CCM Implementation Status

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Intensive activity has been invested in the preparation of planning the Control and Computational Module (CCM) implementation into the DSN. A de facto standard has evolved from work performed by the Communications Systems Research Section. The DSN Data Systems Section is currently coordinating the total effort involved with the CCM implementation. Part of this effort is the selection of a Standard CCM family. A CCM Selection Recommendation Committee has been formed of representatives of the Telecommunications Science and Engineering Division and the DSN Engineering Section. A support CCM Policy Committee has also been formed of broad representation to develop policies to govern use of CCMs in DSN application. Every effort is being taken toward the establishing and support of a CCM Standard family for use in designing and implementing applicable equipment for the DSN.

I. Introduction

Because of the widespread availability of Large Scale Integration (LSI) programmable modules and their support chips, the DSN has for some time been interested in establishing a standard family of chips to be used for applicable new designs for implementation into the network. The Control and Computational Modules (CCMs) refers to a family of IC chips consisting of a CPU (central processing unit) Group, Memory Group, Input/Output chips, Special Function chips, and Support chips. See Table 1 for definition of CCM Family. The LSI CPU chips are generally referred to as microprocessors. In the latest technology where the CPU, memory, and I/O are on a single chip, the proper term is "microcomputer" (this configuration is not at this time being considered for inclusion in the CCM Standard). The strongest driver for going to a CCM standard is reduction of life cycle costs in the maintenance and operation area. There has been design activity (using microprocessors) in progress for several years at JPL and an initial effort to establish a standard was carried on in the Communications Systems Research Section culminating in an initial microcircuit set (CCM design review, September, 1976). This set is being considered a de facto standard until a standard can be selected.

Involvement by the DSN Data Systems Section (338) engineers in helping to establish and support a standard CCM set began with FY'78 (Oct. 1, 1977). This effort has been directed toward the establishment of a DSN standard and has involved the forming committees made up from several sections. One committee has worked on establishing a CCM policy and another on the selection of a DSN standard CCM. Meetings have been held in gathering data about the available chips. Surveys have been made to gather information; one to determine internal requirements and another to determine

available industry capabilities. All efforts are focused on establishing a CCM standard family and supporting its use in the DSN.

II. Background

In preparation to the effort beginning FY'78, a memo was written by the manager of the DSN Data Systems Section (338) that discussed: (1) CCM selection; (2) development of specifications; and (3) support effort. The support effort included: Hi Rel packaging; Hi Rel ICs (current SSI SMI Standard), Applications Data, establishment of documentation standards, main frame packaging, parts failure analysis, and ROM and PROM programming and configuration control.

A CCM implementation schedule was prepared by the Command Systems and Computational Module Group and reviewed by the Telecommunications Science and Engineering Division (33). The purpose of the review was to show the schedules intended to accomplish the CCM implementation. The areas of activity were broken out as in the aforementioned memo. Schedules of the activities were proposed, and an outline expansion of the activities was included. The plan is to make the CCM selection first and overlapping this closely by an update of the standard IC Hi-Rel program. For the Hi-Rel ICs the plan is to survey the potential users to determine the needs. Other effort would be directed to determine the applicability and the completeness of the current list of standard ICs, taking into account the newer chips available from industry. The plan also calls for making recommendations for updating the standard Hi-Rel IC list and for establishing procedures to accomplish such an update.

Support services were put on the schedule to show when they would be available. It is intended that Section 338 will be the focal point of the gathering and disbursement of applications information. It is expected that as successful applications are documented, other designers can benefit from such experience. In providing this service, this Section will set up a file and a distribution system.

Packaging support will be provided to assist designers in establishing their configurations, or they can use the documented designs of existing equipment. Also, a prototype wire wrap service will be established to provide the capability to receive a wire list (in prescribed format) and deliver wrapped boards.

Parts testing from SSI to LSI (CCMs) will be provided. Section 338 currently has a tester to test the standard line of chips. The plan is to procure a tester to test the CCM chips that will be selected as standard for DSN applications. In order to keep track of the reliability of the parts supplied to the DSN, parts failure analysis program will be set up to look for trends that can provide information to correct any failure tendencies. This program will require coordination with the DSN operations to make certain that adequate data will be available from which to draw credible conclusions.

Development system will be necessary in the support of program generation for the new CCM CPU chip. After the standard CCM family is established, a development system will be procured. An additional feature designed in the development system will be the capability to program ROM and PROM modules as the last step of program development.

