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**Contractor's Progress, Status and Management Report --
Monthly Progress Report**

**Period Covered by the Report
1 January through 31 January 2000**

Date of Report: 2 February 2000

Wrist Interactive Device for Wearable PC
SBIR Phase II Topic N95-137
Contract No. N00421-97-C-1293
Dollar Value \$1,708,653

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Northfield, MN 55057

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Charles D. Caposell
Naval Air Systems Command
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1. Progress & Plans

Hardware

Phase 3 Boards

The rigid-flex board housing the CPU and display chip sets has been released to the manufacturing house. They estimate a 4-6 weeks lead time on delivery, which puts it at the first half of March. This late delivery does not impact software development as equivalent functionality is implemented in previous and concurrent boards, which are ready.

The Phase 3 audio (WID202), RF (WID204), and 3 interface boards for software development (WIDIB201, WIDIB202, and WIDIB204) have been populated and delivered to ViA. Hardware testing has begun to allow their use for software development by the first half of February.

After careful consideration, it was decided to utilize the Phase 3 CPU and Display rigid-flex board also for Phase 4. The original plan was to extend the rigid-flex substrate to the audio board on one side and to a bus carrying the battery signals and the RF signals to a stacking connector for the RF board (since its impedance properties would necessarily be different). This course of action would have allowed us to dispense with 5 ZIF connectors, thereby gaining in board real estate and/or shrinking the size of the WID. Upon closer examination of the assembly procedure, however, we realized that it would have been next to impossible to fit the audio module through the rubber boot holding it mechanically to the main housing. Slicing the boot along one side seemed too risky both from the point of view of strength and flexibility as well as of resistance to moisture. Furthermore, the gain in real estate afforded by the elimination of the ZIF connectors on the CPU side of the rigid-flex board would have brought no real benefit since the display side could not be shrunk any since its layout cannot be changed for electrical performance reasons and its chipcount cannot be decreased. If we couple this with the fact that next year CMD will release a third ASIC that will absorb most of the discretes now present on the display side of the board, it seems more efficient to wait until the WID goes to production before doing another design iteration that will shrink all sides of this board. Last but not least, using the Phase 3 CPU board until the end gives the software engineers the greatest flexibility to download into the CPU and DSP flash updates and fixes to the WID's operating system, since the WID interface boards connect the in-circuit emulators to the flash through the ZIF connectors.

RF

Some time was spent trying to make the Digianswer PCMCIA card communicate ("interoperate") with the Ericsson Bluetooth Evaluation Kit (EBDK). It was eventually discovered by talking to a Symbionics engineer that the difficulty was caused by a feature of the EBDK firmware that is not Bluetooth 1.0-compliant. Specifically, in the frame protocol used by Ericsson an additional 4 bytes are introduced to facilitate the packetization of the data; in the Bluetooth technical jargon, the 4 bytes contain the L2CAP header. This manner of handling the data is likely to be integrated into the Bluetooth specification, eventually, but is not yet performed by Digianswer since it is not part of the current spec. Once this was understood a work-around was found and implemented in short order and the two radios were demonstrated to interoperate during a visit by Office of Special Technology personnel on January 28.

Following the completion of the board characterization tests, in mid-January, the ViA Bluetooth board could be fitted with appropriate discrete elements to insure proper antenna impedance, which is now at 44 Ohms. This is close enough to 50 Ohms for proper operation. Given the 10 m range of the BT module, in fact, an impedance slightly different than optimum is actually better, since at the short distance the WID is expected to operate from the Digianswer card the receiver could otherwise get saturated by too much radiated power. Further tests will in any case quantify these speculations and guide the design of the Rev 2 (Phase 4) Bluetooth board.

Audio

The 36-Ohm speaker made by AKG perfomed better than other alternatives. The CODEC's gain will be adjusted to optimize its performance and further tests to fine-tune the system will be conducted.

Andrea and ViA have agreed to implement Andrea's linear-array directional microphone rather than the passive noise-canceling microphone previously tested. This will require us to spin another audio board, which will correspond to Phase 4, in order to provide contacts for the second input channel of the CODEC. The audio streams coming from the two ports of the linear array mic will then be processed by Andrea's software running on our DSP in order to filter out-of-phase sound sources. Whereas with a planar array of microphones (3 or more) the receptivity space can be tuned to be conical in shape and directed at the user, with a linear array of two microphones it will take the shape of a plane, specifically the plane of symmetry of the array. Clearly, however, sounds coming from the front will be advantaged over sounds coming from behind the wrist of the user, so we expect adequate performance from this system.

