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Wednesday, May 6, 1992

To: P1394 High Speed Serial Bus Interested Parties,

Subject: Minutes for April 16, 1992
Apple Computer, Inc.
Cupertino, CA

Secretary's Report: Ken Stewart, NCR

April 16, 1992 IEEE meeting on P1394 held at the Apple Headquarters in Cupertino California. This meeting was called to order at 9:14 AM.

Agenda

1) Draft 5.1

2) Cable and Connector status

3) Backplane task group

4) Cable tests

5) Self Clocking and termination codes

6) New Arbitration Proposals

7) Cable electrical I/F

8) Clocked Ack

9) New priority

10) channel sustain function

11) multi-speed isochronous

12) meeting schedule

13) status of bridging

Draft Specification Status

Once again ... P1394 documents are available only through the IEEE document service or Apple FTP. Mike Teener no longer mails the documents. The mailing list now has 193 people and is growing.

Draft 5.1 is not yet ready for publication. Pete Bartlett (NCR) has been translating the proposed P1394 protocol into an experimental protocol language developed by Bell Labs. As a result of this formal specification of the P1394 protocol, Pete has uncovered several problems in the current proposal. To set things right, Pete has offered to help edit draft 5.1. Mike Teener is very thankful for the help.

Connector Working group report: Dave Hatch (Stewart Connector)

This newly formed working group held it's first meeting yesterday. They are actively seeking input from interested parties and want to set up a peer review at a later date. Dave had some proposed cables and connectors for people to look at and feel. One decision they made yesterday was to leave the connector mounting style open for such frills as squeeze to release, interlock et cetera, rather than require the currently proposed dimple retention mechanism.

Apple has been testing the current proposed cable with good results at 100 MB/s. At data rates higher than that, the cable may need to be to either be shorter, or require heavier gauge wire. The data suggests that 25 meter cables may require 19 or 20 gauge wire, while 5 meter cables may only need 26 gauge.

The group is focusing on the same connector as was in the original proposal. It was originally designed for the Nintendo Game Boy, and consequently is very rugged. As a connector person, Dave thinks it will be an excellent choice. Spacing of connectors is another important issue that will be explored in a future meeting. In addition, they will improve the mechanical drawings. Dave says the current proposal is "basically good but needs some tweaking to become document grade." Dave's biggest issue at the moment is to get input from interested users.

Next, Dave entertained questions. Question: is a 24 lead variant under discussion? Answer: no, it was not discussed yesterday, but the group would be willing to entertain the concept. If it is an issue, please send Fax or mail a letter. Q: does the connector offer ESD protection? A: Yes, in spades. Q: Can it be mounted on a PC board? Yes. Q: What about cross talk and impedance? A: Florin Oprescue (Apple Computer) will give a presentation later today. Q: Height off PC board? A: There are two sockets for PC mount. The vertical mount is 12 mm high and the horizontal mount is about 7 mm.

Backplane update: Kim Clohessy (DY4 Systems)

There are two areas of interest: secondary bus; and interface to 1149.1. Kim offered to head the backplane task group but didn't want to tread on anyone toes, as someone has already been appointed. Mike Teener took chairman's prerogative and appointed Kim because the current chair was dragged in kicking and screaming at a Futurebus meeting. Mike has list of people who are interested in forming the group.

Meeting Schedule

Gerald Marazas (IBM) requests moving the May meeting forward one day to Friday May 22 in order to host it at the IBM research center in South San Jose. This is the Friday of Memorial Day weekend. If we can change to the 22'nd, IBM can promise good weather, blue skies, a minimum number of suits and ties, colorful flowers, roadblocks to prevent wrong turns to the near-by mental institution (Girls Ranch), nice lunch et cetera. On the 21'st, it would be much bleaker. A quick vote confirmed it ... May 22 at 8:00 AM.

The European meeting will be held on May 8 in Frascati Italy, at the center for High Energy Physics. Someone noted that it is also good wine area. Mike won't attend. Mike suggests that all the task group chairmen present as much documentation as possible. We want to solicit inputs from Europe. Dave James will chair the meeting. Maps and agenda were in the last mailing.