III. CCM Standard Selection Process

Meetings were held with JPL personnel to become familiar with the previous work performed in evaluating microprocessors. Using this information, an initial version of selection criteria was generated. Because the standard family is to be used by Division 33 and the DSN Engineering Section (355), a CCM Selection Recommendation Committee was called together of representatives selected by the managers of those sections who felt a need for a vote in selection of a standard line. The first of many meetings of the committee was held 9 March, 1978, with subsequent meetings being held weekly. Much of the first meeting and parts of subsequent meetings was spent in discussing why CCMs were selected and what configuration they should take. Many question were raised on what policies should govern their use. As a result of these concerns and to allow the committee to proceed with the business necessary to make a selection for a standard CCM family, another smaller committee (with representatives from several sections) was formed to work out a policy governing the use and application of CCMs within the Division. When completed, the CCM policy will be reviewed at the division level before approval is granted. With the formation of the second committee, work has proceeded in preparing for a selection of a standard.

In order to gather data for the selection process, an engineering survey of requirements and an industry survey of capabilities were initiated. The Engineering Survey was made of projected needs within Division 33 and Section 355. The survey was in the form of a memo with attached response forms. It was sent to all group supervisors of Division 33 and Section 355. The memo requested a list of which applications were anticipated (dedicated controllers, or data processors, or computations), the word length needed, the operating speed requirements, the microprocessor characteristics desired, and the software support needed.

There were 15 responses to the engineering survey from 35 requests that went out to all group supervisors of the involved

sections. The responses did provide a rather broad set of requirements. The respondents indicated: an intent to use the CCMs either dedicated controllers or for performing data processing or compilation; reserved opinions that an 8080 would be fast enough to do the job, with some definite opinions that it would not; most indicated that an 8-bit word would be satisfactory, and two indicated a need for a 16-bit word. No definite conclusion could be reached regarding functional characteristics priorities. It was generally considered that the software support was at least as important as the choice of hardware characteristics offered.

The industry survey is being sent to 12 manufacturers. The type of information being requested includes; chip availability (of the line considered most likely candidates to date, i.e. 8080A, 6800, Z80 and 6502); capability to meet various screening levels; flexibility in meeting JPL/vendor interfacing needs; vendor history and future planning; availability of software support tools; availability of test equipment (could be from other than CCM manufacturer, i.e., Tektronix); description and outline of courses of instruction provided by vendor; and expected deliveries of chips. This survey went out to industry on 4-18-78 and responses are due by May 11, 1978.

Consultants have been contacted and have been and will be used to provide additional insight into certain aspects of the selection criteria that need their expertise. The group supervisor of the Parts Engineering Group of the Electronics Parts Engineering Section (365) and two other members of his group came to one of the CCM selection recommendation meetings and explained the spectrum and ramifications of screening options available from industry (MIL-M-38510D, Class B to Commercial, manufacturers Spec Sheet).

Members of the committee have come with various backgrounds to apply to the selection process. Some members have direct design experience; others are acquiring experience from manufacturers courses and seminars; and some are gaining experience by purchase use and study of kits available from the various manufacturers. Insight into the technology is also being gained by investigating, by studying, and by experiencing demonstrations of test equipment that are available.

The proposed CCM Selection Criteria have been discussed at great lengths at the several meetings. The main topics addressed are:

(1) Projected Availability

> To be assured of multiple sources and gain confidence in the vendors market strength and expected longevity.

(2) Vendor Capability and Responsiveness

> To feel confidence in the ability of a vendor to meet JPL's QA and support needs as they might arise.

(3) Device Applicability/Adaptability

> To provide a measure to assess how well the microprocessor meets the JPL requirements including the M and O aspects of long-term use.

(4) Availability of Support Tools

> To be sure that the products are sufficiently supported in the testing and program development areas.

(5) Energy Conservation Considerations

> To compare how much power is needed to support the competing candidates.

For a complete copy of the criteria, see Table 2. The purpose of the selection criteria is to provide a common reference of comparison to support the justification of the final selection, when made.

In order to use the criteria in the selection process, a CCM selection Evaluation form is being developed. The purpose of the evaluation sheets is to provide an agreed upon reference for making the evaluation comparison. In effect the evaluation sheet defines how to implement the criteria in the selection process. The evaluation Sheets include weighting factors for each item in order to provide a resultant number for comparison among competing candidate microprocessor lines.

The plan is to complete the CCM selection by June 1, 1978 so that CCM standard can be published in order that use (as governed by the CCM policy) in new designs can commence at that time.

IV. CCM Policy Committee

As stated before, this committee grew out of the need for answering the basic questions concerning the establishing and implementing of a standard CCM family. The topics addressed by this committee were: (1) Why CCM? (2) What are CCM? (3) CCM Committee membership and responsibility, (4) Selection criteria, (5) Screening requirements, (6) Implementation of selected standard, (7) Use of CCMs before the standard,

deviation from standard, (8) Addition to Standard, and (9) Support services.

