



Intel® Corporation Presents:  
The Eco-Technology Great Debates

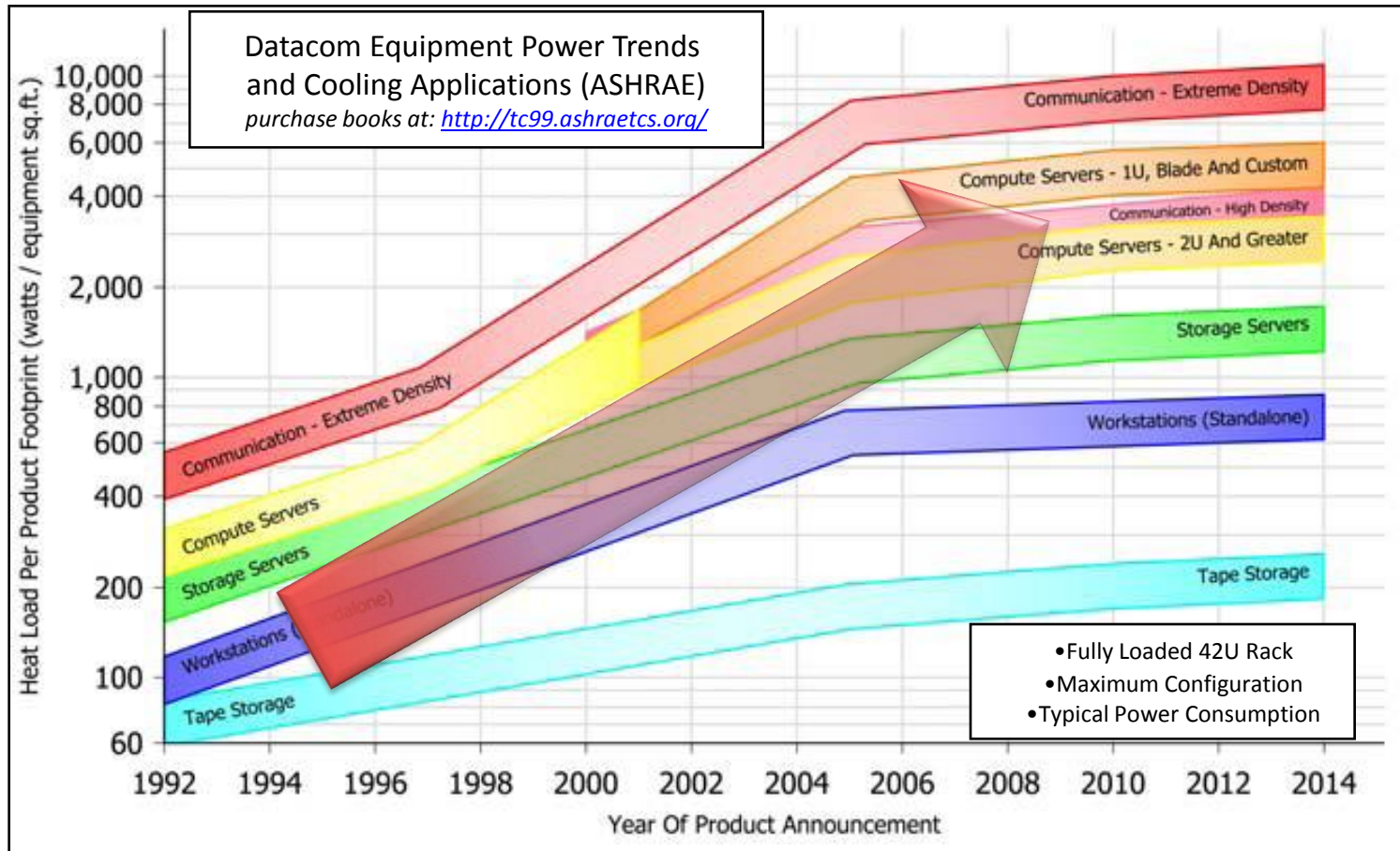
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# Low-Density Computing

