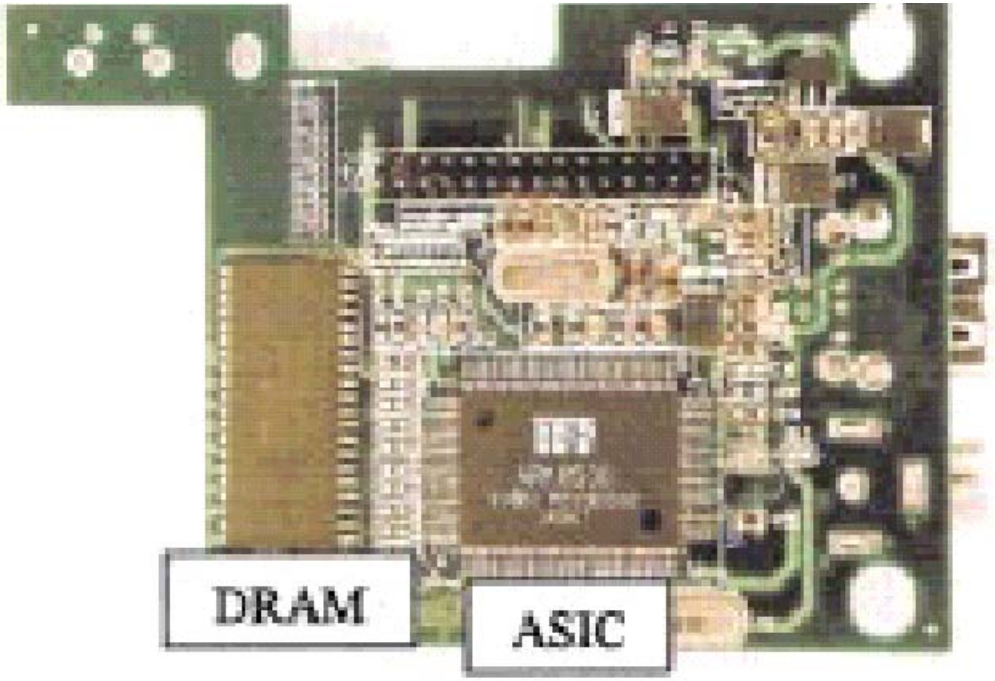
# System on Chip & System on Package

A Comparison of the Two Paradigms

# Semiconductor Microelectronics


# Pre – SOC/SOP (ASICs)



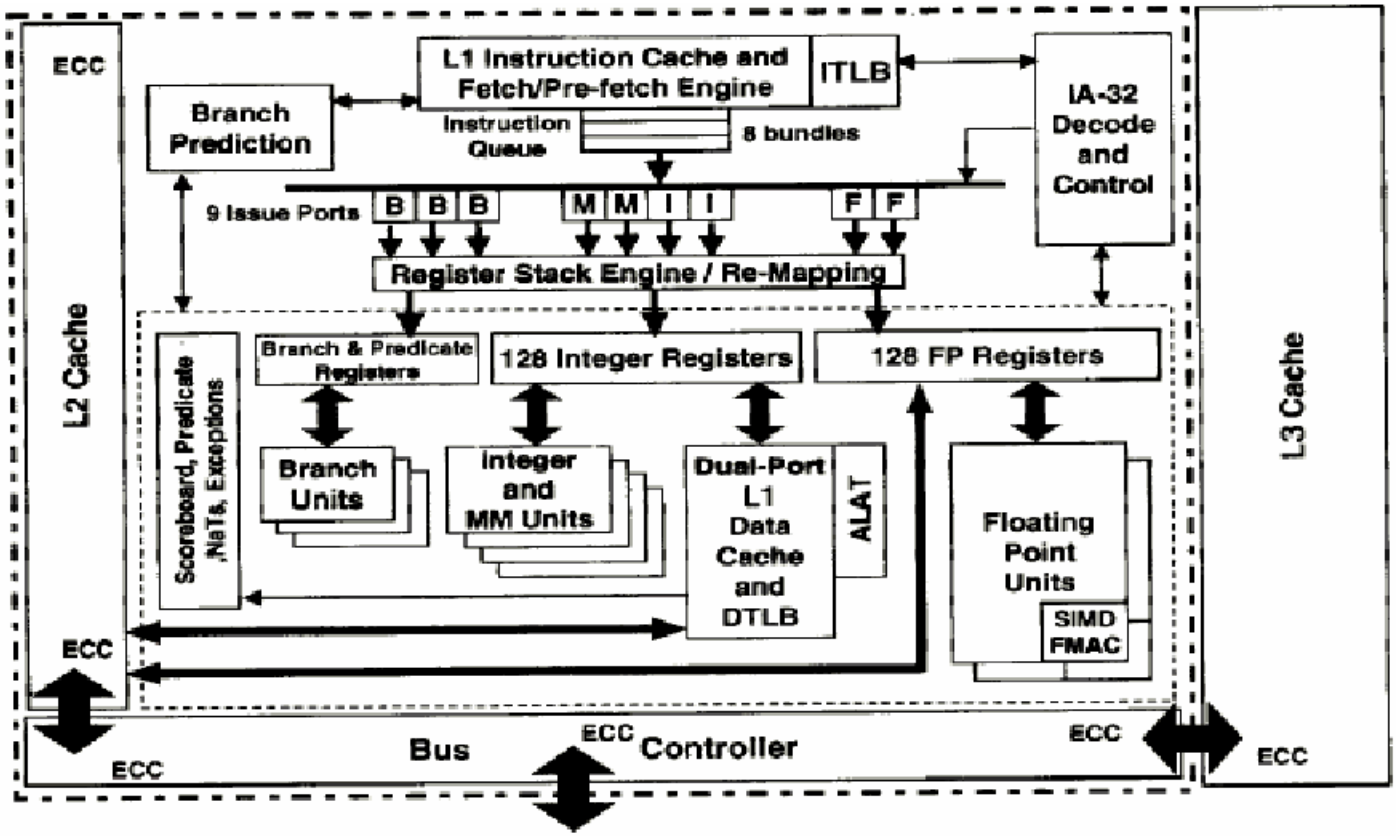

**Tsai, R.B; Implementing ASIC/Memory Integration by System on Package*

# SOC

- The realization of an entire system's functionality in a single, large IC. The IC integrates digital, RF, analog, and other functions.

