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DATA LINK PROCESSOR ON PC

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DATA LINK PROCESSOR ON PC

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Abstract :

A Mode-S Data Link Processor developed on a PC using PASCAL and a Real Time Operating System.

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DATA LINK PROCESSOR ON PC

by

Patrick HUNT

Summary

A Mode-S Data Link Processor developed on a PC using PASCAL and a Real Time Operating System.

C O N T E N T S

1. GENERAL

Earlier this year, it was required to build a DLP (Data Link Processor) for a differential GPS/Mode-S application (See Technical Note No. 01/95 by P. HUNT/L. CROUZARD).

For this application, a Real Time Operating System based on and for PASCAL applications was purchased.

It soon became apparent that this system offered many possibilities for Mode-S application development that had been previously difficult to implement using a PC with MS-DOS due to the lack of a multitasking real time environment.

As the processing logic and interfaces have been developed for this application, it is quite simple to modify the application software for other experiments.

This note describes a DLP developed for monitoring and testing Mode-S protocols with the THOMSON radar at Orly.

2. HARDWARE DESCRIPTION

The following hardware is required for the DLP :

a) A PC, preferably 486, with at least 1 I/O slot. A ruggedised PC is recommended for airborne applications

b) An ARINC 718 interface card (EUROCONTROL M254 - EEC note No. 17/94). Shares dual ported memory with the PC.

See ***Figure No. 1.***

3. SOFTWARE REQUIREMENTS

The real time system running on the PC is from ON-TIME GmbH, Hamburg, called ,Real Time Kernel 4.0 which exists in two versions C++ or PASCAL. The PASCAL version was used for this application which also written in PASCAL.

On the ARINC card, an assembler program written in INTEL 86 language controls the Transponder/DLP interface over the ARINC 718 lines. This interface may be a single channel or dual channel version depending on the type of transponder used.

This programme is downloaded via the PC and can be considered as a front end processor which takes the load off the PC as far as the ARINC 718 processing is concerned.

3.1. Software Description

A detailed software description is not given here. The source programme in well commented PASCAL is available on request.

See ***Figure No. 2.***

4. TRANSPONDER / DLPU Messages

Uplink messages from the transponder are transferred to the PC via interrupt from the front end processor.

Downlink messages to the transponder are sent with a polling method to the front end processor.

These messages are available in the dual ported memory of the PC.

5. UPLINK PROCESSING

Uplink messages are displayed on the PC screen in real time. These messages are decoded into clear Mode-S text with all Mode-S fields displayed. DLP coded data may optionally be displayed via the control screen commands. Both 6 bit coded messages and phrase coded messages are displayed (NLR DLPU C2 coding).

The following uplink messages are displayed and the total message counts for each type of messages are also displayed in a separate window.

Close-out Messages	Comm-B & Comm-D
Surveillance Messages	UF4, UF5
Comm-A Messages	UF20, UF21, Single, Linked & Broadcast
Comm-C Messages	UF24, Two to sixteen segments

6. DOWNLINK PROCESSING

The DLP can send all types of downlink messages using the application's control window.

These are :

Cancel Messages,	Comm-B / Comm-D
Comm-B Messages	Single, linked or broadcast
Comm-D Messages	Two to sixteen segments

The messages sent downlink are displayed in the Downlink window in clear text and the downlink message counts for each type of message are displayed.

The DLP also sends downlink GICB messages to the transponder. This is a standard set of parameters of which the GMT parameter is dynamic and taken from the PC's timer.

GICB messages may be inhibited from the control window.

7. CONTROL WINDOW

With the control window, on-line real time commands may be sent to the application.

This window is menu driven and self evident in use .

One can control the following processes :

a) Send downlink messages,

b) Enable/Disable GICB messages,

c) Enable/Disable on-line time dated recording on hard disk,

d) Enable/Disable DLPU C2 message decoding,

e) Reset message counts,

f) Stop application.