# A Case for Low Density Cooling

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Microsoft Corporation

# What's Driving Density Up?

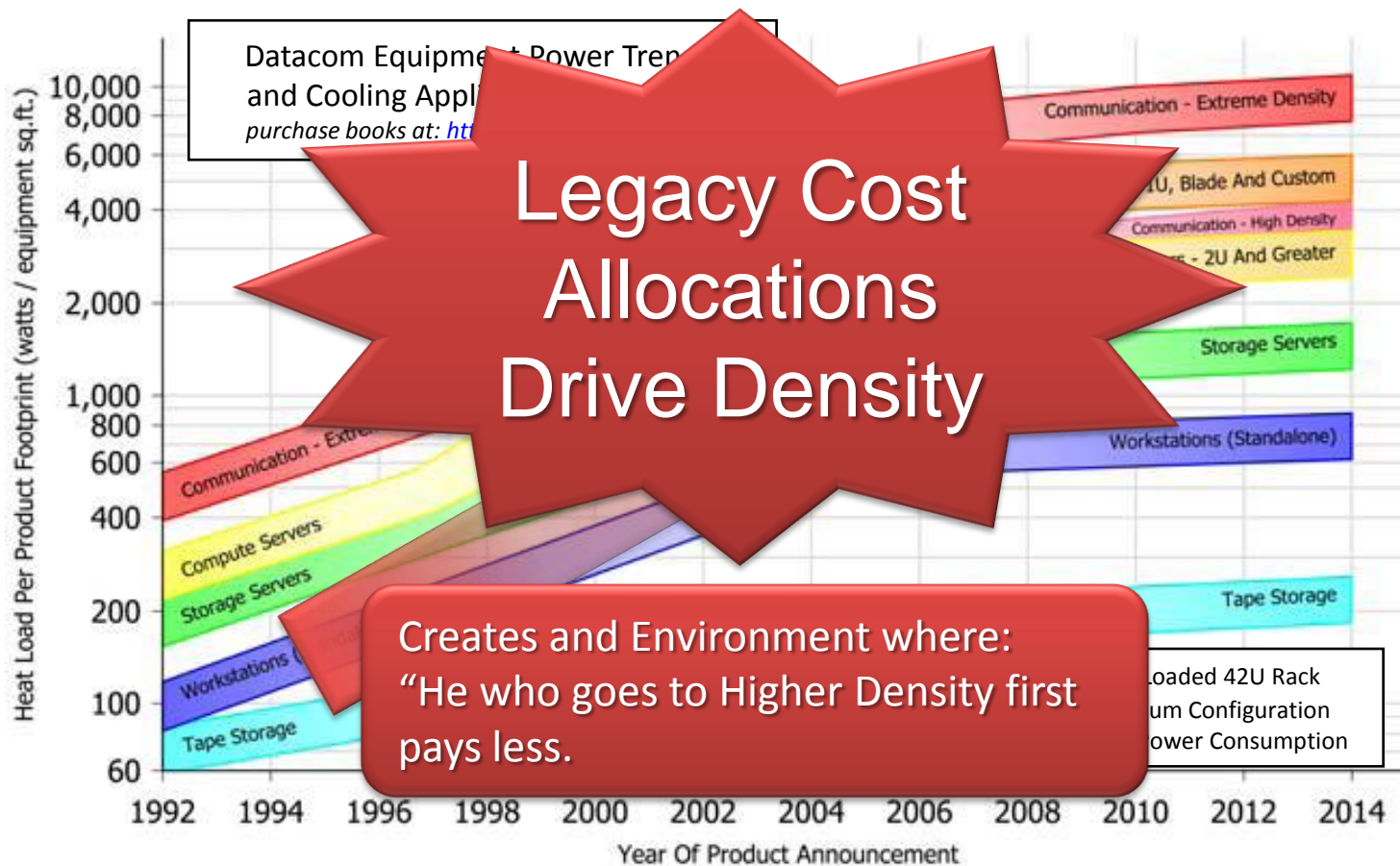


# Disclaimer

- There are good arguments for both low and high density
- The ideas presented here do not necessarily represent Microsoft's views but rather to illustrate some possibilities
- This is a complex discussion and the real answer will depend on the business need



# What's Driving Density Up?



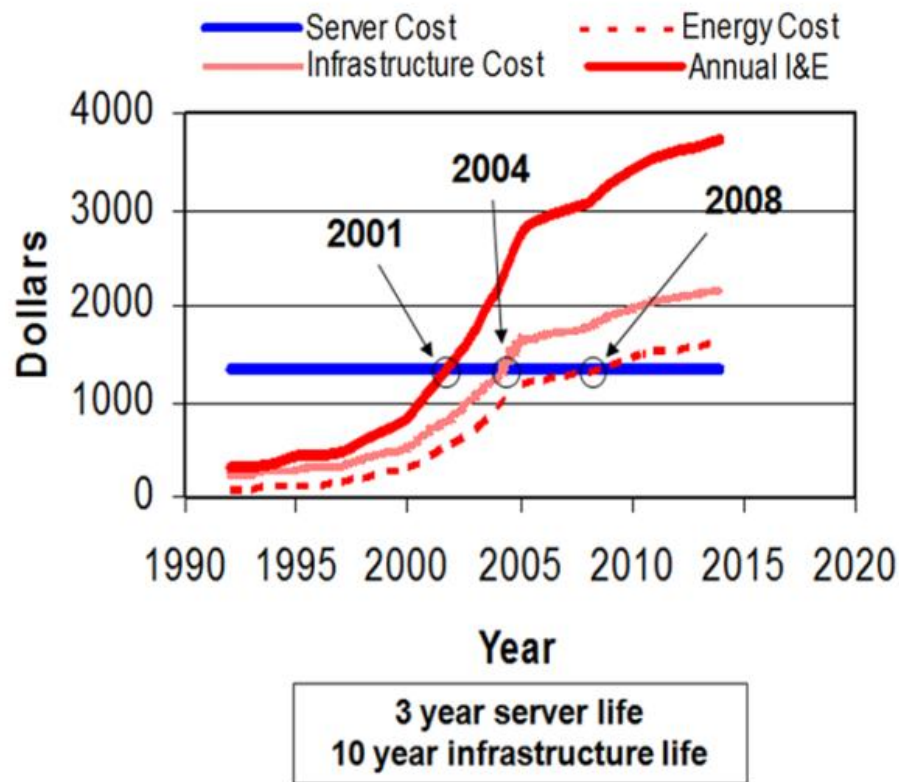
## The Legacy

- Cost of physical space was a primary consideration in data center design
  - Chargeback based on space
  - Drove Efficient use of space (Density)
  - Easy to do

