BECHTEL'S SATELLITE NETWORK

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ABSTRACT

Bechtel's Satellite Business Systems (SBS) network began operations during the month of May 1983. Both voice and data traffic are carried on the network. Voice traffic originates in the Ann Arbor, Gaithersburg, Houston, Louisville, Norwalk, San Francisco, Walnut Creek, and Washington, D.C. Bechtel offices. Voice transmission allows calls to be originated in these network locations and terminated in any other location either on-net or off-net in the continental United States. Data traffic is transmitted to and from Univac computer complexes in San Francisco and Dallas.

INTRODUCTION

Established in 1898, Bechtel has provided development, engineering, procurement, construction, and project management services to public and private clients on projects of varying scope and size in more than 116 countries throughout the world. Today, the permanent staff numbers more than 40,000 including some 18,000 graduate engineers, scientists, and related personnel. Bechtel headquarters, located in San Francisco, is supported by over 30 permanent offices around the world. Many more project offices support its worldwide activities. The size of its geographically dispersed operations necessitates a sophisticated, single, integrated communications network to tie its offices together and provide the rapid exchange of vital information.

SBS TECHNOLOGY

The earth stations, or Network Access Centers (NACs), provided by SBS, consist of a number of advanced features. (See Figure 1, Network Architecture.) The Satellite Communications Controller (SCC) is a highly integrated hardware/software device comprised of processors, storage units, and control programs. The SCC performs the essential time-division multiple access, demand assignment, switching, and other control and processing functions as well as analog/digital conversion for voice-grade signals. The

NAC contains a burst modem. The modem modulates outgoing, measured bursts to the microwave dishes, located on the roofs of Bechtel buildings, and demodulates incoming traffic for the SCC. The terminal equipment provides radio frequency transmit and receive functions and frequency translations between the 12 and 14 GHz transmit and receive frequencies and the 0.48-1.5 MHz interface with the time-division multiple access burst modem. A buffer within the NAC holds the bursts of digital or analog data, and then transmits smoothly, having the effect of a continuous flow without interruption.

A port-adapter system connects the SCC's digital and analog (voice) ports to Bechtel's communications equipment. A monitor and command loop, in each NAC, enables the remotely located SBS Network Control Center in McLean, Virginia, to determine the status of earth-station equipment, obtain diagnostic information, and command corrective actions. A port-adapter system provides the interface between the SCC and the various interconnecting communications facilities. The SBS system permits direct access to the wideband communications network and reduces dependence on terrestrial access facilities. The SCC acts as a local concentration point. With this arrangement, all of Bechtel's earth stations benefit from the traffic engineering advantages normally attained only in the design of high-density trunk groups.

SBS tailored its system to meet Bechtel's telecommunications needs – geographical locations and distribution, traffic mix, traffic intensity, quality of service desired, and grade of service. Within this design, the company is able to obtain a fixed fraction of the time-division multiple access framing adequate to meet its traffic loading and grade of service objectives. The lead time associated with configuration changes for varying bandwidth requirements is days. Weeks were required with the traditional point-to-point terrestrial communications systems previously in place.

BECHTEL NETWORK

All earth stations in Bechtel's network communicate directly with all other earth stations in the same network through a satellite transponder, which operates in the 12/14 GigaHertz bands. The system interconnects the company's PBXs, telephone company access lines, computer networks, and office automation systems.

The network is based on time-division multiple access with demand assignment. The San Francisco Home Office and each office in the United States – San Francisco, Ann Arbor, Gaithersburg, Houston, Norwalk – has the entire transponder capacity for its use during one or more of the time slots in a 15-millisecond cycle, depending on immediate needs. This arrangement is similar in concept to computer time-sharing. Bechtel's communications equipment is connected to the SBS network by local and intercity access

lines. Voice and digital ports are available. The voice port is used for voice conversations. The digital port is used exclusively for digital computer traffic.

Voice Communications

The voice (telephone) systems in the San Francisco Home Office, Ann Arbor, Gaithersburg, Houston, Louisville, Norwalk, Walnut Creek, and Washington D. C. are directly connected to the earth stations via user-access lines. They are either colocated within the same building or, in some cases, geographically distant. Telephone calls between these network locations bypass the public switched network and are routed directly over network facilities.

