TCP Meeting Notes
30 & 31 January 1978

Agenda

Monday, 30 January
8:30-8:40 Introduction and Objectives - Cerf
8:40-8:45 Arrangements - Cohen
8:45-10:30 Status Reports
  1. BEN TENEX & TOPS-20 status.
  2. BEN UNIX TCP (and FTP/TELNET)
  3. UCLA 350 TCP (and FTP/TELNET)
  4. MIT Multics TCP
  5. SRI LSI-11 TCP
  6. CCA RSX-11M TCP
10:30-11:00 TCP-3 Comments Review - Postel
  A list of issues brought up by the review of the TCP-3 Draft
  Specification is to be circulated by Postel before the meeting. A
  working party will be assigned to sort out final editing on
  Tuesday.
11:00-11:30 Fragmentation Issues and Choices - Cerf
  Object here is to get fragmentation issues out on the table and
  assign a small working group to resolve them on Tuesday.
11:30-12:00 Sequencing -- Octets vs. Segments & Rubber EOS - Cerf
  Object here is to get issues these out on the table and assign a
  small working group to resolve them on Tuesday.
12:00-1:00 Lunch
1:00-1:30 CCA PSMF & TCP - Kou-Mei Chuang
  Packet Speech Measurement Facility/TCP Measurement
1:30-2:30 NSFW Protocols and their Requirements - Thomas
  The object here is to understand how TCP might have to change to
  support the NSFW protocols.
2:30-3:30 Multidestination Addressing, Broadcast, Datagrams, and
  Emmission Control Mode - Cerf
  Discuss the multidesignation and broadcast topic, set up a working
  group on it, and introduce the issue of incorporating a datagram
  mode and an emission control mode of operation into TCP.
3:30-4:00 Types of Services Revisited - Cohen
  Can we get a specific proposal for the first cut set of services
  and set up a working party to worry about how they are coded,
  characterized, etc. Includes discussion of Plummer's ideas and
  Craighill's ideas.
4:00-4:30 Real Time Conferencing - Cohen
4:30-5:00 TCP Demo - Plummer
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Tuesday, 31 January
8:30-12:00 Working Groups
(a) TCP 3 specification editing
(b) Fragmentation
(c) Multidestination/broadcast
(d) Speech/real-time
(e) Sequence Counting and Rubber Everythings
12:00- 1:00 Lunch
1:00- 2:30 Reports from Working Groups
2:30- 3:30 Specific Plans for 1978 - Cerf + inputs from others
   Experiments, milestones, demonstrations, developments, analysis, etc.
3:30- 4:00 Agenda for Next Meeting - Cerf

Introduction and Objectives - Cerf

The main objective is to get TCP-3 straightened out, and to discuss extensions.

Arrangements - Cohen

The arrangements are: see Debe.

Uses this time to complain about TCP-3 becoming all things to all people. Also illustration of the approach to voice service via an "unreliability" package on top of TCP.

Status Reports

1. BBN TENEX & TOPS-20 status.

Bill Plummer reports that both Tenex and Tops20 TCPs are running. These are most simi-lar to TCP 2. (For example, Urgent and Rubber EOL are not implemented.) Both are monitor versions (not user code). Some documentation has been done.

2. BBN UNIX TCP

Ray Tomlinson reports that the BBN Unix implementation is essentially Jim Mathis' TCP11 encapsulated into the Unix environment, with user to TCP communication via the RAND port mechanism.

3. UCLA 360 TCP

Bob Braden reports that work is in progress, right now focusing on cleaning up the network interface environment, still planning on a 1-June date to begin testing TCP-3 with other sites.
4. MIT Multics TCP

Dave Reed reports that TCP-3 for Multics is now being coded but that testing of the revised 1822 interface has higher priority. Dave expects that Multics may be ready to test its TCP-3 against other sites as soon as a month from now.

5. SRI LSI-11 TCP

Jim Mathis reports that the running version of TCP in his MOS and ELF systems is version 2.5, and has been distributed to several other sites.

