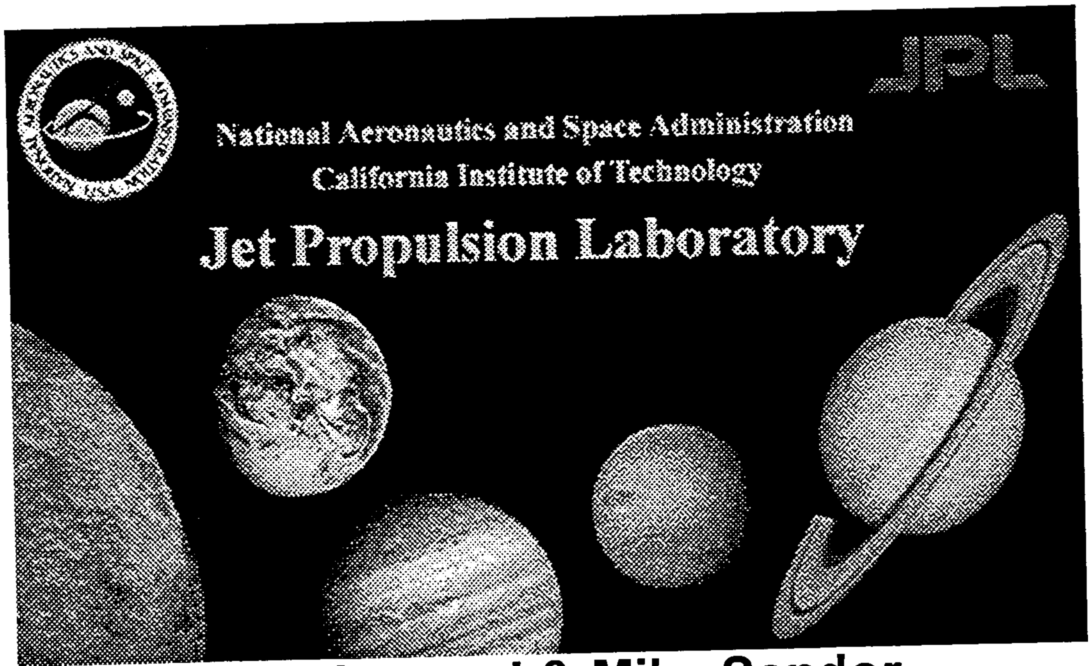
Technology Management Symposium and Expo

1997,

Commercial Off-The-She (COTS)

Search for Low Power Space Electronic Parts (LPSEP) - COTS Parts Evaluation Results



