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Living with uncertainty

A systems architect's view on real-time

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Properties

- CE domain
  - Low price per functionality
  - High reliability and robustness demands
- High quality digital video and audio
  - High throughput
  - Hard real-time
- Ever increasing complexity

My concern as a systems architect …

How am I going to realize our future systems?

You can help!

But then you need to understand a few things …

- Your solution should not create more problems than it solves
  - I have one hundred and more problems …
- You should not be the only one smart enough to apply your solution
  - There is an engineering practice shared by thousands of engineers …
- WCET might not be what we are looking for
  - There is uncertainty all around you …

In 1970 life was simple …

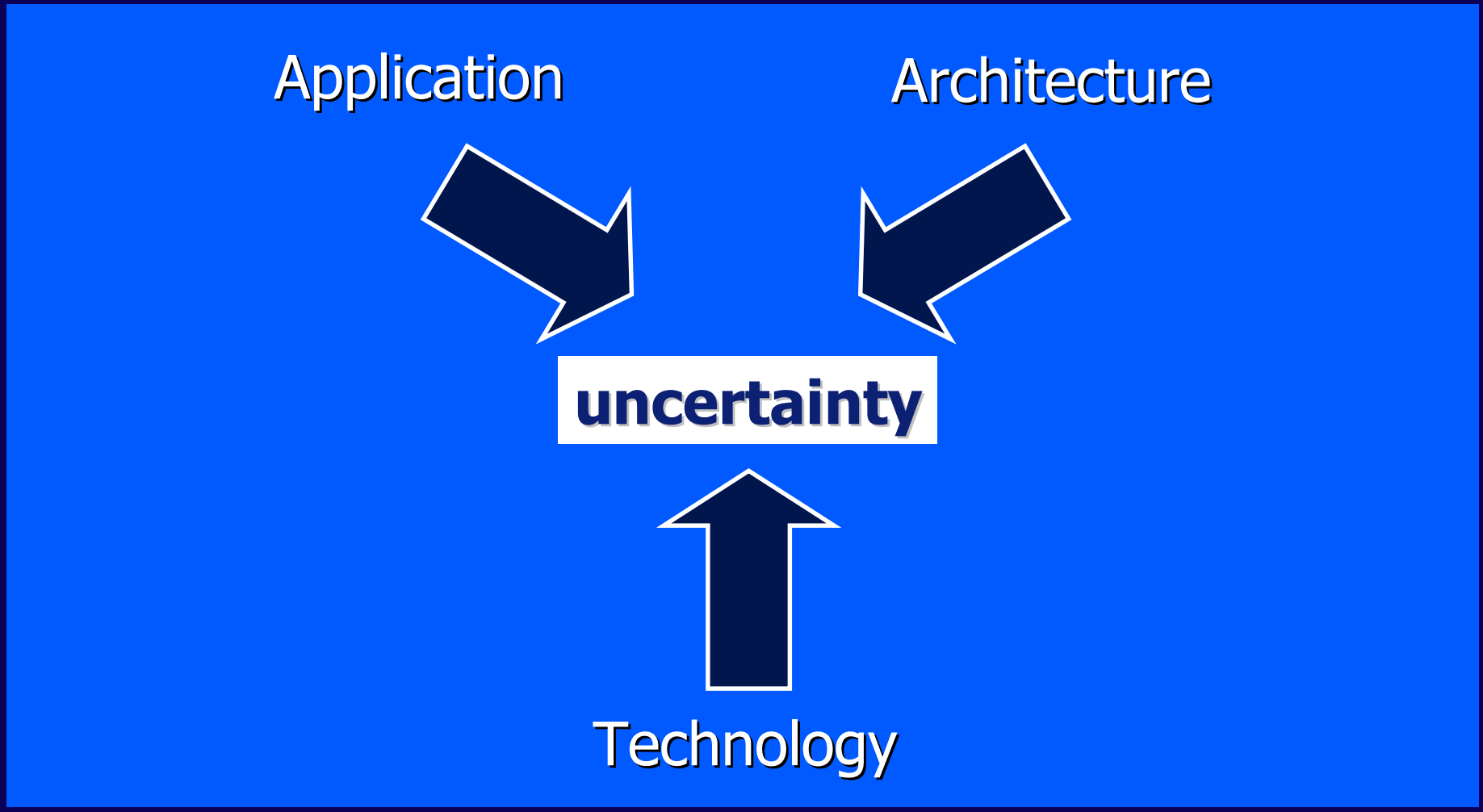
- Simple environment
  - CPU dedicated to application
- Simple RT requirements
- Simple programming model
  - Single threaded assembler
- Simple CPU-model
  - Fixed instruction execution time