6. CCA RSX-11M TCP

Kou-Mei Chuang reports that CCA is building a packet speech measurement facility which is to include a TCP measurement facility. CCA plans to use Mathis TCP11 on a RSX system.

7. DTI Unix+ TCP

Gary Grossman reports that DTI is working on a TCP-3 implementation funded by a DCEC contract.

TCP-3 Comments Review - Postel

Jon reviews the main points on the list of issues circulated before the meeting. A brief discussion of the European use of the interrupt facility and the relation of that to TCP's urgent mechanism took place. A working party is to sort out final editing on Tuesday.

Fragmentation Issues and Choices - Cerf

Vint proposes that fragmentation be removed from TCP and be designated an internet protocol task. John Shoch presented a brief summary of his memo on this topic. A working group is to resolve this issue on Tuesday.

Flow Control - Cerf

Some discussion of sequencing of octets vs. sequencing of segments. Arguments about the unit of work of a TCP being a segment. Other arguments about when a TCP is required to send ACKs. A suggestion that there be a per connection segment size negotiated at connection set up. Talk of allocations of segment counts and octet counts (shades of NCP!). Result of all this => DO NOTHING (thank goodness)!

Postel
Protocol Specification Techniques - Sunshine

Carl presented some ideas on how to make better specifications of protocols. There were 5 categories: Introduction, Design Goals, Pure Specification, Implementation Suggestions, and Analysis of Specification. These five categories are to be applied to the protocol itself and to each of its interfaces. Others suggested that there should be a functionality specification, an algorithmic specification, and an interface specification. A user guide was mentioned. There is to be a working group on this too.

CCA PSNF & TCP - Kou-Mei Chuang

Packet Speech Measurement Facility/TCP Measurement

Kou-Mei made a presentation about the CCA Packet Speech Measurement Facility and showed some of the analysis that can be performed. The facility can record streams of speech packets and play them back, a pass through feature is now being added.

NSW Protocols and their Requirements - Thomas

Bob gave a presentation of the MSG protocol and especially its role in the NSW. There was some discussion of how TCP could help and how MSG could use a datagram mode.

Multidestination Addressing, Broadcast, Datagrams, and Emission Control Mode - Cerf

Vint led a general discussion of these topics which turned up a lot of questions and few answers.

Types of Services Revisited - Cohen

Earl Craighill made a brief presentation of the material in his note. Danny made a presentation of the type of information he sees needed on the outside of the envelope and on the inside of the envelope. This led to a discussion of the dependencies between protocol function, which led to having a working group on the topic on Tuesday.

TCP Demo - Plumner

Bill ran a demo of TCPs on various Tenexes and Top20s talking with each other.
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Working Groups

(a) Protocol Specification Techniques
(b) Fragmentation
(c) Type of Service Dependencies
(d) TCPs for PDP-11s
(e) TCP 3 Document Editing

Working groups a, d, and e met in parallel sessions for about an hour and a half, then groups b and c met in parallel until lunch time. After lunch the fragmentation discussion continued briefly, with the summary presented by Ray Tomlinson.

Reports from Working Groups

(a) Protocol Specification Techniques -- Sunshine

The following outline for improved TCP documentation was developed by a working group at the Jan 30-31 1978 TCP meeting. It suggests dividing the current single document (Version 3.0 spec) into five sections: a brief introduction; more detailed philosophy, explanation, and justification of TCP design; a formal specification of the TCP-TCB mechanisms and the functional interfaces to users (above) and network or internet (below); a rigorous verification; and implementation suggestions based on the experience of the several TCP implementations to date.

The introduction, philosophy, and implementation sections would be based largely on material already in the Version 3.0 spec. Techniques for formal specification appear to require further study, although section 4.2.9 of the current spec again provides a basis. Verification techniques are definitely a research topic. Carl Sunshine will be heading a continuing working group on these topics, and any comments on the suggested outline are welcome.

OUTLINE FOR IMPROVED TCP DOCUMENTATION

1) Introduction (about 10 pages)

   Brief history, context
   Scope, purposes and goals of TCP
   Mention rest of documentation
   Emphasize 3 levels (User-TCB, TCP-TCB, TCP-net)
   Brief operation of protocol-philosophy
   Glossary

2) Philosophy:

   Detailed history - lessons learned
Compare with others (NCP, INWG 96)

Explain mechanisms, intuitive description of
3-way handshake, addressing, termination,
no Resynch, urgent, letters, etc.

