Precise Remote Interrogation over Long Distances

Satellite and power line carriers transmit protection data in Peru

The company

In Peru, legal requirements call for the strict separation of power generation companies and power transmission companies. As a transmission company and former central power system company, ISA (Interconexión Eléctrica S.A.) is responsible for the coordination, operation, and administration of the interconnected system for the whole country.

The starting situation

The Siemens regional company in Columbia equipped six substations in Peru with SIPROTEC protection relays (generations V2, V3, and V4). A PC equipped with DIGSI 4 (Fig. 1) operates the relays from one substation. The core of the system includes the PC, passive series 7XV5 converters, and the active mini star coupler 7XV5550, which matches the serial data rate for relays of different protection relay generations. DIGSI 4 directly supports the setting of these relays, which allows the user to easily operate, from one substation, the relays at all the different locations. The user can use the central system PC to evaluate and administer all data pertaining to a protection relay.

ISA wanted to operate the substations centrally from the station in the capital, Lima, in order to avoid long and sometimes hazardous journeys to the substations. The plan was to establish a connection to the substations using leased lines over specially installed communication routes. ISA also intended to implement control functions and voice transmission over these routes, dividing the bandwidth of 64 Kbps between the different services. Two substations were linked to the capital via leased satellite links (see Fig. 2).

