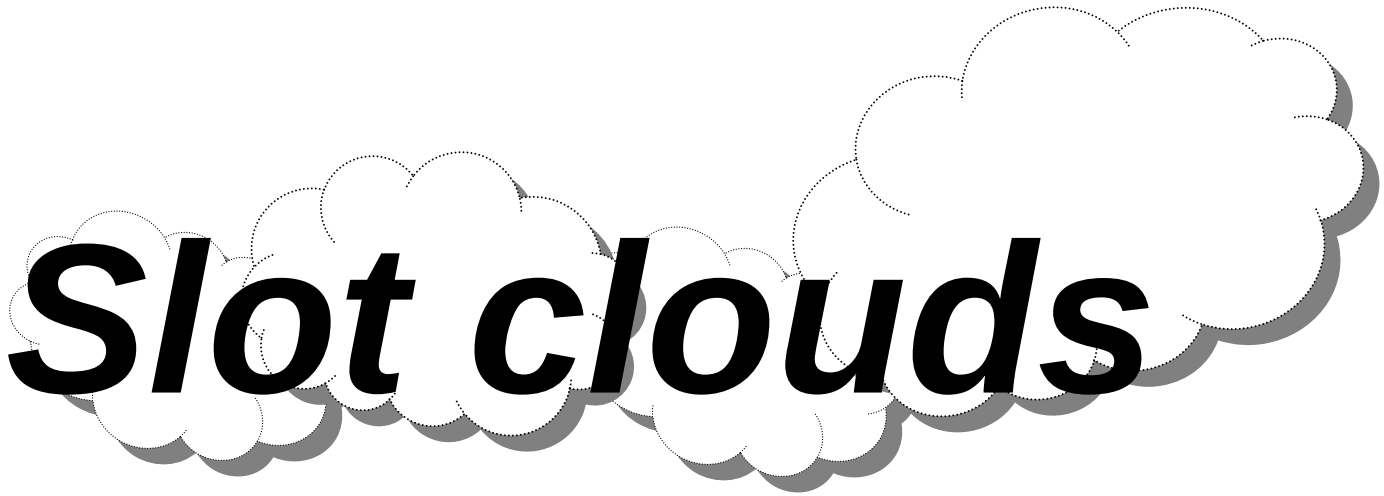

getting more from orbital slots with networking

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IAC-03-U.4.07, Space Systems Architectures, Thursday 2 October 2003 a.m.

54th International Astronautical Congress, Bremen

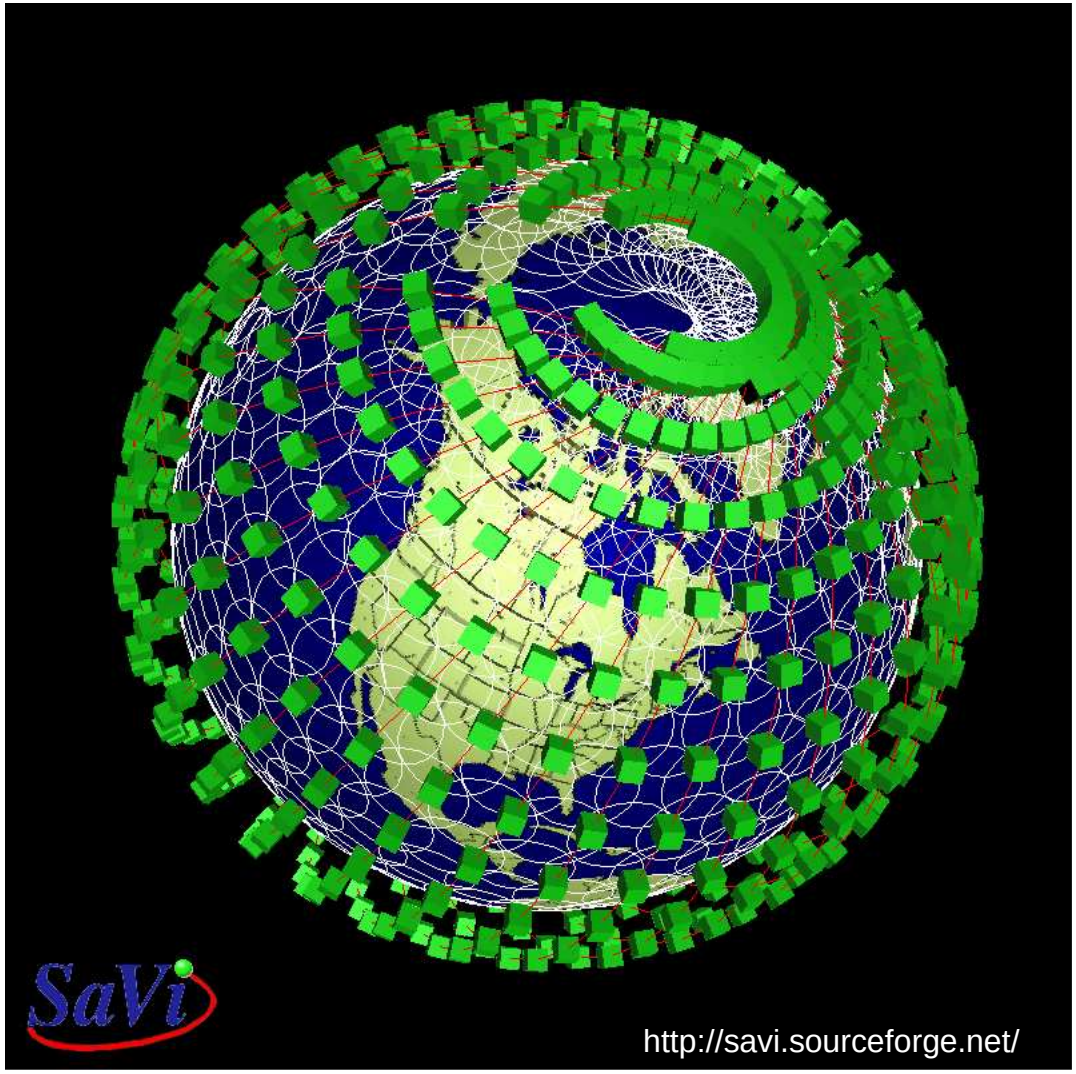
Broadband constellations.