Optics

The shortest-possible optics design was delivered to ViA by DisplayWear and is shown in Fig. 1.

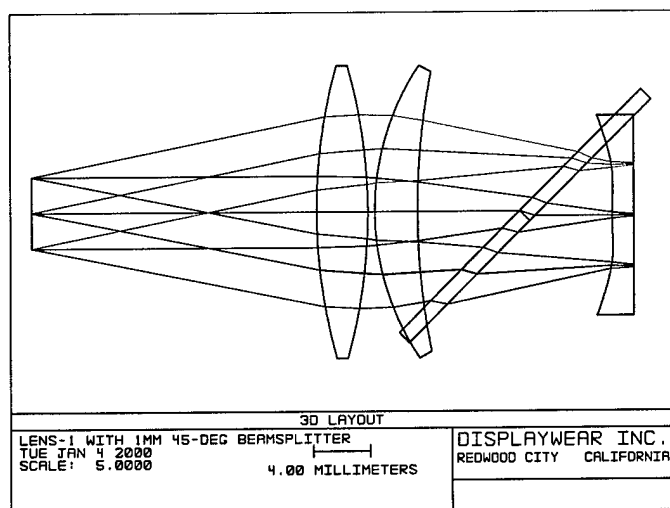


Fig. 1 Shortest possible on-axis magnification system with CMD reflective display (35 deg. FOV)

This design has been partly incorporated into the mechanical design of the housing, along with the CMD lens as the alternative. "Partly" means that the impact on the overall appearance of the housing and on its overall height were studied compatibly with the presence of the frame supporting the beamsplitter, lightbox and Fresnel lens, but the details of how the lenses will be held in place have not been worked out yet.

Fig. 2 shows the frame that holds the lightbox, beamsplitter, collimator (Fresnel lens), and field flattener. This same frame can be used for either lens system. If the three-piece, short stack solution is implemented, the field flattner shown in Fig. 1 can be cut to a rectangular shape and slid onto the display itself.

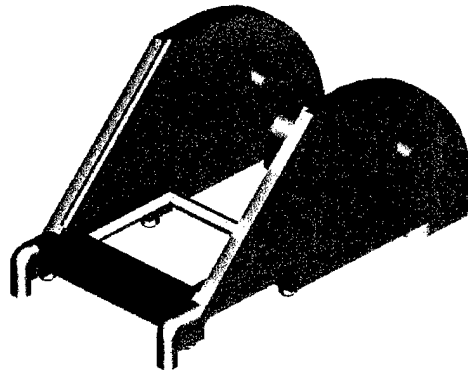


Fig. 2 Frame supporting the beamsplitter, collimator, lightbox, and field flattener.

Fig. 3 shows how the frame is mounted onto the WID's display board.

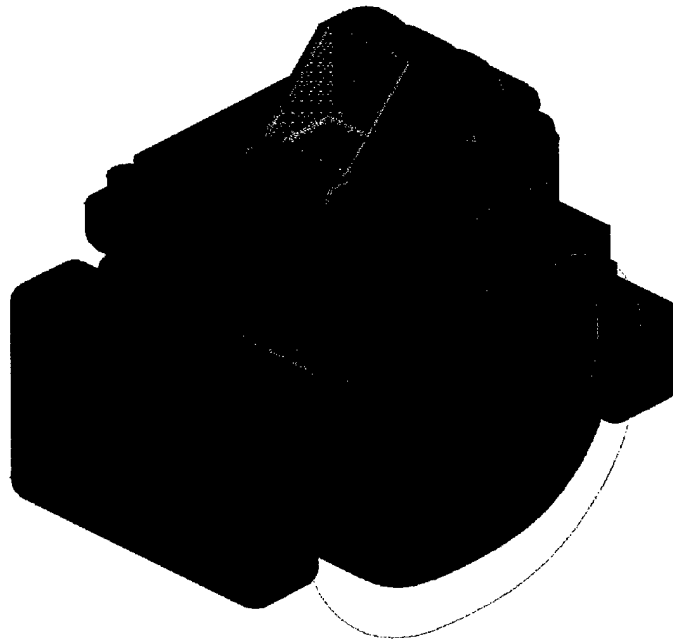
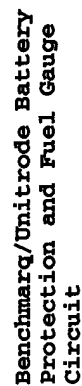


Fig. 3 Perspective view of the beamsplitter frame mounted on the WID display board

Battery System

The design of the battery protection circuit progressed. We are planning to build our own development board implementing both the battery protection and the fuel gauge ICs. Based on the ensuing tests we will decide whether or not both are needed and will design the final (Phase 4) board accordingly. Fig. 4 shows the current circuit.