Colorado Springs, hosted by NCR. Ken will try to get something on September 15 or 16. (Confirmed. September 15 at the NCR Microelectronics facility.)

May 8, Frascati, Italy

May 22, Almaden, California

June 24, Minneapolis, Minnesota

August 19, Seattle, Washington

September 15, Colorado Springs, Colorado

Channel Sustain: Dan O'Connor (Apple Computer)

First, a description of the problem. A cycle starts, and the message goes out, to be repeated from node to node until it reaches the respondent. But what if one talker dies or is unplugged? The train of isochronous packets is broken and the following channels will fail to transmit. Channel sustain allows some other node to replace the message by timing out faster than other nodes and inserting an empty isochronous packet. The base assumption for this is that it looks like a zero length packet. Tcode is a cycle response. Dan proposes that the channel number should look just like the real one. But the respondent may want to know that it is a sustain. Dan proposes using the priority bit, which is only used by asochronous packets and has no meaning in this case. The cycle master should not be the one to insert a sustain. One voice: sounds likes a great idea. Another voice, Q: What if you have two in row that miss? A: Distributed answer may be more attractive, but much more difficult to sustain. Every node would have to know how many nodes there are...not a wonderful solution. The channel master gets chosen by the Monarch. Q: When does this get inserted into the spec? A: we all looked at each other, but no one volunteered. Q: How does it heal itself? If a channel fails to respond only once, is he removed forever? A: The cycle master observes that node 3, for example, continually needs sustain. Old arb scheme 600 ns. To keep the terminology straight, someone reminded us to use Cycle Manager, not channel master nomenclature. Ramiro Calvo (Apple) volunteered to head a Channel Sustain management task group.

Multi Speed Isochronous: Dan O'Connor

Late the previous night Dan somehow convinced himself that a given node might not know that a packet went by. This would lead to problem for isochronous nodes because for isochronous to work correctly, the node must know what the previous transmission speed was. But if the node missed the packet, it would have also missed the speed code. After a brief discussion, we had general agreement that a node MUST know when a packet went by. False alarm. Sit down Dan.

Cable Testing: Florin Oprescue (Apple Computer)

Florin passed out a written summary of his test results--well mostly. Florin is concerned with saving trees (paper), so he omitted all the oscilloscope pictures. He showed many interesting waveforms on the overhead projector that were not in the handout. But we like wave form pictures, so we persuaded him to give them to Mike, who in turn, will attach them to these meeting minutes. Rather than distribute ALL of Florins pictures, we compromised and agreed to include only the ones referenced in the conclusion.

Florin's research is based on this question: How good a cable is required for what we are trying to do? Engineers are nothing if not practical. The first results he showed us were for cable skew. Florin would have expected the skew to vary linearly with cable length. He illustrated this by drawing a graph on the overhead projector with a straight line going out from the origin at a 45 degree angle. Surprisingly, this was not the case on the handful of cables he tested. His experimental results show that skew falls off less than that (below the 45 degree line), and approaches an asymptote. Ed Gardner (DEC) tossed out one possible explanation: cable segments are independent so they add up as an RMS sum rather than a linear sum. The theoretical reason is still unexplored, but Florin's experimental results prompt him to propose decreasing the skew budget.

Florin found that Inter-Symbol Interference (ISI) rather than cable skew becomes the limiting factor as the cable length increases and the data rates increase. Florin concludes that, from an ISI point of view, 5 meters is OK for any of the proposed transmission rates (100 Mb/s, 200 Mb/s or 400 Mb/s). At 10 meters, ISI is acceptable at 100 MB/s, and becomes marginal at 200 Mb/s. At 400 MB/s the eye closes completely. At 10 meters, 28 gauge wire may not be adequate. These results prompt Florin to recommend 26 gauge wire for 10 meters at 400 MB/s. The power pair also needs significant increase in diameter at this length, much more than the increase in the signal wires. The use of a DC balanced code will improve the length and data rates. Gerald Marazas (IBM) stated that IBM has also seen the flattening off of the skew curve. Maybe not to 100% flat, like Florin sketched, but the IBM experiments support Florins claim that ISI is more of a problem than cable skew.