Shri Agarwal & Mike Sandor

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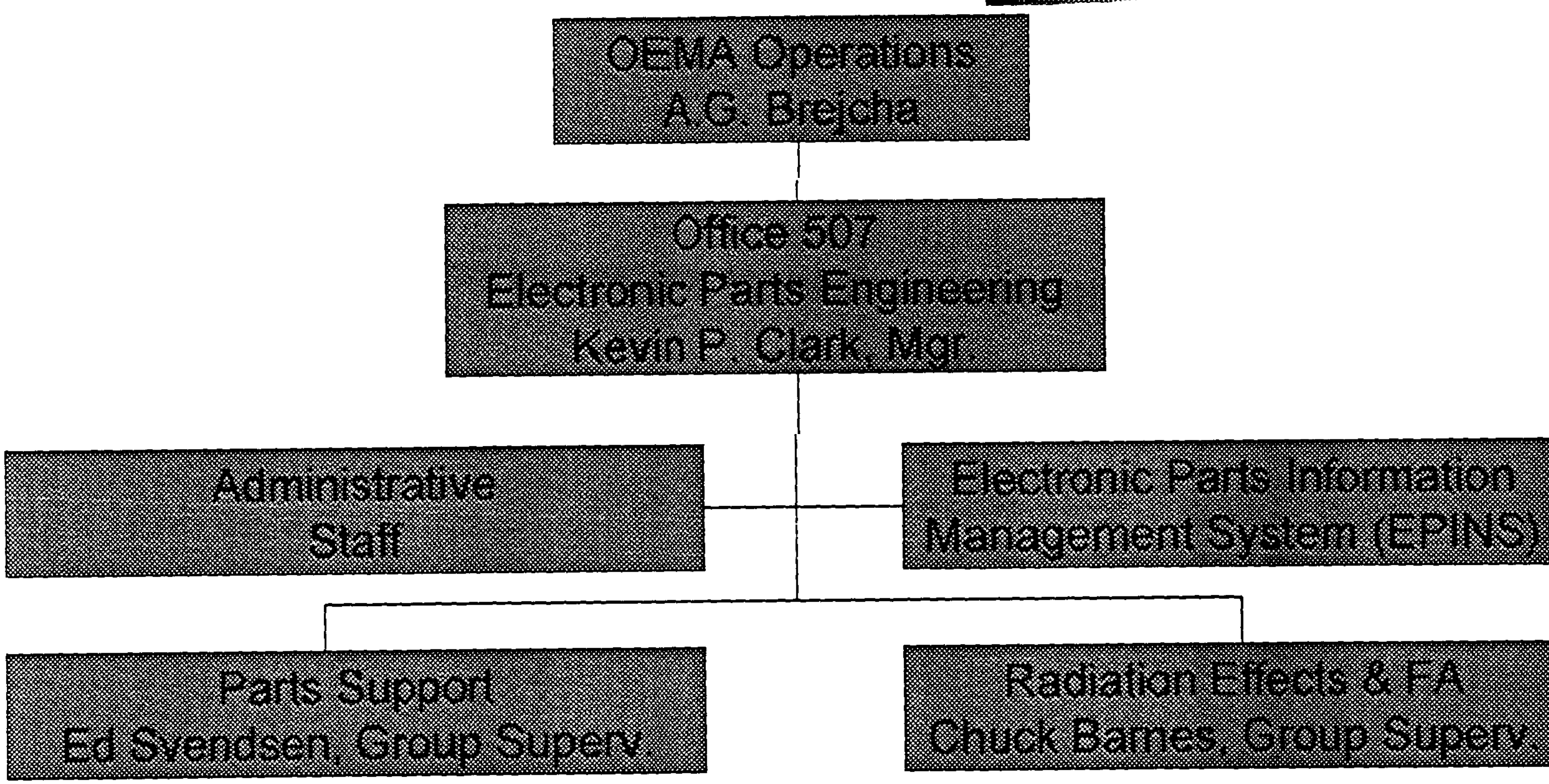
Organization



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Agenda

- Low Power (LP) Parts in Space
- Achieving Low Power
- Parts Evaluation Results
- Summary

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The Meaning of COTS

- “Buy and Fly”
- “Procuring via catalog part number to QML-V standards”
- “Procurement is performed without formal specifications”
- “The usage of any COTS equipment does not constitute any waiver to fundamental applicable requirements”

Our Interpretation:

COTS are parts whose specification is ***manufacturer-controlled*** as opposed to traditional “Hi-Rel” parts whose specification was ***Government or customer-controlled***

Why Put COTS Low Power (LP) in Space ?

1. The availability of COTS LP parts is proliferating.

2. COTS LP parts performance capabilities continue to increase (e.g. processing power & high density memories).

3. A new generation of leading COTS LP IC technologies is forthcoming: Bulk CMOS/RH & Silicon-On-Insulator (SOI).

4. COTS LP parts typically cost much less than radiation hardened counterparts; by using radiation tolerant parts the cost advantage can be preserved.

5. Some COTS LP parts (plastic only) have been reported to demonstrate good to excellent reliability.

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Spatecraft Power Migration:

	Cassini	Galileo	X2000	Mars Pathfinder
Power Source	**3** RTGs	2 RTGs	ARPS	Solar/Battery
SC Power Usage/ Requirements	**900** Watts	**600** Watts	150 Watts	**3-12*** Watts (Rover)

Notes:
RTG: Radioisotope Thermoelectric Generator
ARPS: Advanced Radioisotope Power Source
SC: Spacecraft
* Dependent on the operational mode