Homogenous. One design. 90's: been there, tried that, failed.

No demand for capacity? No business case? 'Build it and they will come'.

Mass manufacture of identical custom satellites not much cost saving – launch costs still high, (re)design costs will *cripple* you.

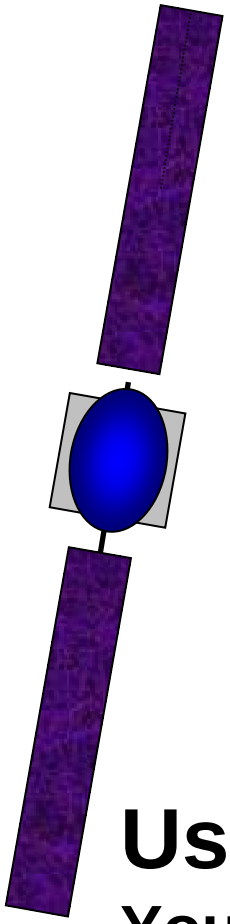
One risky great big leap towards networking. No incremental steps.



Time for a different approach?

Interoperability matters.

(No man is an island.)



A quick comparison

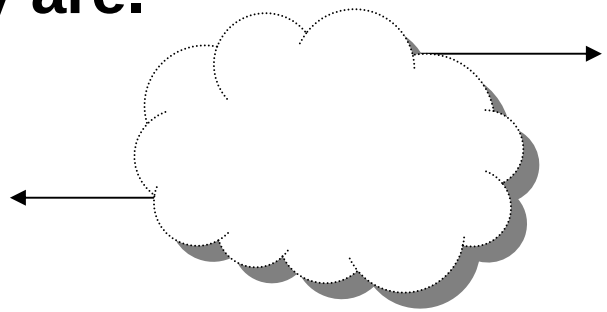
Using transponder in orbital slot

What's the frequency? coding scheme (3/4 etc.)?
modulation? polarisation, even?
Where does coverage reach to?

vs

Using the Internet

You're connected to a networking cloud of functionality.
Everyone else is connected to that same cloud – somehow. You just presume that they are.
Don't sweat the connectivity details.



Which model is better? More useful?

Some satellite trends

Spotbeams really require switching to be useful.
More spotbeams, more need for onboard switching.

DSP is a form of OBP – onboard processing. See the P!
DSP has benefits. You'll get some OBP that way.

Shared launches have been common for a long while.
Now seeing more complex payloads on a shared satellite bus, e.g.:

***EchoStar 9/Telstar 13* – Ku/Ka- and C-band transponders**
***Galaxy 13/Horizons 1* – C-band and Ku-band transponders**

And do these talk to each other?
Is there interoperability? Is there a cloud?

Two ways to get payloads talking

1. Intersatellite links.

These things *work*. Free space. No atmospheric limits. Iridium's not cutting-edge. Seems nobody can agree on an ISL standard or take the deployment risk.

2. Inside on the satellite bus.

Get payloads owned and operated by different people talking to each other across common bus and common standards at ever-higher levels of abstraction.

Break the uplink/downlink dependency. Copy signals around – why should a TV channel ever need to go up from Earth more than once? Why isn't there a TV cloud?