Gerald also voiced concern with transmission, cross talk, susceptibility and power distribution. As the cable gets longer, it becomes more of an antenna. The problem is the antenna receiving signals rather than transmitting them. Dan O'Connor (Apple) suggested that instead of specifying cable length, wire gauge, et cetera, maybe we should specify inputs and outputs. Spec a rise time and cross talk, (DC-DC converter can couple significant noise into signal wires). Maybe, Dan continued, we should propose using repeaters instead of longer cables. Ed Gardner (DEC) had previously polled his constituents; they want 10 meter cables and are willing to pay for it. Pete Bartlett (NCR) had also polled his constituents and they feel that 5 meters is OK because it is possible to use repeaters. A supplier of military equipment said that in secure systems the cable is usually enclosed in a conduit, where there may not be room for repeaters. Florin and others said that the repeater would be small and could be powered from the cable, so that shouldn't be a problem. Several people spoke out at once in response to this and said that repeaters reduce reliability, in fact even the connectors needed for the repeater will reduce reliability so it is better to avoid them if possible.

Lunch 11:43-12:28

During lunch, there were several questions about the prototype chips being made by Apple. The chips are actually being made by Orbit Semiconductor for Apple engineers to evaluate for this standards effort. The arbitration protocol has been placed in an Altera programmable gate array. Everything else has been placed in two chips. Apple is leery about giving out data sheets because this is all experimental so far. The PHY chip is a transceiver, that performs the synchronization and level translation. Arbitration should be added to the PHY chip. The Link Layer chip performs addressing, read/write, and things like that. Compared to the other two chips, this one is fairly stable. So far their efforts have been toward a cable implementation, but this set of chips should work on a backplane. Apple would rather share information to guarantee interoperability.

Arbitration Proposal: Florin Oprescu

Florin presented a rather interesting, if lengthy, proposal for arbitration. In this proposal, there are four processes: RESET, TREE ID, SELF ID, and ARBITRATION. Tree ID mode takes a graph and turns it into a directed acyclic graph (a tree). After the creation of a tree, the self ID process establishes a deterministic ordering which gives each node a physical address. During this process each node sends a message announcing things like how much power they need.

In this proposal, there are Leaves, Branches and one Root. The key for this whole algorithm is the LEAF node: one that has only one port connected. By knowing that it is a leaf, a node knows that it has less priority than the branch it is connected to. (The PHY chip is able to sense whether or not there is something connected to its various ports.) If it wakes up and discovers that only one of its ports are connected, it knows that it is a leaf. The leaf sends a message that says "you are my parent." We will need two bits in this arbitration scheme. The first is the Parent/Child bit. It records whether the port is connected to a Parent node or a Child node. Thus if node 1 is a leaf and node 2 is a parent, the port in node 2 connected to node 1 will have C and the port in node 1 connected to node 2 will have a P. Again, the bit records what the port is connected to, not what the node itself is. A node 3, which is above node 2, will receive node one's message from node 2 and set the P-C bit to C because node 2 is node 3's child. Eventually, the message makes its way to node 4. In this example, node 4 is the root. It has another branch, similar to this one connected to it. Node 4 receives messages on both its ports and says "hey, all my ports are children, I am the parent." Florin feels that it is very difficult to resolve any conflicts parent/child assignment using digital techniques. It is very easy using analog. Anybody can be a root. It would be nice to have a root reference timer that would prevent the node from sending this "hey you are my parent" message until the timer has expired. In this way, we may force a particular node to become the root. For all kinds of bus management reasons it is desirable to have a fixed root.

This scheme requires that the PHY layer be alive in every node. This allows a powered down node to pass these messages. Message passing in this system is asynchronous using DC levels (high, low, and off). It propagates throughout the system like a wave. First a node sends reset. In phase 2 the next immediate nodes get reset and so on. As some of the nodes are getting reset, some are sending the You-Are-My-Parent message. Q: What is the mechanism to generate reset? How does a leaf decide that there are no ports connected? PHY chips provides that service. Because each differential receiver can detect whether the port is connected. Must have cross over (null modem) to sense connection. We have two differential ports, each of which can be high, low or high impedance. Thus we have a lot of line-states to work with. If a PHY layer receives a high-high (high on both pairs) state, then reset.

