J. Postel
ISI
17 May 1979

# Internet Meeting Notes - 8, 9, 10 & 11 May 1979

## I. INTRODUCTION TO ISI - Strazisar

Ginny welcomed us to BBN and discussed the arrangements for facilities, refreshments, and lunch.

## II. OVERVIEW AND OBJECTIVES - Cerf

Vint stated the objectives of this meeting as the development of

(1) a schedule for the implementation and installation of TCP 4,

(2) procedures for speech conferencing in the internet,

(3) a backup capability for partitioned networks.

Vint reviewed the importance of the Internet Protocol and TCP work in the development of standards for DoD internetting. IENs 80 and 81 have been made the basis of a standard to be developed for all DoD. This effort is to be managed by Dr. Robert Lyons of DCEC.

From now on the acronym for Internet Protocol is IP.

## III. STATUS REPORTS

### A. DARPA - Cerf

Vint discussed the schedule for three events which impact the internet activity:

1. The NORSAR-LONDON ARPANET line will be removed in June '79. This means all UCL and RSRE internet (and ARPANET) traffic must be carried via SATNET.

2. The Ft. Bragg Packet Radio network will be installed in August '79. This means that ISID and the TIUs at Ft. Bragg have to have TCP 4 and IP 4, and the PRNET/ARPANET gateway at Ft. Bragg must have IP 4. This also means that ISID must run to TOPS 20 release 3A.

3. The "Secure Net" experiment using BCR devices will cut over to using TCP 4 and IP 4 on 1 August '79.

Vint also mentioned that in FY80 work will begin on the implementation of a TCP TIP.

B. BBN - Strazisar, Haverty, Wingfield, Plummer, Binder, McNeill

Ginny reported on the gateway status. The current activity is the transition to minigateways. This involves moving from ELF-based to MOS-based systems. At the current time, testing is being done on 11/40 and 11/35 systems, will move to LSI-11s. The minigateway code is separated from the station code, and these can now be run on separate machines.

Jack reports that his MACRO based TCP 4 and IP 4 is in normal operation, and there is a simple FTP for his system.

Mike reports that his C-based TCP 4 and IP 4 continues in normal operation as it has since March. The UNIX TCP performance is about 12 KB when tested with a loop through the local IMP using 500 byte packets. The main delays seem to be in the UNIX I/O via pipes. The simple FTP achieves about 8 KB.

At BBN there is one (at least) UNIX system that is on RCCNET and not on the ARPANET. For this system, TCP 4 is the only way to communicate with a host on the ARPANET.

Bill reported that TCP 2.5 continues in service at SRI-KA, ISIA and ISIC, BBNC and BBNE. TCP 4 is in service on BBNB. The TOPS 20, 3A version is being tested on BBNF, and work is in progress to integrate the TCP telnet server into the monitor. One interesting note was that performance was improved when the elaborate calculation of the retransmit time is replaced by a constant retransmission time.

Dick and Dale reported on the use of a SATNET stream allocation for a replacement of the ARPANET NORSAR-LONDON line. The main point is that STREAM allocations now are operational in SATNET. This pseudo line is called "line 77". Initially, this line is allocated 75% at the capacity of the channel. With either experience or a benchmark test of the traffic pattern, it will be possible to set the allocation to a more realistic level.

C. COMSAT - Mills

David reported on the experiments in progress at COMSAT. These focus on a multi-media "terminal" called the "demo terminal" that David has put together. This is combined with experiments with the Unattended Earth Terminal (UET). The UET operated at 16 KB while the larger ground stations operate at either 16 KB or 64 KB.

David distributed a written report on COMSAT status that contains a good deal of additional information.

D. DCA - Cain

Ed described a plan to build a gateway by using two port expanders back to back. Instead, they received an additional IMP.

E. FORD - Abramovitz

Norm reported on the KSOS project, which is a secure operating system for the pdp-11. It will have a TCP written in C plus a Daemon process written in MODULA. The security code runs in kernel mode, the TCP and Daemon run in Supervisor mode. They have an IMP-11B which is a new kind of IMP interface from DEC. Norm also mentioned that a LH/DH IMP interface is available from ACC (Roland Bryan) for about $6,500. The KSOS design is near completion, and the B5 and C5 specification documents will be available through proper channels.