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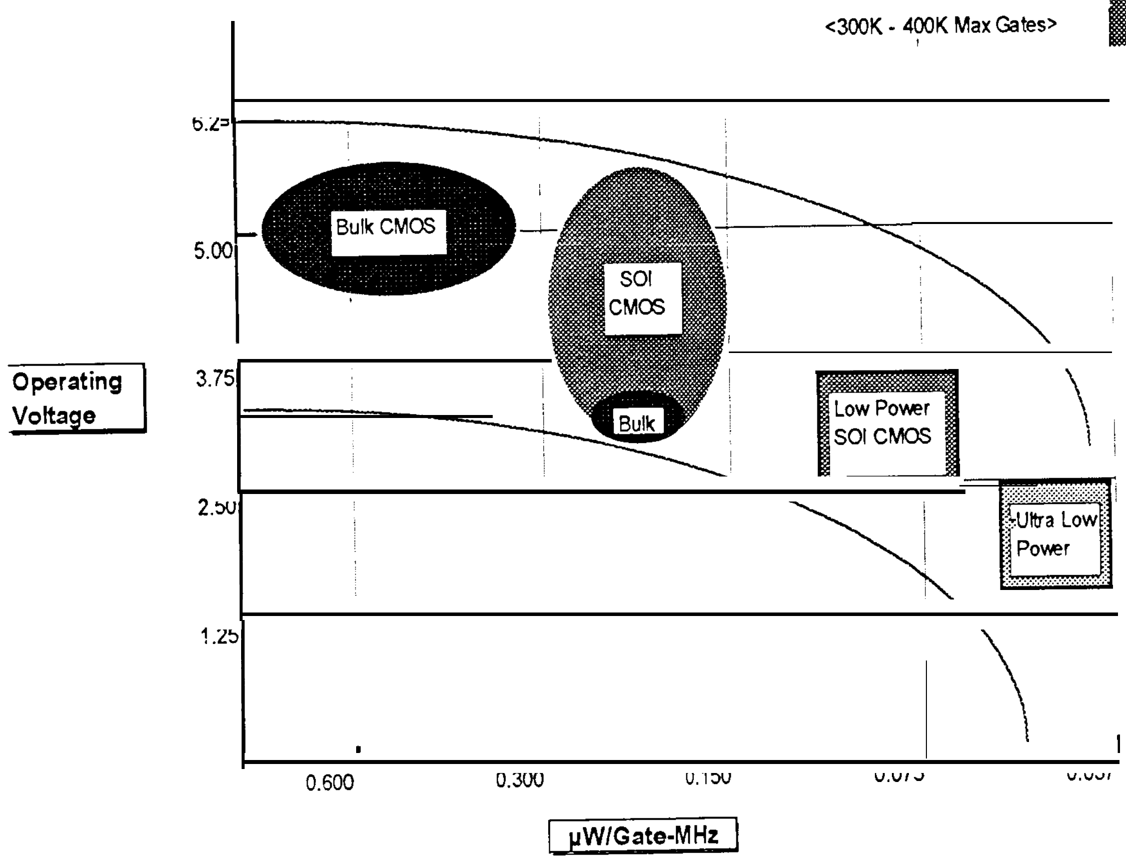
LOW POWER TECHNOLOGY MIGRATION PATH



Approaches:

. Further Sca ng of Structures for Conventional Bulk/RH

2. Thinner Si Active Regions for Si icon-On-Insulator

3. Ultra Thin Gate Dielectrics for Silicon-On-Insulator

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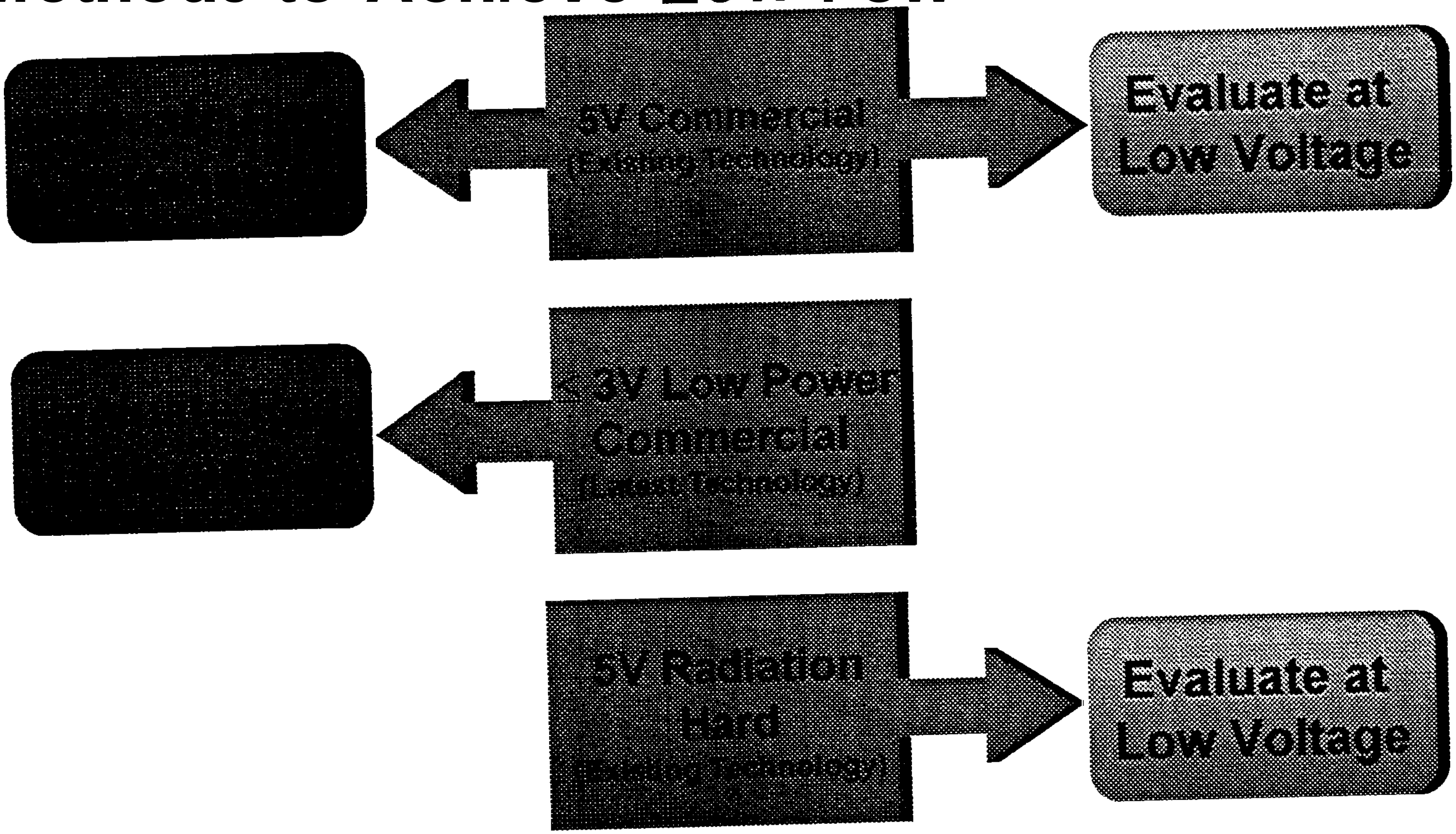
Methods to Achieve Low Power Parts:



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Reducing CMOS Device Power Dissipation:

{------------------------Dynamic Switching--------------------} {Short Circuit} {----dc Static----}

Power Equation: $P = n_p C_{load} V_{out} V_{dd} f_{clock} + I_{sc} V_{dd} + I_{leakage} V_{dd}$

n_p = activity factor determined by power management schemes

Isc = short circuit current during switching transient

Ileakage = dc static current (junction leakage)

Dominant Power Dissipation Factor: Dynamic Switching

Dominant Power Reduction Controls for User:

1. **Vdd (supply voltage)**
2. **f (clock frequency& clock cycle)**

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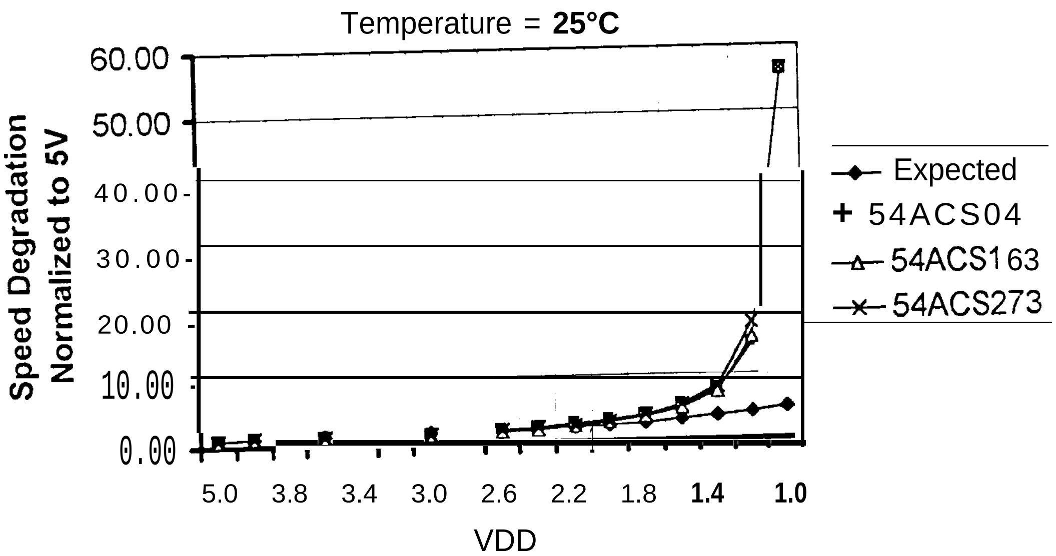
Issues To Consider When Using Low Voltage (Vdd) Parts:

- Speed degradation
- Realized power savings vs theoretical
- Performance over temperature
- Radiation effects
- Increased signal to noise ratio
- Inadequate burn-in voltage and time
- Efficacy of applying derating factors

Speed Degradation Results:

Low Voltage Performance of 5V Radiation Hardened Products

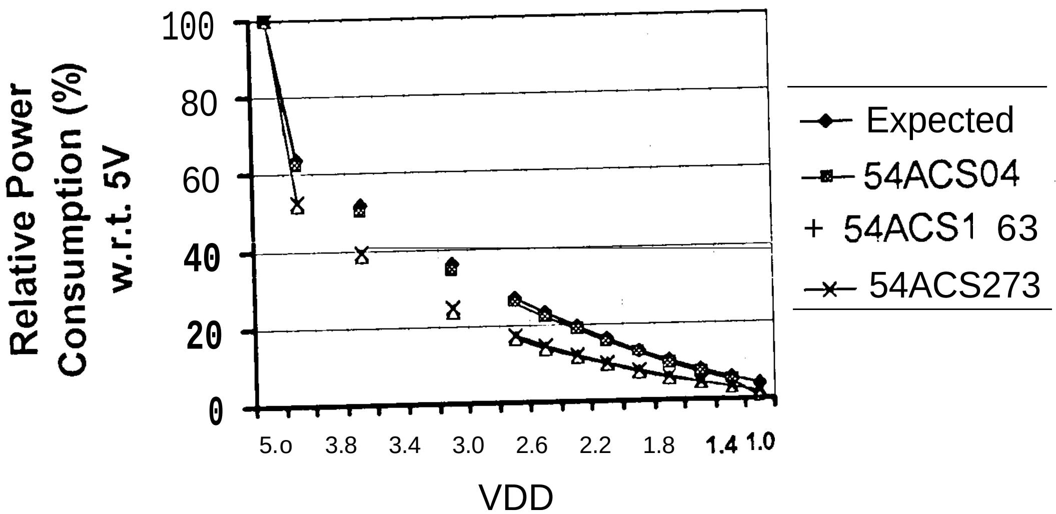


Notes:

1. **54ACS163** and 54ACS273 **failed** functional test at VDD = **1.0V.**
2. Below VDD = 2.5V there is **a speed penalty over and above the expected** degradation.

Realized Power Savings vs Theoretical Results:

Relative Power Consumption of 5V Radiation Hardened Products



Notes:

1. 54ACS1 63 and 54ACS273 are better than predicted.
2. 54ACS04 follows the prediction.
3. Power is calculated for each part using its dynamic current. The quiescent current contributions are negligible.