** Frantz, G; System on Chip: A System Perspective*

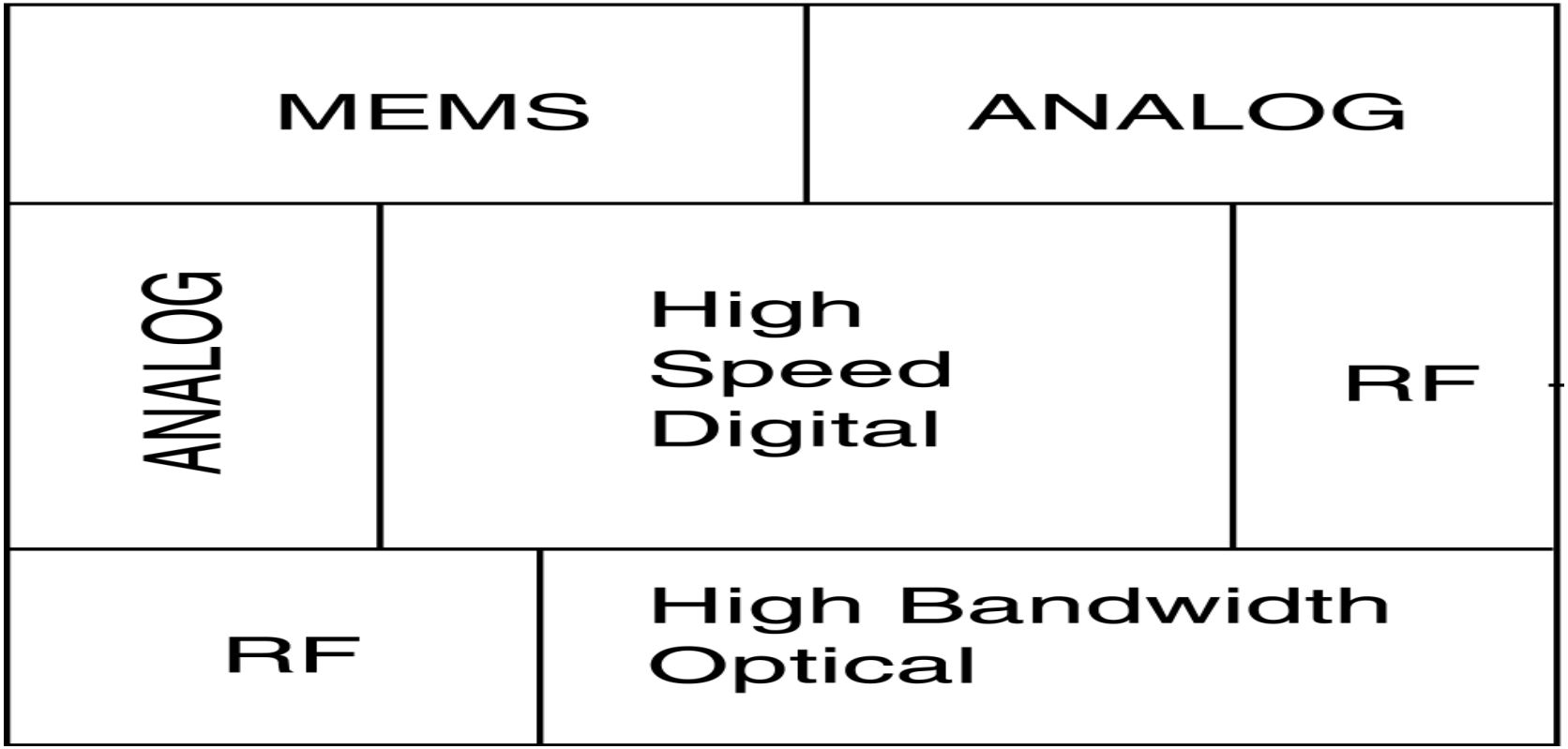
# SOC




An example of a SoC, the