Voice traffic to non-network locations, within the continental United States, is accommodated by network earth stations as well as local and intercity access lines. The proper terminating earth station is selected by the originating SCC, and the terminating SCC selects the appropriate off-net access line for the most efficient and economical routing.

Future plans focus primarily on the expansion of the network through the inclusion of certain jobsites and other Bechtel offices.

Data Communications

In San Francisco, digital service extensions connect the NAC to three Univac mainframe computers and two IBM 30XX. All area offices also have access to two Univac CPUs (System 1100/82) at the University Computing Center in Dallas, Texas. There are a total of seven SBS data channels linking the various offices.

Data traffic is transmitted from the San Francisco Home Office at 448 kbps to the Norwalk and Houston offices and at 224 kbps to the Ann Arbor and Gaithersburg offices. The Univac computers in Dallas are connected to the network at Houston through a 1.5 mbps terrestrial link. (See Figure 2, SBS Data Configuration.) Norwalk, Ann Arbor, and Gaithersburg are connected to the Dallas Univacs by 112 kbps links.

Satellite data communications presently in use at Bechtel include remote batch input and output using a modified Univac protocol (NTR) and support of Univac synchronous screen terminals (uniscopes) connected to remote Univac communications processors (DCP/40s). In addition, asynchronous teletype terminals dialing in through remotely located statistical multiplexers are supported over the satellite network along with 3780-type bisync terminals dialing into ports on the remote DCP/40s. Planned expansion of data

communications includes the transmission of data between remote screen and batch terminals, and IBM computers located in San Francisco.

NETWORK ENHANCEMENTS

Enhancements to present network services will be examined on a case-by-case basis for both technical and economic merit. If feasible, each service will be thoroughly tested before implementation. Applications currently under consideration include expanded televideo conferencing, facsimile transmission, high-speed electronic mail, word processing applications, and dial-up analog data communications.

Video Conferencing

Bechtel has had considerable experience with video conferencing on certain jobsites, at client offices, and in the San Francisco and Norwalk offices. Both freeze-frame and full-motion video have been tested. Freeze-frame video, via telephone lines, has worked successfully with client offices across the country. Freeze-frame is used more extensively, rather than full-motion, because most jobsites require information in the form of graphics – drawings, charts, and photographs – and freeze-frame can transmit at a fraction of full-motion video costs.

Bechtel uses the TVS 783 transceiver because it is the first dial-up freeze-frame video that can handle both color and black-and-white transmission. This video transceiver system is also compatible with many of the largest video systems in the country. SBS has provided remote sites with matching TVS 783 equipment for experimental and demonstration purposes. At present, the company has two pilot models with monochrome capability in the San Francisco Home Office. Under consideration is an upgrade to full-color, 56- and 4.8-kbit. Larger monitors are also under consideration.

The evolution of compressed video, transmitting at 56 kbit and simulating full-motion, will result in equipment that can be installed side-by-side with the freeze-frame video currently proposed for area offices and jobsites. Besides the usual video conference, the system can be used like a video telephone booth to enhance long-distance telephone discussions of visual information such as design-change requirements. The upgrade will allow the present equipment to utilize the SBS digital transmission between NACs. Bechtel has the unique opportunity to install and use a distributed video conferencing network because of the nature of its business and the need to communicate rapidly with all parts of the country. The technology is at an advanced level and many enhancements to the communications network are envisioned.

Facsimile Communication

Bechtel's many divisions, special operations, services, and jobsites, use a wide variety of facsimile equipment and various switching arrangements. Before a satellite service is introduced, a uniform dialing plan must be developed. Present plans include use of store-and-forward facsimile to reduce the impact on the end users, who have a variety of end devices. Store-and-forward facsimile will act as translator/buffer and, via the satellite, provide more efficient services.

Service Extensions

Bechtel is also examining the acquisition of additional network voice traffic by bringing remote locations and small offices onto the satellite; a consolidation of local facilities with the network facilities; and off-net origination of traffic. Bechtel also plans to investigate the potential use of satellite "thin-route" technology to extend the network into additional locations. The thin-route earth stations of interest are portable, with relatively low cost and capacity, but with the capability of integrating directly into Bechtel's time-division multiplexed network.

