Power Matters

Microsemi – Your Partner for Space System Solutions

Microsemi Space Forum Russia – November 2013

Patrick Franks
Director of Engineering, Power Management Group

Agenda

- Technical Overview
- Space Heritage
- Systems View of Product Definition and Development
- Recent Products
- Processes, Capabilities, and Products in the Development “Pipe”
- Summary

About Microsemi Corporation (Nasdaq: MSCC)

- Global provider of semiconductor solutions for applications focused on delivering power, reliability, security and performance

- High-value, high barrier-entry markets
  - Communications
  - Defense & Security
  - Aerospace
  - Industrial

- FY 2012 Revenue: $1 billion
  - 3,000 employees globally

Corporate headquarters in Aliso Viejo, CA

About Microsemi

- Microsemi is focused on key markets where we look to apply our system knowledge to help define integrated roadmaps to leverage our breath in applications
- Microsemi has a very broad portfolio of technologies to serve our partners product needs
- Microsemi excels where solving problems is difficult, there is a need multi-disciplinary engineering, or where reliability and security are critical
- Microsemi applies its breath of capabilities to develop broad-based solutions to specific circuit and system problems (leverage.)

Technical Overview - Design

- Deep and Broad Engineering Team
  - Systems
    - Space/Aerospace/Industrial power generation, conversion, and switching
    - Security: mmWave, integrated systems, secure components
    - Avionics systems and subsystems
  - Circuits
    - RF: transceivers, AFEs, power modules, ULP radios, PAs, LNA, mixers
    - Timing: sync, synth, distribution, frac-N, Ultra low jitter, any in any out
    - Communication: SLICs, SLACs, voice processing, PoE
    - High Density: FPGAs, SoCs, ASICs
    - Power: switchers, drivers, conversion, regulation, protection
    - SSD: high speed, security, and reliability
  - Module/Hybrid
    - High density/integration
    - POL, linear, digital
    - SS relays
    - Build to print

Technical Overview - Design

- Process Engineering
  - Device: SiC, GaN, IGBTs, RH, high temperature
  - ICs: CMOS, HV Biploar, HV CMOS, NVM, Anti-fuse, MIMICs
  - Misc: TVS, sensors
  - Packages: Stacked die, multi-die package, hermetic, non-hermetic, high temp
  - Modeling: Process, device, reliability, thermal, photonic

Technical Overview - Design

- Security
  - Information assurance: IP, circuits, firmware, and software
  - Anti-tamper: systems, IP, circuits, firmware, and software
  - Black hat, white hat, red hat, etc.
  - SoCs: special security features, extensive IP, NV memory

- Integration
  - High gate count: FPGAs, ASICs
  - Mixed signal: ASICs, FPGAs, SoCs
  - Multi-die packaging: horizontal, vertical, interposer, TSVs

- Harsh Environment
  - Radiation hard: process development, RH by design, circuit library, HV and power processes, TID, SEE, ELDRS
  - High temperature: devices, drivers, POLs, FPGAs
    - Up to 250 degrees, low and high temp cycle

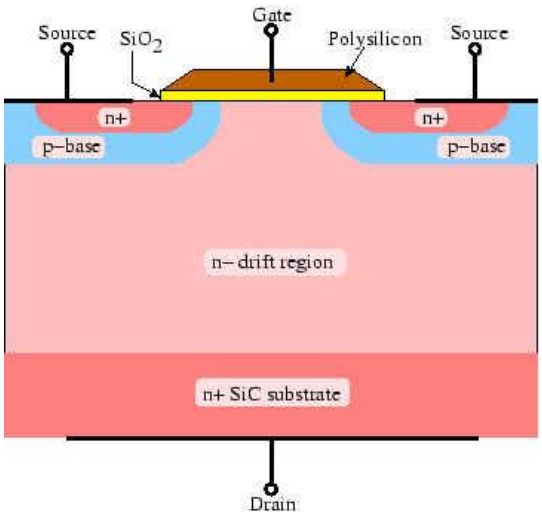
Technical Overview: Design

- World's best tools and procedures
  - System simulation
  - Circuit simulation
  - Process simulation
  - Thermal simulation
  - Radiation Modeling
  - Software ecosystems
  - Mechanical stress
  - Parasitic extraction
  - Environment modeling/simulation

