Introduction to the K5 System

Communications Research Laboratory, Kashima Space Research Center
Yasuhiro Koyama, Tetsuro Kondo, Junichi Nakajima, Moritaka Kimura, and Hiro Osaki

1. What is the K5 System?

The K5 VLBI system is designed to perform real-time or near-real-time VLBI observations and correlation processing using Internet Protocol over commonly used shared network lines. Various components are being developed to realize the target goal in various sampling modes and speeds. The entire system will cover various combination of sampling rates, number of channels, and number of sampling bits. All the conventional geodetic VLBI modes will be supported as well as the other applications like single-dish spectroscopic measurements or pulsar timing observations will also be supported. As shown in the Fig. 1, sampler units (ADS1000 and ADS2000) and the PC-VSI board are used. The sampler units and the PC-VSI boards are connected using the VSI (VLBI Standard Interface) based connector cables. The same PC-VSI board will support data output function from the PC systems. When relatively low sampling rates are required, PC systems with the IP-VLBI boards are used. The IP-VLBI board is installed on the PCI bus of the PC system and the boards are capable to convert base-band signal into sampled data stream.

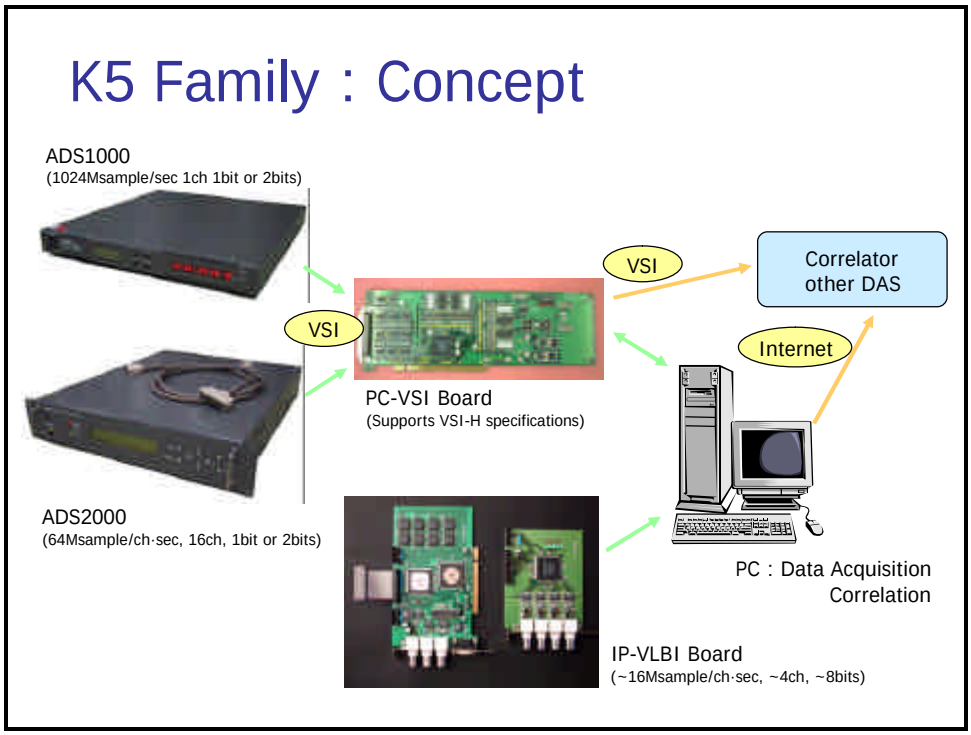

Fig. 1 Concept of the entire K5 System.

As shown in the Fig. 1, the K5 system is characterized by the use of conventional PC systems. The data correlation will be performed on the PC systems using software correlator programs. Similarly, the K4 system can be characterized by the use of

rotary-head, cassette type magnetic tape recorders, and the K3 system can be characterized by the use of open-reel magnetic tape recorders (Fig. 2).