Intel IA-64 CPU Microprocessor.

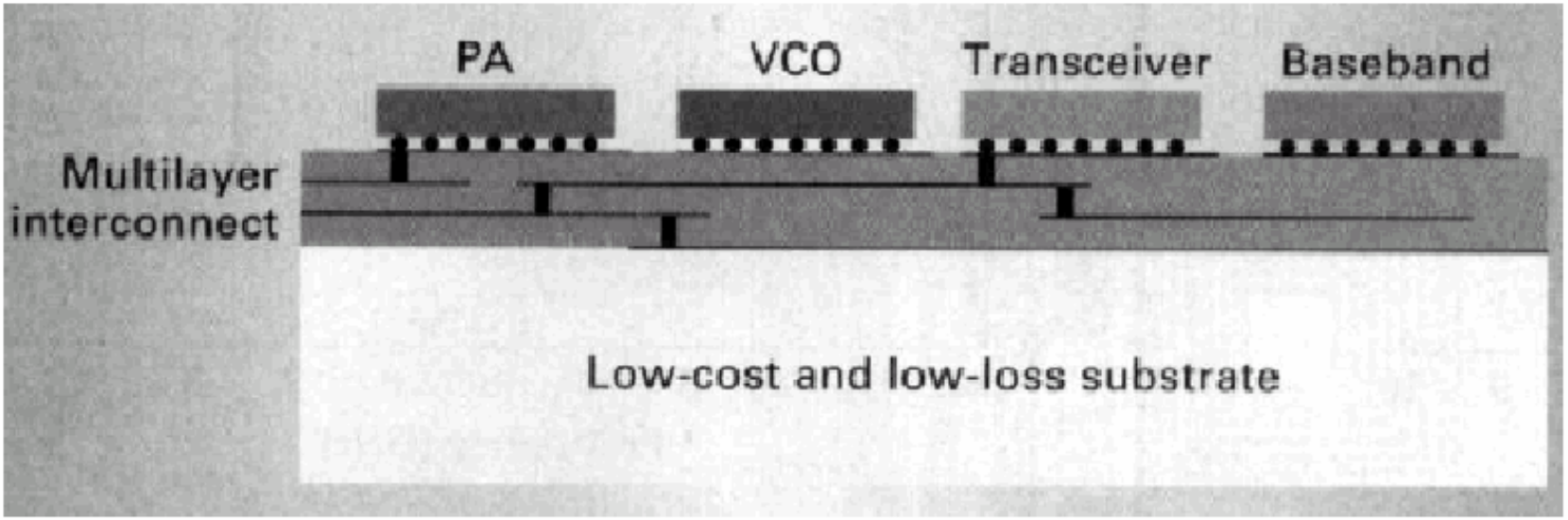
** Davidson, Evan; SOC or SOP? A Balanced Approach!*