F. MIT - Clark

Dave reported that the LCSNET/ARPANET connection was nearly ready, but there are some minor hardware problems. The IMP to MIT-XX line works. When this is replaced with an IMP to port expander line and a port expander to MIT-XX line, it doesn't work. The LCSNET would be attached to the port expander too.

The LCSNET is currently connected to a 11/40 UNIX, 11/70 UNIX, a VAX, a 11/15, and the port expander. There is work going on to connect a TIU to the LCSNET. A "trivial" file transfer protocol (TFTP) has been implemented directly on User Datagram Protocol.

TCP 4 and IP 4 is up as a service on MIT-Multics and occasionally on MIT-XX.

The local net at UCLA using the same ring interfaces is operational with two interfaces now. Two more will be added later.

G. MITRE - Skelton

Anita reported that the cable bus has been operational for three months. There have been interface and protocol problems. The 11/70 UNIX is interfaced to the BIU with a DR11-C. This will be changed to a UMC Z-80. IEN 96 describes the cable bus, and IEN 97 describes a protocol for the cable bus environment.

H. NDRE - Lundh

Yngvar reported that the NDRE work on the internet is essentially a new program with new people. NDRE will be involved in the internet speech experiments and will be looking for other cooperative internet experiments. The NORD-10 TCP 4 and IP 4 are operational, but there are no server programs.

I. RSRE - Davies

Brian discussed the system being built and the interconnection to UCL. At RSRE, a local net called PPSN is being implemented; it will have some internet hosts. The PPSN will be connected to the TIP at UCL via a gateway, a PIXIE, and a port expander. The PIXIE is a device that uses X-25 on one side and 1822 on the other. This configuration should be operational in three months. Later, there will be interconnections between PPSN and PSS, and UCL will be connected to PSS providing alternate routes.

J. SRI - Kunzelman, Mathis

Ron discussed the Packet Radio/ARPANET interconnection at Ft. Bragg. There will be 30 to 50 users making telnet access to ISID. There will be multi-terminal TIUs connected to PRUs. There will be separate machines for the station and the PRNET/ARPANET gateway. The gateway will be connected to the Ft. Bragg TIP via a port expander. The link between the TIP and the port expander will be supported with ECUs.

Some issues in the internet program that Ron brought up are the need for dual homing and multiple gateways for alternate routing and robustness.

Jim noted that the packet radio environment is treated as an operational service, and the switch to TCP 4 will cause some trouble. Among the programs to be converted are XNET and the Loader Server.

Jim also reported that a Name Server has been implemented on the SRI-KL TOPS 20 using the Name Server and User Datagram Protocol on top of TCP 2.5. Also, a Name Query program is being developed for both the TOPS 20 and the TIU. A TIU was displayed.

There was some discussion of equipment ordered and delivery schedules. This was clarified in a subsequent session.

K. UCL - Kirstein

Peter presented several diagrams of the configuration at UCL. The desired configuration is a TIP with connection the the ARPANET (via the pseudo line 77 supported via SATNET). The TIP has three hosts, 2 pdp-9s which are front ends to big hosts, and a port expander. The port expander connects to a gateway to SATNET, a gateway (i.e., PIXIE) to PPSN, a UNIX host, a development host, and the FAX machine. This is more things than a normal port expander expects to talk to.

Peter described the interface to the FAX machine. Programs are operational to take a FAX image and put it in a Tenex file at BBN, and to take it from the file and reproduce it on the FAX machine.

Sometime in the future, there may be a "Cambridge Ring" local net at UCL with each of the things on the port expander also on the Cambridge Ring.

Peter then mentioned the experiments with the NI FTP. There are implementations at ISIE and ISIA that use NCP. There have been files exchanged between an EPSS host and Tenex with some hand-patched address fix-ups in a translation gateway at UCL.

L. XEROX - Shoch

John discussed some results of ETHERNET testing that he also presented at the local networks symposium. The main results seems to be that the ETHERNET is relatively insensitive to load; that with very high offered load, the channel utilization remains above 97%.

John also discussed some very interesting experiments in distributed computation. In particular, a "worm" program that seeks out otherwise unused hosts and takes them over to continue the computation.