Continued Investment in R&D

Technical Overview - Process

- Device
  - High performance
  - Harsh environment
  - Power

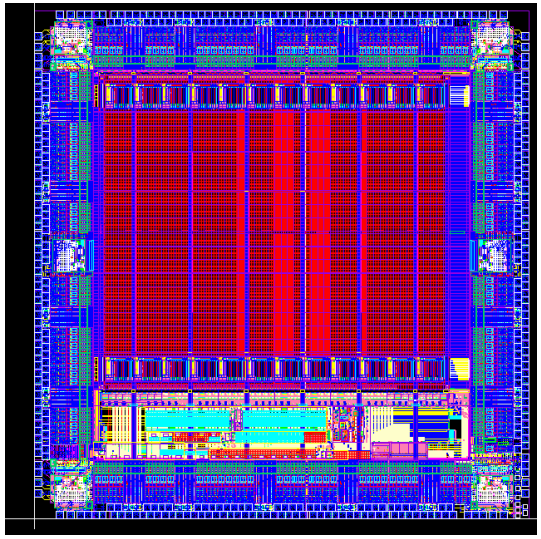


Device Technologies:

- **Wide Band Gap (Compound Semiconductor)**
  - **SiC**
  - **GaN/SiC, GaN/Si**
    - **NG 0.25um (Low noise Epi and power Epi)**
- **SiGe**
  - **0.18u**
  - **0.35u**
  - **0.35u on 1K Substrate**
- **GaAs**
  - **HBT3 (2u, High Linearity for WAN PA applications)**
  - **Enhancement Mode pHEMT (LNA's)**
  - **Depletion Mode pHEMT (Switches)**
  - **pHEMT Low Noise**
  - **pHEMT Power**
  - **HFET 0.25u**
  - **VPIN High Power**
- **InGaP**
  - **HBT Low Phase Noise**
- **SOI**
  - **0.32u, 0.28u, 2.5v FET's**
- **IPD**

Technical Overview - Process

- IC
  - High density
  - High voltage
  - Radiation hard
  - Power switching
  - Pico-power
  - RF



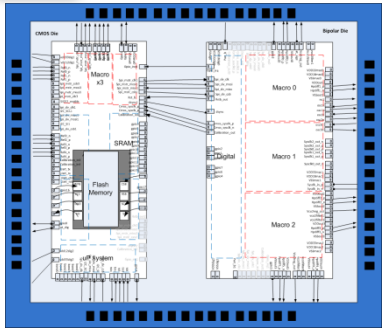
Process Technologies:

- **Pure CMOS**
  - **0.5u, 0.35u, 0.35u with color filter, 0.18u, 0.13u, 0.065u**
- **CMOS with NVM**
  - **0.15u, 0.11u, 0.065u**
- **CMOS with Anti-Fuse**
  - **2.0u, 0.35u, 0.15u**
- **BCD CMOS**
  - **0.5u 30V**
  - **0.35u 20V, 30V, 40V (Full Float)**
  - **0.35u 80V (Trench Isolated)**
  - **0.35u SmartFET**
  - **0.35u 20-60V, natural Vt and 5,12Vgs**
  - **0.18u, 40v, 80v (Full Float)**
  - **100V and 200V N and P MOSFETs for military and RT applications.**
- **Bipolar**
  - **9 to 11 mask with voltage from 12V to 60V, single or double metals.**
  - **BiCMOS: 4mm and 1.4mm double metals with 19 mask Non-RT**
  - **Schottky: up to 200V with Pt, W, TiW barrier metal.**
  - **Rectifier: Planar or Mesa, switching or non-switching, up to 1600V**
  - **SCR: up to 1200V SCR and RGT**
  - **Zener and TVS: 5V to 250V**
  - **5 Ohm-cm Bipolar with Buried Layer, Deep Collector, 24 KA SLM RT**
  - **12v, 20V, 40V Bipolar with Buried Layer, Deep Collector, SLM or DLM – Rad Hard**