## The New Reality

- Cost of power and cooling has risen to prominence
  - Chargeback needs to be based on power
  - Drives Efficient Use of Power!
  - Needs better measurement & monitoring (we have the technology)
  - Costs are scaling with Power and not space

## Annual Amortized Costs in the Data Center for a 1U Server



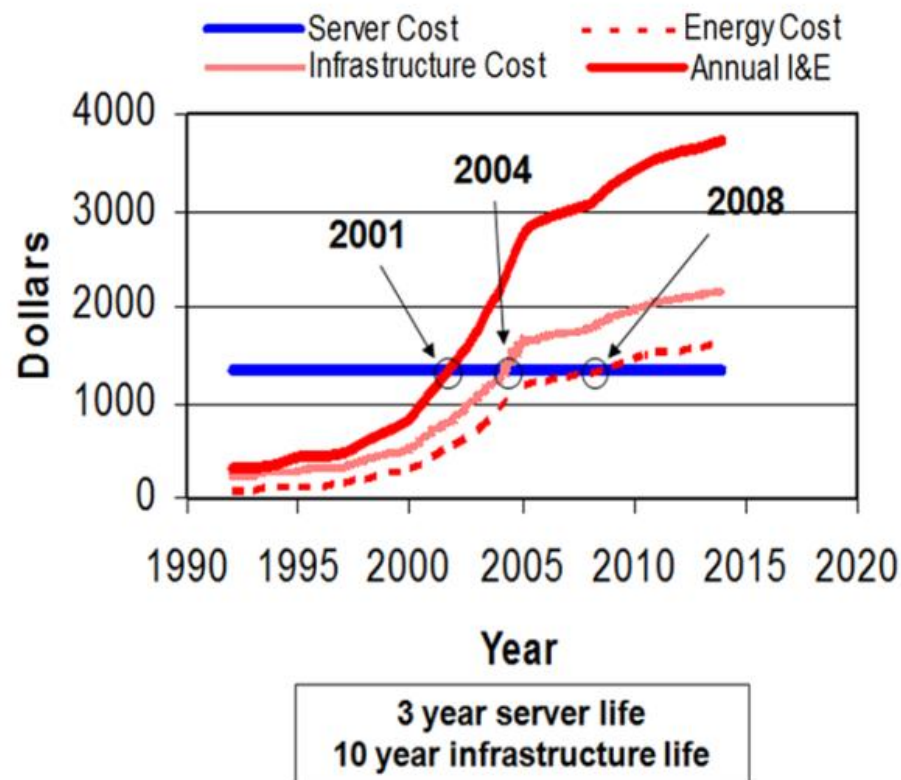
Belady, C., "In the Data Center, Power and Cooling Costs More than IT Equipment it Supports", Electronics Cooling Magazine (Feb 2007)

HPC probably wants density for cluster performance but...

...the rest of the world may be different:

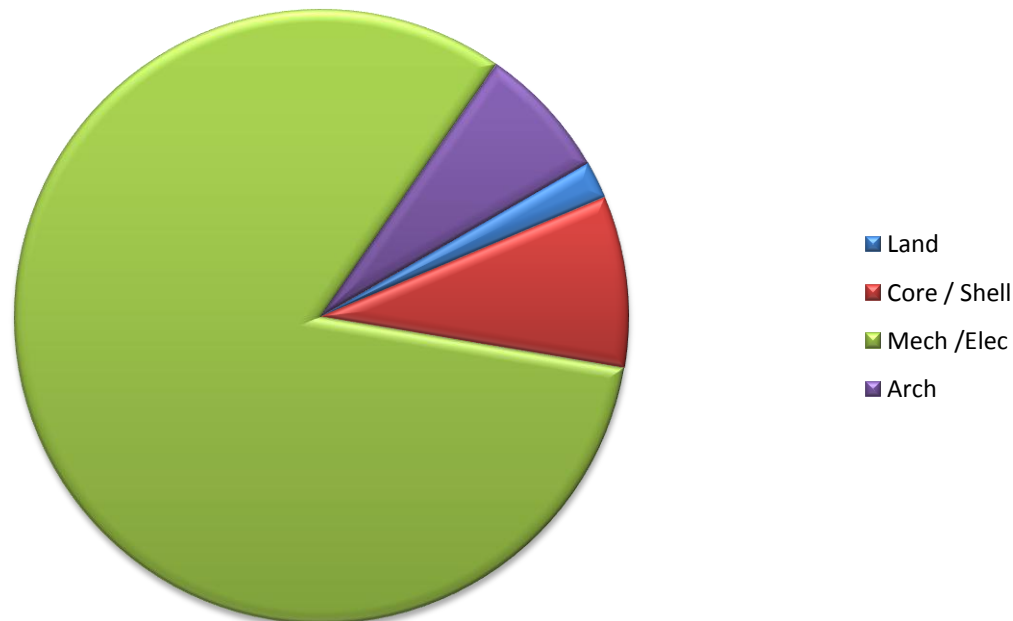
- Want to Drive down infrastructure costs
- Want to drive down server costs
- Want to improve efficiency

## Annual Amortized Costs in the Data Center for a 1U Server



Belady, C., "In the Data Center, Power and Cooling Costs More than IT Equipment it Supports", Electronics Cooling Magazine (Feb 2007)

