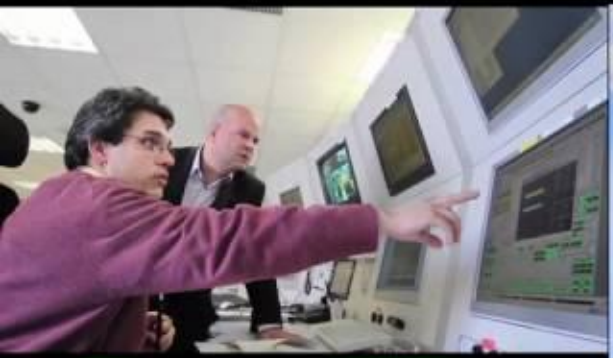


esa

1
00:00:00,000 --> 00:00:20,244
Sound of communications traffic and music.

2
00:00:20,279 --> 00:00:21,956
Spaceflight missions of the future …

3
00:00:21,991 --> 00:00:24,756
will be collaborative ventures of many

4
00:00:24,791 --> 00:00:27,492
nations. But with technology changing

5
00:00:27,527 --> 00:00:30,117
rapidly, how can space agencies ensure

6
00:00:30,152 --> 00:00:32,645
that their data and communications

7
00:00:32,680 --> 00:00:34,661
systems will work together… to even

8
00:00:34,696 --> 00:00:37,204
allow international spaceflight missions?

9
00:00:37,239 --> 00:00:39,892
As technology evolves, our missions and

10
00:00:39,927 --> 00:00:41,652
international agreements need to evolve

11
00:00:41,687 --> 00:00:44,453
too. It’s a challenge, but necessary for

12
00:00:44,488 --> 00:00:47,461
us to work together. Looking back, who

13
00:00:47,496 --> 00:00:49,541

would have foreseen all the consequences

14
00:00:49,576 --> 00:00:51,877
of international air travel or the

15
00:00:51,912 --> 00:00:54,916
internet availability across the globe?

16
00:00:54,951 --> 00:00:56,596
Similarly, the “Space Race” has yielded

17
00:00:56,631 --> 00:00:59,125
untold benefits to mankind including the

18
00:00:59,160 --> 00:01:01,828
seeds of cooperation between nations in

19
00:01:01,863 --> 00:01:08,725
space. Early international science

20
00:01:08,760 --> 00:01:10,852
missions in the 1960’s were followed by

21
00:01:10,887 --> 00:01:13,092
joint manned missions with the Soviet

22
00:01:13,127 --> 00:01:16,229
Union and later Russia from the 1970’s

23
00:01:16,264 --> 00:01:18,596
to the present. These set the stage for

24
00:01:18,631 --> 00:01:21,988
the possibilities to come.Those early

25
00:01:22,023 --> 00:01:23,765
missions proved that there are great

26
00:01:23,800 --> 00:01:26,278
benefits to cooperation, and to

27
00:01:26,313 --> 00:01:29,445
international standardization!

28
00:01:29,480 --> 00:01:32,196
That is where CCSDS or the Consultative

29
00:01:32,231 --> 00:01:35,572
Committee for Space Data Systems comes in.

30
00:01:35,607 --> 00:01:37,925
This international consortium capitalizes

31
00:01:37,960 --> 00:01:40,421
on new technology and moves it rapidly

32
00:01:40,456 --> 00:01:43,589
to an international standard.

33
00:01:43,624 --> 00:01:45,285
Today we enjoy the benefits of an

34
00:01:45,320 --> 00:01:46,965
international internet with rarely a

35
00:01:47,000 --> 00:01:49,156
thought about the speed and complex

36
00:01:49,191 --> 00:01:51,188
routing that allows us to take it for

37
00:01:51,223 --> 00:01:52,997
granted. But for the internet to work

38
00:01:53,032 --> 00:01:55,268

globally, many nations had to accept

39
00:01:55,303 --> 00:01:59,205
one set of communications standards.

40
00:01:59,240 --> 00:02:01,333
Just as our home computers are becoming

41
00:02:01,368 --> 00:02:03,477
more plug-n-play because of better

42
00:02:03,512 --> 00:02:07,220
terrestrial standards… CCSDS aims for

43
00:02:07,255 --> 00:02:09,557
those same kinds of improvements in

44
00:02:09,592 --> 00:02:11,925
“space” communications and data systems;

45
00:02:11,960 --> 00:02:15,157
establishing agreements similar to those

46
00:02:15,192 --> 00:02:17,701
that founded the global internet.