Functional spec of User-TCP, TCP-net interfaces Problems,
shortcomings

Future Directions

Examples - scenarios

Glossary

3) Formal Specification

Explain formalisms used
Discuss other techniques

Potential techniques:

- Formal Language: BNF, W-grammars
- State Transitions (Events-->Actions)
- Program Description
- Processing of Events in prose

Module Definition
- Illinois Event spec.
- Requires further research

4) Rigorous Verification

May require different formal spec. techniques
Based on combination of state reachability and
assertion proofs

Requires further research

5) Implementation Hints

What not to leave out (see functional interface spec) User
interfaces
- TCP mechanisms
- Data structures
- Program sizes, performance
- Test sequences, procedures, exerciser
- Parameter values: timeouts, segment sizes, quit time, ACK
times, buffering strategies, windows
- Debugging
- Separate general from specific

(b) Fragmentation -- Cerf

This group had a lengthy discussion. One immediate result was
the decision to remove fragmentation from TCP and place it in the
internet protocol, subsequent discussion focused on how to do
fragmentation. This discussion resulted in the definition of a
series of numbers and relations between the numbers regarding
segment, fragment, and packet sizes.

M0 := a segment of this size or smaller will not need to be
fragmented by any network in the internet system. That
is, all networks will handle segments of this size (and
smaller) as complete units.

M1 := all internet fragment reassemblers will handle segments
of this size.

M2 := the largest segment a particular internet module is able
to receive from the network, independent of reassembly.
This a local implementation parameter.

M3 := the largest segment a particular higher level module
(e.g. TCP) is able to accept from an internet module.
This a local implementation parameter.

M4 := the largest segment that can be handled by the internet
system.

MF := the unit of fragmentation.

and

MF <= M2 <= M1 <= M2 <= M3
M2 <= M4

M0 = 126 octets (1008 bits).
M1 = to be determined.
M2 = local option.
M3 = local option.
M4 = 2**14 octets (2**17 bits).
MF = 64 octets (512 bits).

To aid in the reassembly of fragments each segment will carry an
identifier (16 bits). A reassembler checks the four fields
identifier, source, destination, and format to decide if two
fragments are from the same segment. The value of the identifier
is set by the sending higher level protocol. To indicate where in
a segment a fragment belongs there is a fragment offset field (8
bits) that specifies the location of the fragment as measured in
MF units from the beginning of the segment. There is a
"not-last-fragment" bit that is set on all but the last fragment.
Finally there is a "don't-fragment" bit that indicates a segment
with this bit set is not to be fragmented in any case.
It should be noted that all of the above is with respect to internet fragmentation, that is, fragmentation visible at the internet level. It is permitted that networks or pairs of gateways use intranet fragmentation as long as the operation is invisible at the internet level.

(c) Type of Service Dependencies -- Grossman

A set of potentially optional facilities in the present TCP were identified. Each of these facilities may be present or absent on an individual connection basis.

Octet Ids: A facility which provides a distinct id for each octet of data.

Sequence Numbers: Octet ids which in addition indicate the order of the data octets.

Reject Duplicates: A facility to detect and discard duplicate data octets. Uses octet ids.

Ack-window: An acknowledgment which defines the left window edge.

Sort: A facility that restores the relative order of the data octets, but does not fill holes in the data stream.

Fill: A facility that fills holes in the data stream.

Flow Control: A facility that allows the receiver to control the flow of data.

Ack-delivery: The acknowledgment by the receiver of all data octets up to a given point in the data stream.

Retransmit: A facility used by data senders to ensure arrival of data at the receiver.

A dependency matrix and graph were developed to show the dependency relations between these facilities. It seems that there are some facilities which are independent of most other facilities.
TCP Dependency Matrix

|                   | A | T | F | K | D | e | r | l | C | n | t | w | o | u | e | m | n | t | b | t | e | l | o | r | i | e | r | d | y | w | t | s | t | l | l | s |
| Ack-delivery      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Ack-window        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Retransmit        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Reject Duplicates |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Sort              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Fill              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Flow Control      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Sequence Numbers  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

Rows depend on Columns.

