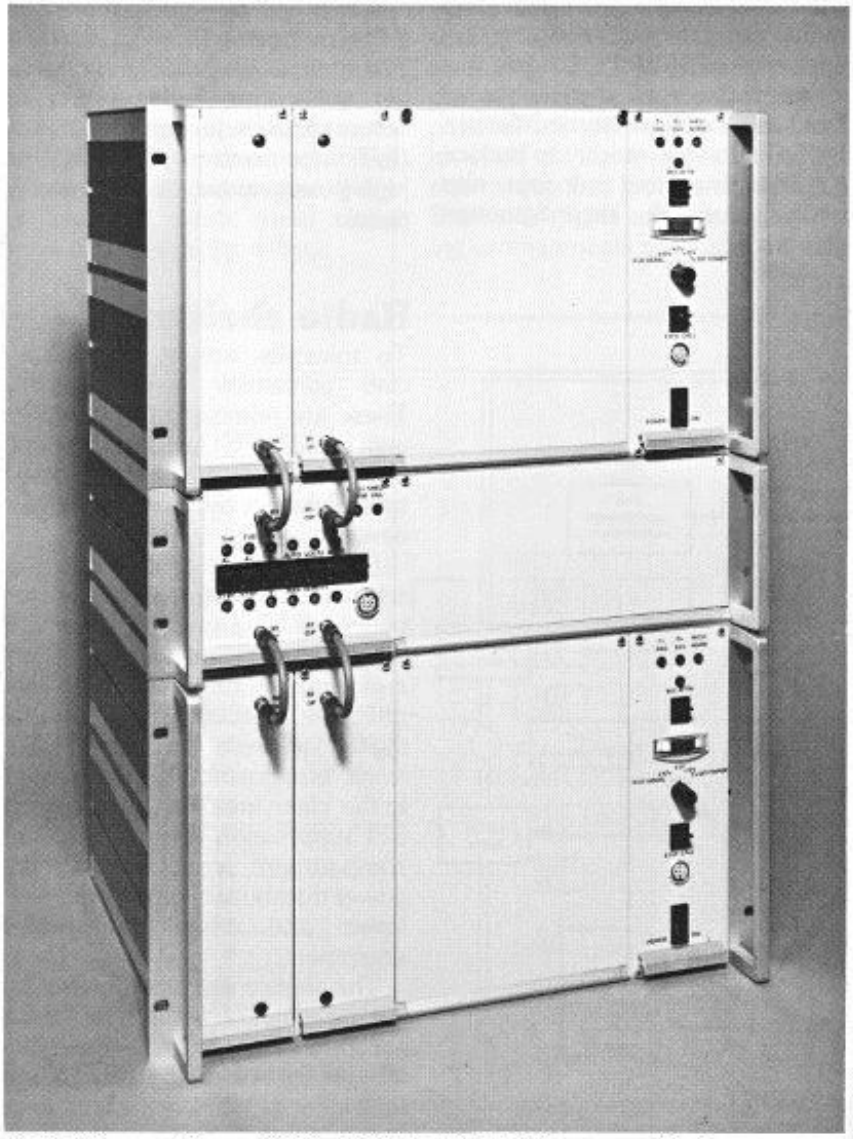


Fig.4. Marconi Type 9050, 4·5GHz Digital Microwave Radio

A joint Royal Signals/Marconi team commenced installation in the Falklands during April 1984. By the end of the programme the average time taken for installing and commissioning a station was approximately 48 hours once the containers had arrived on site.

A container fitted with bunks and catering facilities provided on-site accommodation for the team, and storage for the installation tools and equipment. This was moved from site to site as the installation progressed.

The quasi-tactical network concept

Although FITS is primarily intended for permanent trunk telecommunications, its modular construction and ease of installation give it fast deployment characteristics. It is now feasible physically to reconfigure an essentially static network as the military situation requires. Moreover the loss of a station due to damage need not be a total disaster since a spare station can quickly replace it.

Network integration of containerized stations designed to this concept is becoming easier with the introduction of the latest generation of digital radio equipments. For example, the new Marconi 4·4GHz to 5GHz line-of-sight radio terminal, Type 9050, is designed for fixed application but has a frequency changing capability without the use of complicated synthesisers or long-delivery crystals (figure 4).

A commander now can have secure permanent trunk microwave communications with the confidence that he has a greater degree of operational flexibility for his C^2 requirements than ever before.

Acknowledgement

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RÉSUMÉ

Cet article traite du système de communication flexible et militaire avec ligne de mire, installé sur les Iles Malouines et couvrant non seulement l'île principale mais aussi reliant les Iles Malouines Orientales et Occidentales. Un accent sera porté sur l'utilisation du procédé de conteneurisation pour fournir un système de communication complet. De même, sera soulevée la question d'applicabilité de ce procédé à l'occasion de dures circonstances telles que les Iles Malouines en ont fait l'expérience.

RESUMEN

Este artículo trata del sistema militar flexible de comunicaciones de línea recta instalado en las Islas Malvinas, que no sólo cubre la isla principal sino que además enlaza las Malvinas Orientales y Occidentales. Se ha dado importancia especial al uso de la contenedorización como medio de proveer un sistema completo de comunicaciones y en el artículo se examina su especial importancia en las duras condiciones que se experimentan en las Islas Malvinas.

ZUSAMMENFASSUNG

Dieser Aufsatz behandelt das anpassungsfähige, in den Falkland Inseln aufgebaute Sichtlinien-Kommunikationssystem, welches nicht nur die Hauptinsel sondern auch Ost- und West-Falkland verbindet. Das Schwergewicht liegt auf Container-Einbau als, sowohl als Methode zum erstellen eines vollständigen Kommunikationssystems wie auch mit Bezug auf die besonders harten Umgebungsbedingungen, die in den Falkland Inseln angetroffen werden.