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Mechanical Design

In the month of January the rubber boots and rubber strain reliefs holding the flex and battery cables were finalized and prototype samples were ordered to test different degrees of stiffness. The housing was then designed based on the specifications of both lens systems. It should be emphasized that the housing design as depicted here is preliminary since no provisions have yet been thought out for holding the lens or lenses, nor has the placement of the On/Off switch been resolved.

In response to feedback from Marines during the exercises held at Quantico Base for the September 99 PI meeting, it was decided to implement two additional switches to turn on and off the display and the audio system independently. This is a desirable feature in night operations or in locations where sound could be problematic. All three switches will be integrated in the housing design in the month of February.

The next pages show various views of the WID housing for the two optics solutions currently being investigated.

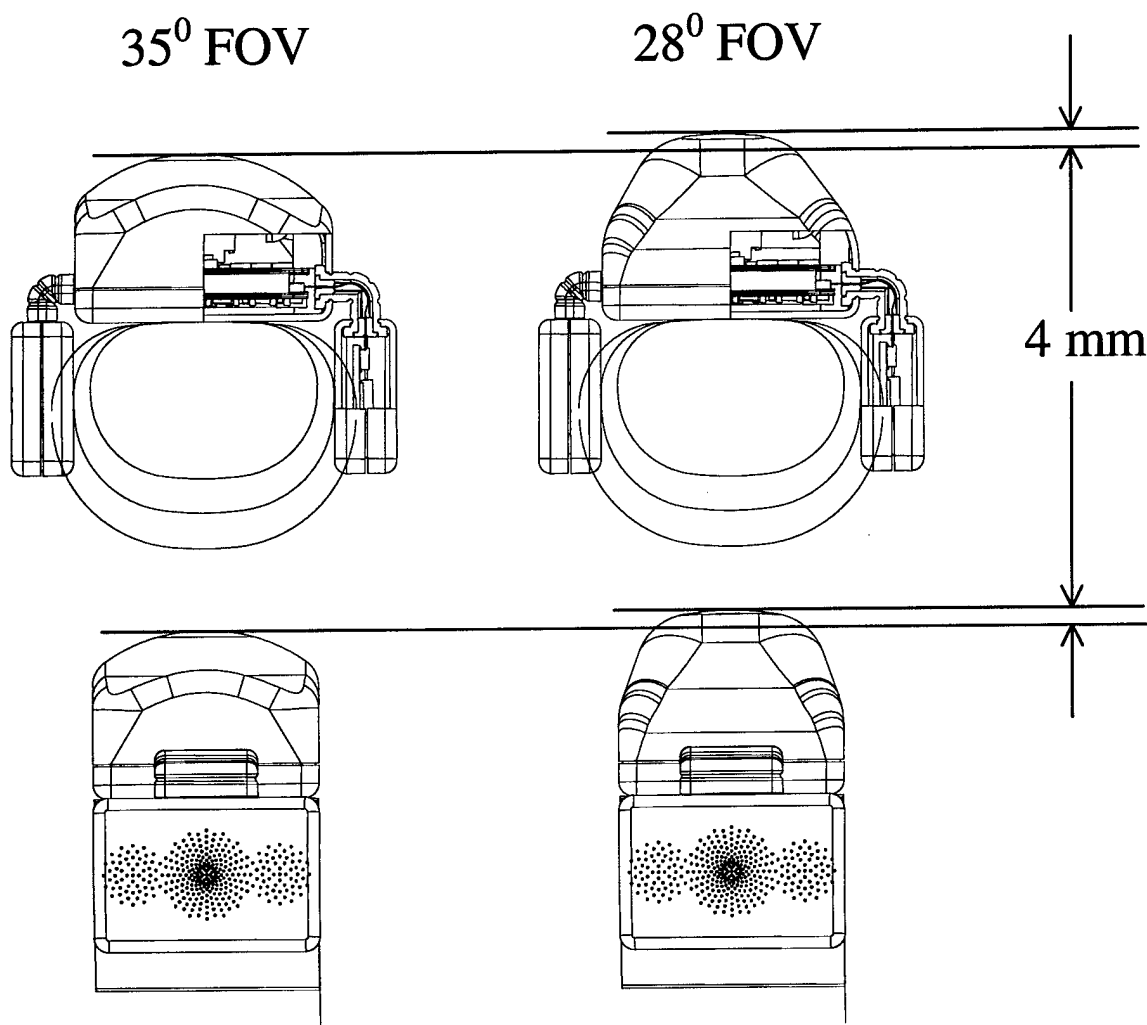


Fig. 5 Side and front views of the WID with the new (left) and CMD (right) optics

