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LLNL-TR-747668

Fibre Channel Development Final Report CRADA No. TC-0340-92-D

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March 12, 2018

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Fibre Channel Development

Final Report
CRADA No. TC-0340-92-V

Date: June 1997 | TACT: | Revision: 1

A. Parties

The project is a relationship between the Lawrence Livermore National Laboratory (LLNL) and Sun Microsystems, (Sun).

University of California
Lawrence Livermore National Laboratory
7000 East Avenue, L-XXX
Livermore, CA 94550

Sun Microsystems, (Sun)
2550 Garcia Ave.
Mountain View, CA. 94043
Attn: Bob Williamsen, M/S MPK12-203

B. Project Scope

The Fibre Channel (FC) Development project was designed to enhance U.S. industrial competitiveness by accelerating the standardization and subsequent industrial acceptance of the American National Standards Institute's (ANSI) Fibre Channel Standard (now X3T11). It was also intended to give the principal U.S. participants a one- to two-year lead in developing heterogeneous high-speed computer networks, distributed computing through clustering, scientific visualization techniques, and high speed channels. The project was proposed to benefit U.S. industry as these high performance computing methods became generally available. In 1992-93, during the initial project phases, Fibre Channel (FC) was emerging as a new ANSI standard. It was envisioned as becoming the mechanism for data transfer between the next generation of computers, and between these computers and their peripherals. Using this channel standard, U.S. computer vendors were expecting to be able to provide high-speed interoperability between heterogeneous computers and their storage devices, with data transfer rates greater than a GBit/sec.

Our project was composed of key principal players in the FC standardization effort from both U.S. industry and the Department of Energy's (DOE's) Lawrence Livermore National Laboratory (LLNL). The industrial participants were developing individual FC interfaces to operate with their platform products. LLNL's role was to be a neutral testing site and a facilitator for helping to resolve conflicting interpretations of the embryonic Fibre Channel specification. LLNL anticipated that conflicts in the interpretation of such a standard would arise and require neutral resolution and that such resolutions would best be achieved in cooperation with the ANSI FC Working Group. Project plans included transfering to U.S. industry any resilient FC testing capabilities at the project conclusion.

This project was extended from its original planned termination of May 30, 1996, until December 31, 1996 under an agreement to shift a portion of the DOE-provided funding from FY95 into FY96.

Project deliverables were defined and modified on a case by case basis to suit the specific industrial partners needs for testing their equipment and their product availability. Since the fundamental

activity performed by LLNL was product testing, the LLNL milestones & deliverables were subject to industrial partners product availability and were adjusted to accommodate each partners readiness for testing. Most scheduling delays were either anticipated or announced by industrial partners in advance such that both parties could adjust resources to accommodate the scheduling changes.

C. Technical

LLNL has made several valuable contributions to the success of Fibre Channel as an acknowledged ANSI Standard:

1. LLNL's (and hence DOE's) presence and participation in the ANSI committees helped to provide industry with the reassurance that this Standard is a worthy pursuit.

2. LLNL authored the Fibre Channel Link Encapsulation (ANSI FC-LE) specification which is now an accepted ANSI Standard for coupling Fibre Channel with higher level protocols.

3. LLNL tested products and discovered conflicts in the interpretation of the early draft FC Standard and sought resolution in cooperation with the ANSI FC Working Group to revise the Standard and assisted the involved industrial partners to achieve interoperable products.

4. During the final project phases several other groups attempted to establish test beds for Fibre Channel and/or test beds for high speed switching & networking product testing. Time will tell if these efforts prove successful. LLNL did have a limited informal collaboration with two of these project groups in an advisory role.

D. Partner Contribution

Sun Microsystems, (Sun) contributed the following products for testing at LLNL:

a. SparcStorageArray, Model SSA100, w/SOC interface (2)
b. Sun Unix Workstation Model SS-10/30 (1)
c. Fibre Channel Adapter Cards, 266 Mbps, SOC S-bus (2)

LLNL tested each of the FC products and reported test results to Sun Microsystems.

Additionally, LLNL and Sun collaborated on several conferences and industry trade shows to provide technical demonstrations of Fibre Channel products.

E. Documents/Reference List

No CRADA Protected information was generated during this project.

No patent or copyrights were generated, nor are any pending as a result of this project.

No subject inventions were disclosed by any industrial partners to LLNL,
nor did LLNL disclose any inventions to any industrial partners during this project.