- A leaf has one and only one port connected.

- A branch has one and only one connected port that is not a child; and one or more ports that are children.

-A root has children on all its connected ports AND its timeout period has occured

The Tree ID is now complete. Now the system will begin the Self ID assignment. After the Tree ID is established, a Leaf will send a bus request for self ID. A Branch node waits for all children to request a self ID, then passes a single Request-for-Self-ID to its parent. Finally when the root has received this message from all its ports, it grants the bus to one of its children. We might decide that all the nodes to the left will talk. In this case, the right side receives a Bus Denied message. The first node on the left side may have be branch (have a fork) and grants to same rule: left gets it, right does not. Eventually, this left-to-talk message will propagate down to the left-most leaf. This leaf now assigns himself a physical ID of 1. Every other node on the bus will be aware of this process. There are three messages: the Request-For-ID message, the Bus-Denied message and the Right-to-Talk message. All nodes will 'see' these messages and thus, all nodes will know what number is next when they finally get their own Right-To-Talk message.

The second bit (remember we need one for Parent/Child) is a U or an I for unidentified or identified. The Branch node says "hey, my child has an ID." The Branch node sends message to the identified Leaf. This message effectively keeps this leaf from participation further in the Self ID process. Next the Leaves that don't have ID's all request the bus. The procedure repeates itself until all nodes have an ID.

This Self ID process is guaranteed for any length cable. Even a satellite link. It allows an arbitrarily complex network. Not only that, but the entire network can determine the arbitration delay. Normal arbitration works very similar to the self ID process, except that you don't need to wait until all your children talk. When a parent and a child try to arbitrate at the same time, the Parent takes precedence over the child. In this case, the bus is denied to the child. Q: What if one node requests fair arbitration when other node requests urgent arbitration? A: inter-packet gap time is shorter for urgent packet, and nodes cannot request the bus until the appropriate gap time has expired. The urgent node would request the bus before a fair node, and so would never conflict with the fair request.

Physical Channel Update: Roger Van Brunt (Apple Computer)

Roger described his PHY chip design. See the attached handout. It runs full duplex on both twisted pairs. Baluns are recommended. Each twisted pair has a transceiver. It outputs a common mode voltage of 2.2 volts that helps detect a connector port. The drivers are current mode, high impedance. Roger increased the current from 3 mA to 4 mA to allow 10 meter cable lengths. The cable is terminated at both ends, developing a signal of +- 220 mV. The receiver has high bandwidth and low offset and acts as limiter. There is a state detector for Florin's signaling. There are three levels of signaling: Z, 0,1. The State detector also detects collisions. The differential signaling scheme causes rise and fall time distortions to cancel out. Florin allows a 0.5 volt drop in power pair. Rogers transceivers will tolerate 0.5V in ground shift.

Signal specification for signals (Roger Van Brunt)

At 200 Mb/s and 400 Mb/s we will need to boost the current from 4 to 6 mA to compensate for the attenuation that Florin demonstrated. Q: Why not just specify 6 mA and forget the 4 mA? A: The lower current is deemed desirable for lower power operation. Florin interjected, "It might be better to improve the cable rather than boost the current." There developed a ten minute free for all with Roger and most semiconductor manufactures saying that it would be very easy to dynamically change the current, and Florin arguing that it would be better to improve the cable. It was pointed out that all the asynchronous signaling must use the same current because of the wired-OR configuration. The question boiled down to how much more does it cost for a better cable, leading to the day's first action item.

AR: Florin and Dave Hatch will come back next month with estimates of cable cost versus cable length and transmission speed for 5 and 10 meters and 100 and 400 MB/s.