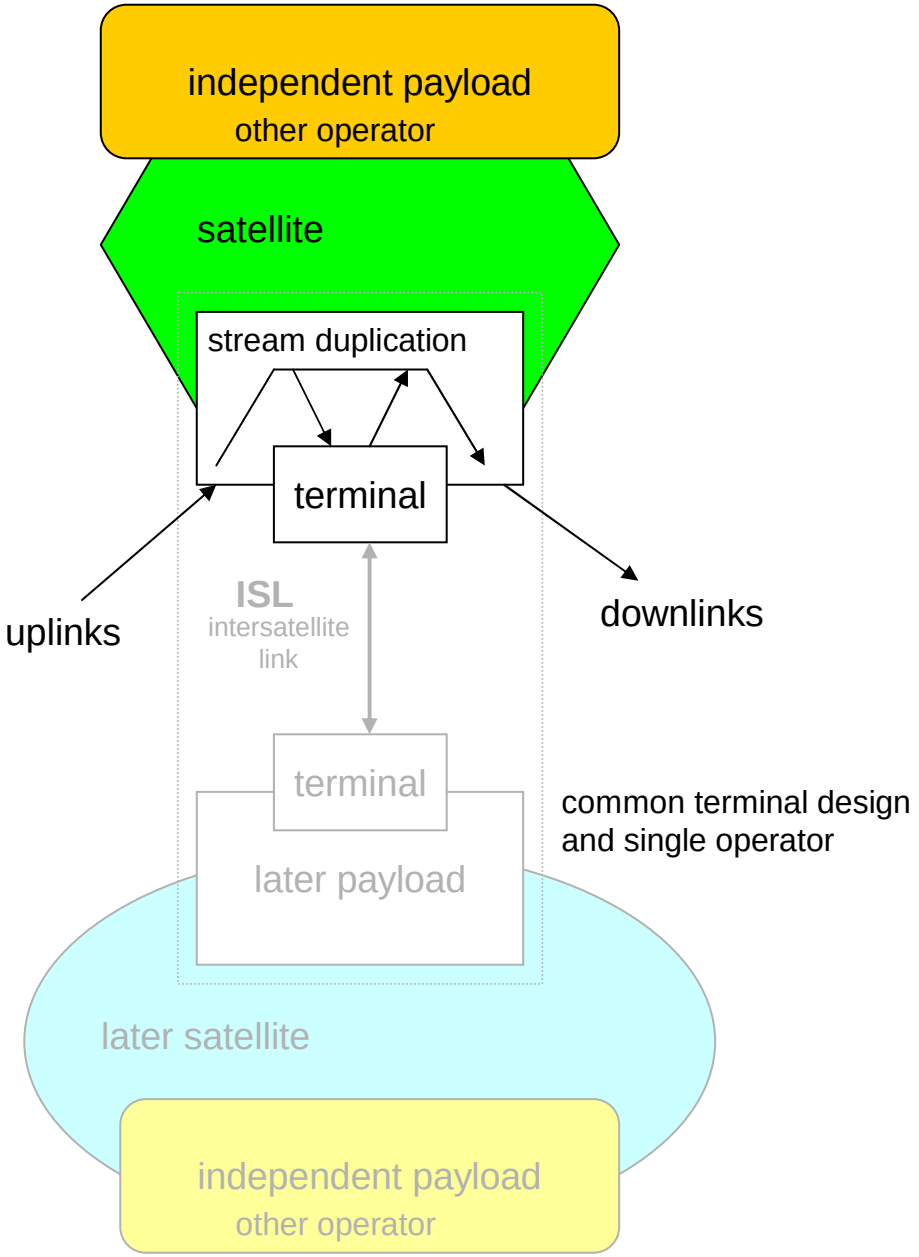
A low-risk method

Launch a payload that: Decodes received signals to baseband streams (making them easier to switch).

Can copy streams as signals out of an ISL terminal – if you tell it to.

That's all.

(Wait...)



