

Applications



Internet connection



Broadband communications



Multimedia

The premier DSP payloads flying today— and tomorrow



Technology

computer.
For more information, please contact us
at www.boeing.com/satellite or at 1-310-662-8685

Digital Signal Processing



The Power of Choice



NANO — SECONDS

50 100 150 200 250 300 350 400

32
25.6
19.2
12.8
6.4
0
-6.4
-12.8
-19.2
-25.6
-32

FREQUENCY

Networks

Fourth-generation Technology With First-pass Success

Digital signal processing (DSP) offers solutions to many situations. Its inherent adaptability keeps business plans current and protects against on-orbit failure. DSP can overcome the uncertainties that accompany opportunities in broadband, new applications, Internet, and two-way direct-to-home services. By adjusting to new formats, a digital satellite never becomes prematurely obsolete. To illustrate, let's look at two possible situations at two fictitious companies:

Example A: Acme Space Systems has a digital satellite that provides broadcast television services. Two years after launch, it's clear that Internet traffic offers more business opportunities and higher profits.

Solution: Acme's digital signal processor gracefully transitions to Internet services in real time. Profits soar.

Example B: THK Communications has two satellites, one digital and one analog. The analog satellite suddenly experiences problems with two transponders.

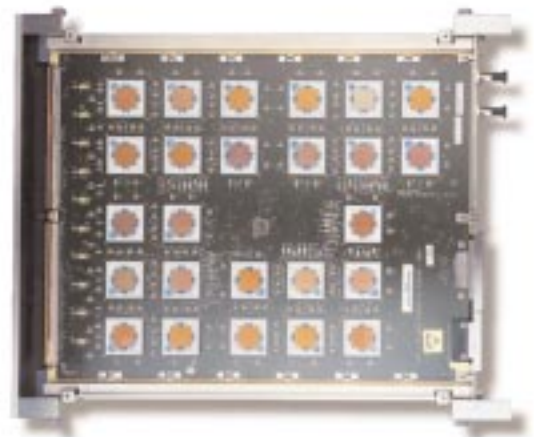
Solution: THK immediately reconfigures the beams of its digital satellite to include the area at risk for coverage loss. Service and revenues continue uninterrupted, and user satisfaction remains high.

Our very large scale DSP communication payloads offer unparalleled flexibility, performance, and producibility as a result of four full generations of development on government and commercial programs. In a further evolution, Hughes Space and Communications Company is now part of Boeing Satellite Services, Inc. (BSS).

After 15 years of cumulative expertise in smaller DSP units, we took the lead in large-scale DSP a decade ago. Our systems feature application-specific integrated circuits (ASICs) with exceptionally high logic gate capacity, which translates into fewer parts per payload, higher reliability, increased functionality, and flexibility to add features. Since 1990 we have delivered and/or flown numerous moderate size and 50 very large scale DSP units incorporating 80 to 2000 complex DSP ASICs per payload—all with first-pass



Digital Payload Assembly



20,000-circuit TDMA Switch

DSP payloads offer nearly perfect signal processing in an ideal mathematical world. BSS' DSP customers can enjoy equally excellent real-world results.

Why Digital?

Customer Advantages of BSS Digital Processing

success.

- **Market flexibility**—Satellite operators can adjust or restructure business plans and adapt to shifting markets and user patterns by reconfiguring the payload on orbit. For example, it's possible to change overnight from a point-to-point to a broadcasting or multicasting application. DSP can deliver last-mile or next-to-last mile services without expensive ground equipment.