CORPORATE ACCOUNTING FOR NETWORK USE

Accounting for the communications network is based on principles of corporate service cost centers. Procedures have been carefully developed to define and differentiate between communication costs incurred for the benefit of the local office and costs incurred for the benefit of more than one office in the network. Costs defined and budgeted as network costs for each area office are accumulated in Network Cost Accounts. The methods and rates used to charge for network use are designed to recover costs only.

The cost of sending information via satellites is not distance-sensitive, but it is sensitive to time. Therefore, pricing for use of network voice communications is based on time. Network traffic records are maintained by the originating network location, which identifies the number(s) called and call location. The call records are summarized monthly, priced at the network determined rate per call-minute, and billed to each network location. The billing method can differentiate between calls terminating on or off the network and price them accordingly.

ACKNOWLEDGMENTS

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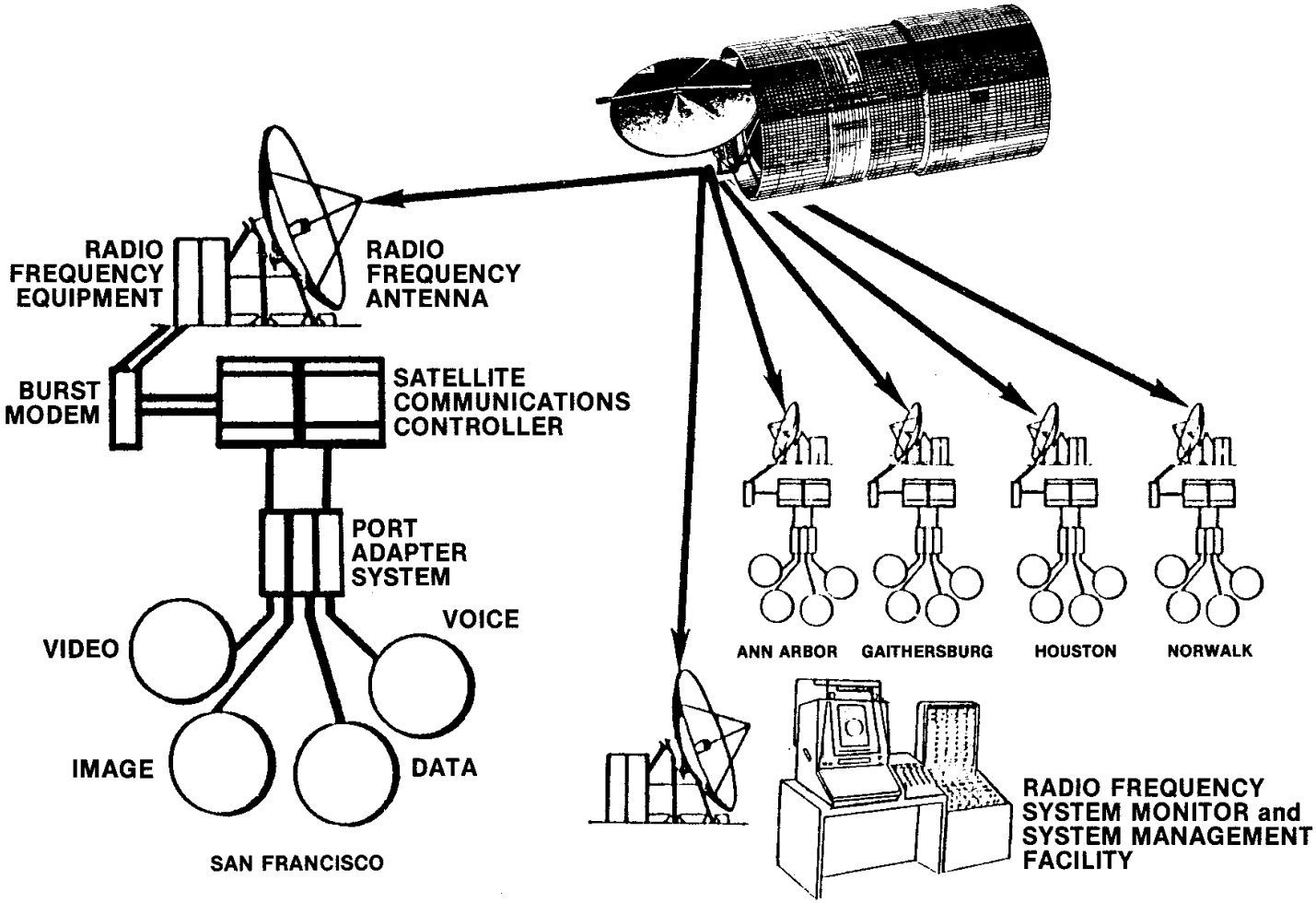

