Computer and VLSI design

Packaging

P.J. Drongowski
SandSoftwareSound.net

Packaging

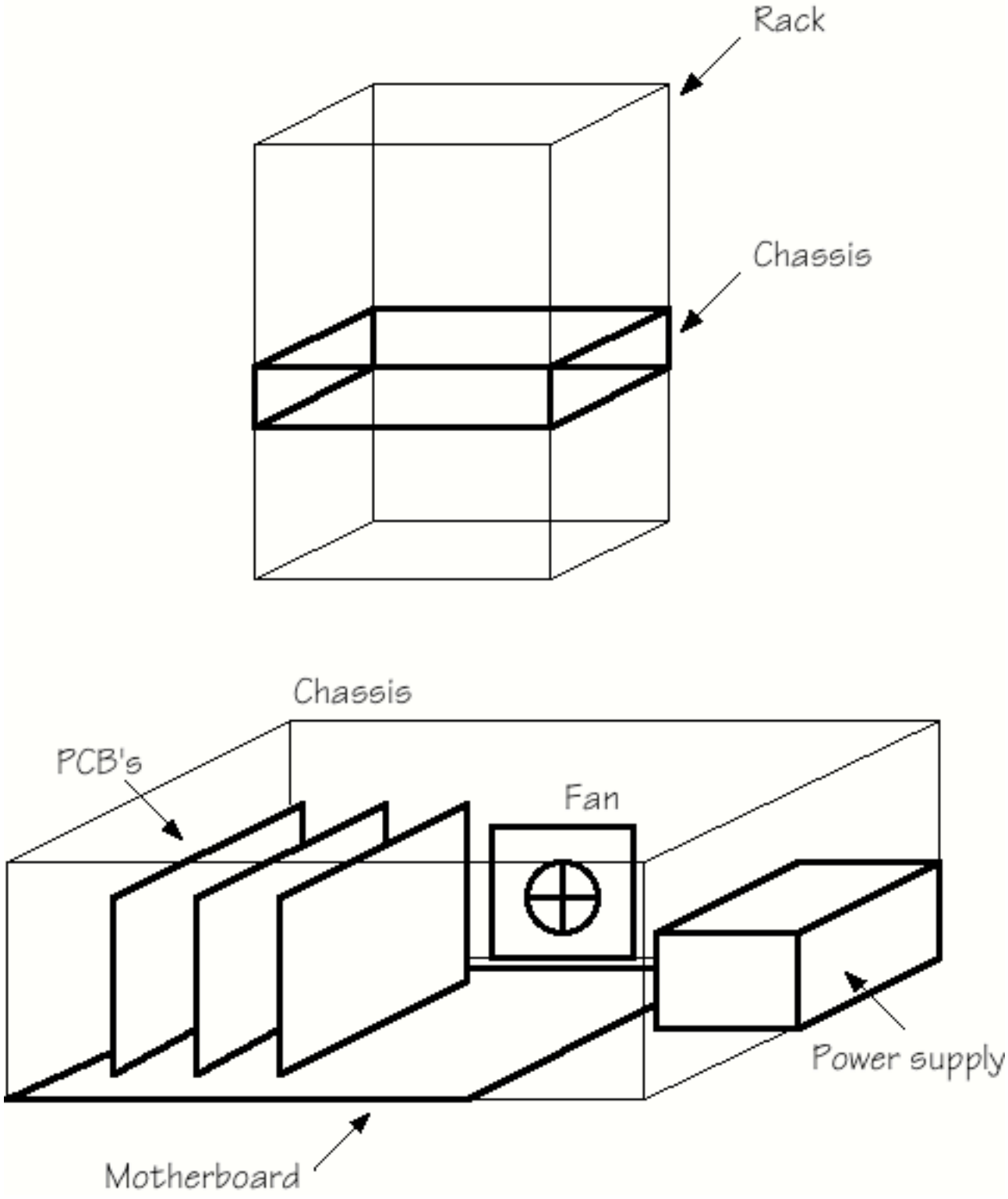
- Considerations
  - Mechanical protection of circuits
  - Interconnection
    - Other circuits
    - Other layers of packaging hierarchy
  - Size
  - Heat dissipation and cooling
  - Power distribution and grounding
  - Noise
  - Shielding
    - Radio frequency inferference
    - Security
  - Assembly
    - Automatic insertion equipment
    - Wire bonding, soldering, wire-wrap, cabling
  - Testing
    - Access to primary inputs and outputs
    - Physical access to internal test points
- Trends in new packaging technology
  - Smaller, denser packages and interconnect
  - Surface mount devices
  - Design for testability, manufacturing
  - Thermal modelling
  - Ceramics
  - Liquid cooling