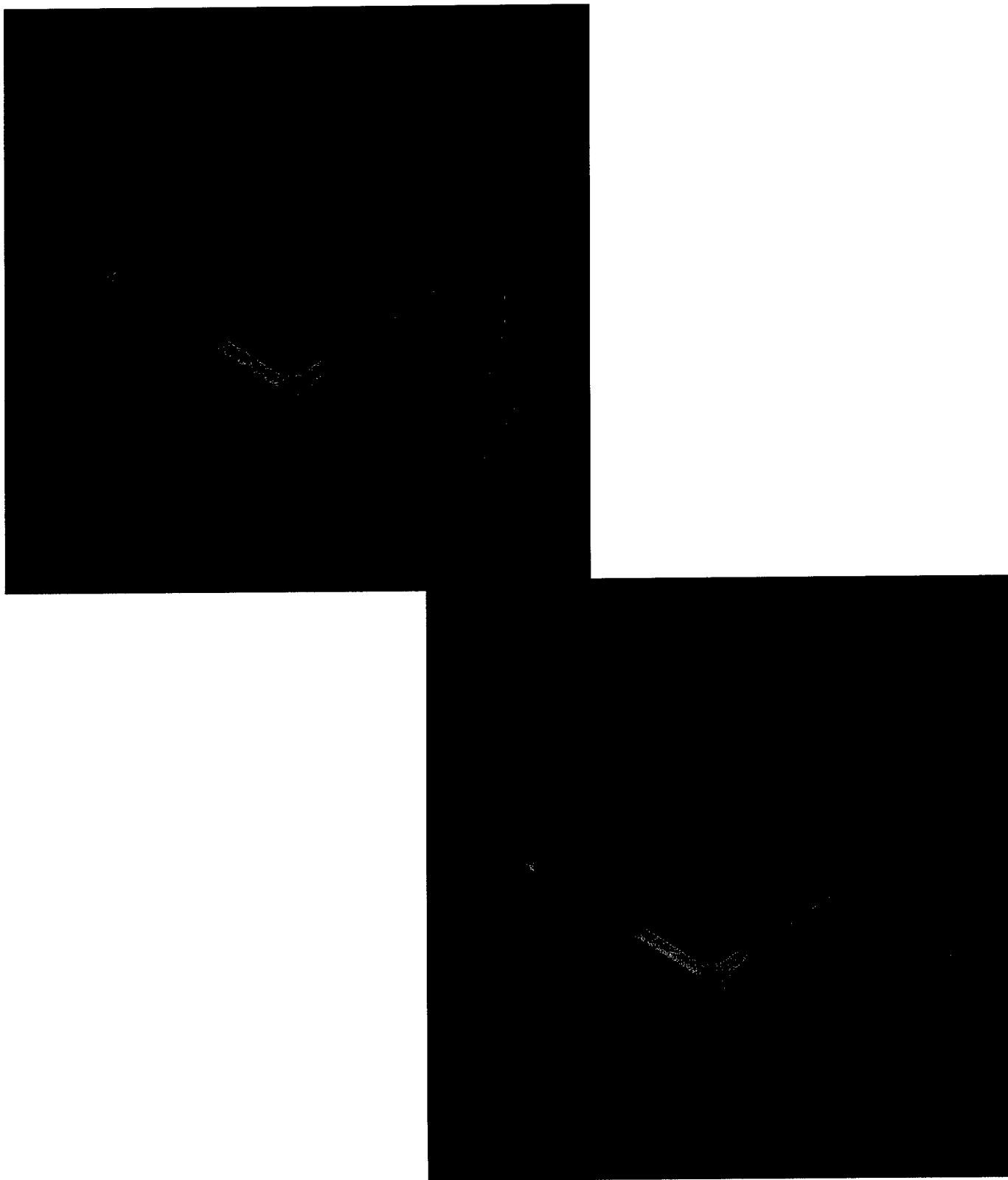


Fig. 6 Perspective view of the WID housing for the two lens configurations



Fig. 7 Cut-away of the WID housing for the two lens systems

Software

CMD Display Driver

The driver for the CMD display under Windows CE is completed as far as the Phase 2 WID board and the CMD Eval Kit will allow. It will be necessary to modify it to port it to the new version of the StrongARM processor that will run on the Phase 3 and 4 boards. This work will take place once the new CPU board is built and populated, by the end of March.