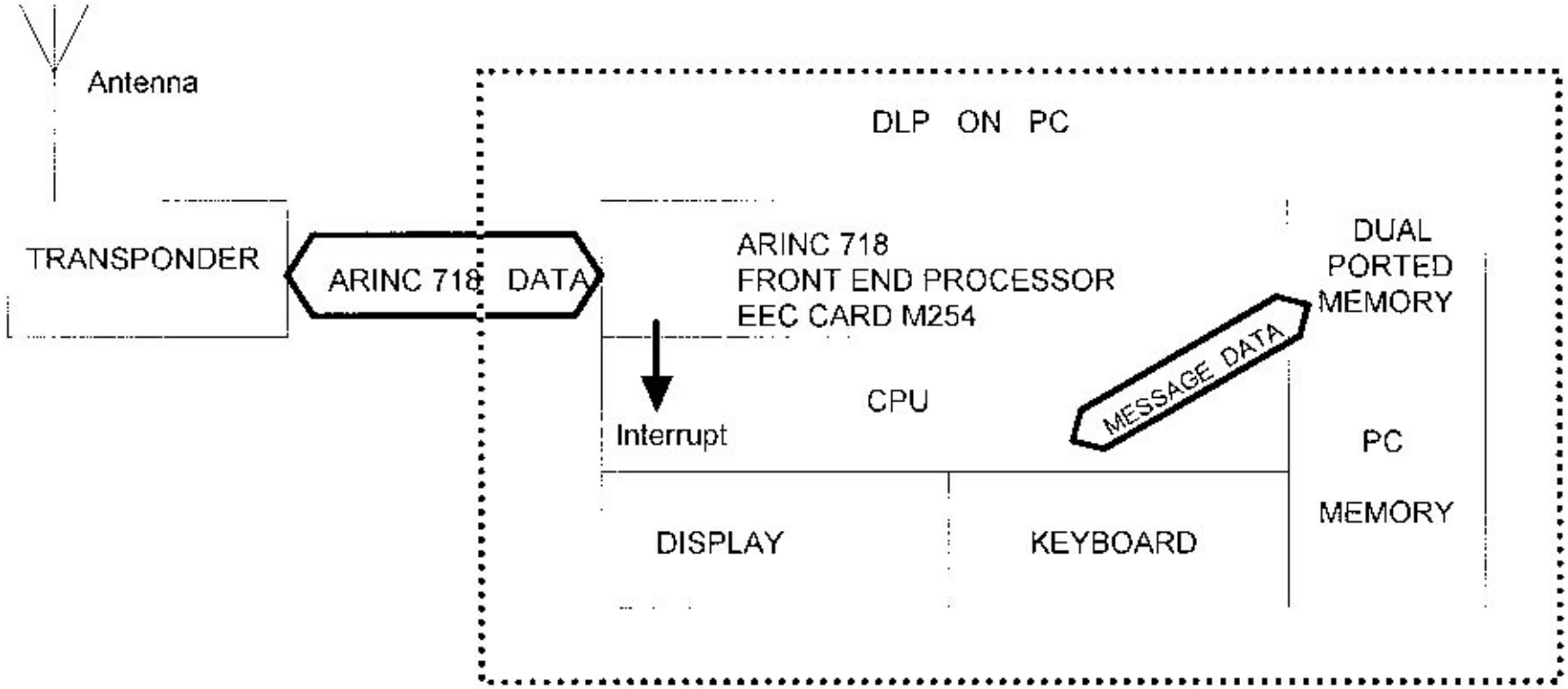
The PC time and CPU % occupation are also displayed on the screen.

See ***Figures Nos. 3 & 4*** for examples of the PC screen and ***Figures Nos. 5 & 6*** for examples of on-line recording

8. CONCLUSION

The Data Link Processor on PC has proved to be a very useful tool when investigating Mode-S protocol problems with the Orly radar or when monitoring or recording transponder/DLP activity.

The executable application programme is available for free distribution. A licence must however be obtained from ON-TIME GmbH if further development or modification is to be made to the application.