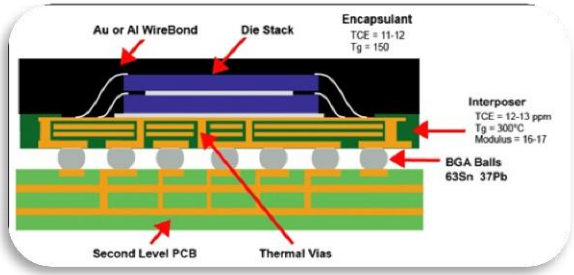
Technical Overview - Process

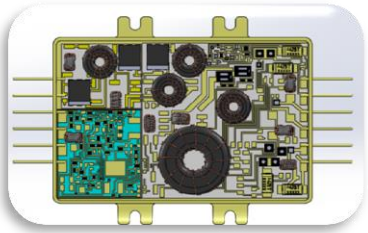
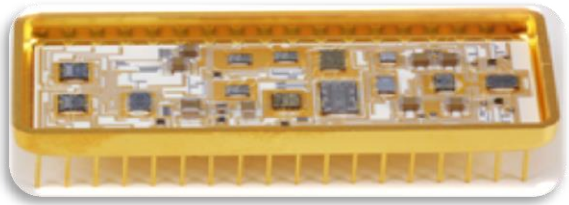
- Module/Hybrid
  - High density/integration
  - POL, linear, digital
  - SS relays
  - Build to print
- Packaging
  - Hermetic & Non-hermetic
  - Multi-die, stacked
  - Power

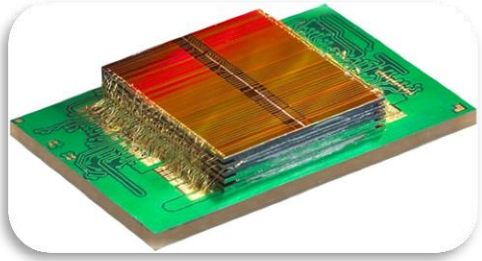










Technical Overview - Test & Reliability

- Test
  - Full device characterization and modeling
  - Production device and IC testing
    - Power
    - RF
    - High performance timing (Jitter, wonder, etc.)
    - Digital/mixed signal
    - Processor, memory, fabric, scan, ATPG
  - Radiation Hard
    - SEE
    - ELDRS
    - TID
    - Process characterization
- Reliability
  - Thermal cycling
  - Mil and Space level testing (more on this later)
  - Circuit DPPM levels below 5
  - QML
  - ELDRS lab

Space Heritage - Part of our DNA

- Microsemi has a greater than a 55 year history in space
  - Very broad product and capability base
  - Experience with systems, circuits and customers

- Microsemi is dedicated to space
  - Enlarging product portfolio - non obsolescence policy
  - Space segment is key for Microsemi growth
  - We continue to invest in space segment (R&D)
  - Leveraging size and diversity of company to expand and enhance product capabilities
  - Building advanced technologies to serve space requirements
    - Packaging, device technologies, system design

- 2013 overview
  - Continued strong market growth
  - Continuing to increase content
  - Systems approach to product development
  - Product Leadership in FPGAs, power converters and control, ASICs, rad-hard components and RF technology

Space Heritage - Where do we fly?

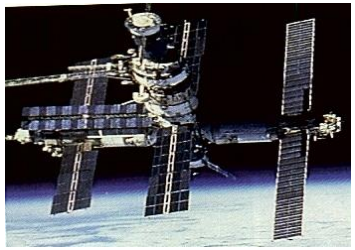
Launchers / Missiles
Delta IV
Sea Launch
VLS
MinuteMan III
THAAD
Pegasus
Arianne Y
H-2A
D5 ENTB
Patriot
Atlas II, V