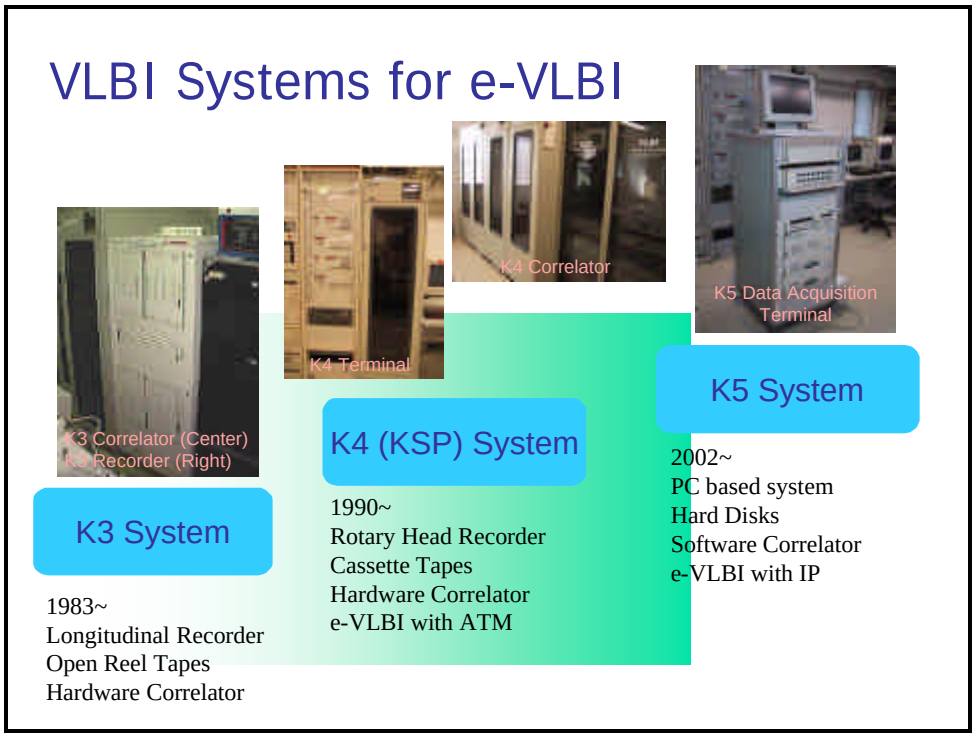

Fig. 2 Developments of K3, K4 and K5 VLBI systems.

The name of the K5 system is frequently used for the Versatile Scientific Sampling Processor (VSSP) system which is designed for geodetic VLBI sessions. Fig. 3 shows the picture of the proto-type system of the VSSP. It is consist of four UNIX PC systems. Each UNIX PC system has one IP-VLBI data sampling board (Fig. 4), or also called as a VSSP board, on its PCI interfacing bus. Table 1 lists the specifications of the board. The board can sample 4 channels of base-band signals at various sampling rates ranging from 40kHz to 16MHz. The timing of the sampling is controlled by the provided 10MHz and 1PPS reference signals so that precise timing information can be reproduced from the sampled data. Quantization bits can be set from 1, 2, 4, and 8. Because the board has these many sampling modes, it has many possibilities to be used not only for VLBI observations but also for various other scientific researches which require precise timing information in the data. Device driver software of the board has been developed on LINUX, FreeBSD, and Windows2000 operating systems, and FreeBSD is used in the prototype K5 data acquisition terminals. Two prototype K5 data acquisition systems have been configured. Four PC systems are mounted in the lower part of the 19-inch standard rack. A signal distributor unit for 1-PPS and 10 MHz signals and 16-channel base-band signal variable amplifier unit are mounted in the upper part of the rack. The monitor and the keyboard on the top of the rack are connected to the four PC systems by using a four-way switch. Each PC system is equipped with four removable hard disk drives of the data capacity of 120 GBytes each. The sampled data can be transferred to the network by using TCP/IP protocol or can be recorded to internal hard disks as ordinary data files. The maximum recording speed is currently restricted by the speed of the CPU and the speed of the PCI internal bus.

Currently, the total recording speed of 512 Mbps has been achieved. It can be expected to record data up to 1024 Mbps by using faster PCI bus and faster CPU in near future. To process the data sampled with the K5 data acquisition system, software correlation processing program is also under development on FreeBSD PC systems. The correlation processing program receives data from K5 data acquisition systems over the network using TCP/IP protocol and then calculates cross correlation functions in real-time. It can also read data files on internal hard disks. These capabilities allow to transfer observed data in real-time if the connecting network is fast enough, or in near real-time if data buffering is required. Since easily re-writable software programs and general PC systems are used, the processing capacity and the function of the correlator can be easily expanded and upgraded. Fig. 5 shows the schematic diagram of the data flow of the K5 system.

Table 1. Specifications of the IP-VLBI (VSSP) board.

Reference Signals	10MHz (+10dBm) and 1PPS
# of Input Ch.	1 or 4
A/D bits	1, 2, 4, or 8
Sampling Freq.	40kHz, 100kHz, 200kHz, 500kHz, 1MHz, 2MHz, 4MHz, 8MHz, or 16MHz
Bus Interface	PCI
OS	FreeBSD, LINUX, or Windows2000

Fig. 3 Picture of the prototype K5 VLBI system (VSSP).