Continuing with the review of Rogers PHY chip design, a question was asked. Q: What causes the range in voltage variation? A: tolerance in output common mode signal. Ground drop gives signal variations of 1.22 to 3.24 volts. Florin's suggestion of tightening the ground drop to 0.5 volt will allow tightening it up. Q: what about 3 volt power supplies? A: tough to do in CMOS. Maybe need BiCMOS. The TP common mode output voltages (section 2.0) does not require any trimming or band-gap reference. If they need to be tightened, then these more expensive things may be necessary. It might be good idea to put lower bound on rise and fall time. A problem with specifying a lower bound is that then we must specify a method for the chip vendor to measure it. If we don't want a lower bound, then we should specify zero (what is a negative rise-time anyway?). There is plenty of margin in the jitter budget. Three sigma on the receiver, approximately 6 sigma on the transmitter. For 100 MB/s assume CMOS and 0.1 skew. For 200 MB/s assume BiCMOS or submicron CMOS, and 0.05 ns skew. For 400 MB/s assume GaAs or Bipolar and 0.025 skew.

New Arbitration Proposal: Bill Duckwall (Apple)

Bill would like like to extend the concept of the Fairness interval, during which everybody who wants to transmit can transmit. Currently, every node has an arbitration enable flag that they set when they they see a Fairness Reset Gap (a longer-than-normal gap) and that they clear when they win arbitration. Bill proposes that the arbitration enable flag be replaced with a counter. When the counter is non-zero, a node may arbitrate. The counter decrements each time the node wins arbitration and is set back to a programmed value at the Fairness Reset Gap. If you keep all this stuff at the PHY level, everybody pays dearly for it. It is much cheaper to put it at higher level in the link IC where the intelligence comes more or less for free. It would be nice if the time delay between packets can be shortened, and currently we have several levels of delay (urgent, fair, and fair reset). A nice feature for this type of priority arbitration is that it does not add extra delay (required for the old Urgent protocol). 1)The root has the highest priority, so if we can agree that the root is allowed to be the cycle master, then we eliminate any need for urgent mode. This should be possible since any node MUST be capable of being a root. 2) Dave James would prefer a choice of every n'th within the fairness interval, vs. n accesses within the interval. The group tentatively decided to make the root the cycle master. If nobody prooves that this is wrong thing to do then it will be official. Florin can make a mathematical proof that shows thathaving the Root become the cycle master is better than any other topology. Get back on Bills original proposal of using a count.

Ack Clocking: Mike Teener

We have changed around the clocking scheme in the past year so that now it is easier to send back clocked information as an ACK instead of the old length-encoded DC siganl. Mike proposed using 8 clocked bits which is 100% redundant, containing 4-bits of information. This will allow 16 different ACK codes. In the old clocking scheme you needed so much data in order to synchronize the PLL that it was viewed as very painful to send a clocked ACK back. Now that we have an instant-on clock, it is very easy. Since it is so useful, why not do it?

AR Mike: put 16 ACK response packets in next minutes mailing.

Improved Encoding: Mike Teener

If the run length is limited to 4, we should get a 30% decrease in ISI, which could give a 30% longer cable. Gerald Marazas (IBM) confirms this theoretical result with experimental data. IBM sees a 30% or more improvement using their 8b/10b encoding scheme. ISI is the problem here, so we should be looking for codes that minimize the run length. MFM may be the best code. We should not exclude other codes (besides 8-bit codes). Is it too late in the game to change? 8b/10b is a DC balanced code with embedded clock. But there is also an 8b10b code without a clock. Ed Gardner thinks we do need a DC balanced code. Florin is very clear about what the code should provide. 1) Minimum number of gates. 2) Minimum ratio between min and max frequency. 3) How many bits for unique identifier. Also, at maximum frequency, and a given a data rate, which code has the best ISI. An alternative approach is to say that P1394 is a 100 and 200 MB/s standard. If you want to go higher, use something else.

AR: Gerald Marazas: bring back 8b/10b data.

AR: Ed Gardner: Explain why a DC balance is required

AR:Everybody: should we code the data?

Send everything on this topic to Ed Gardner gardner@ssag.enet.dec.com (lower case is best).

Status of Bridging: Dan O'Connor

Nothing has happened. AR Dan present algorithm at next meeting.

Meeting adjourned at 5:19 PM.