➢ Meeting RT requirements = Counting instructions

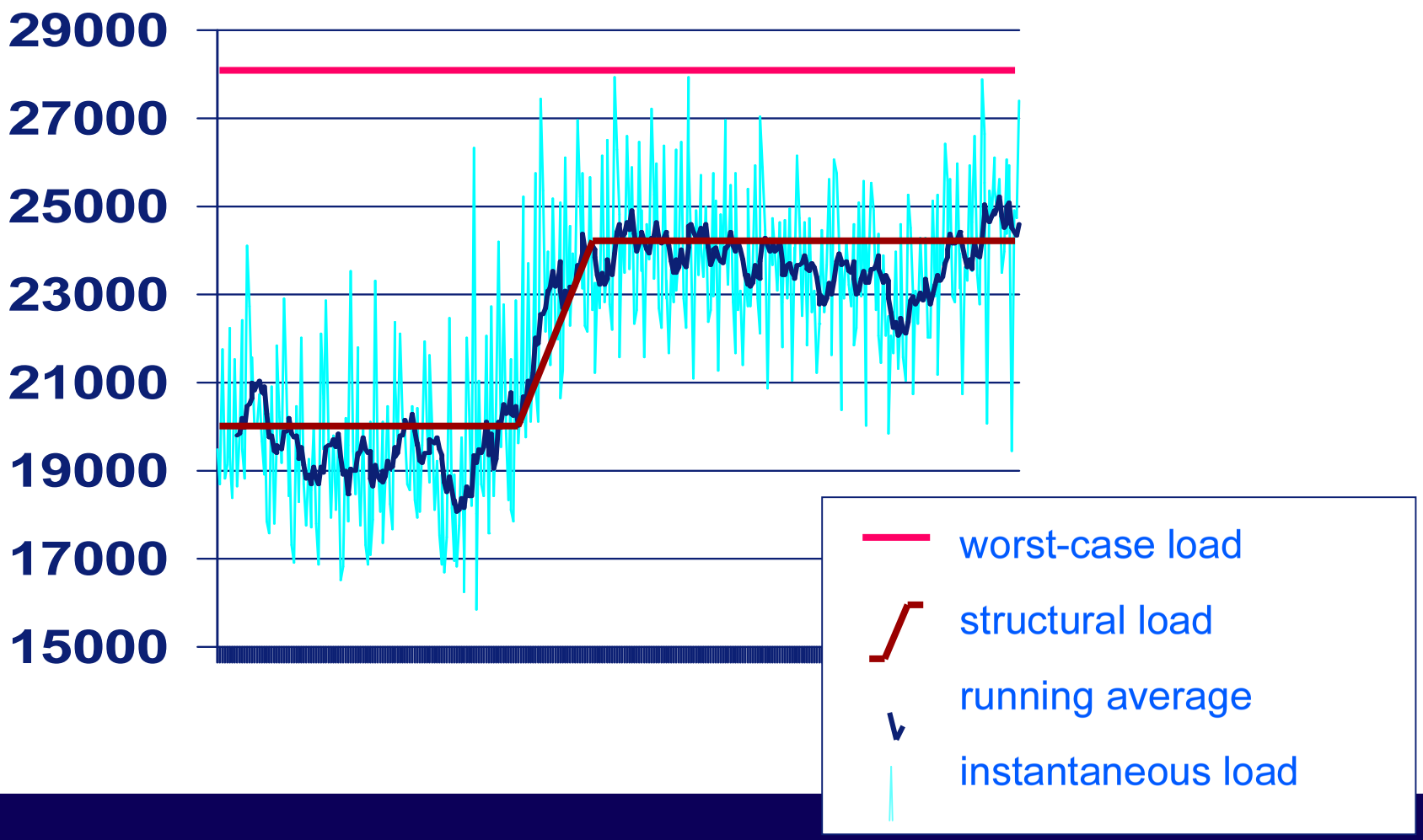
➢ No uncertainty!

My first RT system had a 1 MHz CPU, 24 K of 18 bit words, and was used to control cyclotron experiments.

In 2003 life is much more complex …



Application-induced uncertainty



Architecture-induced uncertainty

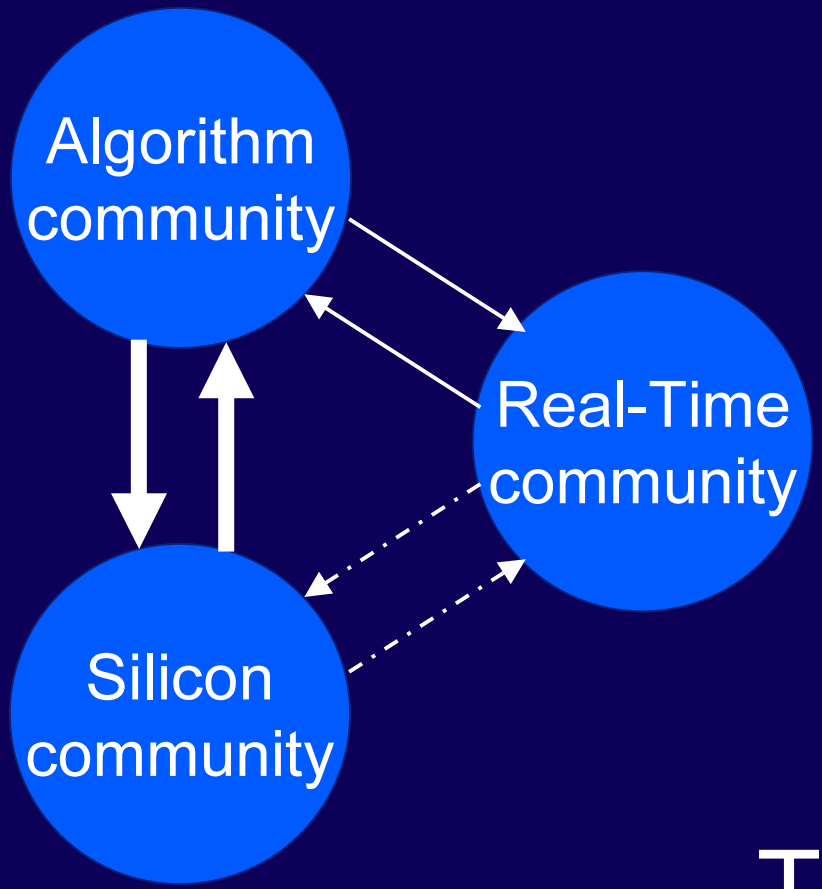
Major cause: Abstractions that hide too much