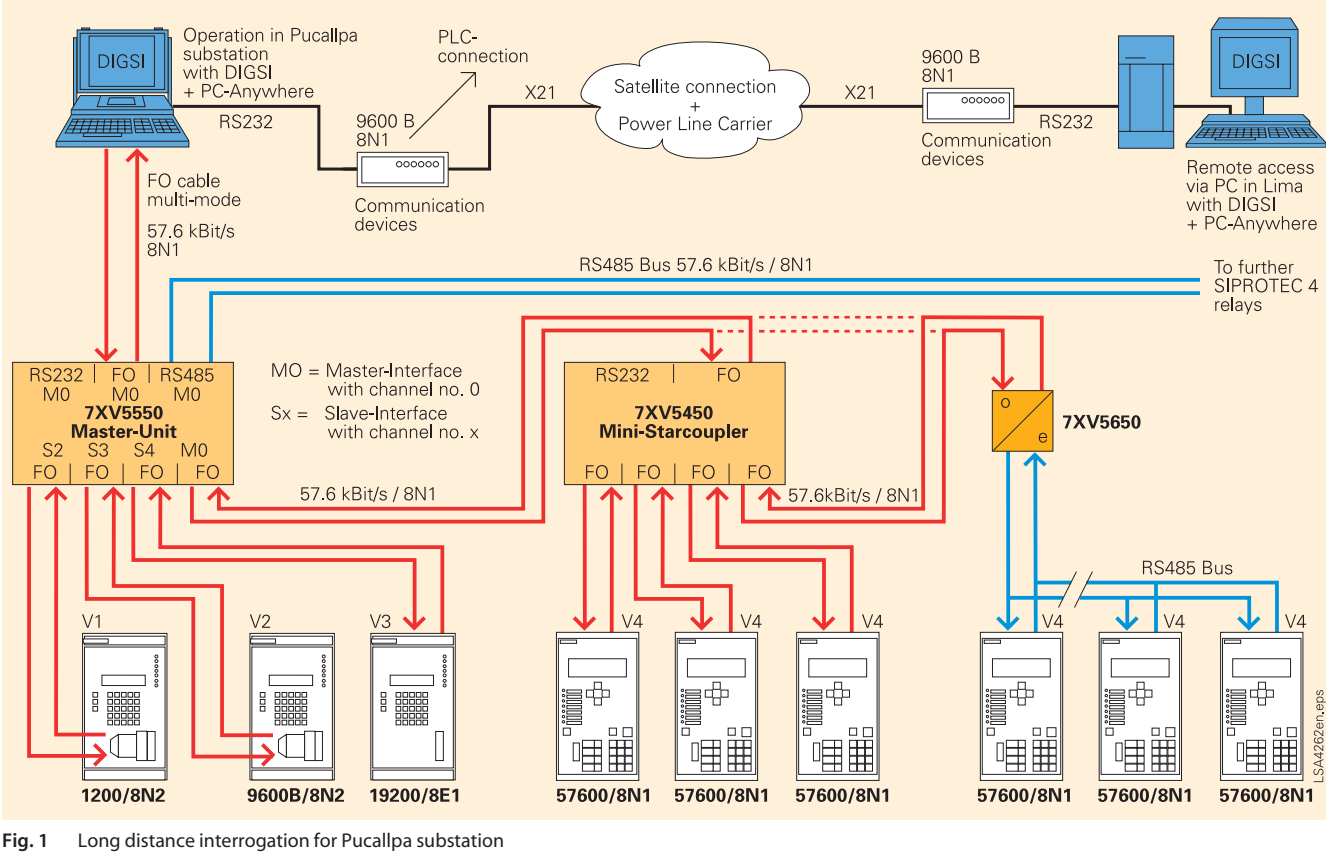

Fig. 1 Long distance interrogation for Pucallpa substation

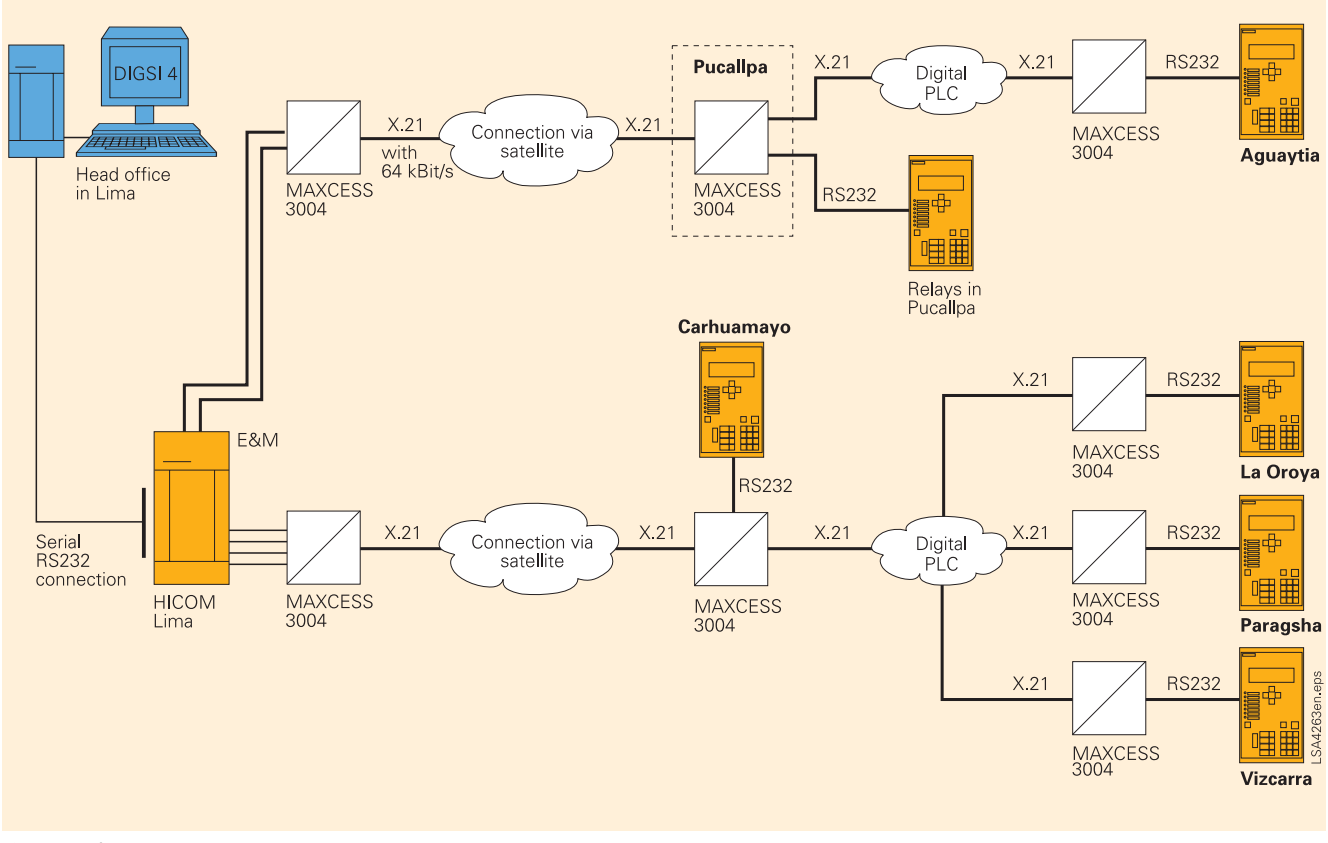

Fig. 2 Substation overview in Peru

One substation is located in Carhuamayo at an altitude of 4,400 m in the Andes (Fig.2), the other in Pucallpa in the middle of the tropical rain forest. Four additional substations are connected to these two substations over distances of up to 140 km using a digital power line carrier (PLC) over an extra-high-voltage line. Siemens PTD EM installed PLC links to transfer data at a maximum rate of 76.8 kbps via the high-voltage line. All links appeared to be adequate for the transmission of protection data with DIGSI, which is specified with a data rate ranging from 9.6 kbps (V3 devices) to 57.6 Kbps (V4 devices).

After installing the system, however, it became apparent that it was not possible to establish stable connections to the protection relays, even though the solution worked in theory and the reliable technology had been tested. This turn of events cast doubt on the entire concept of operating the relays centrally from Lima using DIGSI 4.

The concept

In order to analyze the fault and to devise a solution, Siemens set up a test system in a laboratory in Nuremberg, using the same power link system, communications cable simulators, and typical protection relays (V2, V3, and V4).

According to the measurements made on the test system, the delay over the PLC routes was approximately 110 ms. The satellite link added another 220 ms delay, resulting in a total delay in one direction of approximately 440 ms when a satellite link and two PLC routes were in series. Because of the structure of the serial DIGSI protocol, which is a Siemens-specific expansion of the IEC 61850-5-103 protocol, an acknowledged data package between Lima and the remote substations took about 1 second. This delay, and the gaps between the data, were not planned for in the protocol and timing concept for either the equipment or DIGSI, and was preventing a stable high-performance link. It was therefore necessary to develop and implement a different concept based on the infrastructure already installed, in order to avoid additional investments.

The Automation division of Siemens A&D provided the solution: the remote control software PC-Anywhere, which allows complete control of remote PCs. The idea was to have the central PC in Lima control the central PC already installed in each substation. By dialing into each substation's central PC, the operator in Lima can monitor the remote station's status, and can start the locally installed DIGSI from the substation PC.