# Data Center "PacMan" in the US

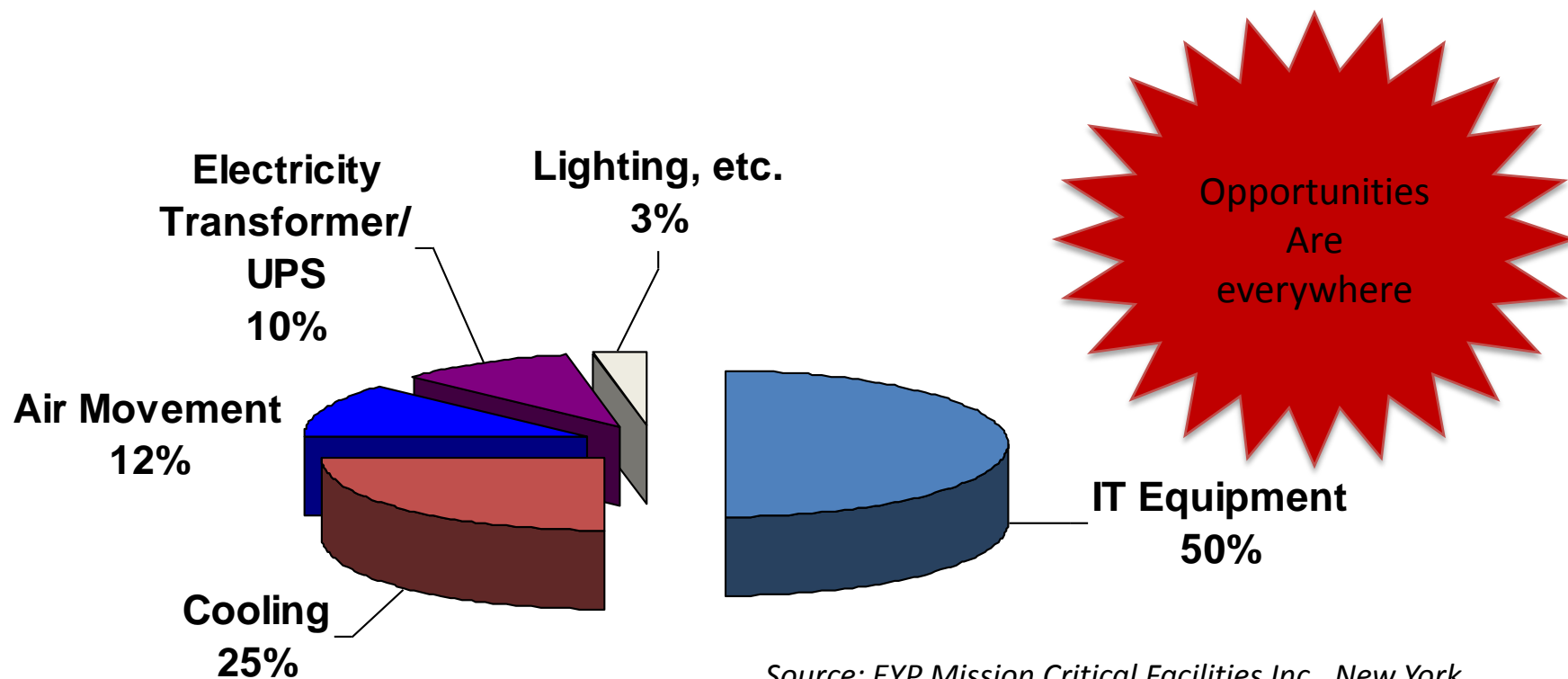


- Land - 2%
- Core & Shell Costs – 9%
- Architectural – 7%
- Mechanical / Electrical – 82%