Notes:
A - need not be delivered to the user in order.
B - One of Ack-delivery or Ack-window is required for termination.
2,3 - 2nd and 3rd order dependency.

A facility was proposed for synchronizing activity between multiple data streams. This facility was relegated to a higher level protocol.
Three basic questions were generated:

1. To what extent are TCP mechanisms independent enough to permit reduced TCP implementations to provide reliable service when used on a relatively reliable transmission media?

   E.G., can a TCP using flow control alone provide reliable service on a virtual circuit?

2. To what extent will reduced service versions of TCP work, provided that errors are handled by RSTs?

   E.G., can partial implementation TCPS work at all?

3. What additions to or modifications of TCP mechanisms would improve the independence and/or performance of the existing TCP mechanisms?

   E.G., when TCP is used on a transmission medium which delivers data in order but may lose data, a selective retransmission request might improve performance.

(d) TCPS for PDP-11s -- Mathis

Garry Grossman from DTI briefly presented their UNIX implementation of TCP v3, scheduled for completion in June. The TCP is built upon the Illinios UNIX InterProcess Communication facility. This facility provides: Events - a "small" message exchanged between processes Segments - data that is shared between address spaces by using virtual memory mapping facility.

The TCP will be interface with the standad UNIX I/O system so that existing programs can be made to use TCP connections with minimal changes.

List of operating systems which provide (or will provide) TCP support:

- MOS - SRI (v2.5)
- ELF - BBN (v2.5)
- UNIX - BBN (v2.5)
- UNIX - DTI (v3, June completion)
- RSX-11M - CCA (mid-1978 completion)

The current v2.5 TCP11 program is expected to be upgraded to v3 protocol by May.

The remainder of the session was used for discussions on converting TCP11 to run on various system configurations.
(e) TCP 3 Document Editing -- Postel

It was decided to produce a slightly revised version of the document correcting the minor points, then to decide whether or not to go ahead with a major revision according to the results of the protocol specification working group.

Among the points to be covered in the minor revision are: reset (to be reviewed by Carl Sunshine and Jon Postel), fragmentation (see result of fragmentation working group), internet format (perhaps as a separate document), and the checksum procedure (with input from Dave Reed).

Specific Plans for 1978 - Cerf

Vint promises to circulate a note covering this topic.

Agenda for Next Meeting - Cerf

The next meeting will be 162 June 1978 at MIT.

Progress Reports

BBN - Tops20
BBN - Tenex
BBN - Unix
NDRE - NORD10
UCLA - 360/91
SRI - TCP11 MOS & ELF
CCA - RSX-11
MIT - Multics
DTI - Unix*
UCL - TCP in various machines

Summary of the Internet Protocol -- Cerf

TCP-3 Specification Issues -- Postel
TCP Facility Dependencies -- Grossman
Real-Time Protocol -- Cohen
Internet Type of Service -- Cohen
Proposal for actual services.
Broadcast/Multidestination -- Cerf
Description of the service desired, description of applications that would use it.
MSG - Response to the Internet Service Proposed
Protocol Specification -- Sunshine
Working Groups
Protocol Specification
Internet Protocol
Real Time Protocol
TCP Issues
Memos Distributed

1) Transmission Control Procedures -- Postel
2) A Quick Approach for TCP Type of Service -- Craighill
3) Protocol Topics -- Postel
4) Comments on TCP-3 (Jan-78) -- Cohen
5) On Names, Addresses, and Routings [IEN 23] -- Cohen
6) Design Considerations for a Real-time Text Conf. System -- Cohen
7) Inter-Network Naming, Addressing, and Routing [IEN 18] -- Shoch
8) Inter-Network Fragmentation and the TCP [IEN 20] -- Shoch
9) More on Internet Fragmentation -- Shoch
10) Assigned Numbers [RFC 733] -- Postel

Attendees

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