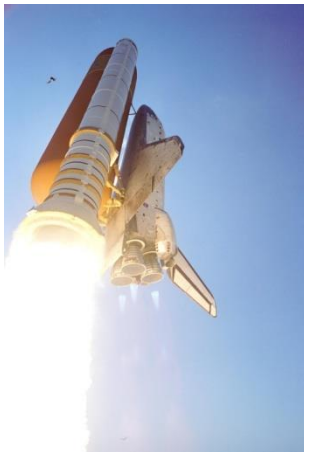
Commercial
Globalstar
Anik F2
Intelsat IX
GE-1,2, . . . 18
Echostar
Telstar
Radarsat I, II
CRSS / IKONOS
OrbView
IndoStar
QuickBird
Hispasat
Astra
WorldStar
Orion 2
KompSa
Orbcom
PanAmSat

Military
MightySat
P81 (Classified)
P59 (Classified)
HESSI
Clementine
SBIRS
AEHF
Myter Joint
GeoLite
WarFighter 1
TSX-5
MTI
STEP
STSS
Midcourse Space Exp
NPP / NPOESS
GPS
MUOS

International
EnviSat
Cluster II
METOP
Rosetta
Champollion
Stentor
Yamal 100
SAC
Sicral
ACeS
L-Star
SOHO
SILEX
Integral
Int'l Space Station
MDS
N-Star
MTSat
ETS VII
JEM
ADEOS II
OICETS
DRTS

Civilian / Scientific
Deep Space I
Mars Pathfinder, Surveyor
Mars MER1 and 2, MRO
Mars: MSL
Contours
Seawinds
SIRTF
Messenger
Lunar Prospector
GALEX
GIFTS
TIROS
Landsat VII
EOS-AM1, Chem1, PM1
Cassini
TDRS
Space Shuttle
Hubble Space Telescope
Windsat
GOES
AXAF
TRMM
XTE
ACE
SMEX
MIDEX
GLAS
NEAR
Timed
FUSE
Genesis