Chair's Report: Mike Teener

Working Group Communication

Bob Snively succeeded in setting up an Internet email reflector. To send a note to the entire P1394 community with Internet access, send a message to "p1394@sun.com." If you want to be added to the reflector, please send a note to Bob at "Bob.Snively@eng.Sun.com" and copy me at "teener@apple.com." I strongly suggest that you join the reflector if you want to follow what is going on. If you absolutely cannot get access to the Internet, and you will be making contributions to the ongoing conversations, then I can FAX the proceedings to you once a week or so ... but any of your contributions must be put on a Mac or PC format 3.5" floppy in plain-text format and shipped to me. -

Note to all AppleLink users: you can get access to the reflector via "p1394@sun.com@internet#", and the address you send to Bob Snively is: "(your alink ID here)@applelink.apple.com."

All p1394 documents given to me in electronic form will be made accessible on Apple's ftp server "ftp.apple.com" in the "pub/standards/p1394" directory.

Action Items

1) (Teener) Put in “actions” for the state machines (continuing).

2) (Teener/James/O’Connor/Gardner) Flesh out the management sections (continuing).

3) (James) Module/node configuration CSR wording (continuing).

4) (VanBrunt) Cable physical layer electrical interface update (continuing).

5) (Hatch) Connector and cable specification update (continuing, Dave Hatch is new task group leader).

6) (???) Priority arbitration number uniqueness. (continuing - may be modified for new arbitration)

7) (Clohessey) Bus backplane implementations. (continuing - task group getting organized/new chair)

9) (Mike Teener) What happens to mode switch if cable is too long or has too many nodes? (continuing - part of error analysis, may be modified for new arbitration)

10) (Mike Teener) Draft 5.1 (continued to May).

11) (Oprescu/Hatch) Estimates of cable cost versus cable length and transmission speed for 5 and 10 meters and 100 and 400 MB/s.

12) (Teener) New ack encoding.

13) (Gerald Marazas) Bring 8b/10b data.

14) (Ed Gardner) Explain why a DC balance is required

15) (Everybody) Should we code the data?

Meeting Schedule

The next meeting will take place at the IBM Almaden Research Center in San Jose, CA, at 9:00 AM on May 22, 1992. To get there from San Jose International Airport, follow the signs to US-101 South. Continue on US-101 South to the Bernal Road exit. Turn right at the end of the ramp, and proceed on Bernal Road (through the county park) to the ARC gate, located two miles inside the park. Altogether, this should be 19 miles from the airport.

An alternative route is to follow the signs to “Downtown San Jose.” Turn right at Guadalupe Parkway. Follow Guadalupe Parkway to the San Carlos Street exit. Turn left on San Carlos. Turn right off San Carlos Street at Vine Street. Continue on Vine Street, which turns into Almaden Expressway. Turn left at the intersection of Almaden Expressway and Harry Road. Proceed on Harry Road, and turn right at the ARC gate. This route takes 17 miles from the airport.

The schedule for the next few months is ...

June 24, 1992. Stanatek, Minneapolis, MN (jointly with X3T9.2 — SCSI). Host: Jim Hamstra (+1-612-474-9428). See attached note for details. (The hotel is not filled up yet, just tell them you are with the "ENDL/X3T9" or "ANSI" meeting.)

August 19, 1992. BOEING Computer Services, Seattle, WA (jointly with X3T9.2 — SCSI). Host: Everett O. Rigsbee (+1-206-865-7364). See attached note for details.