John mentioned a XEROX Grants program which will result in some PARC developed equipment to be provided to three universities: MIT, CMU, and Stanford.

## IV. ACTION ITEMS

### A. Documentation Status - Postel

Jon noted that IP is documented in IEN 80, and TCP in IEN 81, and that these documents were distributed in early March. The Internet Mail Protocol is documented in IEN 85 which was distributed in early April. Then IENs 83, and 86 through 104 were distributed.

### B. Access Control - Perlman

Radia pointed out that this topic is scheduled for a discussion later in the meeting, and noted that access control is now considered part of "extended routing".

### C. Internet Speech Capability - Forgie

Jim presented his plan for experiments with internet speech in the short term. The principal thing is a special gateway which does protocol conversion. The issues are Boadcast vs Replicated messages and Central vs Distributed control. A new protocol is being developed.

### D. TCP Bakeoff Results - Postel

Jon discussed the TCP testing that took place immediately following the last internet meeting. Jon gave a quick overview of the contest rules and of the connectivity between the TCPs tested. The TCPs tested were:

| Author | System | Language |
|---|---|---|
| Wingfield | UNIX | C |
| Clark | Multics | PL/I |
| Plummer | Tenex | MACRO |
| Haverty | UNIX | MACRO |
| Mathis | MOS | MACRO |
| Braden | OS | BAL |

### E. Internet Status Report - Mathis

Jim categorized the software of the internet into four sections: (A) the gateways, (B) the host internet modules, (C) the host protocol modules, and (D) the application level programs. Category C includes TCP, SATNET measurements, LDRSRV, Cross Net Boot, XNET. Category D includes Telnet and FTP. The goal is to have everything in all categories implemented at the TCP 4 and

IP 4 level. For category A (the gateway), this is done. For category B (the host IP), this is done for most hosts and underway for TENEX/TOPS 20. For Category C (protocols), this is done for TCP, but not the collection of other services. For category D, only Telnet is done.

This means there must be an effort to convert many small programs to version 4 before we can get rid of older versions. This is true of the BCR experiment program too.

V. OPERATIONAL SATNET TRANSITION PLAN - Binder

Dick presented a picture of the SATNET and described the role of the SATNET in providing the pseudo "line 77" ARPANET line between London and SDAC. Dick discussed the host/SIMP interface. The interface between the SIMP and the minigateway is based on the VDH/RTP ARPANET interface. The performance of this interface has been poor, an early implementation achieving only 8 packets/sec. A modified interface has achieved 43 packets/sec. The changes involve altering the RTP to send the leader and data together rather than as distinct transmissions, and changing the minigateway to a MOS-based system rather than an ELF-based system.

Dick also discussed the plan to change the configuration at each ground station to include a port expander.

There is a new phase called PSP being readied for SATNET. Testing will begin at COMSAT using ETAM and Clarksburg. Then using TANUM and Clarksburg, and finally all four sites.

VI. HARDWARE ALLOCATION - Cerf

The five port expanders currently being fabricated will be allocated in the following order:

1. DCEC
2. BBN for PR minigateway development then to Ft. Bragg
3. Ft. Bragg minigateway
4. UCL minigateway to SATNET
5. BBN minigateway to SATNET

These items should be available in August.

Equipment to be ordered:

1. SRI-development equipment - large port expander with DMA and 2 high speed TIU's and 10 robustness cards
2. UCL - large port expander with DMA, 4 robustness cards, 6 DMA 1822 cards

3. COMSAT - port expander with DMA
4. BBN - large minigateway development machine, two 1822, and robustness cards
5. Ft. Bragg - 2 minigateways and 4 ECUs
6. UCL - a TIU
7. ARPA - a 16-port TIU with DMA
8. Collins - two DMA 1822 cards

Items 1 through 4 will be ordered in FY79, items 5-8 in FY80.

## VII. SUMMARY OF SMALL GROUP MEETINGS

### A. Standard Tests - Brescia

Mike reported that two types of tests seem useful: existence proofs and performance measures. Existence proofs test the basic functioning of implementation as well as the correct behavior of various features of a protocol. Things like the TCP Bakeoff are of this type. Performance measures result in reports of bit/sec throughput and the like. Both types of tests need to be conducted in a standard way.

The group recommends that a standard set of existence proof tests be documented for both TCP and IP, for both hosts and gateways.