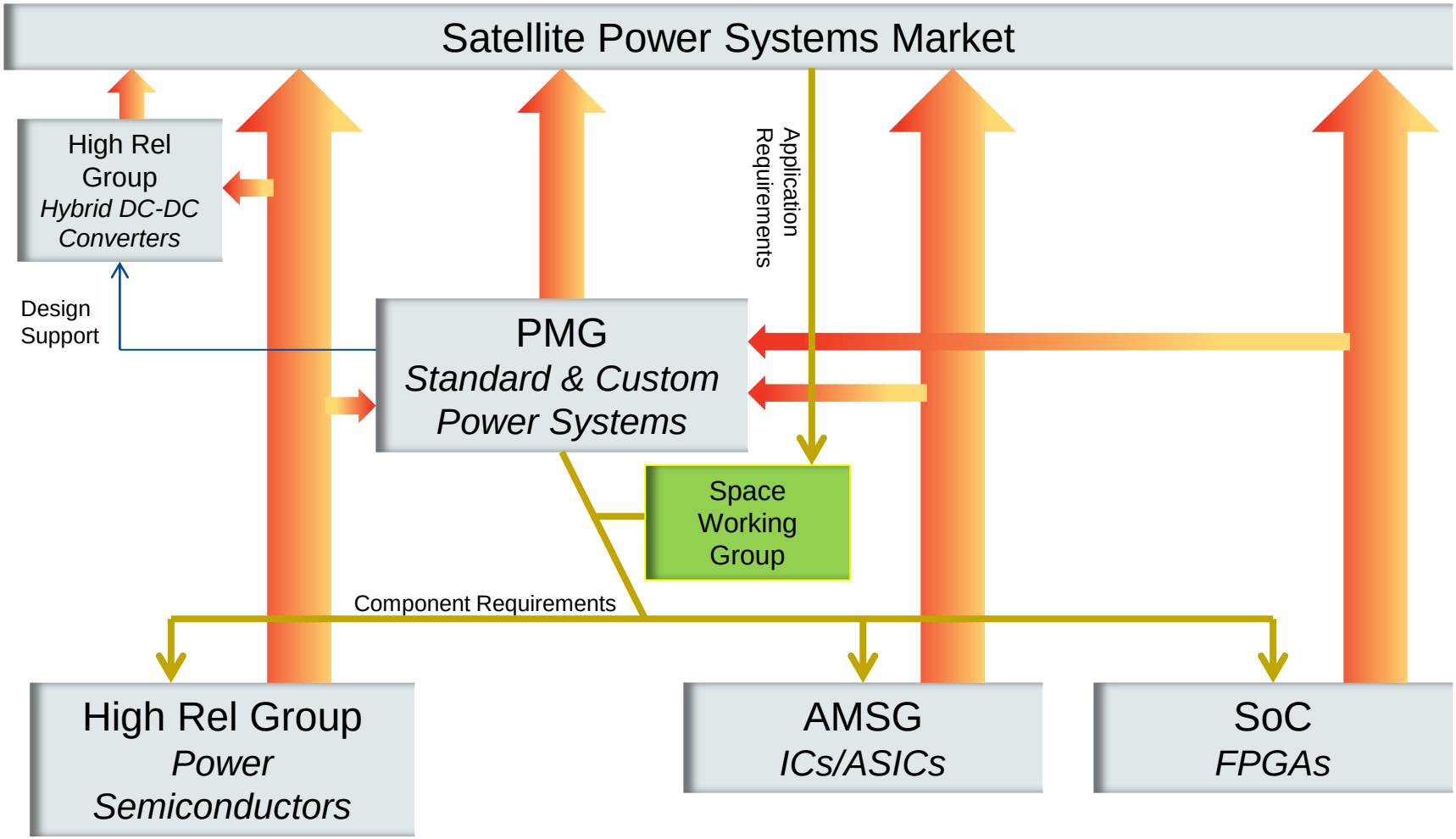
Space Heritage - Committed to QPL-19500

- Microsemi remains committed to the QPL-19500 system for discrete
  - 100% committed to the QML system
  - Still have the largest number of QPLs in the industry
  - We are adding parts on a continuing basis
    - RH MOSFETs
    - Small signal transistors
  - Also expanding our commitment to MIL-PRF-38534

System View Device Development

- We look at the total system when building our product roadmaps to build devices that work together better in the final system
  - Smaller, lighter, less expensive, faster, more reliable
- System engineers always look at a satellite as a system
- Interfaces and partitioning are done at this level of engineering
- Without coordination of component development
  - Difficult and limited choices in partitions
  - Performance, power, weight, and cost are sacrificed
  - Interoperability assurance diminished