Bluetooth Drivers

The drivers for the Bluetooth radio have been started both on the ViA II side and on the WID side. The Digianswer software stack has been ported to the ViA II PC for the purposes of running the Digianswer demo application. Work is underway to modify the existing ViA video and audio drivers to interface to the Host Controller Interface (HCI) layer provided by Digianswer. Fig. 8 summarizes the architecture of the communication/display drivers for the ViA II-WID system. At this time we are not planning to implement a VCOMM or RFCOMM layer, since direct calls to the HCI layer can be made from the application level. The background app, in turn, is necessary because calls to the HCI cannot be made directly from the VxD that packetizes the data extracted from the ViA II VGA and audio drivers. When the WID or its chipset go into production, the software stack will have to be completed in order to meet the Bluetooth specification.

On the WID side the structure of the HCI driver has been understood and laid out. It will take a few weeks to flesh it out, with the UART-specific driver development following thereafter. Note that the HCI layer on the ViA II side is already provided by the Digianswer PC card, while on the WID side we have to develop it in its entirety, which is a rather extensive task.

USB Drivers

At the present time the development of the USB drivers is not funded under this grant. It is however being pursued in parallel with the Bluetooth drivers because of their similarity and strong likelihood of future use on WID-like platforms. At the time of this writing ViA has completed roughly half of that development.

Audio Drivers

The audio driver development is temporarily on hold while attention is focused on the USB drivers. Nonetheless, a Purchase Order was issued to Andrea Electronics to port their phase filtering code to the WID's DSP, the ADSP2185L. This code will become active in the Phase 4 audio board, which will be designed to enable both channels of the AD73322 CODEC to support the directional microphone array. The audio driver development is planned to resume in February.

High-Level CE Software

No work was done in January on the high-level CE software.