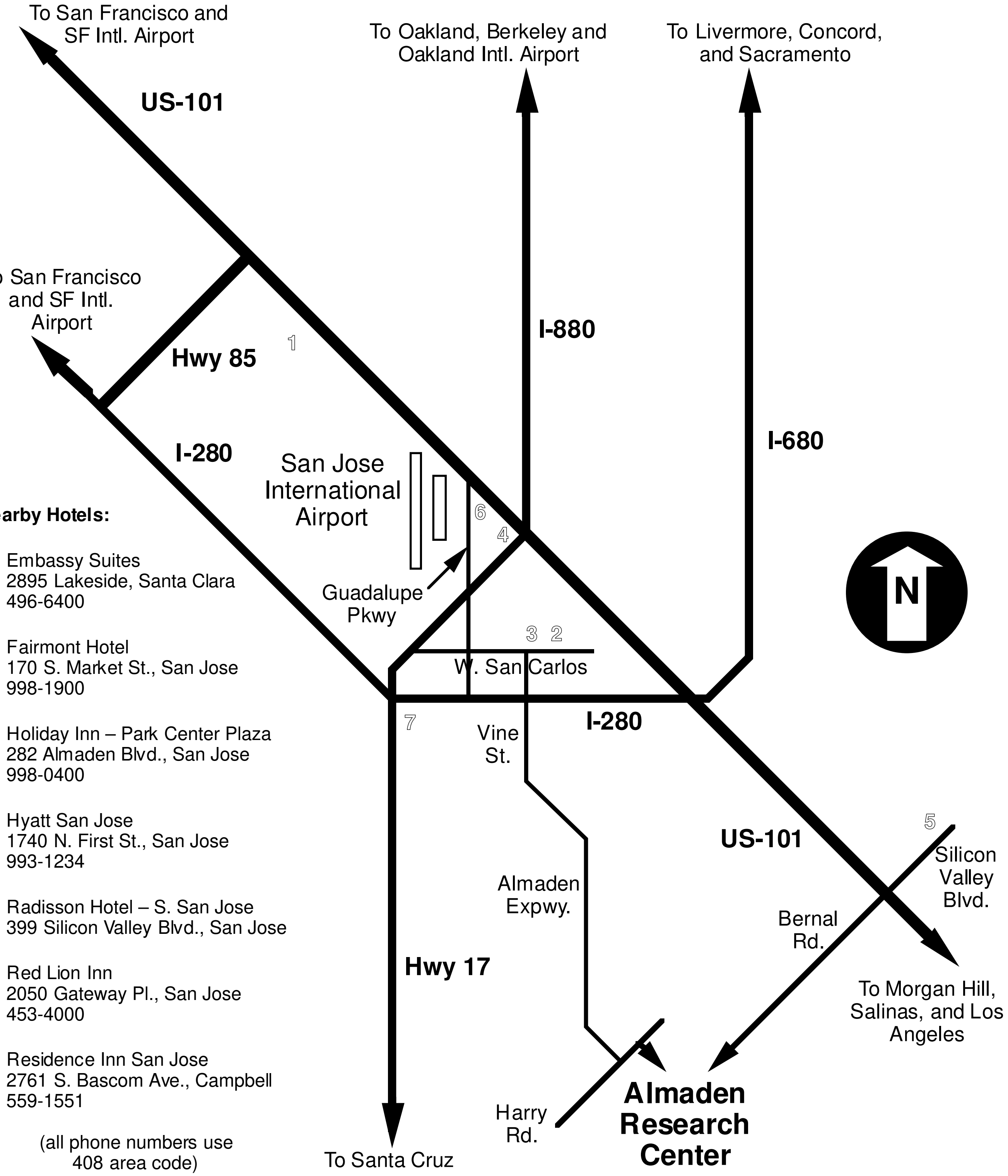
September, 1992. NCR , Colorado Springs, CO. Host: Ken Stewart (+1-719-596-5795, kstewart@ncr-mpd.FtCollins.NCR.COM)

See you in a few weeks ...

Sincerely,

Michael Teener

Attachments:
- Map to IBM Almaden Research Center
- June meeting details
- August meeting details
- Oprescu - cable test results
- Duckwall/Oprescu - tree arbitration state machines
- Van Brunt - transceiver design



Nearby Hotels:

1. Embassy Suites
   2895 Lakeside, Santa Clara
   496-6400
2. Fairmont Hotel
   170 S. Market St., San Jose
   998-1900
3. Holiday Inn – Park Center Plaza
   282 Almaden Blvd., San Jose
   998-0400
4. Hyatt San Jose
   1740 N. First St., San Jose
   993-1234
5. Radisson Hotel – S. San Jose
   399 Silicon Valley Blvd., San Jose
6. Red Lion Inn
   2050 Gateway Pl., San Jose
   453-4000
7. Residence Inn San Jose
   2761 S. Bascom Ave., Campbell
   559-1551

(all phone numbers use
408 area code)