Microsemi Space Product Flow

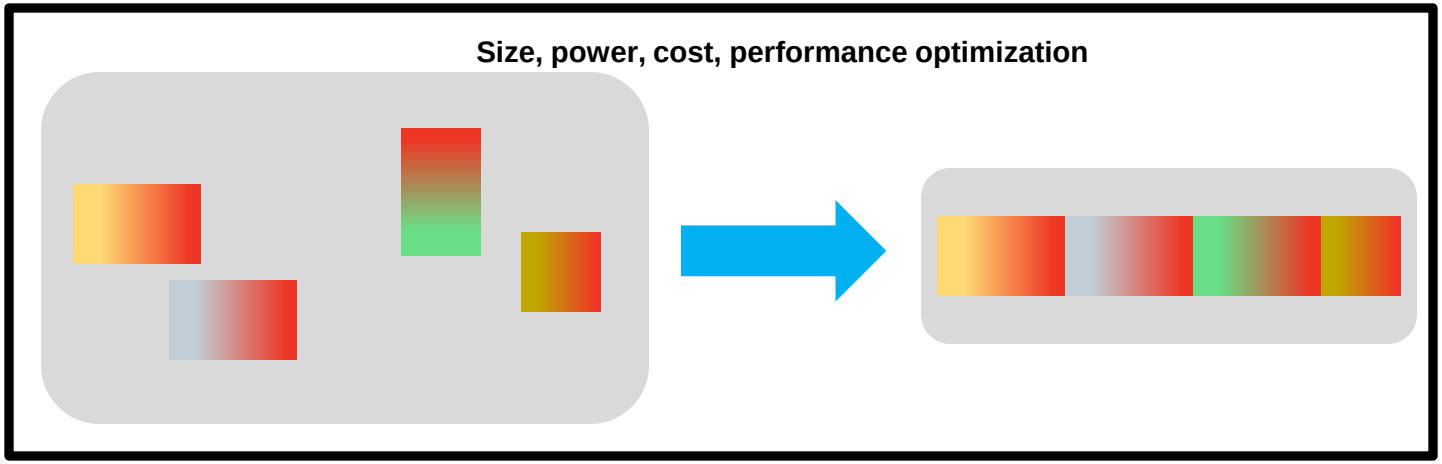


System View Device Development

- If device designers look at the system design to define products
  - Digital interface formats aligned
  - Digital and analog physical interfaces aligned
  - Power generation optimized for load and rails
  - No more level converters, signal dividers, extra clock channels
  - Product introductions aligned
  - Reliability architected into the component systems

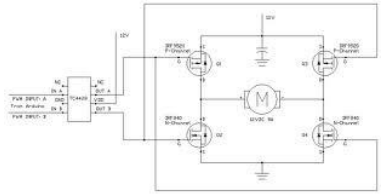
System View Device Development

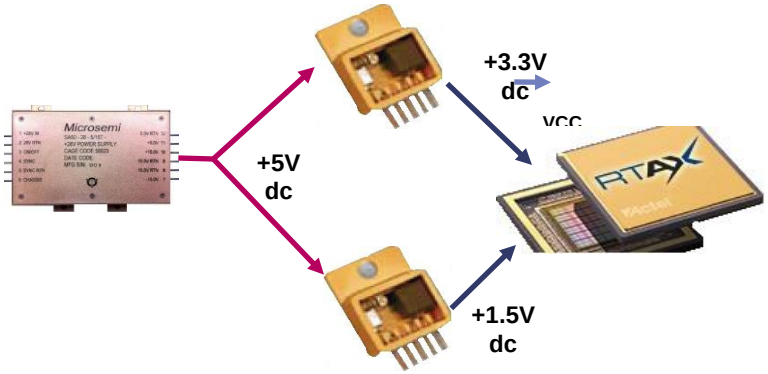
- To take advantage of this advanced view of product definition
  - Companies can align products in their portfolio
  - Companies can partner
  - General standards