Packaging & interconnection hierarchy

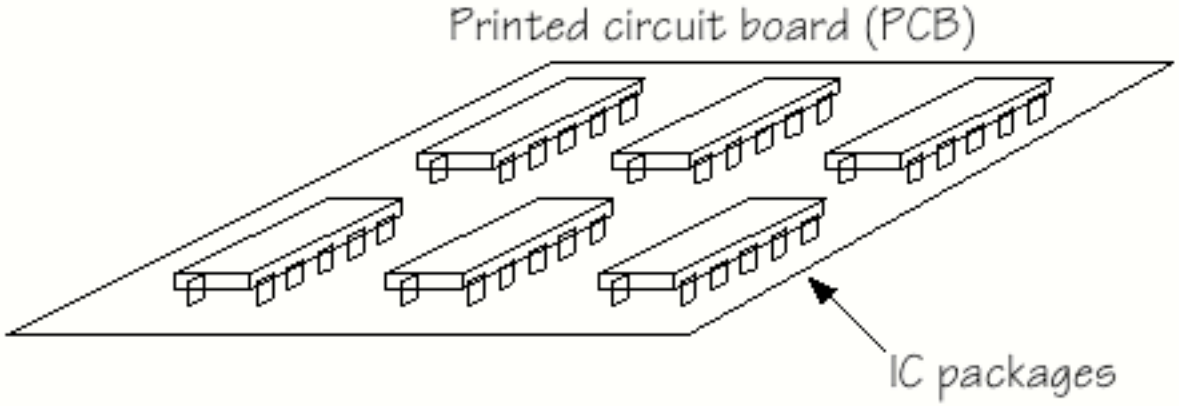
- Packaging and interconnection form a hierarchy
- Within each layer
  - Specific package type(s)
  - Interconnection scheme
- Between layers
  - Connection scheme
  - Compatible bridge between higher and lower layers
- Each layer has physical and electrical limitations
- Partitioning has physical and electrical implications