Where the cost are:  
>80% scale with power  
<10% scale with space

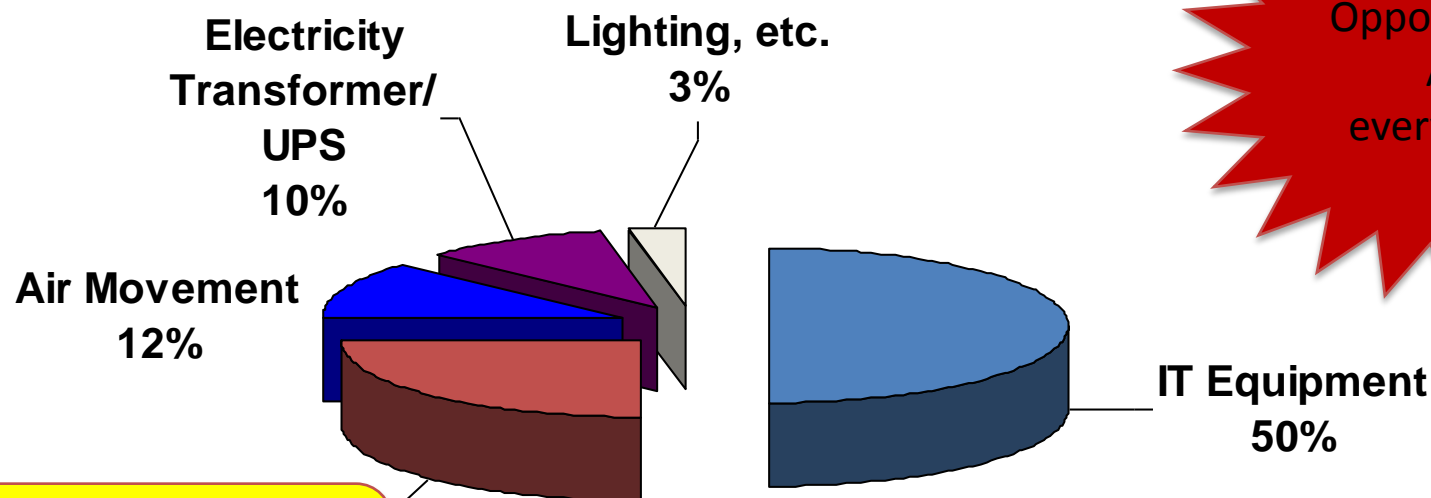


# Where Data Center Power Goes



Infrastructure Services is focusing on all the pieces of the pie

# Where Data Center Power Goes



Opportunities  
Are  
everywhere

Widening environment  
can remove chillers  
perhaps across the globe

Source: EYP Mission Critical Facilities Inc., New York

Infrastructure Services is focusing on all the pieces of the pie

# How Do We Get a 50 C Server?

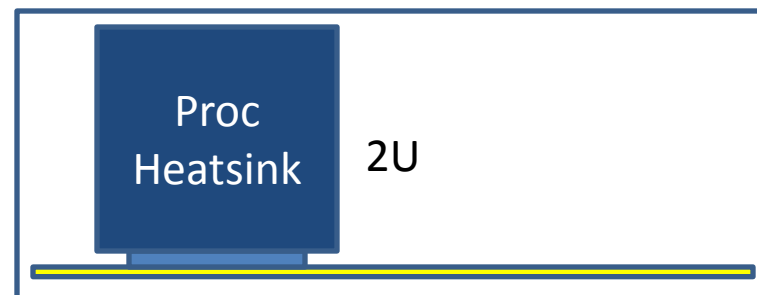
## Example: 200 W server

1U Server has 50 C  $\Delta T_{\text{ambcase}}$   
 Processor Case 75 C  
 Ambient 25 C



**So for heat transfer from a heatsink  $Q = \epsilon h A \Delta T$**

2U Server has 25 C  $\Delta T_{\text{ambcase}}$   
 Processor Case 75 C  
 Ambient 50 C



# Benefits of Lower Density

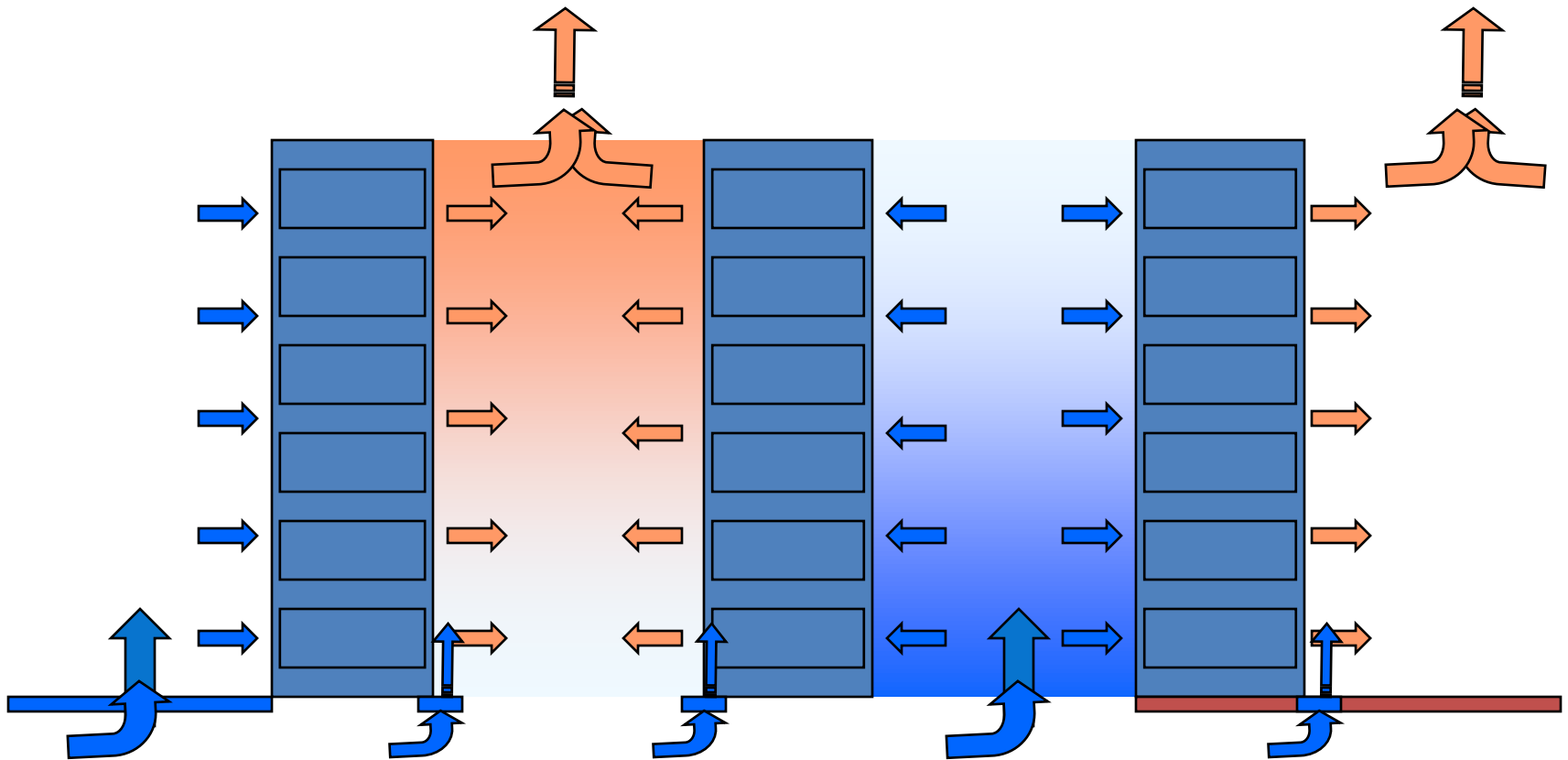
- Lower Cost
  - Elimination of Chillers or DX
    - Lower CapEx and OpEx
  - Less Dense Power supplies
- Better Efficiency
  - No chiller or DX power
  - Lower Fan Power
- Misc
  - Easier Servicing
    - Rack cabling less dense
  - Weight on raised floor is less
  - **Global Air-side Economization**