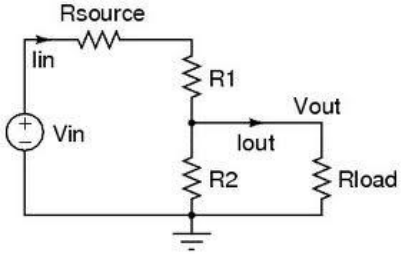


System View Device Development

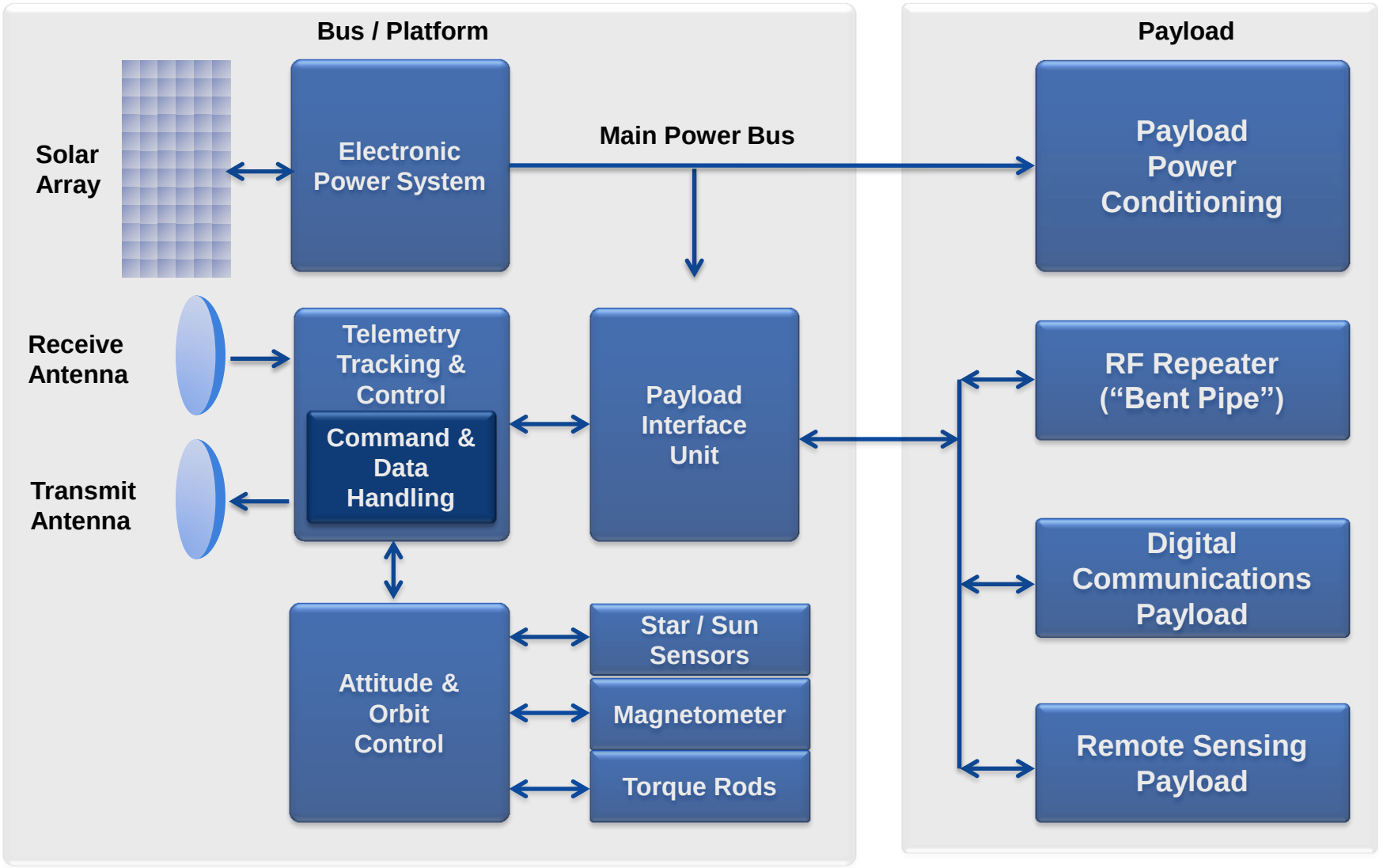
- Examples
  - High-speed digital interfaces, standard, and custom
  - Analog converters (A/D, D/A) dynamic range alignment
  - Integrated voltage and current references
  - POL devices and FPGA or ASIC current and voltage load matching
  - Consistent cross device radiation performance (weakest link)
  - High temperature switching device drivers optimized to switching device characteristics
  - Serial communication width appropriate for the device technologies involved
  - FPGAs control and monitoring clock and power generation
  - Optimized device power down







Satellite Block Diagram



System View - Roadmap Alignment Examples

- Next-generation RT FPGAs
  - High-speed communications common with our space system managers
  - POL matched to load requirements, programmable and monitoring
- Space system companion devices
  - Analog and/or digital processing
  - “Custom ASIC”
  - High speed interfaces
  - Digital bus alignment

- High power switching devices
  - Custom drivers for optimized performance and protection
  - Device switching constraints eliminated from user
- Needs of system designers built into roadmaps from the start

Summary

- Microsemi is dedicated, focused, and investing in space products and capabilities
- Microsemi has been in the space business as a partner with our customers for more than 55 years and expects to be for a long time
- Microsemi has the system, circuit, and production experience in space to be a long term supplier of state-of-the-art products for long life cycles
- Microsemi uses a system view of applications, our breath of technology and design experience to build the best in class products for space

Microsemi

Thank You