# SOC




** Tummala, Rao; ECTC 2001*

# SOP Example of Cellular Technology




An example of a SoP, the mixed technology FCM for a cellular telephone.

** Davidson, E; SOC or SOP? A Balanced Approach!*

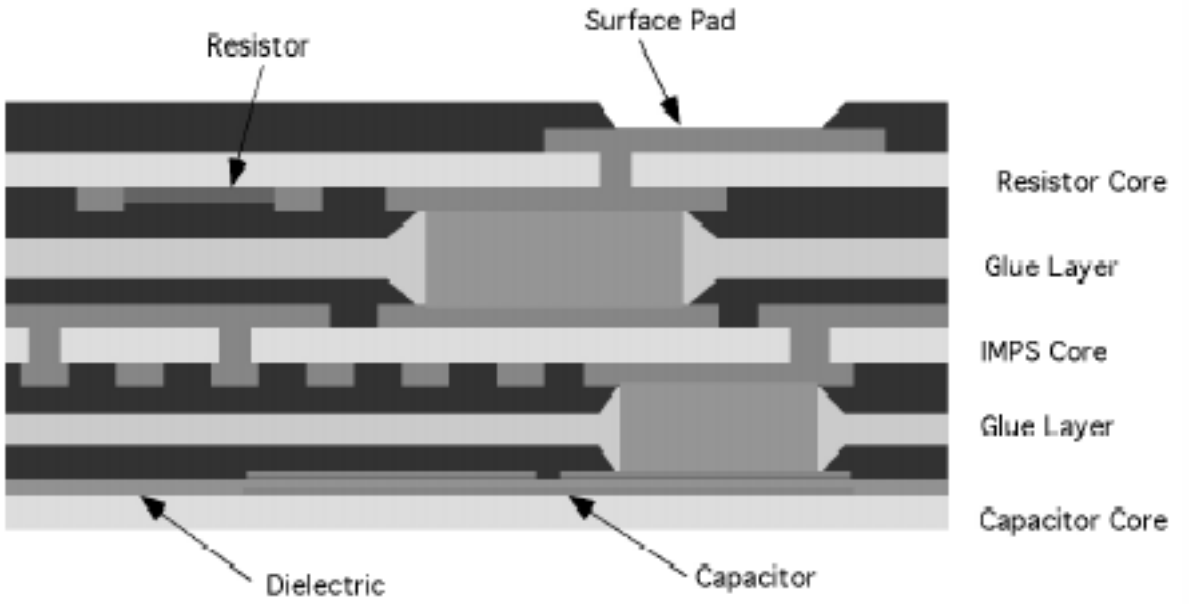
# Long Lossy Line ($L^3$) Problem

- The high delay associated with inherently resistive on chip global transmission lines.

| | Total Resistance | Line Delay |
|---|---|---|
| Small Cross Section Long Lines | 10-20X total resistance of a low loss line | 5-10X low loss value |

Means: Above 2GHz operation, the highest clock rates will be supportable only in localized regions of a large chip. As a result global long lines may have to run at a sub-multiple of the local clock rate.