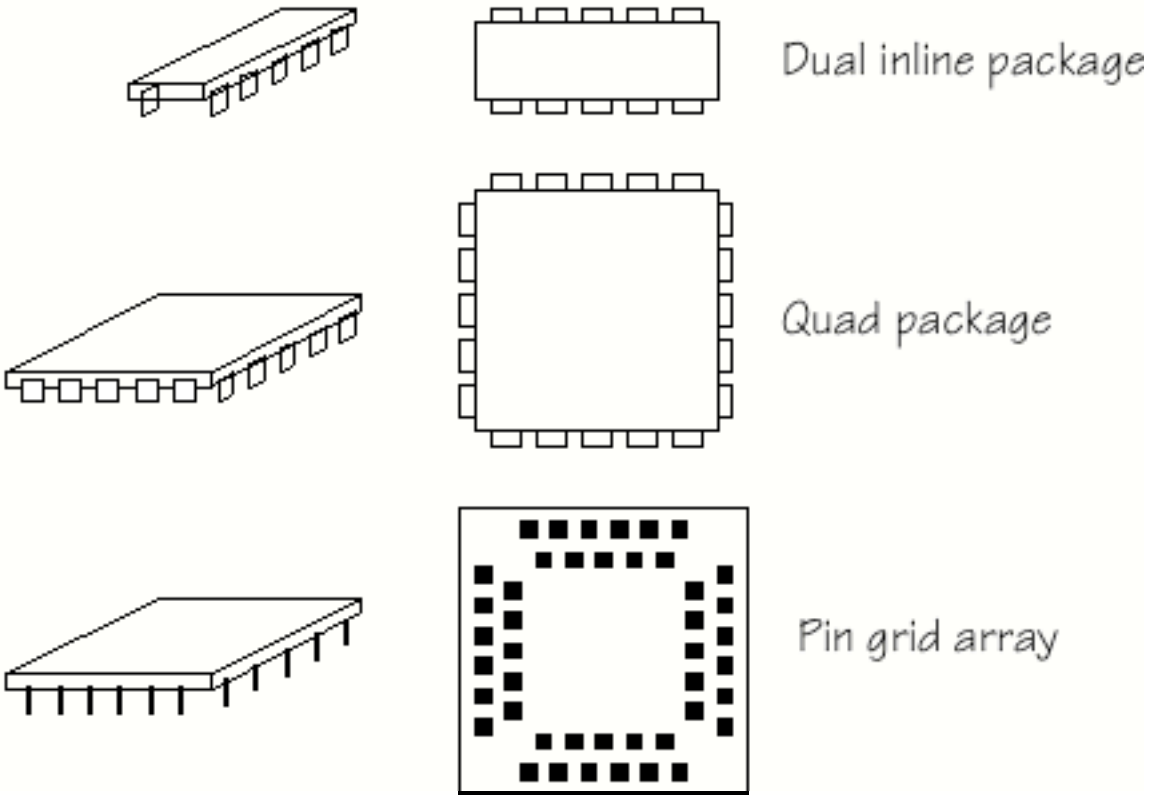
Level	Package	Connection scheme
Cabinet	19 inch rack	Cable
Chassis	Metal frame	Cable
Backplane	Motherboard	Trace or WW
Board	PCB	Metal trace or WW
Component	DIP, PLCC, etc.	Wire or metal film
Chip	Substrate	Si or metal wire
Transistor	Substrate	Si or metal wire