HARDWARE SCHEMATIC

Figure No. 1

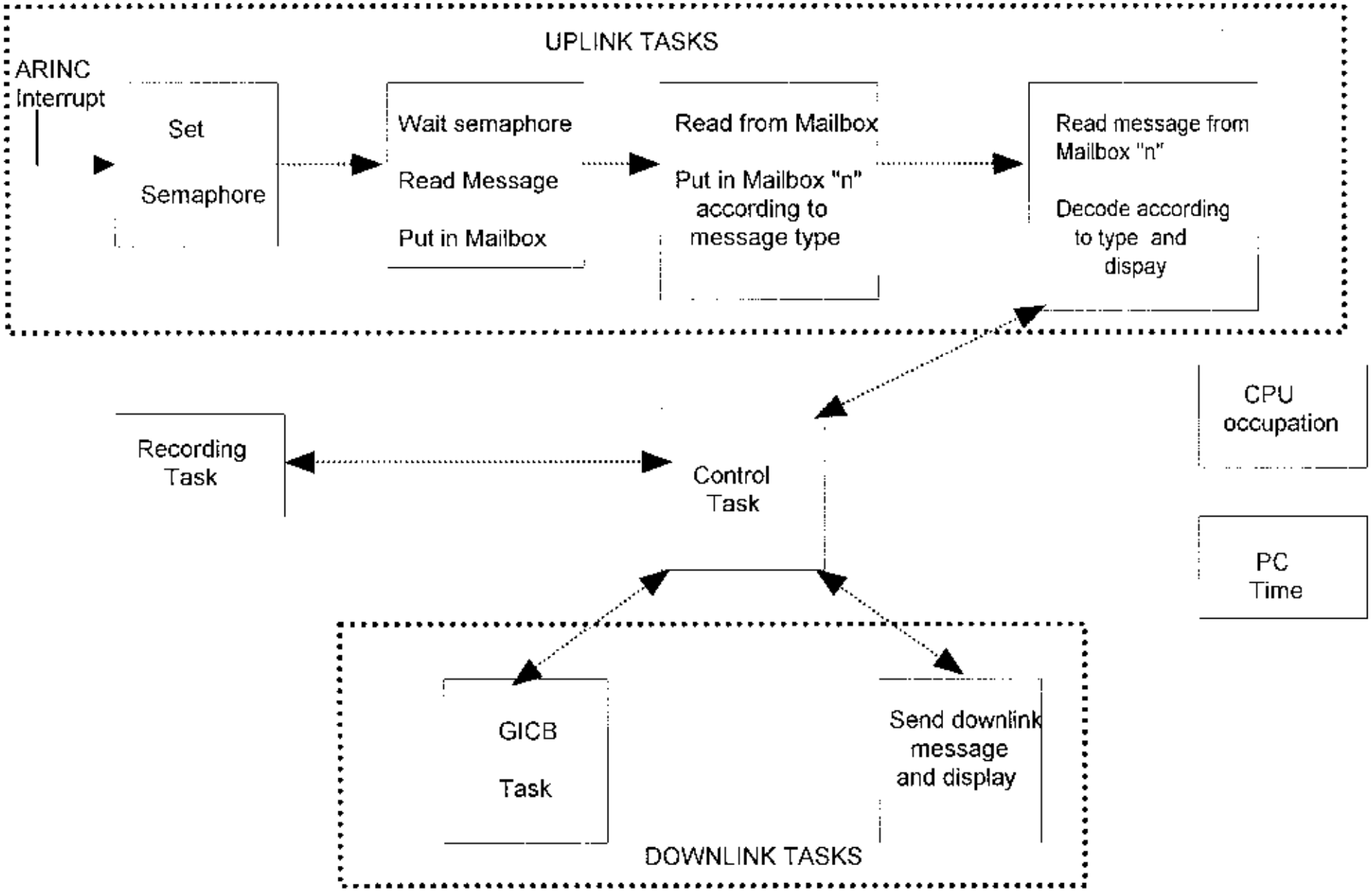
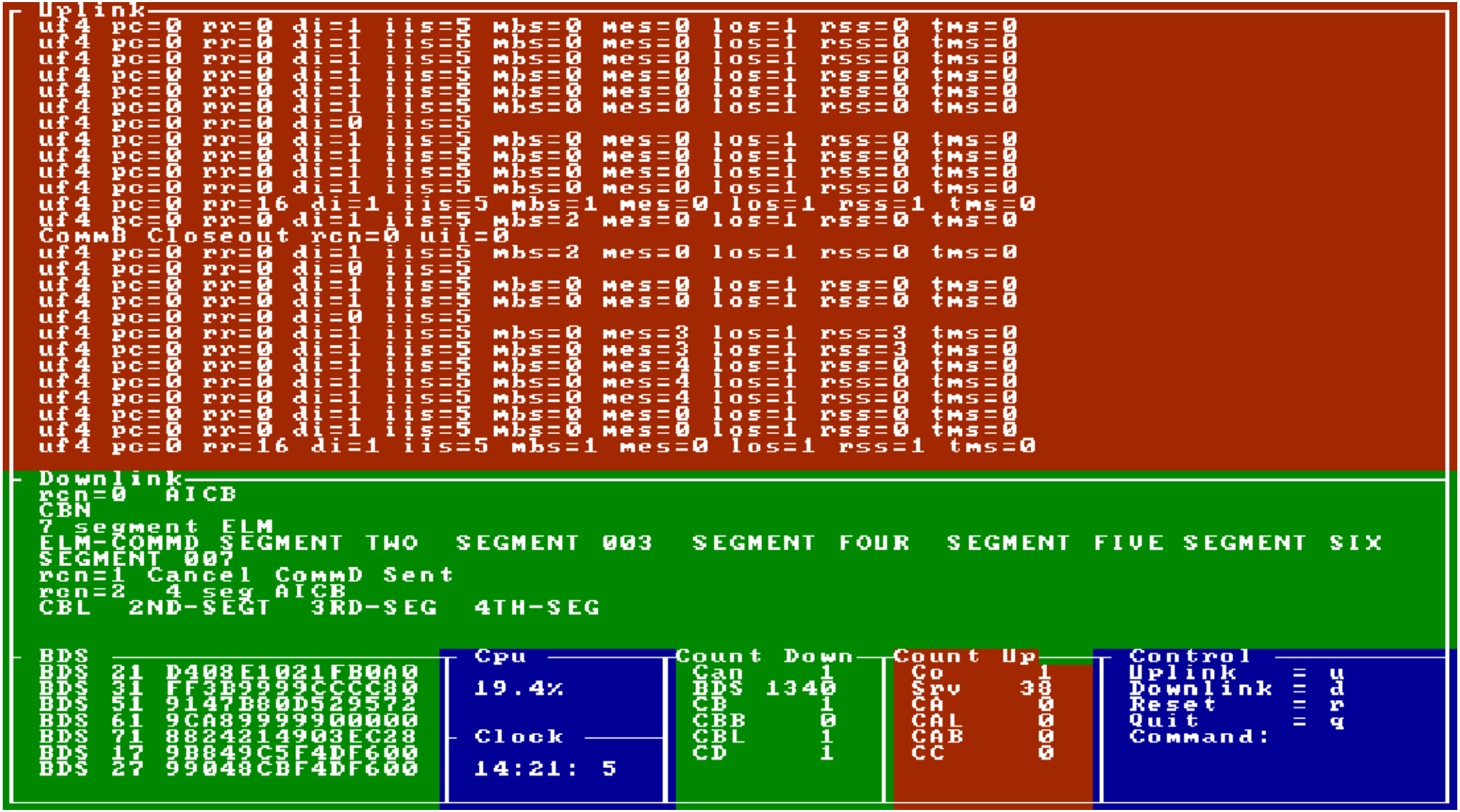