# Summary

- There are interesting possibilities with low density
- Clearly there is no right or wrong answer
- Is perf/W or Perf/space the right metric?
  - Using perf/W and the right cost models will ultimately yield the optimum answer.
- The Optimum is probably somewhere in between but we need to optimize holistically

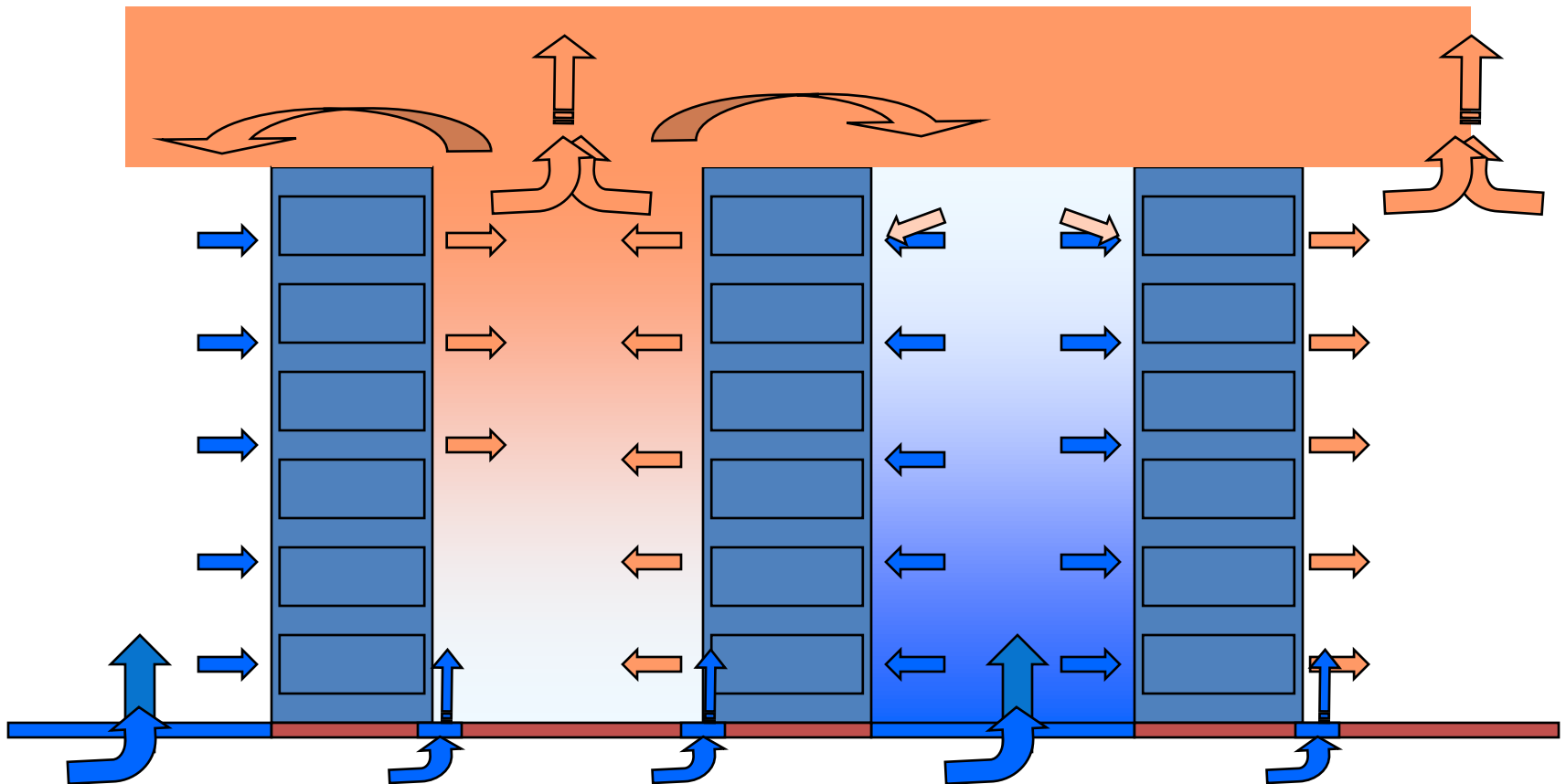
# Hot Aisle/Cold Aisle Airflow Management