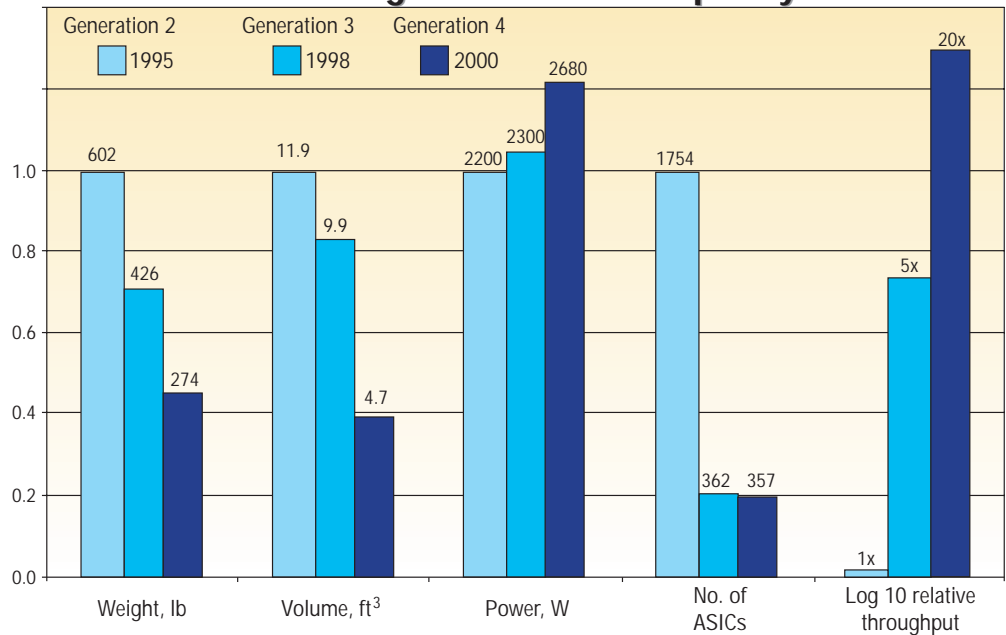
- **Performance to match future demands**—BSS' DSP technology outpaces competitors by 2 to 5 years, offering the first flexible DSP systems with more than 10 Gbps throughput, 7-million-gate ASICs, and 50,000 GigaOperations per second.

- **Higher profit potential**—Dramatically increased revenue-generating bandwidth and reliability with drastically reduced complexity, power consumption, and weight.

- **Resource efficiency**—Optimum spectrum and channel bandwidth allocation and vastly higher throughput from nearly unlimited frequency reuse—up to 512 times to date.

- **Maximum producibility**—Designing for automated

1995 to 2000 Digital Processor Capacity Growth



assembly with pre-tested parts and modular plug-in slices ensures assembly speed and quality. Automated built-in self-test (BIST) from ASIC through subsystem levels improves manufacturing efficiency and adds reliability. BIST also offers precise on-orbit systems diagnosis.

- **Inherent stability**—No tuning or age degradation over life, radiation resistant.

- **Available as a payload alone or as part of a satellite system**—Customers can select from a multitude of processing functions to create their

Generation 1
1992



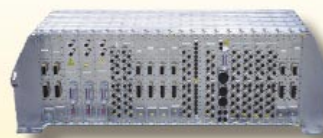
- 100 ASICs
- 15,000 gates per ASIC
- 8 MHz clock rate

Generation 2
1995



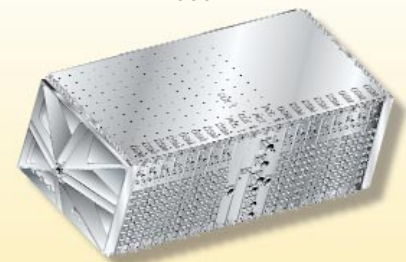
- 150,000 gates per ASIC
- 40 MHz clock rate
- Plug-in slices
- Built-in test

Generation 3
1998



- 2.7 million gates per ASIC
- 80 MHz clock rate
- Built-in self-test
- Commercial ASIC technology

Generation 4
2000



- 7.1 million gates per ASIC
- 180 MHz clock rate
- Built-in self-test *on orbit*
- Commercial ASIC technology