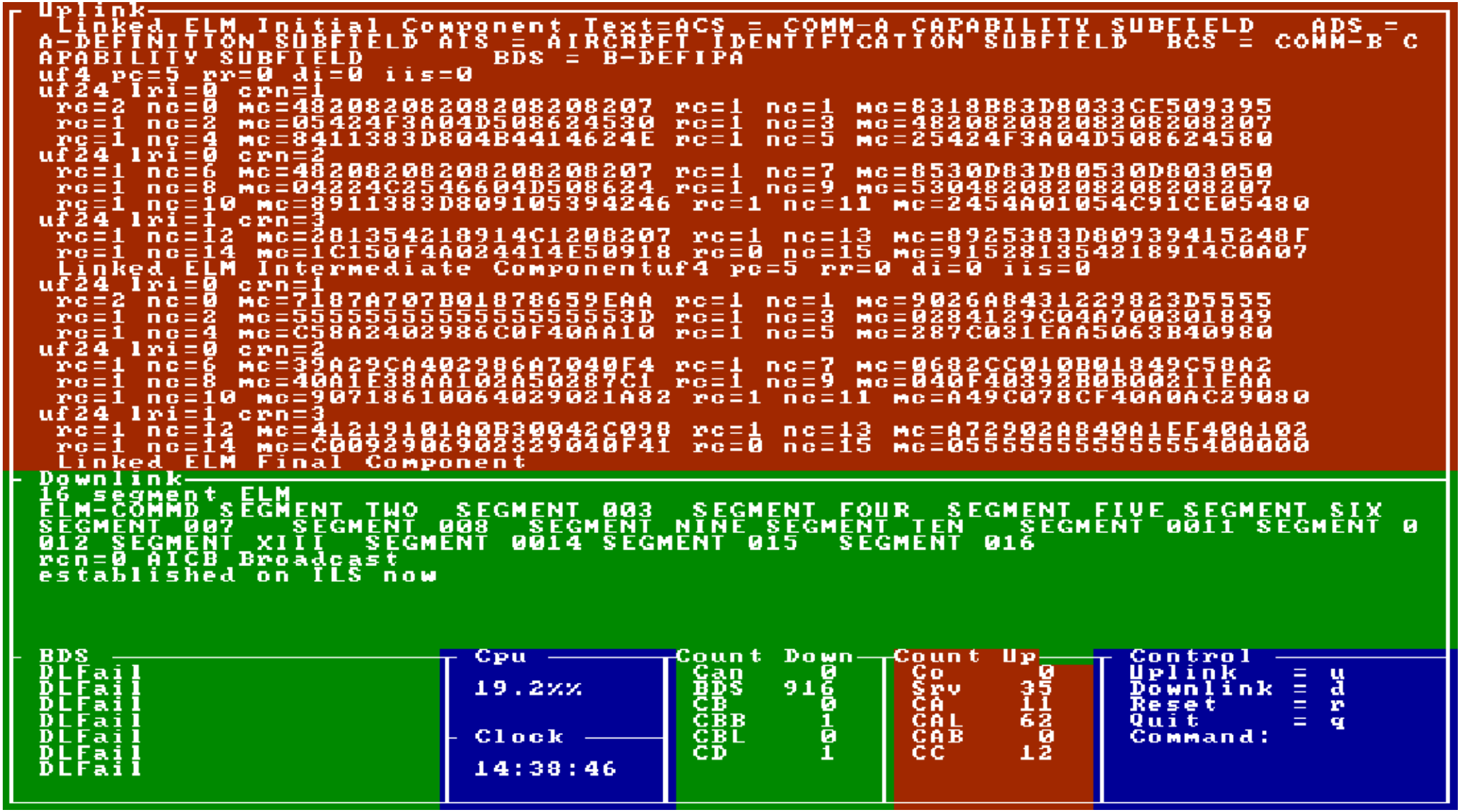