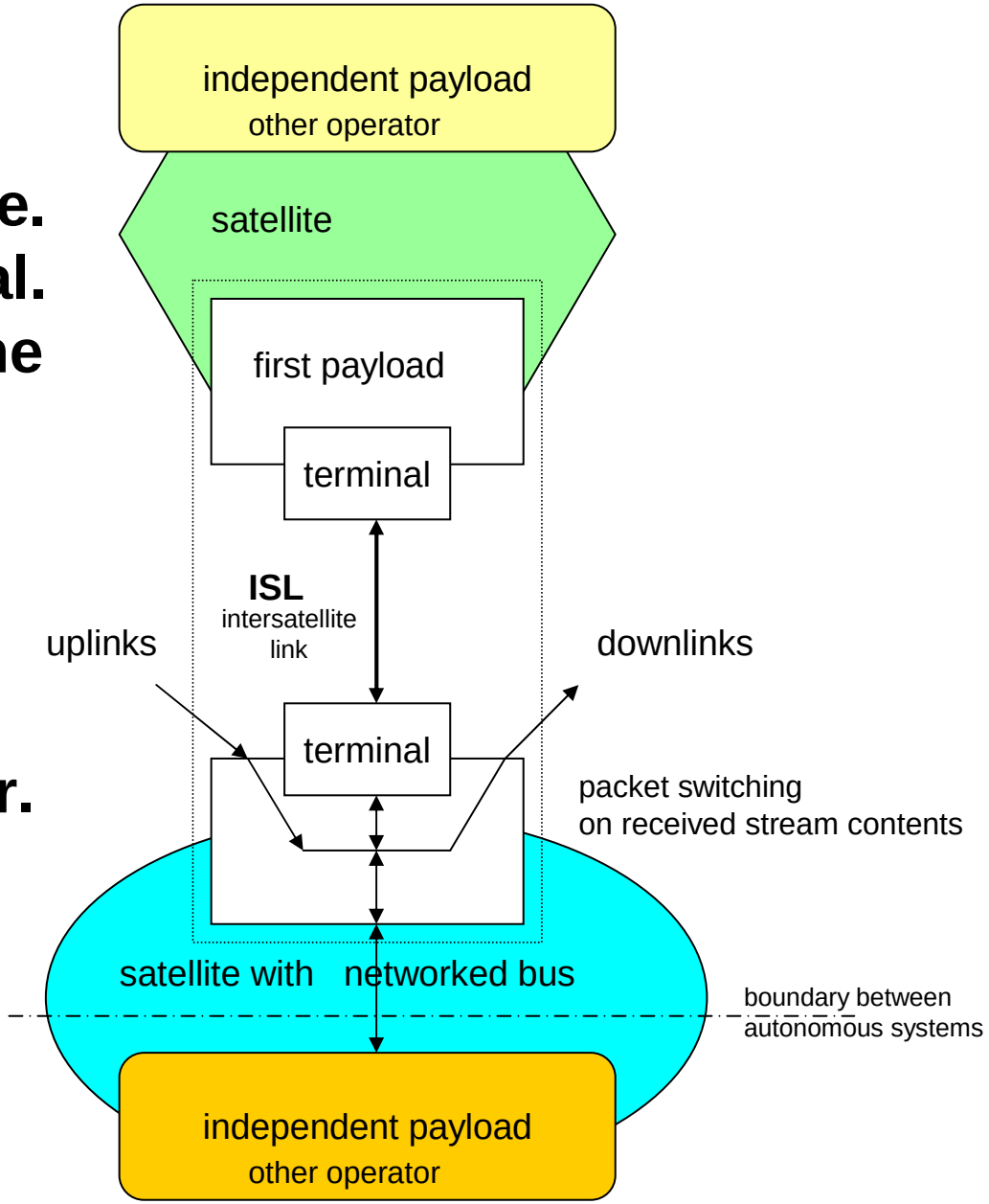
Later steps...

Your second payload gets launched on another satellite. That also has an ISL terminal. May even be smarter than the first payload.

You've just built your own little in-space cloud. Using your own ISL that suits you. In one payload, out the other.

Could also communicate across the satellite bus to a common standard.

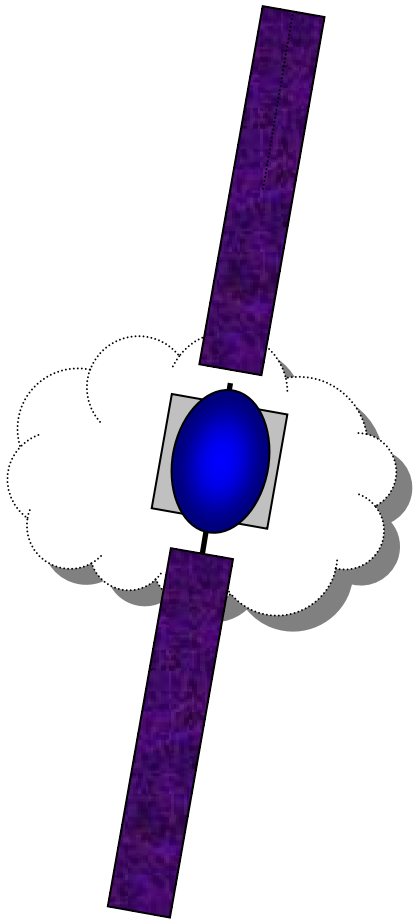
Grows your network cloud.



Last millennium/this millennium

In that world, satellites were part of big elegant-concept single-operator networks.

In this world, satellites can *themselves* be networks – of payloads. Boundaries between network autonomous systems lie *inside* the satellites. ISLs can link similar payloads on different satellites. It's messier.



The satellite becomes a useful cloud; a cloud of television switching functionality, of network functionality...