# Hot Air Seeps into Cold Aisle



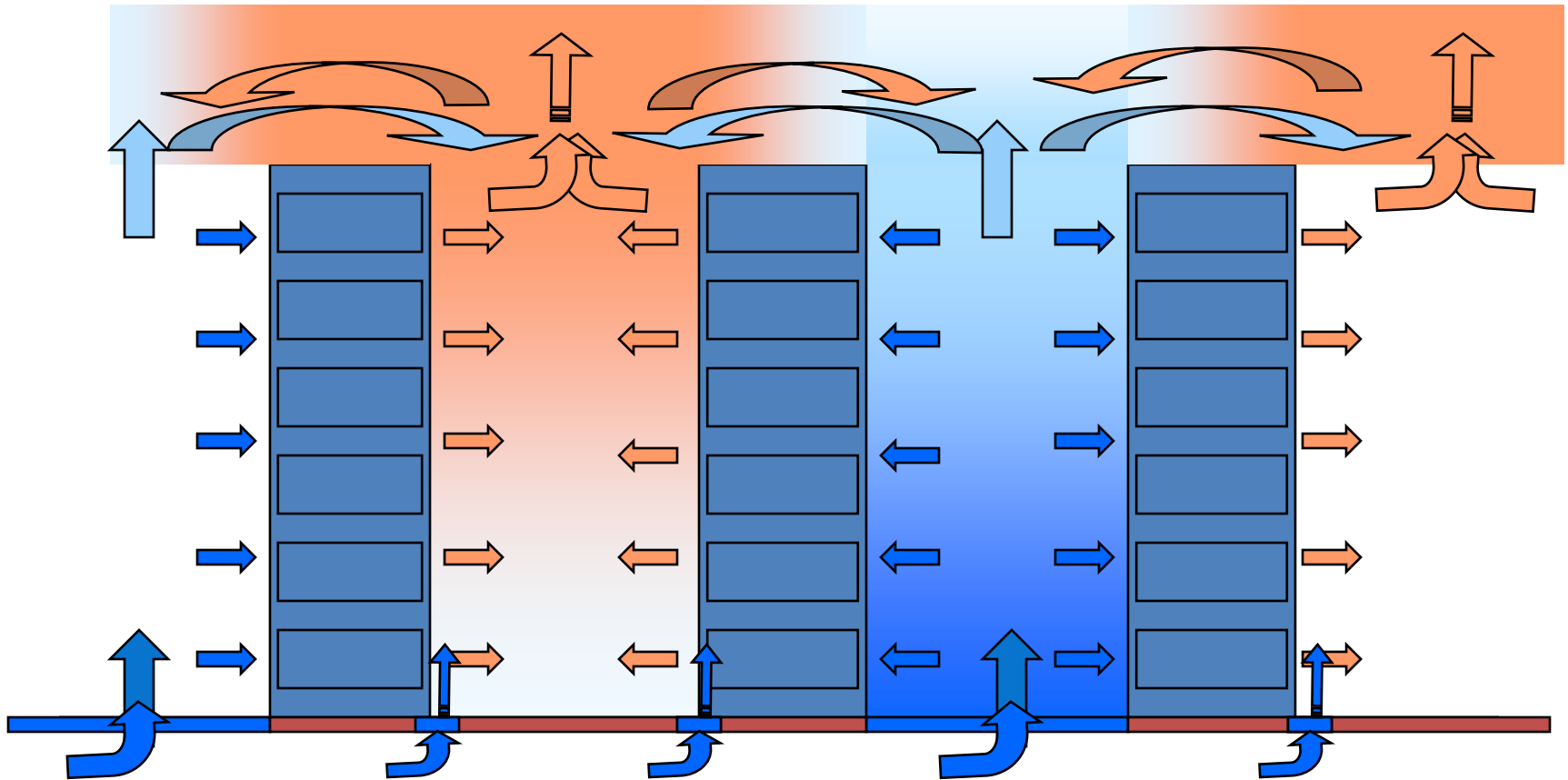
...premature IT equipment failures located near top of racks