ViA II

WID

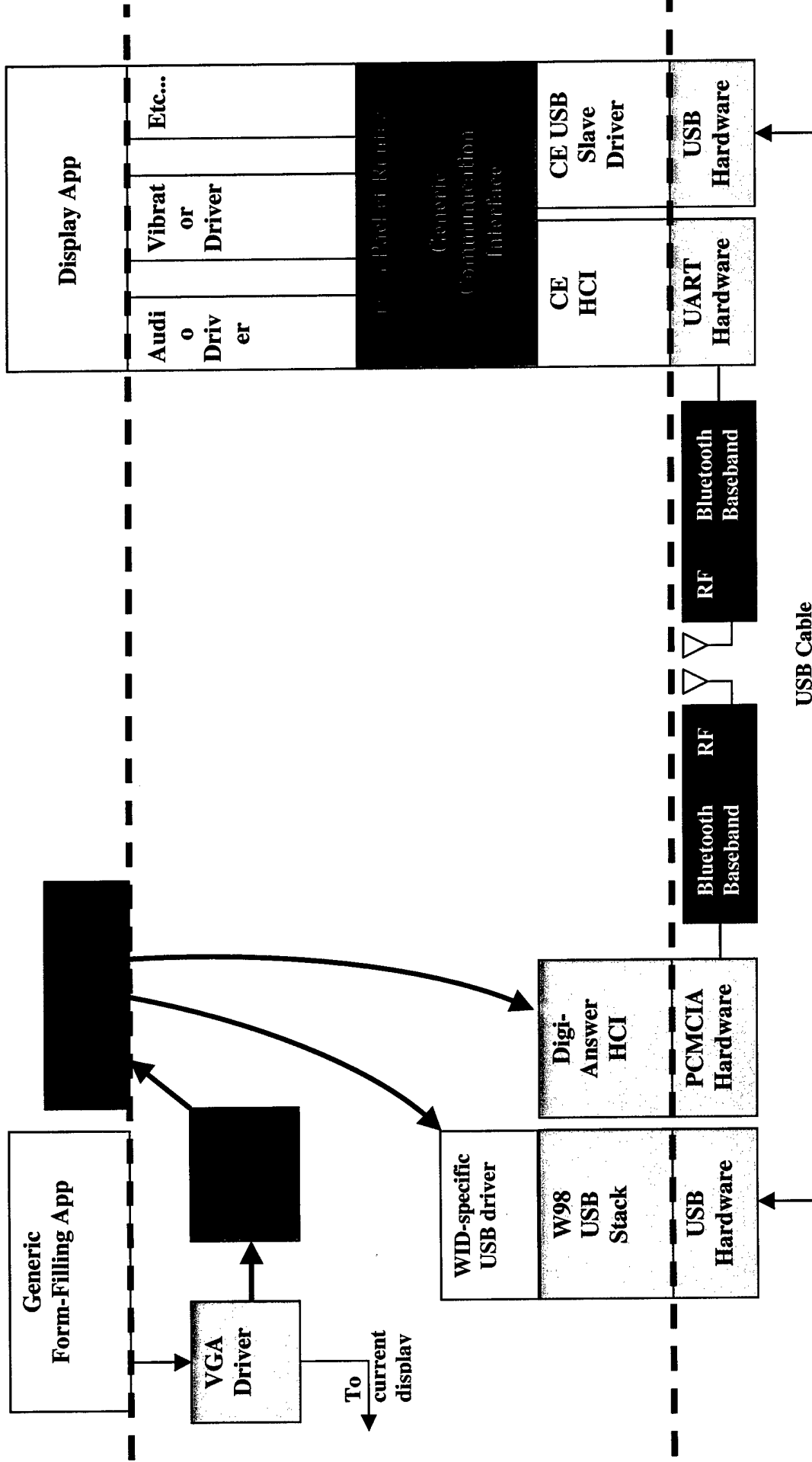
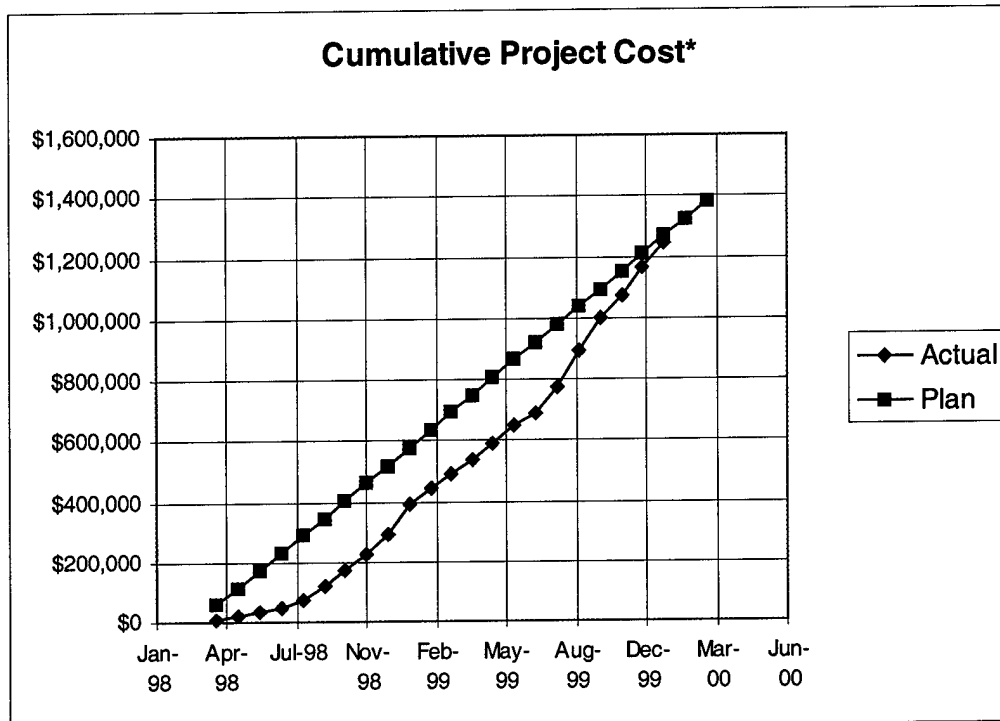


Fig. 8 Communication drivers for the ViA II-WID system



***without G&A and fee**

2. Project Cost

Cost incurred for the period and total cost, without G&A and Fee:

Current Month's Cost*	Cumulative Cost
\$80,616	\$1,245,528

* Current month cost is 1 January through 31 January

Person-hours for the period and cumulatively:

Current Month's Hours	Cumulative Hours
765.5	15,842

3. Schedule and Staffing

The staffing remains at 6 full-time hardware and software engineers. June 2000 deliverables are still expected.

ViA is moving to new facilities on Feb 5, 2000. Please note our new address below.

4. Author

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