# Embedded Passive Elements



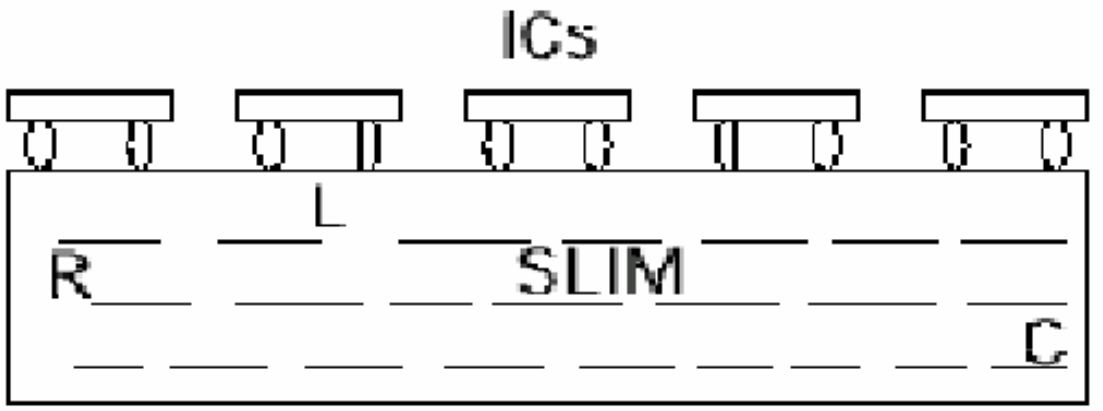

The cross-section of a SoP substrate that contains embedded passive devices.

*Davidson, E; SOC or SOP? A Balanced Approach!*

# What is SOP?

- A system level package containing multiple large ICs that integrate all the system functions
- Proposes a unified chip-plus-package view of the design process.

# SOP




*The SOP provides electrical connectivity and functionality, integrated in a single-level structural hierarchy, such as this single-level integrated module (SLIM) package. (L, C, R: inductance, capacitance, resistance)*

** Tummala, Rao; System on Chip or System on Package?*

# SOC Challenges

- Technical
- Business
- Legal

# Legal Problems

- Significant rework and design
- Difficulty writing indemnification contracts
- Legal scrutiny

# Business Challenges

- Long design time and test cycles
- Higher SOC design and production costs
- Reuse library integration difficulty

# SOP Advantages

- Technical

1. Memory bandwidth
2. Transfer of interconnection functionality
3. Improved system integration

   - Noise Isolation

   - Integrated Passive Components

# SOP Advantages

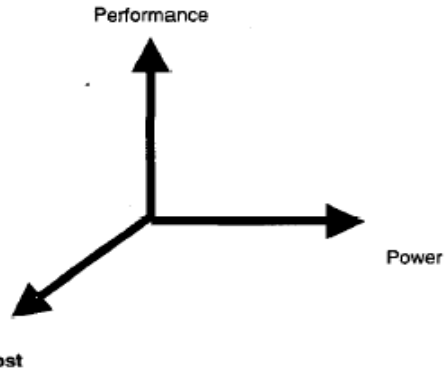
- Business
- Legal

# Changing Role of Electronic Packaging

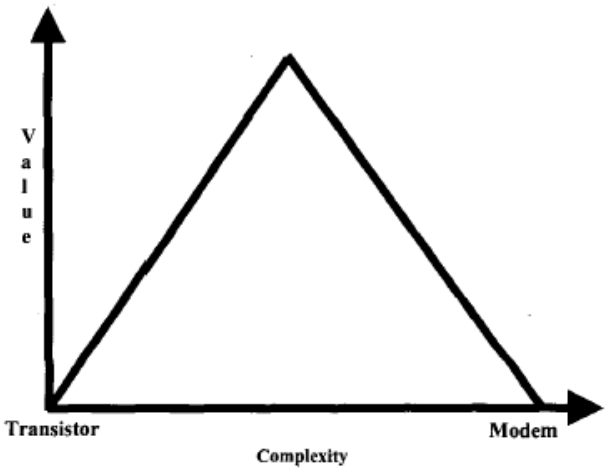
| *Area Affected* | *Past* | *Present* | *Future* |
|---|---|---|---|
| **Environment** | **XX** | **X** | **X** |
| **Mechanical** | **XX** | **X** | **X** |
| **Space Transformation** | **XX** | **XX** | **XX** |
| **Thermal** | | **X** | **XX** |
| **Electrical** | | **X** | **XX** |
| **Homogenous Integration** | | **X** | **XXX** |
| **Heterogenous Integration** | | | **XXX** |
| **Time to Market** | | | **XXX** |
| **Functional** | | | **XXX** |