The group recommends that performance measurements be based on common testing parameters and reported in standardized units. In particular, the following measurement conditions are recommended:

(1) small messages of 1 data octet
(2) large messages of 512 data octets

(a) internal loop back at lowest level
(b) external loop back via wire or plug
(c) external loop back via local IMP
(d) external loop back via remote echo process

All measurements of throughput should be reported in both bits/sec and messages/sec.

Delay (elapsed time) should be measured for the transmission of small messages to a remote echo process.

### B. Document Editing - Postel

Jon reported that this small group session discussed several problems with the specifications. There does not appear to be any call for changes to the protocols, rather clarification to the documents are needed.

C. Internet Services - Clark

Dave reported that the group discussed the Name Server Protocol and the proposed additions suggested by John Pickens in IEN 103.

D. Transition from TCP 2.5 to TCP 4 - Cerf

Vint summarized the discussion of this small group meeting. The main point is that there are three major activities: SATNET, PRNET, and network security. Several action items were identified:

1. The specification of XNET compatible with IP 4 is due 1 June - Strazisar, Mathis.

2. Comments on the Tenex/Tops 20 interface to IP 4 are due to Bill Plummer by 10 May.

3. Generic Internet Protocol Services Specification is due 1 July - Postel.

4. Specification of SATNET services compatible with IP 4 is due 1 September - D. McNeill.

5. A transition plan document is due 1 June - Cerf.

6. A "hack" IP 4 is to be installed at SRI-KA for loader-server debugging 15 May - Plummer, Mathis.

E. Transition from an NCP world to a TCP world

Things to be done:

1. Replace NCPs with TCPs
2. Provide translations, e.g., X.25 to/from TCP only where necessary.
3. Provide the following services on a TCP base:
   Internet Mail
   Remote Terminal Access
   File Transfer
   User Services
   such as directory information

In the intermediate time frame, we have to plan for

1. The coexistence of TCP and NCP
2. The coexistence of X.25 with PAD, and TCP with Telnet
3. Local Net Mail and Internet Mail

In the short term, we must establish an Internet service site which has installed

1. IP 4 and TCP 4
2. Telnet on TCP
3. ARPA FTP on TCP 4
4. NI FTP on TCP 4

Other issues to be addressed are:

1. Telnet remote echoing problems, examine RCTE, multiplexing, more local processing.

2. Internet performance testing.

3. Accounts on Internet service hosts.

4. Temporary internet mail provision: a simple hack is to assign every host a globally unique name. Put all these names in the Host Table of every host. This maps every host name to a 32 bit Internet Address. Then FTP on TCP can use these addresses.

5. A FTP on Unix is needed.

6. A FTP on MOS ?

7. Internet Message Service in the long term to support multi-media messages.

   It seems that there will be 3 mail systems that must co-exist:

   a. ARPANET OLD Mail - NCP Based

   b. Internet OLD Mail - TCP 4 Based

   c. Internet NEW Mail - TCP 4 and IEN 85 Based

To provide interoperability between NCP systems and TCP 4 systems, it may be necessary to provide a service host to stage the communciation. For Telnet, this would involve piggy-back use of telnet to the staging host and then telnet to the destination host. For FTP, this would be file transfer to the staging host then file transfer to the destination host.

VIII. SOURCE ROUTING - Cohen

Danny went over the Source Routing Option defined in IEN 95. The option data contains a series of internet addresses. When the address in the destination address field is reached, if the source routing option is present, the first address is copied from the source route data and placed in the destination address field replacing the previous contents of the field; the first address of the source route is then deleted.

The addresses in the source route data are points that this datagram must pass through; there may be other points the datagram passes through. This option does not provide any means to prevent a datagram from passing through a particular point.

Danny also discussed a Return Route option, which accummulates the route a datagram actually traverses.

Motivations for the source route option: to conduct experiments, to reach destinations the internet does not know about, and to route around failed gateways or partitioned networks.

IX. STREAMS AND CONFERENCING - Forgie

Jim made a presentation of a new protocol for controlling streams and conferences in the internet environment.

The goal is to create a low-level protocol to support applications, such as speech in either point-to-point or conferencing, which require controlled-delay limited throughput service.