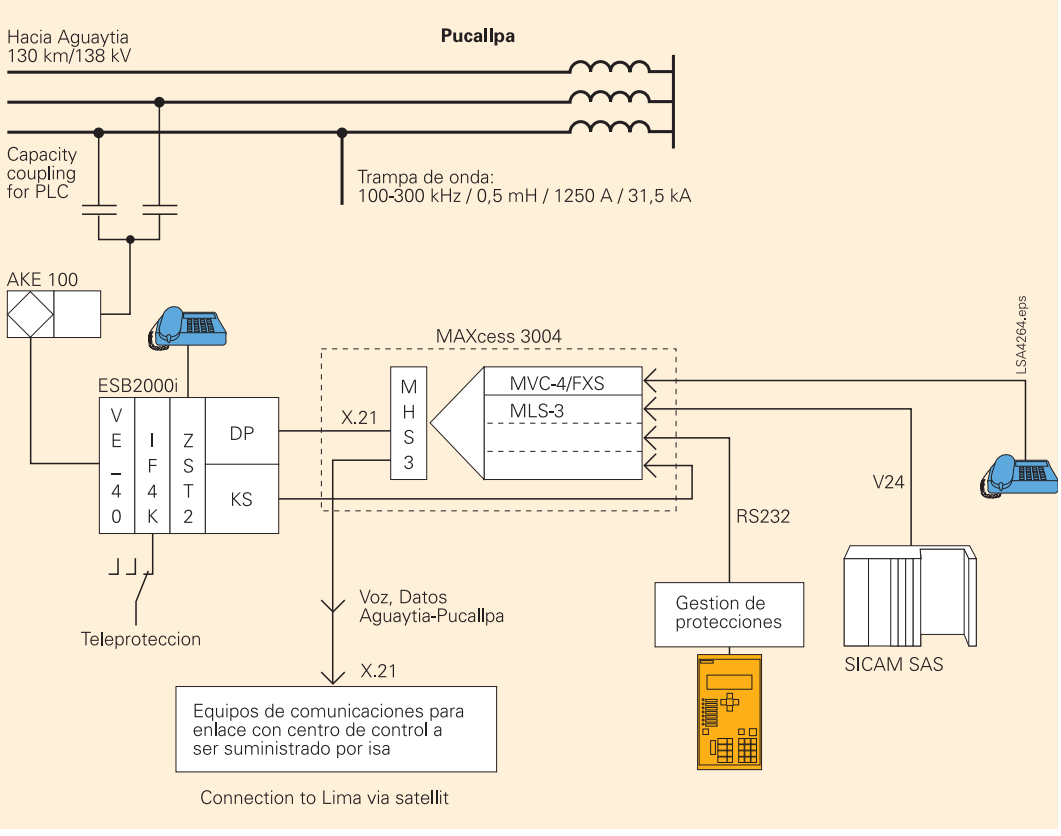

Fig. 3 Communication devices in Pucallpa

The special advantages

Once PC-Anywhere was installed, the operator undertook the first tests from Lima. The local link to the protection relays functioned. The application is configured as follows:

- PC-Anywhere establishes the connection between the central PC in Lima to the substation PC via the selected dedicated connection. The data is transferred via the satellite link and the PLC route.
- DIGSI 4 operates on the substation's central PC, which is now completely remote-controlled from Lima.
- A connection to a SIPROTEC protection relay with DIGSI 4 is established. The protection data is transferred at the maximum data rate via the serial links in the substation. Since DIGSI is installed locally, no delays occur.
- Protection data is stored using a quality recorder in COMTRADE format. Alternatively, all protection data for a device, as well as the entire substation's data, can be stored in a compressed Dex file. DIGSI supports this file export, which can be used for the analysis of protection data anywhere in the world.
- PC-Anywhere transfers files to Lima; data can be exchanged between PCs
- DIGSI 4, installed on the PC in Lima, allows for the importing and analysis of the data files in DIGSI and SIGRA. The protection data can be administered and analyzed centrally.

From practical experience

The test setup in the laboratory made it possible to plan the local installation in minute detail. This considerably simplified the work of the team of technicians from PTD PA 13, PTD EM personnel, the operator, and Siemens Columbia. Given the difficult travel conditions between the substations – the thin air and icy cold of the installation at 4,400 m altitude in Carhuamayo, the tropical temperatures in the rain forest in Pucallpa – extensive preparation in Germany reduced costs and avoided the need for improvisation.

Conclusion

The customer was highly satisfied with the solution. As a result, Siemens used this solution for further substations and implemented complete remote operation of protection relays of different generations over the communication routes. The operator can now operate substations remotely and control protection and control functions centrally.

This solution can be used for slow modem links with long delays, such as GSM links. In principle, DIGSI can be remote-controlled anywhere in the world using a variety of communication paths supported by the remote control software. With data transfer via PLC, communication is possible over long distances, since the high-voltage line is already routed to the substation. This means that numerical protection relays in remote substations may be operated centrally. Other protection and control functions can be integrated in the concept and multiplexed by means of the common data link (see Fig.3).