* *Tummala, Rao; System on Chip or System on Package?*

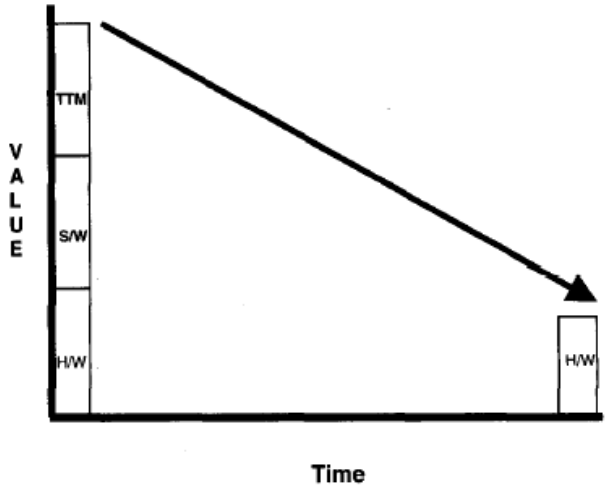
# System Analysis



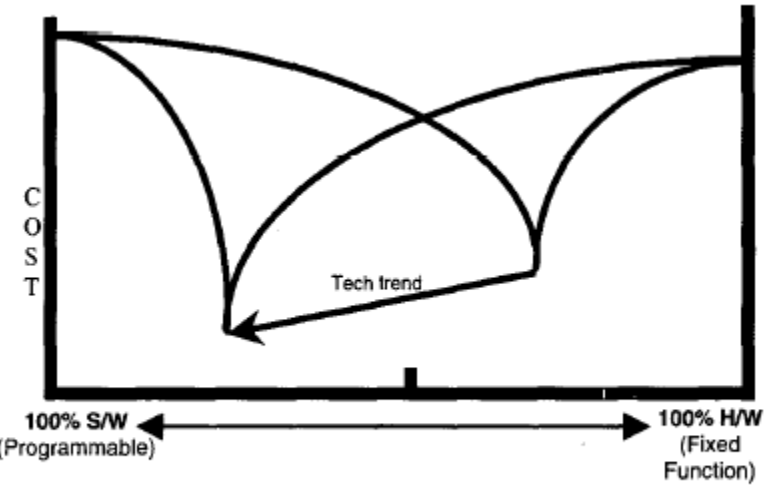

The three vectors of value in an integrated circuit.




Value versus Complexity. To a point, value grows with complexity. But, at some point, the value decreases with added complexity.