The approach is to:

1. use local network capabilities
2. shield higher level protocols from network topology and oddities
3. use remembered state information to minimize message overhead

The basic concepts of the protocol involve:

1. Connections

   - setup prior to use
   - globally unique name
   - simplex, half-duplex, omniplex
   - allocated Resources

2. Participants (Ps)
   - end users

3. Controllers (Cs)
   - control access
   - guarantee uniqueness of name owner/controller/temp name

4. Forwarding Agents (As)
   - servers (hosts)
   - gateways
   - replicators

The routing and forwarding of messages is based on the contents of the Headers and of Agent Tables.

Headers contain:

- Connection Identifier (CID)
- Forwarding Bit Map (FBM)
- Source Identifier (SID)
- Type - stream or datagram
- Header length, data length, etc.

Agent Tables contain the following items for each possible destination:

- Filter Bit Mask (FIL) [FIL.AND.FBM =FBM ]
  IN OUT
- CID for Output
- Local Net Address for Output
- Stream ID, etc. for allocated resources

To set up a connection the following three steps must occur:

1. Creation Owner(O)->C : Create

   - C generates names O/C/X
   - O specifies requirements
   - O specifies membership limitations

   [Using some higher level protocol (DGs), O invites Ps to join connection]

2. Joining P -> C ; Join
i

- C adds P to list of active Ps (PLIST)
i
- C sends PLIST to all active Ps and As

[when 2 or more active Ps then]

3. Connection P -> P ; Connect
i j
for all j not equal i

- routes selected
- resources bound
- Gs and Rs brought in as required
- C builds lists of active As

A Connect and a Connect Reply message contain the following information:

Connect message:

- Connection Name
- Routing Bit Map (RBM)
- CID
i
- Local Net Resources already connected
- Agent List (for loop detection)

Connection Reply

- Connection Name
- Routing failure bitmask
- CID
j
- Local Net Resources Committed

There are also messages for disconnecting and leaving.

This protocol is still in the design phase.

X. IP TENEX/TOPS 20 INTERFACE - Plummer

Bill described the JSYSs he is implementing to provide access to the internet layer in Tenex/Tops 20 systems.

There are four JSYSs:

Assign Internet Queue (ASNIQ)
Release Internet Queue (RELIQ)
Send an Internet Message (SNDIN)
Receive Internet Message (RCVIN)

The ASNIQ call requires as an argument a filter to be used to select incoming datagrams to be routed to this queue.

One must have NETWIZ status to use any of these JYSs.

Bill presented a datagram of how all this software fits together.

User access to the IP protocol layer has the following features:

- permits developing internet protocols in user mode
- is network independent
- provides automatic routing - user doesn't have to decide which net to use
- user (program) doesn't have to know internet gateway addresses
- user doesn't have to worry about fragmentation and reassembly
- checksum filled in on SEND and checked on RECV
- provides logical host capability

Bill distributed a draft document on these JSYSs.

XI. FTP - Wingfield, Forsdick

Mike explained that BBN has the task of creating a file transfer protocol for AUTODIN II. In carrying out this task, they considered several FTPs, including NI FTP. This session was to be a comparison of AUTODIN II FTP and NI FTP. In preparation, people from UCL and BBN met to discuss the two protocols and then separately produced IENs 99, 100, 101, 102.

Harry presented the AUTODIN II FTP. The key features are:

1. based on the model of the copy command
2. purely FTP, no support for Mail or RJE
3. data transfer sub-protocol, could be common to other protocols
4. three party model, Controller, Donor, Recipient

To transfer a file, the control relationship between the three

parties is based on one of the Donor and Recipient being Active. The Controller has a control connection to the active party. The active party has a control connection to the passive party.

Access control is a major concern in the AUTODIN II FTP.

There are levels of implementation: core, base, extensions.

The data transfer protocol is clearly identified and is separable. It is used for all aspects of data transfer, including FTP command exchanges.

The FTP allows for partial transfers.

XII. EXTENDED ROUTING - Perlman

Radia discussed extended routing in which there are categories with distinct routing decision made on a per category basis. If this method is used, it is essential to keep the number of categories very small, i.e., less than 10.

Another routing decision for access control could be based on a key value carried in the header of datagrams. The key value would have to be obtained from an access control server.