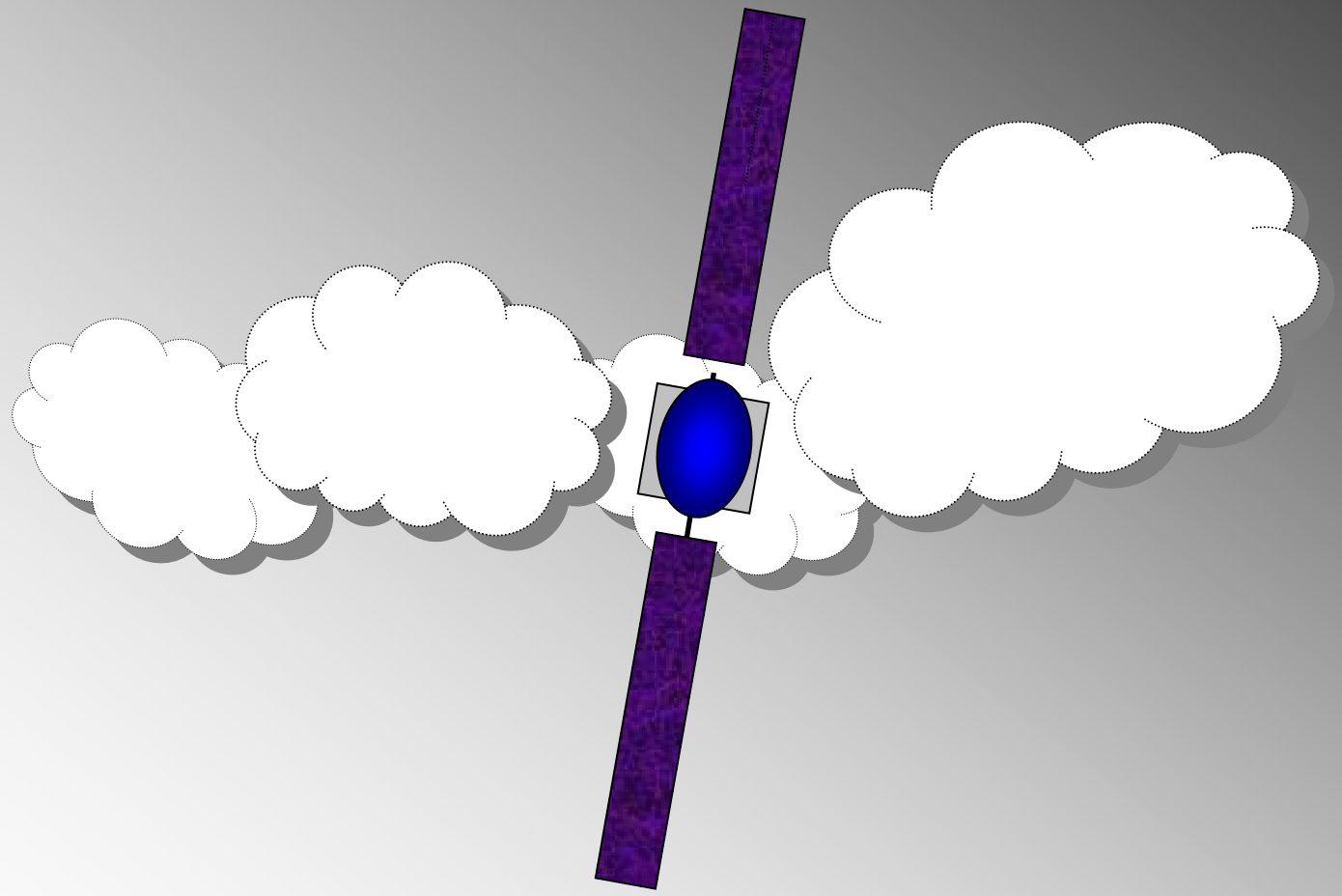
IP increasingly common everywhere.

Earth is one big IP networking cloud; interoperability with Earth at a high level is attractive. It's an n^2 *network effect*.

IP designed as an overlay network originally. IP overlays can be in individual clouds – IP in television MPEG streams, for example. Could parse streams and switch on each packet...

Satellite clouds become Internet clouds in their own way; for every satellite application, the evolution is different, the details of the incremental steps and technologies differ.

...what about practical reality?



enough academic theorizing...

As satellites would become the boundaries of autonomous systems, routers might interconnect separate payloads on very smart satellite buses.
What might such an onboard router look like in an eventual IP-oriented slot cloud? It *must* be:

- **low power (solar power – constrained budget)**
- **small (no space for 19” rack mount router)**
- **robust (no air conditioning)**

So, we took Cisco’s 3251 Mobile Access Router (MAR)...

PC/104-Plus form factor, 200MHz MPC8250 processor, smaller/lower-power than other routers running Cisco’s IOS.