47
00:02:17,736 --> 00:02:19,861
As humans have pushed back the space

48
00:02:19,896 --> 00:02:21,589
frontier with a permanent international

49
00:02:21,624 --> 00:02:24,212
presence in low earth orbit, we’ve

50
00:02:24,247 --> 00:02:27,060
adapted that internet technology for space,

51
00:02:27,095 --> 00:02:30,324
and we’re expanding the International Space

52
00:02:30,359 --> 00:02:32,532
Station’s role as a test bed for more

53
00:02:32,567 --> 00:02:34,949
advanced internet technology.But what

54
00:02:34,984 --> 00:02:38,373
happens as we routinely expand both robotic

55
00:02:38,408 --> 00:02:41,236
and human exploration beyond a near Earth

56
00:02:41,271 --> 00:02:44,260
orbit? New challenges and opportunities

57
00:02:44,295 --> 00:02:46,964
emerge in an environment where data

58
00:02:46,999 --> 00:02:49,797
transmission takes seconds, several minutes,

59
00:02:49,832 --> 00:02:55,285
or even longer. One of the key CCSDS efforts

60
00:02:55,320 --> 00:02:57,765
that will lay the groundwork for future

61
00:02:57,800 --> 00:03:00,644
international space missions is Delay or

62
00:03:00,679 --> 00:03:04,116
Disruption Tolerant Networking or DTN.

63
00:03:04,151 --> 00:03:06,980

DTN pushes the boundary of internet

64
00:03:07,015 --> 00:03:10,501
communications into space! This will adapt

65
00:03:10,536 --> 00:03:12,901
internet systems to become tolerant of the

66
00:03:12,936 --> 00:03:16,389
deep space environment and provide automatic

67
00:03:16,424 --> 00:03:19,092
network routing. The routing of data from

68
00:03:19,127 --> 00:03:22,164
Earth, for example, to a robotic lander on Mars,

69
00:03:22,199 --> 00:03:25,460
currently relies on a disruption prone series

70
00:03:25,495 --> 00:03:27,477
of paths that are vulnerable to a variety of

71
00:03:27,512 --> 00:03:30,597
single point failures. Commands must be routed

72
00:03:30,632 --> 00:03:32,948
through a series of communication nodes; then

73
00:03:32,983 --> 00:03:37,013
on to Mars, only when every node is available.

74
00:03:37,048 --> 00:03:40,772
Now imagine a human mission endangered because

75
00:03:40,807 --> 00:03:42,615
a communication link is lost. Critical life-

76
00:03:42,650 --> 00:03:47,221
saving time or priceless data could be lost

77
00:03:47,256 --> 00:03:50,772
because of an inability to buffer and reassemble

78
00:03:50,807 --> 00:03:53,828
that communication. Unlike the terrestrial

79
00:03:53,863 --> 00:03:56,804
internet, space is not a richly connected

80
00:03:56,839 --> 00:04:00,021
environment. A Delay and Disruption Tolerant

81
00:04:00,056 --> 00:04:02,821
Network will be required to ensure both faster

82
00:04:02,856 --> 00:04:05,668
and more reliable transfer. To remedy this

83
00:04:05,703 --> 00:04:08,596
situation “bundles” of data will need to be

84
00:04:08,631 --> 00:04:10,981
stored and forwarded automatically to the

85
00:04:11,016 --> 00:04:13,381
next available link in the communications

86
00:04:13,416 --> 00:04:17,157
chain. To smoothly transition to the future

87
00:04:17,192 --> 00:04:20,453
communications environment, some very obvious

88
00:04:20,488 --> 00:04:24,340

steps need to be taken. Moving from lag time

89
00:04:24,375 --> 00:04:26,980
or “latency” of a few seconds near Earth to as

90
00:04:27,015 --> 00:04:29,796
much as 40 minutes, round trip to Mars, will

91
00:04:29,831 --> 00:04:32,757
require a blended approach that more reliably

92
00:04:32,792 --> 00:04:36,709
integrates terrestrial and space-based networks.