Vint suggests that a real application is needed to drive this development.

XIII. STANDARDIZATION EFFORTS - Cerf

Vint discussed the standardization effort within DoD for internet protocols. The Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence [OASD(C3I)], has assigned DCEC to be the Executive Agent to carry out the establishment of a DoD standard for internet protocols. The IP and TCP (IENs 80 and 81) are to be used as the basis for this standard.

Another standards effort is at NBS. NBS is starting a program to do something about higher level protocols. The program seems to be a five year effort and involve analysis, specification, verification, etc.

## XIV. AGENDA FOR NEXT TIME

The next meeting is September 10-13 at University College in London. Peter Kirstein is the contact. Attendance will be limited so each organization should tell Vint who they want to send.

Agenda Items:

1. Vint - Transition Plan for moving from TCP 2.5 to TCP 4, and from NCP to TCP.

2. Kirstein - Examples of Restricted Routing

3. Davies, Kirstein - Internet Traffic Experience

4. Strazisar - How to Build a Gateway
   Plummer - How to Build a Host IP

5. Forgie - Resource Allocation and Multiaddressing Protocol

6. Cohen - Multiplexing

7. Cohen - Source Routing

8. ? - Internet Services

9. Postel - Documentation

10. BBN - Demo of GMCC

11. ? - Congestion Control

12. Kirstein - Demonstrations

## XV. DOCUMENTS DISTRIBUTED

| IEN | Author | Title |
|---|---|---|
| 83 | Kirstein | Addressing Through Port Expanders |
| 84 | Cohen | A Modern Application of Teleprocessing |
| 85 | Postel | Internet Message Protocol |
| 86 | Perlman | Extended Internet Routing |
| 87 | Perlman | Internet Flow and Congestion Control |
| 88 | Postel | User Datgram Protocol |
| 89 | Postel | Internet Name Server |
| 90 | Cohen | Multiplexing Protocol |
| 91 | Postel | Address Mappings |
| 92 | Postel | Protocol Options |
| 93 | Postel | Assigned Numbers |
| 94 | Postel | Internet Protocol Handbook - Table of Contents |
| 95 | Cohen | Source Routing |
| 96 | Skelton | The MITRE Cablenet Project |
| 97 | Holmgren | Flexible Datagram Protocol |
| 98 | Postel | TCP Implementation Status |
| 99 | Higginson | NI FTP: Summary and Assessment |
| 100 | Bennett | Comparison of the DIN FTP and the NI FTP |
| 101 | Forsdick | AUTODIN FTP Summary |
| 102 | Forsdick | Comparison of AUTODIN FTP with NI FTP |
| 103 | Pickens | An Experimental Network Information Center Name Server (NICNAME) |
| 104 | Strazisar | Minutes of the Fault Isolation Meeting |
| --- | Cohen | Oceanview Tales |
| --- | Plummer | Internet User Queues |
| --- | Mills | COMSAT Status Report |

## XVI. ATTENDEES

| | | |
|---|---|---|
| Dick Binder | BBN | BINDER@BBNE |
| Mike Brescia | BBN | BRESCIA@BBNE |
| Jack Haverty | BBN | JHAVERTY@BBND |
| Dale McNeill | BBN | DMCNEILL@BBNE |
| David Flood Page | BBN | DFLOODPAGE@BBNE |
| Radia Perlman | BBN | PERLMAN@BBNA |
| William W. Plummer | BBN | PLUMMER@BBNA |
| Virginia Strazisar | BBN | STRAZISAR@BBNA |
| Mike Wingfield | BBN | WINGFIELD@BBND |
| David L. Mills | COMSAT | MILLS@ISIE |
| Vint Cerf | DARPA | CERF@ISIA |
| Ed Cain | DCEC | CAIN@EDN-UNIX |
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| Jon Postel | ISI | POSTEL@ISIB |
| Jim Forgie | MIT/LL | FORGIE@BBN |
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| Yngvar Lundh | NDRE | YNGVAR@SRI-KA |
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| Andrew Bates | RSRE | RSRE-T4@ISIA |
| Brain Davies | RSRE | RSRE-T4@ISIA |
| Ron Kunzelman | SRI | KUNZELMAN@ISIE |
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| Ron Jones | UCL | UKSAT@ISIE |
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