The CCM Policy Committee is made up of members of several Division 33 sections. Four meetings have been held to date to fill in the outline of topics provided above. A memo describing the topics will be published after the concurrence and/or approval of the Division 33 Office.

V. Conclusion

The effort to establish a DSN standard CCM family is essentially on schedule. Involvement in deriving this standard has been extended to all interested sections within Division 33 and also Section 355 to assure the widest possible acceptance of the standard and to insure the best possible fit of need (requirements) with capability of the standard set.

Table 1. Definition of a CCM family

CPU group	One to three chips.
CPU ALU REGs Control unit Bus interface Clock System bus	The CPU contains the usual computer functional capabilities; Arithmetic Logic Unit, ALU: Registers; and Control Unit. By their nature bus structures are necessary for interfacing. For our purpose the address bus should accommodate memory up to 64K bytes. A clock is necessary (this is included in some chip types). The Instruction Set should be one that can efficiently support DSN requirements. This will require some bench mark comparisons.
Memory group ROM RAM EPROM	The memory will be implemented, according to need and cost, from a selected set of the various configurations available: PROM, EPROM, ROM and RAM.
I/O	Single chip per function except perhaps SIA.
Peripheral controller Interrupt Floppy disk CRT Cassette DMA controller RS 232 IEEE 488 DSN 15-line SIA Floating point Peripheral interface adaptor Bidirectional bus driver (I/O support)	These functions are self explanatory and are the various interfaces that should be made available to support the expected needs of the DSN applications.
Special functions	May be a group of chips.
Display AD/DA FFT Timers (programmable)	Displays will probably be needed for stand alone troubleshooting of the CCM built equipment. For interfacing with analog equipment, AD/DA converters will be necessary. For Fast Fourier Transforms applications the FFT chip will save on hardware and the software development efforts for this special computation. Timers can provide a range of controlled timing signals to reduce the burden on memory and reduce operating time.
Support SSI and MSI ICs	The above-mentioned chips will not be sufficient to implement the circuit functions that will be needed. Therefore, the standard IC line will be used to supply this need.

Table 2. Proposed CCM selection criteria

- Projected availability
  - Multiple sources
    - Basic CPU
      - Identify sources who produce using identical masks
      - Identify sources who produce on cross license
    - Peripherals for DSN system requirements
      - (Same source question asked under CPU for each DSN identified peripheral)
  - Current history (for each device in Part I)
    - How long a producer
    - Principal user (which segment of industry)
    - Current % of sales to military applications
    - Currently producing to MIL-STD-883/B or not
  - Future projection (for each device in Part I)
    - What is the expected market life
    - What is expected date of next generation
    - Vendor estimated delivery time cycle
    - Cost to reproduce line (when obsoleted by mfg.)
  - Financial health of vendor
- Vendor capability and responsiveness
  - Adequate process controls (QA survey of candidates)
    - Permit JPL visibility into process
    - Supply desired test data
  - Responsiveness
    - Interest in JPL
    - Provide special device symbolizing
  - User publications
    - Accuracy
    - Readability
    - Completeness
- Device applicability/adaptability
  - Requirements
    - DSN applications
      - Dedicated controller
      - Data or file manipulation
      - Computation
    - DSN HD/SW compatibility (with existing equipment)
  - Device functional capability (to be evaluated)
    - Speed
      - Clock rate
      - Clock cycles/instruction
      - Number instructions/real-time function (using bench mark tests)
      - I/O capability
      - Specific characteristics
      - DMA
      - Interrupts
      - Universal interface
      - Compatible bus structure
    - Software/hardware applications adaptability
      - Software/hardware tradeoffs
      - Board real estate needs (chip count)
        - Level of integration of family
        - Completeness of set
      - Interface/debug simplicity
        - Timing
        - Interface controls
        - Interrupt
        - Single-step operation
      - Life cycle cost considerations
        - Future expansion of compatible family
        - Initial cost HW/SW vs. support cost
- Availability of support tools
  - Software development aids
    - Cross assemblers
    - Assemblers/translators
    - Editor
    - Debug/monitor
    - Linking loader
    - Simulators
  - Software.packages
    - Development system
      - Operating system
      - Utility routines
  - Hardware development aids
    - Development system
      - Operating system
      - Emulators
  - Personnel training aids
    - Self teaching
    - Courses
    - Consultants available
    - Manuals
  - Device testing aids
    - Test equipment available
    - Degree characterized
- Energy conservation considerations
  - Number of power supplies required
  - Total device family power requirements