93
00:04:36,744 --> 00:04:38,997
The new Space Internetworking environment will

94
00:04:39,032 --> 00:04:41,989
integrate traditional spacecraft data types;

95
00:04:42,024 --> 00:04:45,844
command, telemetry, voice, video… plus new data

96
00:04:45,879 --> 00:04:49,956
types like message bus technology and web

97
00:04:49,991 --> 00:04:52,485
browsing in an autonomous and standardized

98
00:04:52,520 --> 00:04:55,317
architecture. A Solar System Internet will

99
00:04:55,352 --> 00:04:57,942
provide highly efficient communications that

100
00:04:57,977 --> 00:05:00,788
integrate DTN and internet technologies for

101
00:05:00,823 --> 00:05:05,252
the benefit of international space missions.

102
00:05:05,287 --> 00:05:08,517
CCSDS is also working in other areas bringing

103
00:05:08,552 --> 00:05:10,485
together technology development and

104
00:05:10,520 --> 00:05:13,493
standardization. They envision that Mission

105
00:05:13,528 --> 00:05:15,926
Operations will benefit from using service

106
00:05:15,961 --> 00:05:19,940
oriented architecture. Standardized “service

107
00:05:19,975 --> 00:05:23,748
interfaces” allow interoperability between

108
00:05:23,783 --> 00:05:25,861
Mission Control Centers and between the

109
00:05:25,896 --> 00:05:29,253
spacecraft and ground systems! Mission Operations

110
00:05:29,288 --> 00:05:32,389
standardization means that Mission Control Centers

111
00:05:32,424 --> 00:05:35,444
become service providers to other operations teams

112
00:05:35,479 --> 00:05:38,436
and potentially even their spacecraft can become

113
00:05:38,471 --> 00:05:41,732

service providers. External institutions can use

114
00:05:41,767 --> 00:05:44,757
the same service to interface with equipment or

115
00:05:44,792 --> 00:05:47,829
experiments on spacecraft or rovers! Everyone

116
00:05:47,864 --> 00:05:51,460
benefits from using standard service interfaces

117
00:05:51,495 --> 00:05:54,901
rather than requiring custom interfaces.

118
00:05:54,936 --> 00:05:59,236
Connecting to Mission control… a spacecraft…

119
00:05:59,271 --> 00:06:03,270
an experiment becomes easier and less expensive!

120
00:06:03,305 --> 00:06:06,517
This is just a small sample of the work done up

121
00:06:06,552 --> 00:06:10,021
to now; by these and other CCSCS teams. There is

122
00:06:10,056 --> 00:06:13,636
much work ahead. The goal of collaboration

123
00:06:13,671 --> 00:06:16,789
between agencies and nations is challenging.

124
00:06:16,824 --> 00:06:19,765
The task of keeping up with ever-changing

125
00:06:19,800 --> 00:06:21,797
technology is difficult, but the rewards are

126
00:06:21,832 --> 00:06:27,285
worth the efforts. CCSDS efforts will allow

127
00:06:27,320 --> 00:06:30,708
international cooperation and standardization

128
00:06:30,743 --> 00:06:33,604
to extend to all aspects of the space-to-ground

129
00:06:33,639 --> 00:06:36,452
communications and mission architecture; from

130
00:06:36,487 --> 00:06:38,933
cooperating control centers, through cross-

131
00:06:38,968 --> 00:06:41,109
supporting communication systems, to multi-agency

132
00:06:41,144 --> 00:06:44,725
mission spacecraft. Investing in a reliable

133
00:06:44,760 --> 00:06:49,060
and efficient space data and communication system

134
00:06:49,095 --> 00:06:53,076
capitalizes on new technology systems and techniques

135
00:06:53,111 --> 00:06:55,893
will pay cost and safety dividends for generations

136
00:06:55,928 --> 00:06:59,909
to come. In essence, we can’t afford not

137
00:06:59,944 --> 00:07:03,573
to make these investments. We owe it to ourselves

138
00:07:03,608 --> 00:07:06,628

and following generations to lay the groundwork

139
00:07:06,663 --> 00:07:09,636
today for a communications and control system;

140
00:07:09,671 --> 00:07:12,469
a Solar System Internetwork that will deliver

141
00:07:12,504 --> 00:07:15,573
the dream of extending human reach wherever