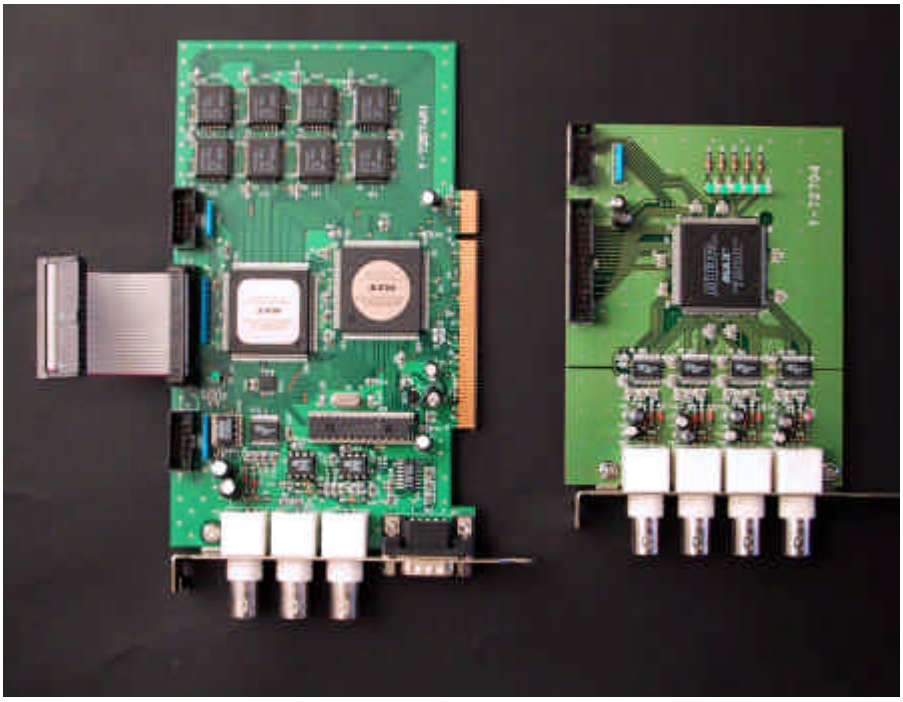

Fig. 4 Picture of the main board (left) and the auxiliary board (right) of the IP-VLBI (VSSP) board. Two boards are connected by the cable attached to the main board in the picture.

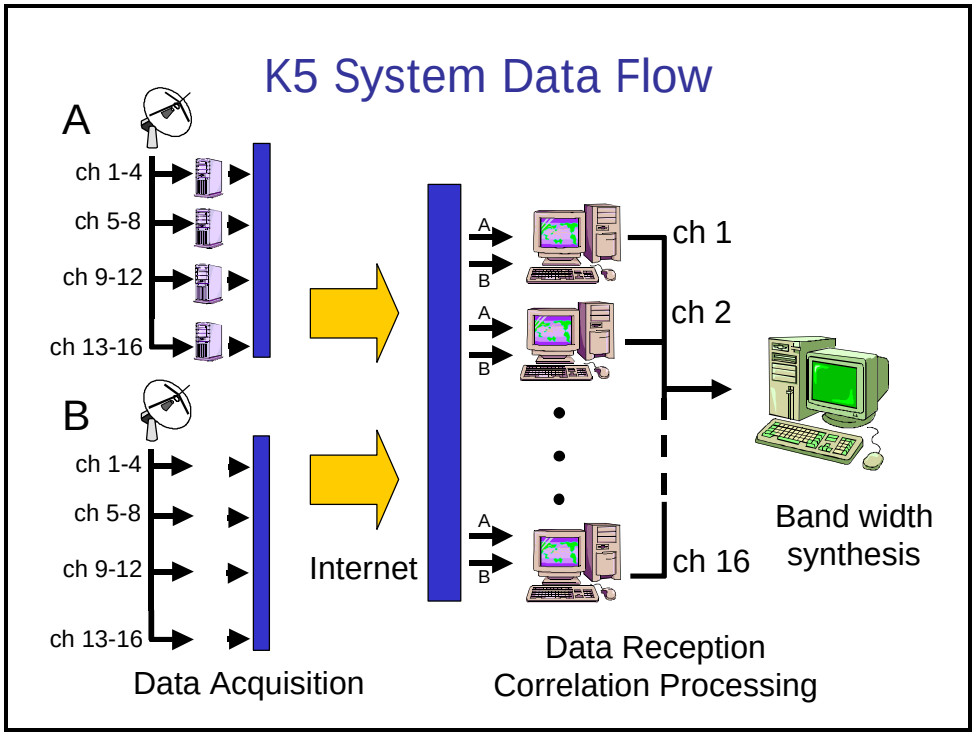

Fig. 5 Schematic diagram of the data flow of the K5 (VSSP) system.

2. What can the K5 system do?

Various supporting software programs are under development to support various observation purposes. The observation program (autoobs) reads Mark-3 original schedule format files and VEX (VLBI EXchange) file format. The observation data can be stored in the data file under the FreeBSD or Linux operating systems. The data files can then be converted to Mark-5 format data files for correlation processing by the Mark-4 correlator system. The data can also be processed on the PC system using FX type correlation processing program (fx_cor) and XF type fast algorithm correlation processing program (cor). File conversion program (m5tok5) has been developed to convert Mark-5 data files to K5 data format files. Spectrum processing program (speana) can be used as a spectrum analyzer. It is possible to extend integration period so that fine frequency resolution can be obtained.