F. Acknowledgment

Participant's signature of the final report indicates the following:

1) The Participant has reviewed the final report and concurs with the statements made therein.
2) The Participant agrees that any modifications or changes from the initial proposal were discussed and agreed to during the term of the project.
3) The Participant certifies that all reports either completed or in process are listed and all subject inventions and the associated intellectual property protection measures attributable to the project have been disclosed or are included on a list attached to this report.
4) The Participant certifies that if real property was exchanged during the agreement, all has either been returned to the initial custodian or transferred permanently.
5) The Participant certifies that proprietary information has been returned or destroyed by LLNL.

BA Williamsen 10/1/97

Bob Williamsen Date
Sun Microsystems

Attachment I – Final Abstract
Attachment II – Project Accomplishments Summary
Attachment III – Final Quarterly Report

Fibre Channel Development

Final Abstract
Attachment I
CRADA No. TC-0340-92

Lawrence Livermore National Laboratory has entered into a research agreement with Hewlett-Packard Corporation, International Business Machines Corporation, and Sun Microsystems, Inc. for a Fibre Channel Development project. LLNL will assess interoperability of heterogeneous Fibre Channel products and facilitate the resolution of conflicting interpretations of the draft Fibre Channel Standard. The CRADA's goal is to accelerate the standardization and acceptance of the American National Standards Institute's Fibre Channel, for the benefit of customers and vendors of Fibre Channel products. The Fibre Channel will be a future mechanism to facilitate communications at data rates greater than one gigabit per second, between heterogeneous computer systems and between systems and peripheral devices.

Lawrence Livermore National Laboratory is operated by the University of California for the U.S. Department of Energy
Technical Transfer Initiatives Program, P.O. Box 808 L-795, Livermore, CA 94551

Fibre Channel Development

Project Accomplishments Summary (Attachment II)
CRADA No. TC-0340-92

Date: July 1997 Revision: 1

A. Parties

The project is a relationship between the Lawrence Livermore National Laboratory (LLNL) and industrial partners: Hewlett-Packard Company, (HP), International Business Machines, (IBM), Jaycor Corp (Jaycor). and Sun Microsystems, (Sun).

University of California
Lawrence Livermore National Laboratory
P.O. Box 808, L-795
Livermore, CA 94550

Hewlett-Packard Company, (HP)
19420 Holmstead Road,
Cupertino, CA. 95014-9810
Attn: Suhas Badve, M/S 43LN

International Business Machines, (IBM);
Advanced Workstation Development (AWD)
11400 Burnett Rd.
Austin, TX 78758
Attn: Carl Zeitler, M/S 9570

Jaycor
P.O. Box 85154
San Diego, CA. 92138-5154
Attn: Terry Flanagan

Sun Microsystems, (Sun)
2550 Garcia Ave.
Mountain View, CA. 94043
Attn: Bob Williamsen, M/S MPK12-203

B. Background

In 1992, Fibre Channel (FC) was an emerging American National Standards Institute (ANSI) standard for next generation computer networking and peripheral I/O. Industry had only a few prototype implementations of Fibre Channel products. FC testing centers had yet to exist. Competing standards existed for high speed networking (e.g. ATM) and alternative standards for peripheral channels and/or clustering interconnects (e.g. SCSI, IPI, IEEE 1394 Serial Bus and IEEE 1596 SCI) had many computer systems manufacturers and end-users in search of better methods for connecting larger and faster storage systems to computers and networks.

This project was intended to give the principal US. participants a one- to two-year lead in developing heterogeneous high-speed computer networks and high-speed peripheral channels using this new FC standard.

LLNL had key principal members who helped originate the concept of Fibre Channel and who were then members of the ANSI committee for Fibre Channel, (then X3T9). LLNL also had needs for this emerging technology as it was envisioned that it would enhance LLNL's ability to build larger and faster computer systems to then contribute to the scientific programs' abilities to achieve their goals, such as stockpile stewardship. LLNL could also serve industry in this effort by being a neutral site for testing and ANSI standards committee negotiations, should that be... necessary to resolve conflicts in standards interpretation.