Cisco

Not quite robust enough: made some modifications to an off-the-shelf MAR to cope with a vacuum environment.

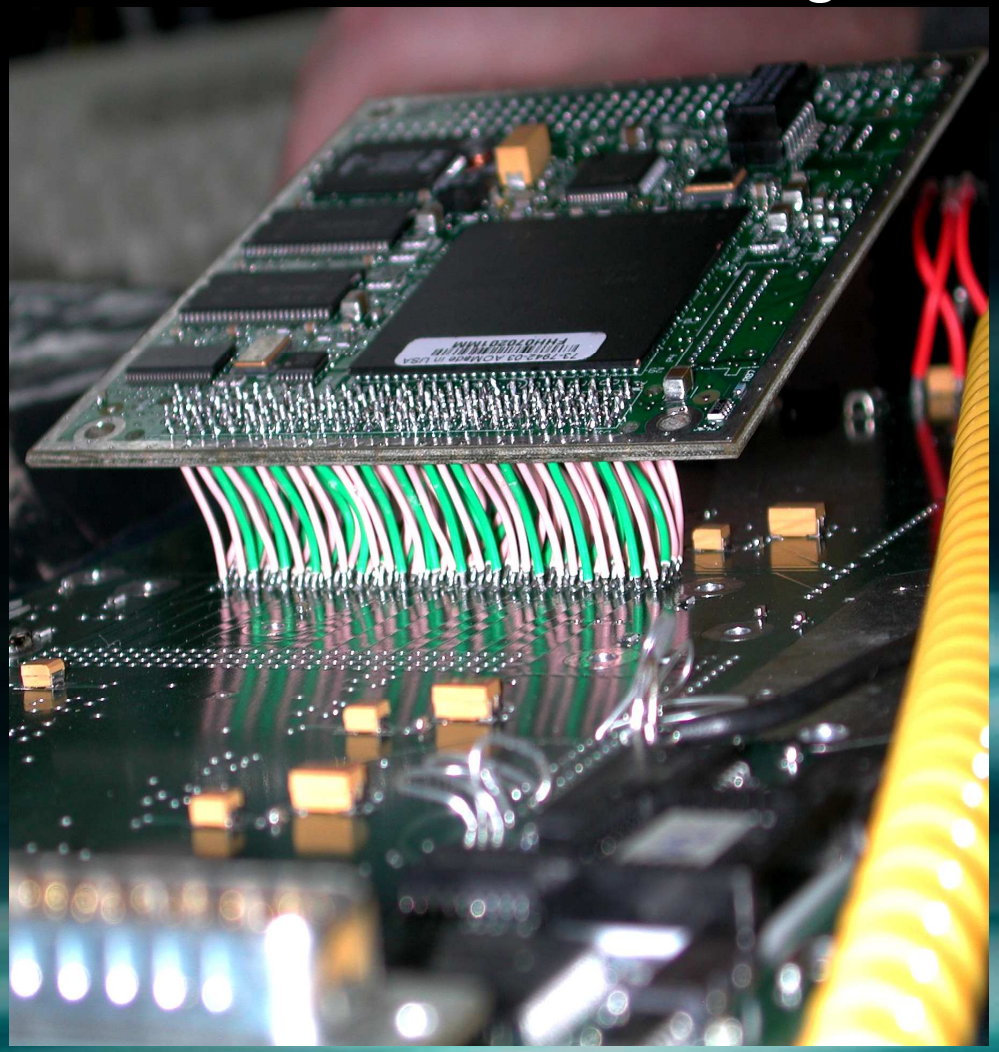
Tin-based solder evaporates; had to redo flow soldering.

Evaporation-prone wet capacitors swapped for dry.

Concerned with vibration and thermal stress.

Plastic connector plugs replaced with direct-soldered connections.