Four Generations of Advanced Digital Signal Processors

Digital Processing Options/Capabilities

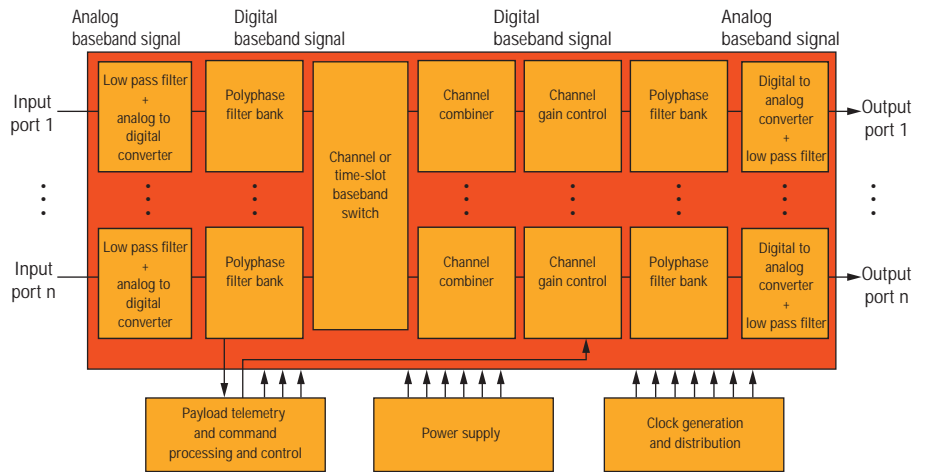
ideal payload.

Programmable channelization—

Supports multiple simultaneous services and real-time modifications. Input/output channels of 250 MHz and beyond, divisible on orbit into 1 kHz to 250 MHz subchannels.

- Perfect channel/subchannel reconstruction from any mix of subchannels
- Currently more than 10 GHz bandwidth; increasing rapidly
- Easily performs time division multiplexing (TDM) circuit switching, channel power control, monitoring, traveling wave tube amplifier (TWTA) linearization and equalization
- Compatible with any signal format and

Typical Channelized Processor



lower power, smaller antennas

- Digital packet power control, monitoring, TWTA linearization and equalization

Digital beamforming—Maintains business adaptability. Available for both transmit and receive, provides virtually infinite number of independent beams, all with different shapes.

- Bandwidths of more than 125 MHz per beam
- A few to hundreds of elements possible
- Antenna patterns, number of beams reprogrammable at any time

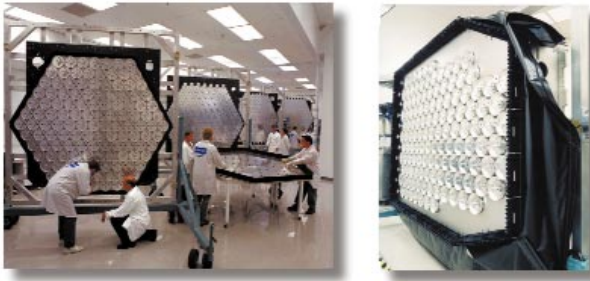
Digitally controlled analog beamforming—

Wideband beamforming (over 1 GHz/beam) and dynamic beam controls. A single 12-beam phased array can rapidly scan many locations on earth, providing thousands of "virtual" time division multiple access (TDMA) beams.

- Simple antenna commanding, fault-tolerant design for increased reliability

Spaceborne computing—For immense throughput with more speed and memory than the competition, choose our space-qualified 250 MHz PowerPC 750

Phased Array Antennas

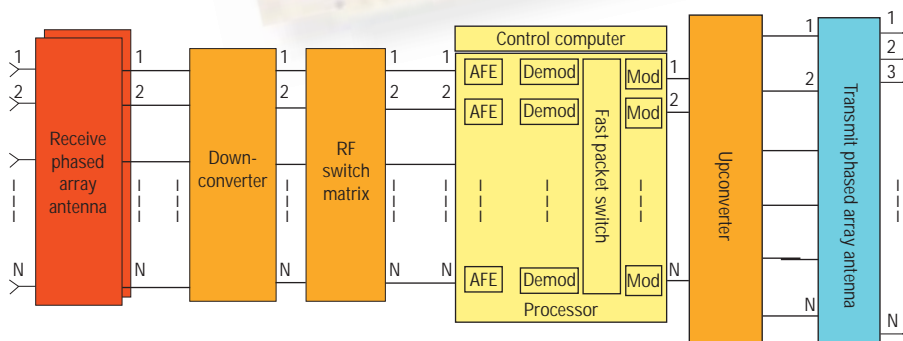


programmable to many bandwidths

Regenerative system—Ideal for Internet services. Highly efficient autonomous operation that requires less link power due to user data recovery and error detection and correction.

- Autonomous packet switching enables mesh connectivity with little or no ground control
- Currently more than 10 GHz bandwidth; technology advancing rapidly
- Demodulation/remodulation and error control vastly improve link margins, allowing link closure with

Typical Regenerative Payload



PowerPc