Figure No. 2

SOFTWARE SCHEMATIC SHOWING MAIN TASKS


Uplink
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=0 iis=5
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=16 di=1 iis=5 mbs=1 mes=0 los=1 rss=1 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=2 mes=0 los=1 rss=0 tms=0
CommB Closeout rcn=0 uii=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=2 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=0 iis=5
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=0 iis=5
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=3 los=1 rss=3 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=3 los=1 rss=3 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=4 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=4 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=4 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=0 di=1 iis=5 mbs=0 mes=0 los=1 rss=0 tms=0
uf4 pc=0 rr=16 di=1 iis=5 mbs=1 mes=0 los=1 rss=1 tms=0
Downlink
rcn=0 AICB
CBN
7 segment ELM
ELM-COMMD SEGMENT TWO SEGMENT 003 SEGMENT FOUR SEGMENT FIVE SEGMENT SIX
SEGMENT 007
rcn=1 Cancel CommD Sent
rcn=2 4 seg AICB
CBL 2ND-SEGT 3RD-SEG 4TH-SEG
BDS
BDS 21 D408E1021FB0A0
BDS 31 FF3B9999CCCC80
BDS 51 9147B80D529572
BDS 61 9CA899999900000
BDS 71 882421490 3EC28
BDS 17 9B849C5F4DF600
BDS 27 99048CBF4DF600
Cpu
19.4%
Clock
14:21: 5
Count Down
Can 1
BDS 1340
CB 1
CBB 0
CBL 1
CD 1
Count Up
Co 1
Srv 38
CA 0
CAL 0
CAB 0
CC 0
Control
Uplink = u
Downlink = d
Reset = r
Quit = q
Command:


Uplink
Linked ELM Initial Component Text=ACS = COMM-A CAPABILITY SUBFIELD ADS =
A-DEFINITION SUBFIELD AIS = AIRCRPFT IDENTIFICATION SUBFIELD BCS = COMM-B C
APABILITY SUBFIELD BDS = B-DEFIPA
uf4 pc=5 rr=0 di=0 iis=0
uf24 lri=0 crn=1
rc=2 nc=0 mc=48208208208208208207 rc=1 nc=1 mc=8318B83D8033CE509395
rc=1 nc=2 mc=05424F3A04D508624530 rc=1 nc=3 mc=48208208208208208207
rc=1 nc=4 mc=8411383D804B4414624E rc=1 nc=5 mc=25424F3A04D508624580
uf24 lri=0 crn=2
rc=1 nc=6 mc=48208208208208208207 rc=1 nc=7 mc=8530D83D80530D803050
rc=1 nc=8 mc=04224C2546604D508624 rc=1 nc=9 mc=530482082082082082207
rc=1 nc=10 mc=8911383D80910539424 6 rc=1 nc=11 mc=2454A01054C91CE05480
uf24 lri=1 crn=3
rc=1 nc=12 mc=281354218914C1208207 rc=1 nc=13 mc=8925383D809394152 48F
rc=1 nc=14 mc=1C150F4A024414E50918 rc=0 nc=15 mc=9152813542189 14C0A07
Linked ELM Intermediate Componentuf4 pc=5 rr=0 di=0 iis=0
uf24 lri=0 crn=1
rc=2 nc=0 mc=7187A707B01878659EAA rc=1 nc=1 mc=9026A8431229823D5555
rc=1 nc=2 mc=55555555555555553D rc=1 nc=3 mc=0284129C04A700301849
rc=1 nc=4 mc=C58A2402986C0F40AA10 rc=1 nc=5 mc=287C031EAA5063B40980
uf24 lri=0 crn=2
rc=1 nc=6 mc=39A29CA402986A7040F4 rc=1 nc=7 mc=0682CC010B01849C58A2
rc=1 nc=8 mc=40A1E38AA102A50287C1 rc=1 nc=9 mc=040F40392B0B00211EAA
rc=1 nc=10 mc=907186100640290 21A82 rc=1 nc=11 mc=A49C078CF40A0AC29080
uf24 lri=1 crn=3
rc=1 nc=12 mc=4121910 1A0B30042C098 rc=1 nc=13 mc=A72902A840A1EF40A102
rc=1 nc=14 mc=C0092906902329040F41 rc=0 nc=15 mc=0555555555555400000
Linked ELM Final Component
Downlink
16 segment ELM
ELM-COMMD SEGMENT TWO SEGMENT 003 SEGMENT FOUR SEGMENT FIVE SEGMENT SIX
SEGMENT 007 SEGMENT 008 SEGMENT NINE SEGMENT TEN SEGMENT 0011 SEGMENT 0
012 SEGMENT XIII SEGMENT 0014 SEGMENT 015 SEGMENT 016
rcn=0 AICB Broadcast
established on ILS now
BDS
DLFail
DLFail
DLFail
DLFail
DLFail
DLFail
DLFail
Cpu
19.2%%
Clock
14:38:46
Count Down
Can 0
BDS 916
CB 0
CBB 1
CBL 0
CD 1
Count Up
Co 0
Srv 35
CA 11
CAL 62
CAB 0
CC 12
Control
Uplink = u
Downlink = d
Reset = r
Quit = q
Command:

Path: C:\TP\DLP
File: EX1.DAT 2,012 .a..27-10-94 15:04:42 Page 1

```
 9:45:26 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:26 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:26 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:26 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:26 uf4 pc=0 rr=22 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:35 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:35 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:35 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:35 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:35 uf4 pc=0 rr=22 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:35 uf4 pc=0 rr=27 di=0 iis=5
 9:45:36 rcn=1  3 seg AICB
CBL  2ND-SEGT  3RD-SEG
 9:45:44 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:44 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:44 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:44 uf4 pc=0 rr=22 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:44 uf4 pc=0 rr=27 di=0 iis=5
 9:45:44 uf4 pc=0 rr=21 di=7 iis=5 rrs=2 los=1 tms=0
 9:45:53 uf4 pc=0 rr=16 di=1 iis=5 mbs=1 mes=0 los=1 rss=1 tms=0
 9:45:53 uf4 pc=0 rr=16 di=1 iis=5 mbs=1 mes=0 los=1 rss=1 tms=0
 9:45:53 uf4 pc=0 rr=16 di=1 iis=5 mbs=1 mes=0 los=1 rss=1 tms=0
 9:45:53 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:53 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:53 uf4 pc=0 rr=22 di=7 iis=5 rrs=1 los=1 tms=0
 9:45:53 uf4 pc=0 rr=27 di=1 iis=5 mbs=2 mes=0 los=1 rss=0 tms=0
 9:45:53 CommB Closeout rcn=1 uii=0
 9:46: 2 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:46: 2 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
 9:46: 2 uf4 pc=0 rr=23 di=7 iis=5 rrs=1 los=1 tms=0
```

Example of On-line recording File
Radar Surveillance with BDS extraction Figure 5