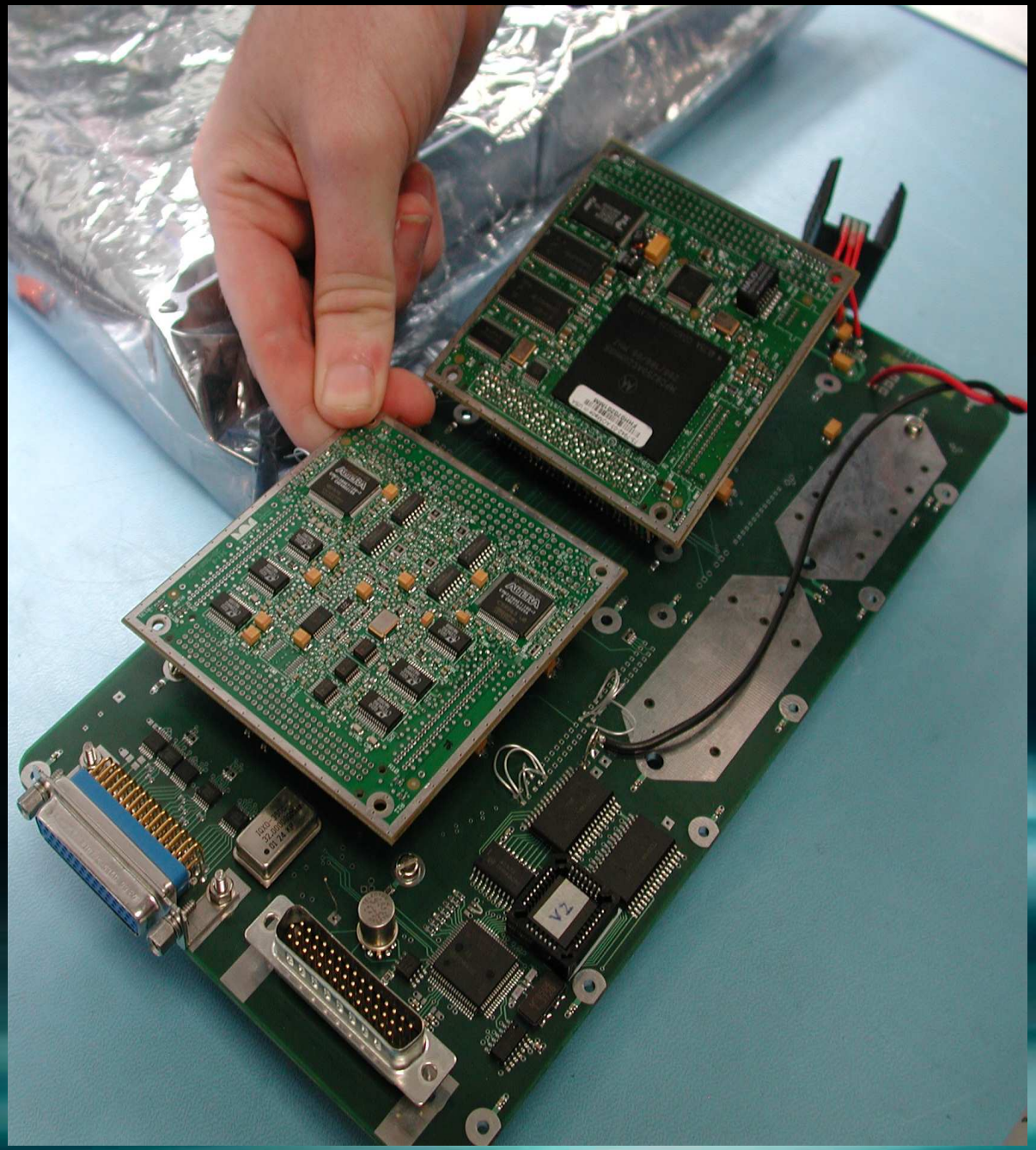
No radiation hardening; LEO not that bad.



Cisco/SSTL

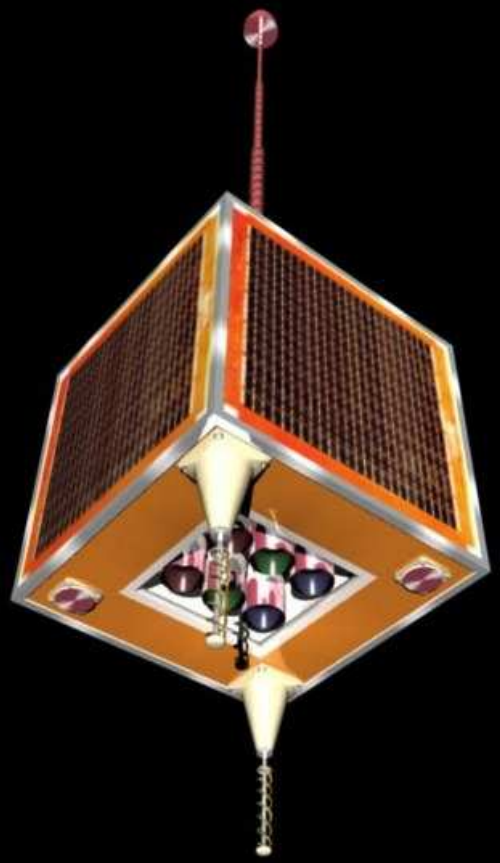
A simple extra board provides power and serial interfacing to other computers.

Designed large heat sink that is strapped across to hold assembly fixed in place (no vibration) and to conduct heat to aluminium case – no convection in vacuum.



Cisco/SSTL

Cisco/SSTL



Integrated assembly into SSTL's UK-DMC Disaster Monitoring Constellation satellite as a secondary experimental payload. Why? (Not just because we could!)

SSTL had done prior simple look-it-works IP-on-satellite tests with NASA Goddard.