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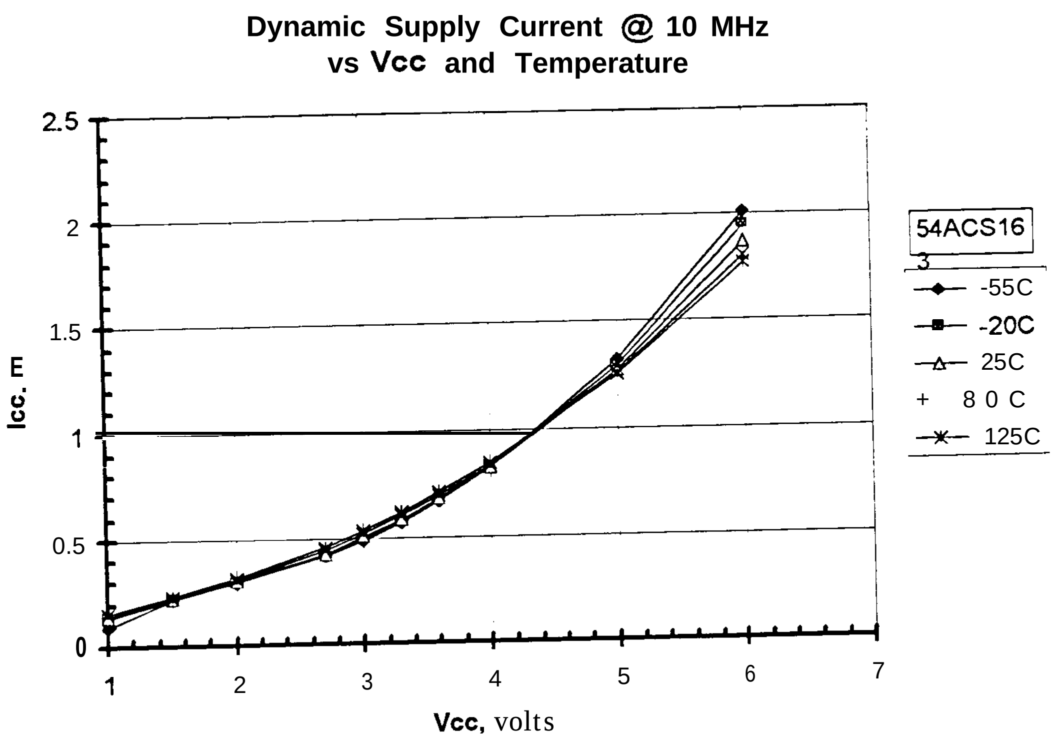
Temperature Compensation Results for 5V Radiation Hardened products:



Notes:

1. **AH 3 parts showed excellent temperature compensation for dynamic current in the low Vcc range.**
2. At **6.0V,** 15% **w.c. divergence is observed for 54ACS163.**

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AID Low Power COTS Radiation Results:

PIN	Resolution	Process	VDD	Power	Speed	Total Dose	SEL
LTC1419	14-Bit	CMOS	+/- 5V	150 mW	800 Ksps	TBD	None, LET>600 MeV/mg/cm2
SPT7725	8-Bit	Bipolar	- 5.2V	2.2 W	300 Msps	>100 Krad (Si)	None, LETz100 MeV/mg/cm2
HI1276	8-Bit	Bipolar	- 5.2V	2.8 W	500 Msps	TBD	None, LET>100 Mev/mg/cm2
AD7714-3	24-Bit	CMOS	+ 3V	2.6 mW	100 Ksps	TBD	LET = 55 Mev/mg/cm2
ADS7809	16-Bit	CMOS	+ 5V	100 mW	100 Ksps	10 Krad (Si)	LET = 19.9 MeV/mg/cm2