# Excess Cold Air Required to Prevent Hot Spots

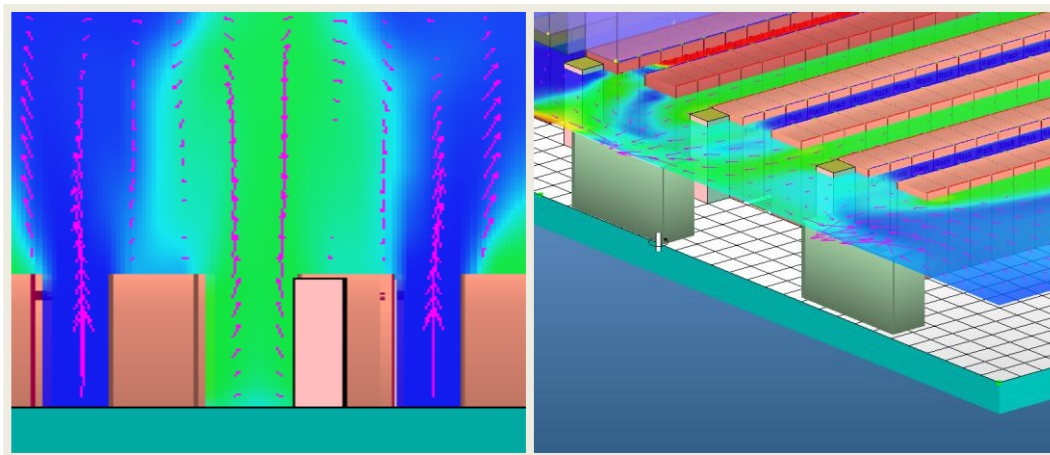


Often, more than twice the minimum required air is supplied





# Excess Airflow in Data Centers



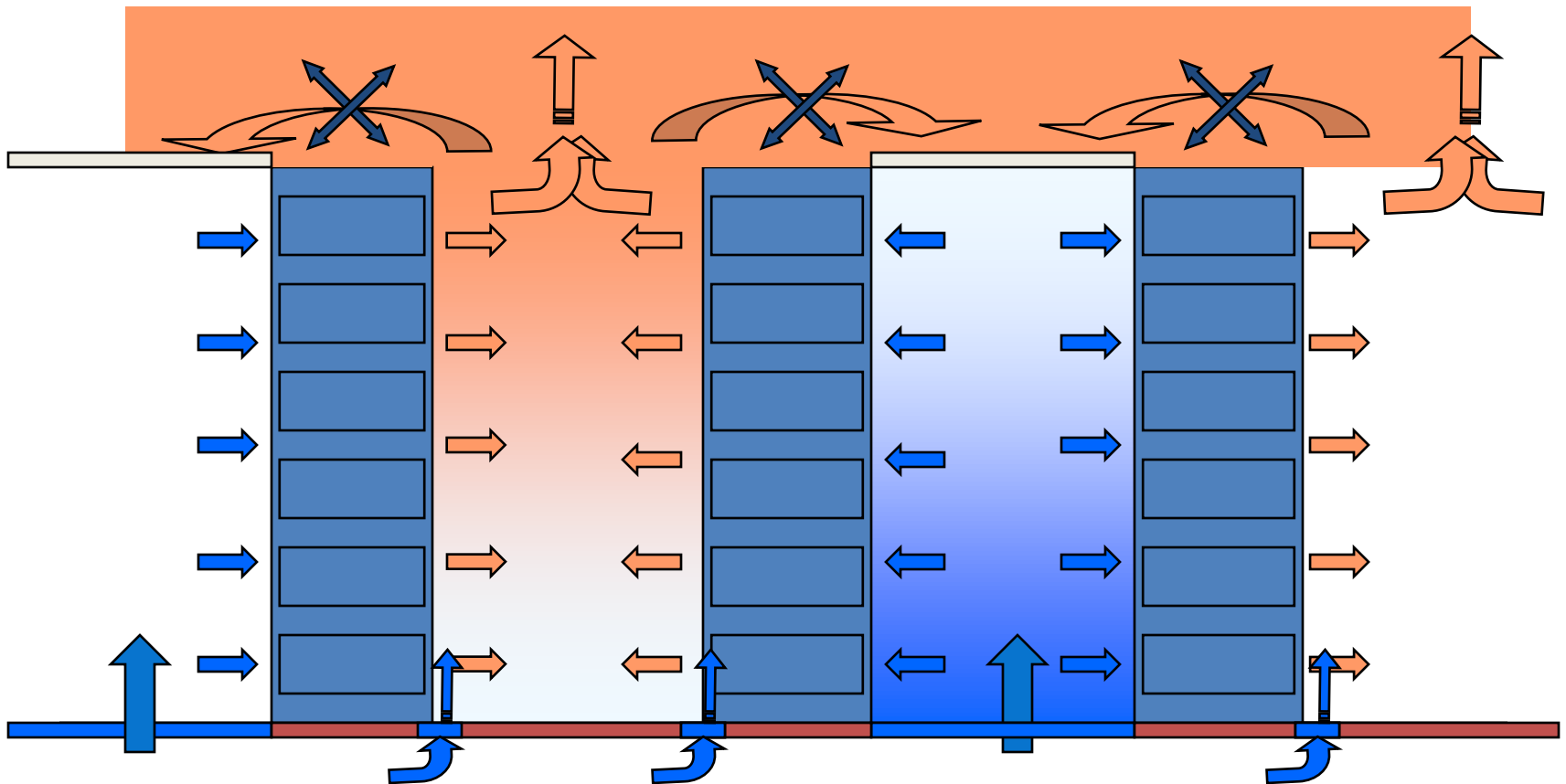
# Preventing Hot/Cold Air Mixing

- *Create physical barriers between hot/cold air streams*
  - Hot air/aisle enclosure
  - Cold air/aisle enclosure
  - Rack hot air exhaust to enclosed plenum

# Cold Air/Aisle Enclosure



...physical barrier prevents seeping of hot air in cold aisle



# Hot Air/Aisle Enclosure



...physical barrier prevents seeping of hot air in cold aisle