@

```
        Path: C:\TP\DLP
        File: EX2.DAT   3,723 .a.. 27-10-94  15:17:52   Page 1

          14:23:51 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=0 los=1 rss=0 tms=0
          14:23:51 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=0 los=1 rss=0 tms=0
          14:23:51 uf4 pc=0 rr=26 di=0 iis=6
          14:23:51 uf4 pc=0 rr=20 di=7 iis=6 rrs=7 los=1 tms=0
          14:23:51 uf4 pc=0 rr=20 di=7 iis=6 rrs=7 los=1 tms=0
          14:23:59 16 segment ELM                                  { CommD sen
t by DLP in clear Text}
          ELM-COMMD SEGMENT TWO  SEGMENT 003  SEGMENT FOUR  SEGMENT FIVE SEGM
ENT SIX  SEGMENT 007   SEGMENT 008  S
          EGMENT NINE SEGMENT TEN   SEGMENT 0011 SEGMENT 0012 SEGMENT XIII  S
EGMENT 0014 SEGMENT 015  SEGMENT 016
          14:23:59 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=0 los=1 rss=0 tms=0
          14:23:59 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=0 los=1 rss=0 tms=0
          14:23:59 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=0 los=1 rss=0 tms=0
          14:23:59 uf4 pc=0 rr=26 di=0 iis=6
          14:23:59 uf4 pc=0 rr=20 di=7 iis=6 rrs=7 los=1 tms=0
          14:23:59 uf4 pc=0 rr=20 di=7 iis=6 rrs=7 los=1 tms=0
          14:24: 8 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=3 los=1 rss=3 tms=0
          14:24: 8 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=3 los=1 rss=3 tms=0
          14:24:16 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=4 los=1 rss=0 tms=0
          14:24:16 CommD Closeout rcn=0 uii=6                          {
 Close-out from radar }
          14:24:16 uf4 pc=0 rr=28 di=1 iis=6 mbs=0 mes=4 los=1 rss=0 tms=0
          14:24:16 uf4 pc=0 rr=26 di=0 iis=6
          14:24:16 uf4 pc=0 rr=20 di=7 iis=6 rrs=7 los=1 tms=0
          14:24:16 uf4 pc=0 rr=20 di=7 iis=6 rrs=7 los=1 tms=0

          14:58:40 uf4 pc=5 rr=0 di=0 iis=0
          14:58:41 uf21 pc0 rr0 di7 iis=0 rrs=0 los=0 tms=1 ma=8822008E79E240
     { CommA linked }
          apn=1 gpn=1 cid=1
     { Data Link fields }
          14:58:43 uf21 pc0 rr0 di7 iis=0 rrs=0 los=0 tms=2 ma=69E91C49C3C008
          14:58:44 uf21 pc0 rr0 di7 iis=0 rrs=0 los=0 tms=6 ma=D9E58000000000
           Text=GOOD MORNING AF320
     { Decoded Message }
          14:58:45 uf21 pc0 rr0 di7 iis=0 rrs=0 los=0 tms=1 ma=882200A840A90A
          apn=1 gpn=1 cid=1
          14:58:45 uf21 pc0 rr0 di7 iis=0 rrs=0 los=0 tms=5 ma=00000000000000
           Text=THERE
          14:58:45 uf21 pc0 rr0 di7 iis=0 rrs=0 los=0 tms=0 ma=88220100336000
          apn=1 gpn=1 cid=2
          turn to heading ... degrees
          14:58:45 uf24 lri=0 crn=1
 {16 segment CommC from radar}
           rc=2 nc=0 mc=82088020869C1EC019E6 rc=1 nc=1 mc=9B6830060A00844984A
8
           rc=1 nc=2 mc=CC09AA10C48A609040F0 rc=1 nc=3 mc=222707B00368828C49C
4
           rc=1 nc=4 mc=A849E7409AA10C48A608 rc=1 nc=5 mc=F024A707B0024A41A48
0
          14:58:45 uf24 lri=0 crn=2
           rc=1 nc=6 mc=CA4048829CA12312182A rc=1 nc=7 mc=1279D026A8431229824
0
           rc=1 nc=8 mc=F041A707B00679A6DA14 rc=1 nc=9 mc=0182802112612A33026
A
           rc=1 nc=10 mc=8431229824104104103C rc=1 nc=11 mc=1089C1EC015A20A31
280
          14:58:45 uf24 lri=1 crn=3
           rc=1 nc=12 mc=2A1279D026A843122982 rc=1 nc=13 mc=41041041041041041
03C
           rc=1 nc=14 mc=1889C1EC01DA20A31271 rc=0 nc=15 mc=2A1279D026A843122
982
          ACS = COMM-A CAPABILITY SUBFIELD   ADS = A-DEFINITION SUBFIELD AIS
=   { decoded in clear text }
          AIRCRAFT IDENTIFICATION SUBFIELD   BCS = COMM-B CAPABILITY SUBFIELD
          14:59: 1 uf4 pc=5 rr=0 di=0 iis=0

                          EXAMPLE OF ON-LINE RECORDING FILE
                          Showing Data Link Activity               Figure 6
@
```