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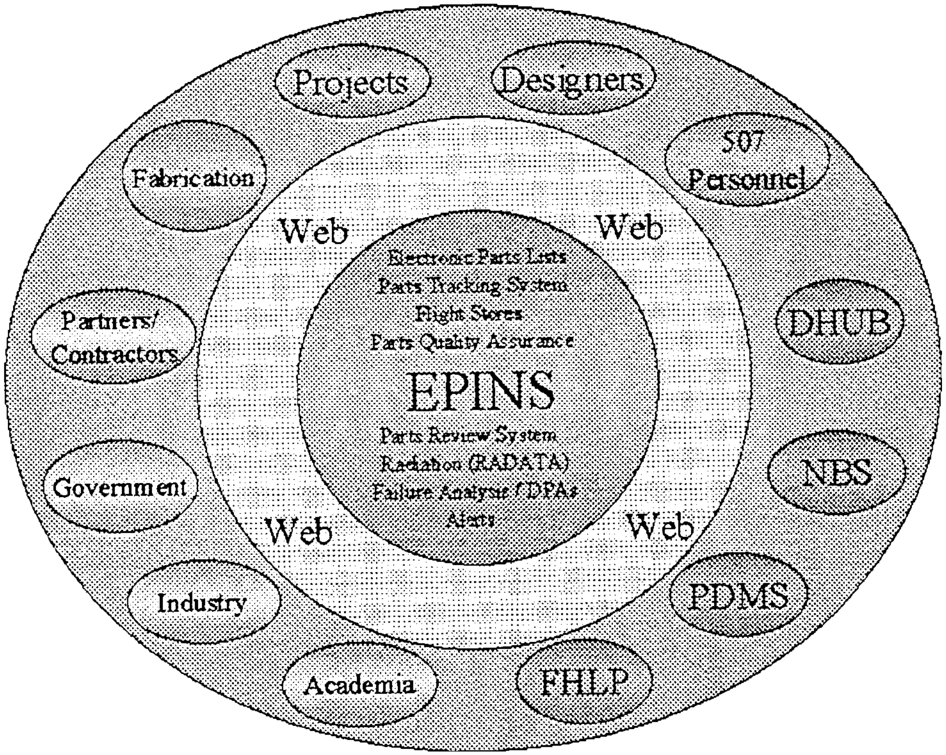
http://parts.jpl.nasa.gov



Electronic Parts Information Network System

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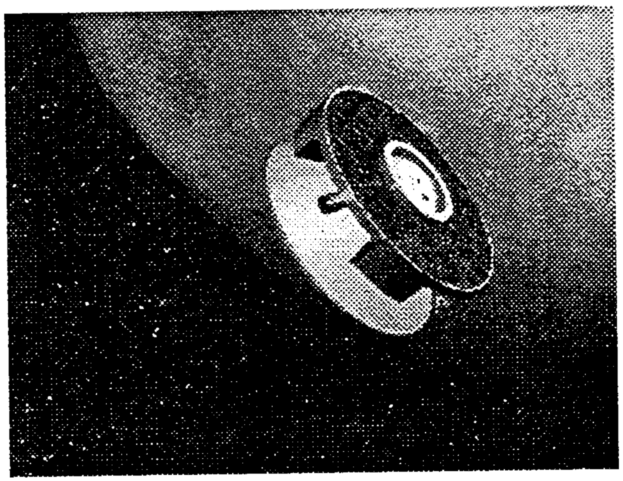
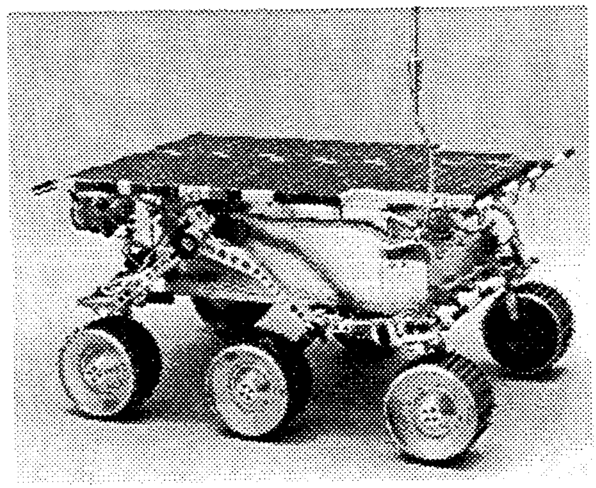
Plastic Parts Successfully Used For Mars Pathfinder:

16 Mbit DRAM Used in Pathfinder Flight Computer



FETs ; ASIC & Microcontroller Used in Modem for Lander and Rover



Passed 1000 Hours Life Test on Mars !

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Con elusion:

More power constraints in future Space designs will necessitate new techniques to reduce power consumption & improve performance via-

	Examples
1. Part selection	→ Lower voltage and power
2. Circuit design	→ Encoding of data or states
3. Architecture trade-off	→ Multi-level bus architectures
4. Power Management	→ Powering off selected bus nodes
5. Radiation Performance	→ Infusion of SOI technology