SSTL now using IP for TT&C with onboard computers (AlSAT DMC onwards); a natural fit between an IP router and SSTL's SSDRs.*

Easy to add as a separate module to SSTL's modular 'stack' design.

Planning testing MAR with NASA Glenn; mobile routing, remote network operation.

*** Solid State Data Recorder**

Launched with other satellites (two other DMC: Bilsat, NigeriaSAT-1) on Kosmos-3M from Plesetsk into LEO orbit, Saturday 27 September 2003.

Commissioning satellites has started, is ongoing (UK-DMC is third/last).

Onboard routers in orbit a chance to play with our own IP cloud?

SSTL is working on a GEO platform for clustering... a *slot cloud*?

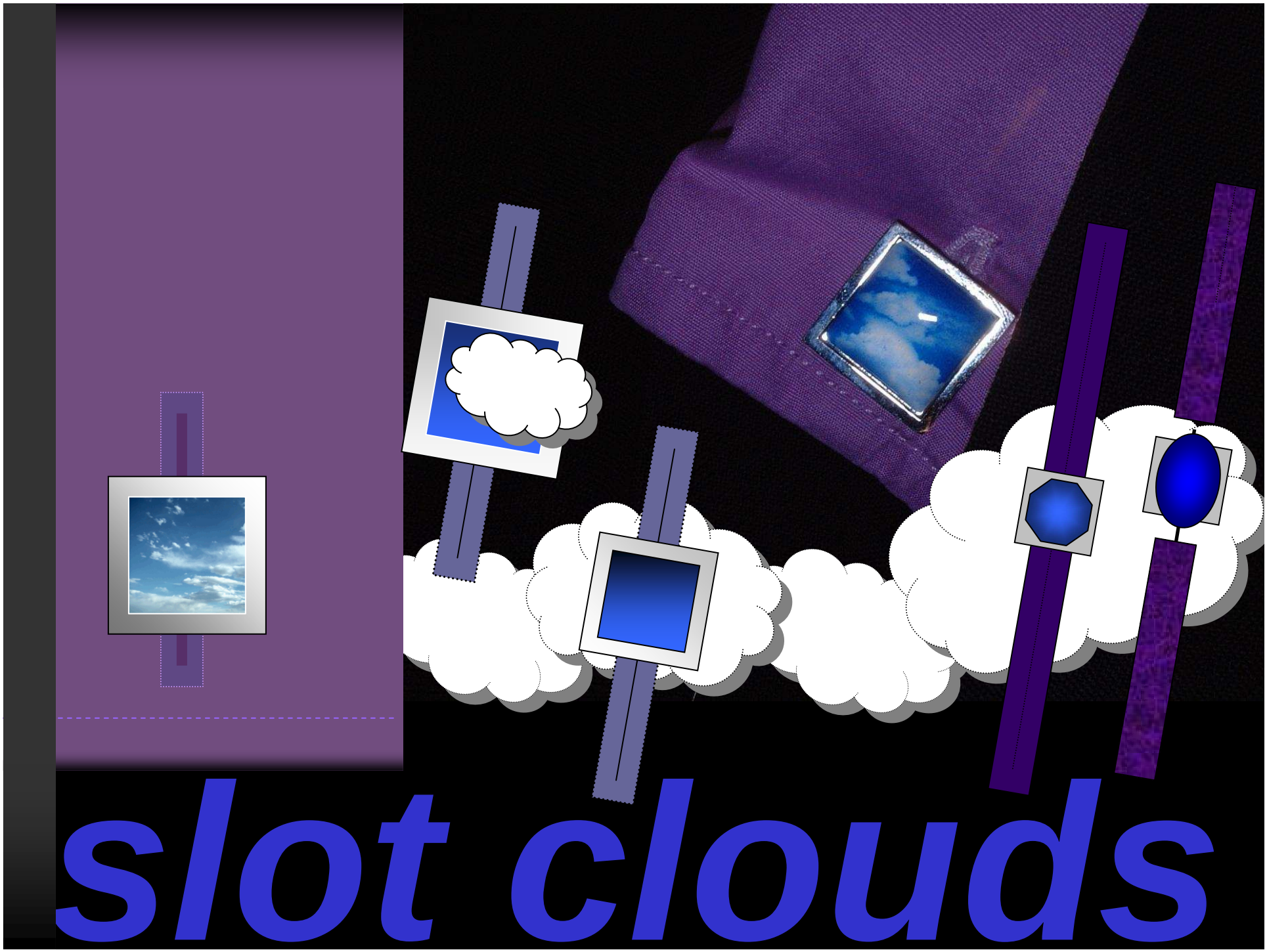
AP Photo/ITAR-TASS

That's using the technology we have;
these are incremental steps we can take.

(Your starting point will be different.
Your steps along your path will suit you.)

Questions?

thankyou.


slot clouds