C. Description

The Fibre Channel (FC) Development project was designed to enhance US. industrial competitiveness by accelerating the standardization and subsequent industrial acceptance of the ANSI Fibre Channel Standard (now X3T11). The project was proposed to benefit US. industry as these high performance computing methods became generally available. In 1992-93, during the initial project phases, Fibre Channel (FC) was emerging as a new ANSI standard. It was envisioned as becoming the mechanism for data transfer between the next generation of computers, and between these computers and their peripherals. Using this channel standard, US. computer vendors were expecting to be able to provide high-speed interoperability between heterogeneous computers and their storage devices, with data transfer rates greater than a GBit/sec.

The industrial participants were developing individual FC interfaces to operate with their platform products. LLNL's role was to be a neutral testing site and a facilitator for helping to resolve conflicting interpretations of the embryonic Fibre Channel specification. LLNL anticipated that conflicts in the interpretation of such a standard would arise and require neutral resolution and that such resolutions would best be achieved in cooperation with the ANSI FC Working Group.

The LLNL FC test bed was established in May 93 and operated until December 1996. During this project time frame, LLNL constructed the test bed and developed testing methodologies and test suites as proposed. LLNL assisted participants in testing their FC implementations and resolving interoperability issues. LLNL also collaborated with participants to demonstrate their new technologies to the open market at conferences and industry trade shows. These events (e.g., InterOP, SuperComputing, HPCN) were key to achieving interoperability and accelerating time-to-market and in gaining market acceptance and visibility.

D. Expected Economic Impact

Results of this effort are being witnessed today with the establishment of Fibre Channel as the method of choice for future high-speed channels and as the successor to SCSI as the peripheral attachment method of choice. Leading US. companies are now producing FC computer host adapters and/or FC storage systems and the market for FC products is projected to grow. US companies are now enjoying a lead in time-to-market for FC products over foreign competitors.

E. Benefits to DOE

Computer simulation and modeling form the cornerstone of the DOE ASCI program's efforts to shift from nuclear test-based methods to compute-based methods for maintaining the safety, reliability and performance of the nuclear stockpile. This modeling and simulation requires advanced data communications and storage capabilities with high transfer rates for rapidly accessing modeling data and running the necessary simulation codes. Fibre Channel is becoming a method of choice for providing this high-speed access.

LLNL core competence has been enhanced through our participation with industry and the ANSI committees including the insights we have gained into the technical aspects of FC and FC product utilization. This knowledge will benefit internal LLNL networks and computing and storage facilities.

F. Industry Area

Areas of industry which are benefiting from Fibre Channel include electronics components manufacturers, computer system manufacturers and integrators, data communications and networking companies, mass storage manufacturers; test equipment manufacturers, cabling and connector providers.

G. Project Status

This project is complete.

H. LLNL Point of Contact for Project Information

Tim J. Voss,
(510) 422-0452
(510) 423-2492 (FAX)
Internet: timvoss@llnl.gov

I. Company Size and Point(s) of Contact

This CRADA has multiple industrial participant companies. Current contacts are:

HP:	Gary Wermuth (916) 785-4520
IBM:	Jerry Chapman (512) 838-7530
Jaycor:	Terry Flanagan (619) 392-6580
Sun Microsystems:	Bob Williamsen (415) 786-6490

J. Project Examples

This project constructed a test bed for testing industrial partners' products. Results were reports of technical operation relevant to the product(s) being tested. After project conclusion, the test bed was dismantled and member's equipment was returned to them. Project notes, test software and results have been archived to off-line storage.

K Release of Information

I certify that all information contained in this report is accurate and releasable to the best of my knowledge.

Karena McKinley, Director
Industrial Partnerships
and Commercialization

3/20/00
Date

RELEASE OF INFORMATION

I have reviewed the attached Project Accomplishment Summary prepared by Lawrence Livermore National Laboratory and agree that the information about our CRADA may be released for external distribution.

_____ _____

Gary Wermuth
Hewlett-Packard Company

Date

RELEASE OF INFORMATION

I have reviewed the attached Project Accomplishment Summary prepared by Lawrence Livermore National Laboratory and agree that the information about our CRADA may be released for external distribution.

_____ _____

Jerry Chapman
IBM

Date

RELEASE OF INFORMATION

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_____ _____

Terry Flanagan Date
Jaycor

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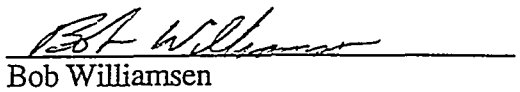

Bob Williamsen
Sun Microsystems

10/2/97
Date

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Timothy Voss 7-29-97
Timothy Voss Date

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