MEETING ANNOUNCEMENT

X3T9 Plenary Meetings

June 22-26, 1992

Minneapolis, Minnesota

Hosted by StanaTek

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      LOCATION: Hotel Sofitel Minneapolis
                5601 West 78th Street
                Bloomington, Minnesota  55439
                  Phone (612) 835-1900, FAX (612) 835-2696

  RESERVATIONS: Call (612) 835-3888 or (800) 876-6303
                Group name is: X3T9 meeting hosted by StanaTek
                Room rates are $95 single, $110 double (tax included)
                Cutoff date for reservations is May 29, 1992.
                   Reservations made after this date will be subject to
                   space availability.

    DIRECTIONS: From the Minneapolis/St. Paul International Airport:
                  go West on I-494 about 9 miles
                  go North on M-100 to first exit (West 77th Street)
                  go West on 77th across M-100
                  turn left on the frontage road
                  go past the Radisson Hotel to Hotel Sofitel

TRANSPORTATION: Hotel Sofitel Minneapolis is located on the "Bloomington
                Strip", about nine miles West of Minneapolis/St. Paul
                International Airport via Interstate 494.  Passenger vans
                shuttle between the airport and hotels along the strip
                every half hour, for a modest fee. Taxis and rental cars
                are also available.

        OTHER:  Additional meeting parlor space is available for
                organizations other than X3T9 that wish to host activities
                in conjunction with the X3T9 meeting.  Arrangements for
                such activities should be make directly with Hotel Sofitel
                sales at (612) 835-1674.  This space is being held until
                March 1, so plan your activities now.
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If there are any questions regarding meeting arrangements, please contact Hotel Sofitel Minneapolis, or:

Jim Hamstra
StanaTek
24000 Highway Seven
Shorewood, Minnesota 55331
Phone (612) 474-9428
FAX (612) 474-6514

April 25, 1992

To: ASC X3T9 Committee Members, Liaisons & Attendees

From: Everett O. Rigsbee, Boeing Computer Services

Subject: Meeting Announcement: Bellevue, WA, August 17-21, 1992

The August 1992 meeting for the ASC X3T9 Committee will be held at the:

Hyatt Regency Bellevue
900 Bellevue Way NE
Bellevue, WA 98004

Phone: (206) 462-1234 or (800) 233-1234, FAX: (206) 451-3017

Hosted by: BOEING Computer Services

during the week of August 17-21, 1992. For this meeting a block of 250 rooms has been reserved which will be available only to X3T9 attendees. Please be sure to identify yourself as an X3T9 attendee when making your reservation by phone or use the reservation mailer provided to insure that you get a room from our block at the discount conference rates. The Conference rates are as follows: Single: $97.00, Double/Twin: $107.00 per night plus a 13.6% room tax.

The Hyatt Regency Bellvue has provided a pre-printed reservation form for making your reservations in advance, or you may call the numbers above any time prior to the deadline. Please note:

RESERVATION DEADLINE is July 27, 1992 !!!

Reservation requests received after this date will be accepted on a space available basis only, so don't be late! You don't want to look for a place short term in August.

The Hyatt Regency Bellevue is conveniently located at the center of Bellevue just across the street from the Bellevue Square Mall. There are many shops and restaurants located within easy walking distance. There are shuttle services which will bring you to/from the airport and the hotel for a nominal fee, so I recommend not using a rental car because the hotel parking will cost you about $10 a night. If you want to go sightseeing you can rent a bicycle. To reach the hotel by car, take I-405 North as you exit the airport and go about 15 miles North until you pass the exit for I-90 East & West and go through a tunnel. The first exit after the tunnel is for "8th Ave SE"; DO NOT take this exit. The next exit is for 4th Ave NE and 8th Ave NE; take this exit keeping to the right, then left and then right to 8th Ave NE Westbound exit. Go 5 blocks West on 8th Ave NE to Bellevue Way, turn right and the 1st driveway on your right is the entry to the Hyatt Regency Bellevue. They will direct you to their underground parking.

I am looking forward to seeing all of you in Bellevue, Washington!

Sincerely,

Everett O. Rigsbee, Boeing Computer Services, (206) 865-7364