- Uncontrolled interference in shared resources
  - Cache
  - MMU
  - Bus
- “Ageing”
  - Fragmentation
- Hyper threading

Technology-induced uncertainty

- Temperature control
- Available power
- Battery management
- Available bandwidth
- DSM (deep sub-micron)

Three design and research communities …



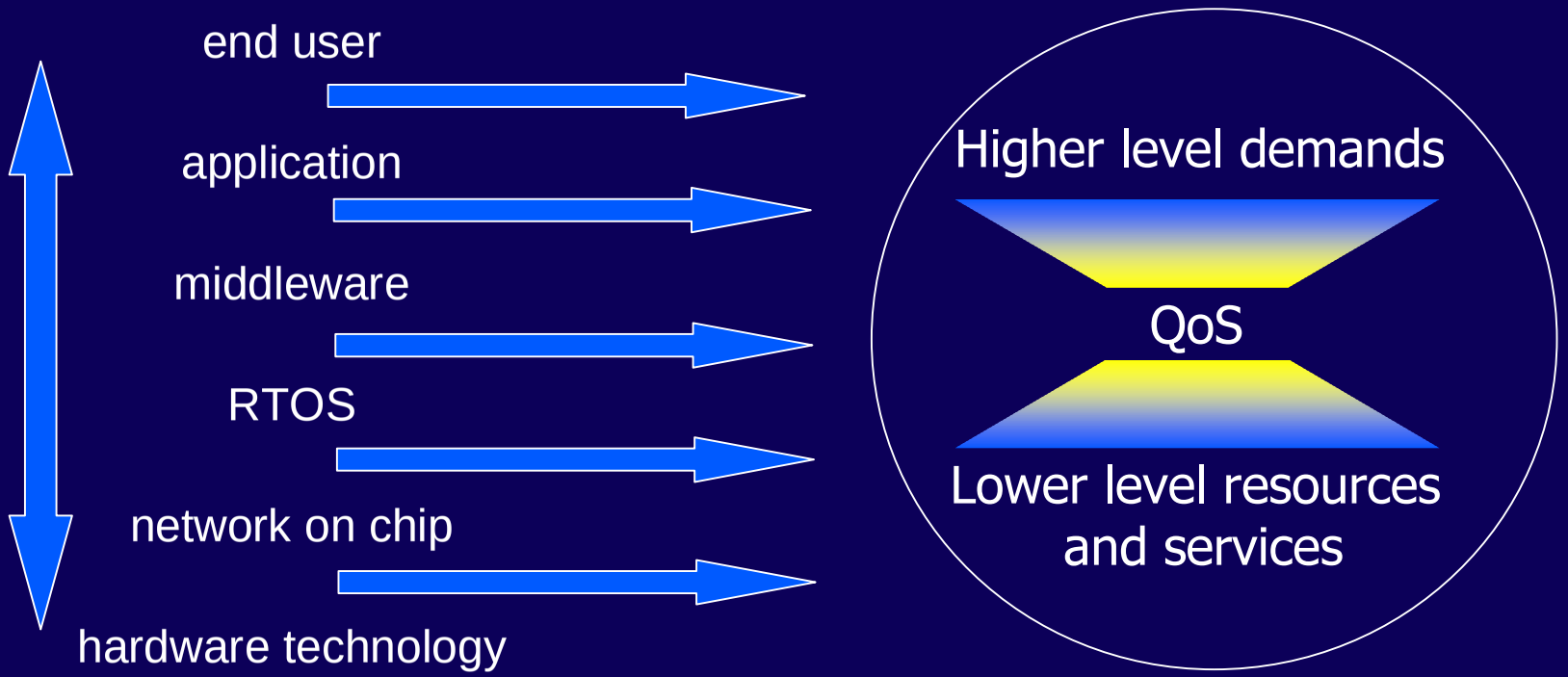
They have to talk,

and understand each others' problems

Quality of Service

Intermediate between demands and resources

- use the same approach at each level.
- propagate ‘from transistor to user’



Look around, and look ahead …

if you are blind
for what is going on

you will become invisible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