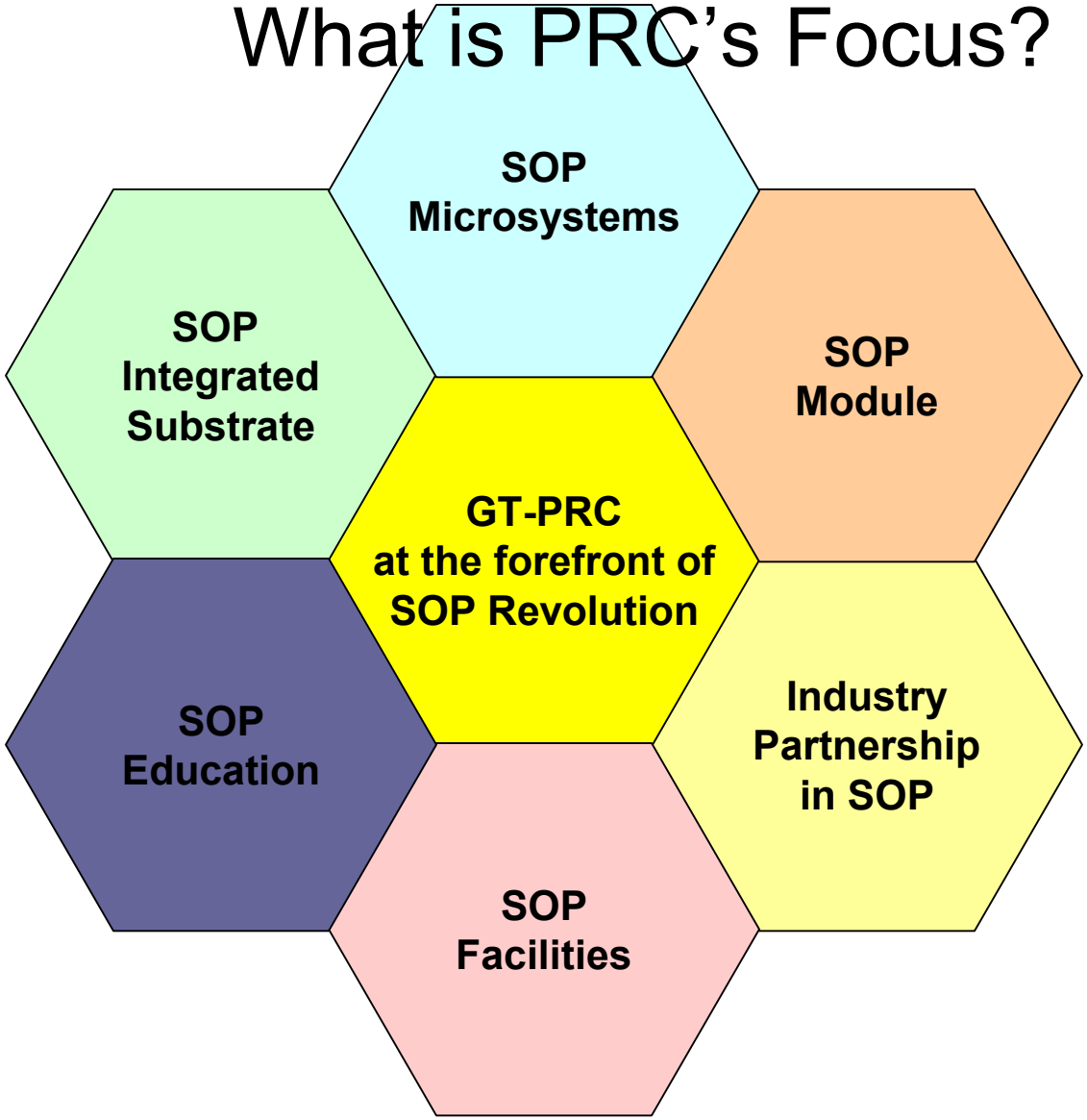

The value of time. The value of a product decreases over time in addition to.




Eutectic diagram shows the cost function of a task as it is related to a combination of software and hardware.

**Frantz, G; System on Chip: A System Perspective*

# What is PRC's Focus?




***PRC's Mission***

- Explore and develop the SOP concept
- Educate a new breed of engineers in SOP
- Develop strategic partnership with industry

# Industries supporting SOP views

- Motorola
- IBM
- National Semiconductor
- Omnipoint Technologies
- Integrated Interconnection Intelligence Inc.

# Conclusions

- SOP has several advantages over SOC
- SOC barriers are very difficult to overcome
- SOP favored choice

# References


- *Davidson, E; SOC or SOP? A Balanced Approach!*
- *Frantz, G; System on a Chip: A System Perspective*
- *Martin, G; Tutorial 2: System-on-Chip Design*
- *Tsai, R.B; Implementing ASIC/Memory Integration by System-On-Package*
- *Tummala, R; System on Chip or System on Package?*
- *Tummala, R; ECTC 2001*