Figure 1. BECHTEL NETWORK ARCHITECTURE

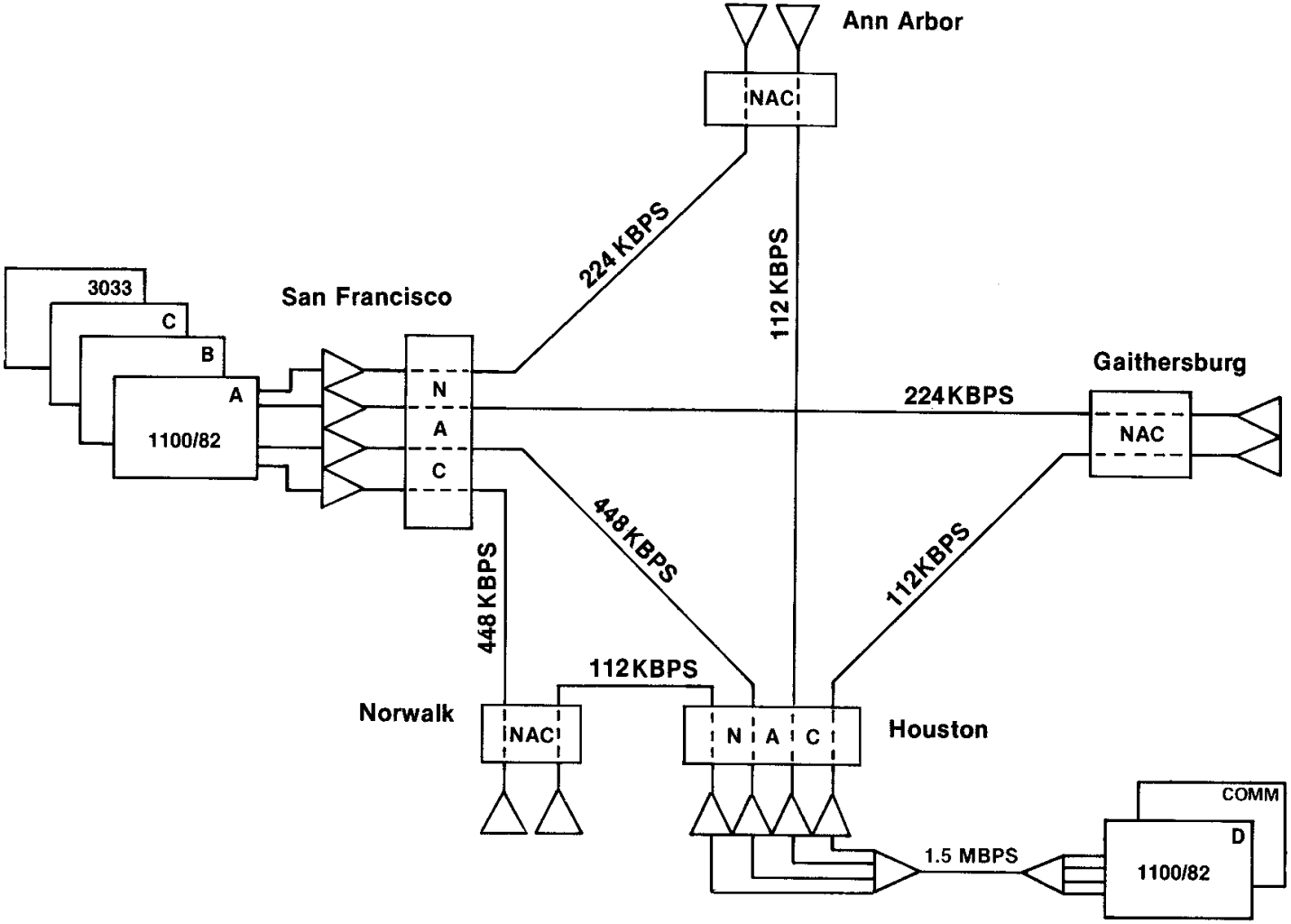

Figure 2. SBS DATA CONFIGURATION