Hierarchy



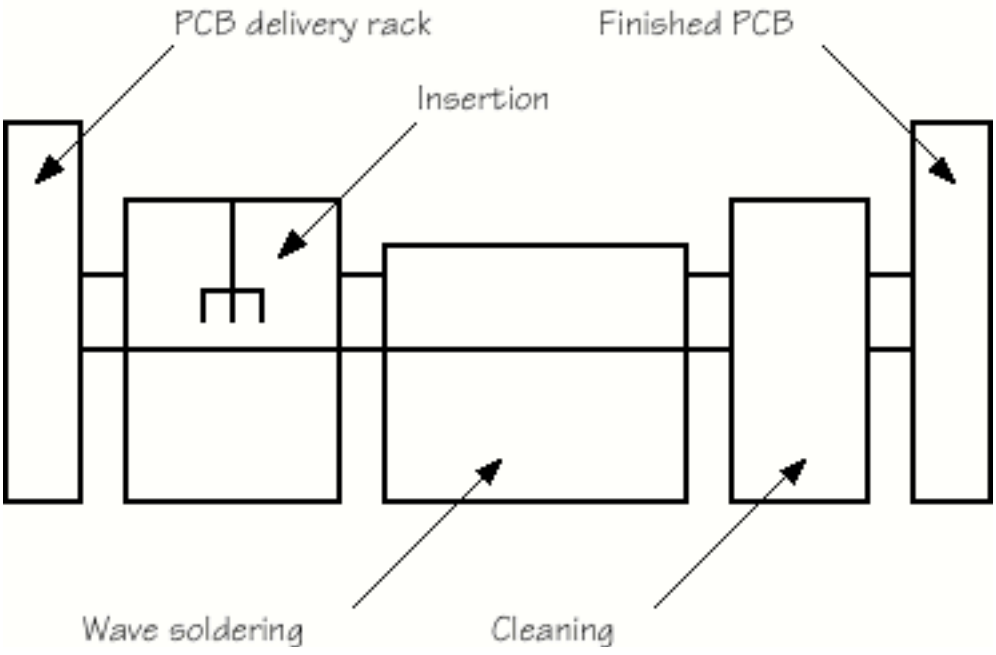
Hierarchy


Printed circuit board (PCB)
IC packages


Dual inline package
Quad package
Pin grid array

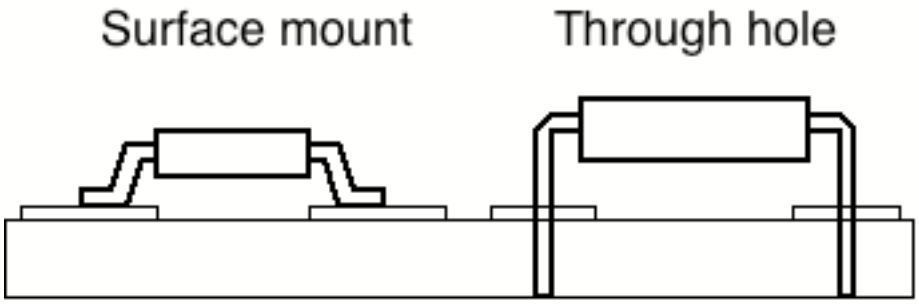
Printed circuit board

- Minimize number of parts and pins
- Standardize parts (surface mount)
- Use design guidelines with checks
  - Component sizes and spacing
  - Test point spacing
  - Border area for handling
  - Rules for high-yield soldering
- PCB production (Apple)
  - 8" and 12" standard PCB sizes
  - Build 90% of PCB at any site
  - Surface mount
    - SE - Only 20% SM technology
    - IIcx - 80% surface mount
  - Only 1% manual insertion in IIcx
  - 10 components in IIcx vs. 16 in SE



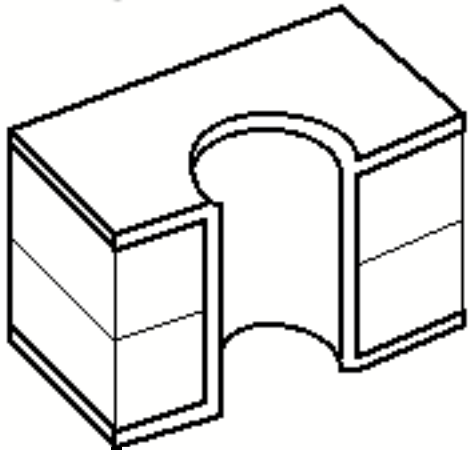
Surface mount

- Components mount on surface
- No through holes
- Can use top and bottom of PCB
- Need less board area and power
- Operate at higher speeds
- Easier for machines to place



14 pin dual in-line	0.1" spacing	0.23 sq-in
14 pin small outline IC	0.05" spacing	0.08 sq-in

Through hole



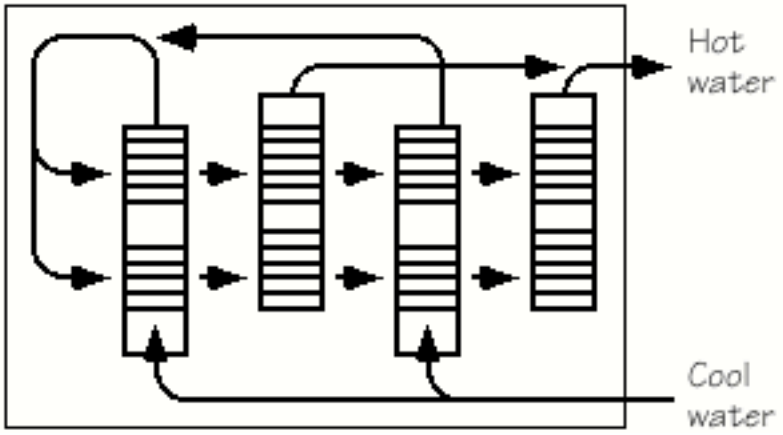
- Drill hole
- Plate via
- Register pin

Cooling

- PCB density is beyond air cooling
- Short delay requires short signal paths
- Shorten life by 50% for every 10° C
- Use liquid cooling
- Inexpensive 'plumbing' is a problem

MCC radiator

- Similar to human circulatory system
- Cool water flows in through large channels
- Passes through smaller channels under IC's
- Narrow capillaries between interconnect
- Hot water flows into larger outgoing channels
- Boards plug in to electrical and cooling backplane
- Multilayer silicon / polymer sandwich
- Channels are etched in silicon



Hierarchy