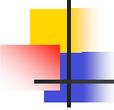


End-to-End Arguments in System Design

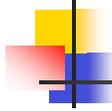
CSCI 634, Fall 2010



What's e2e argument?

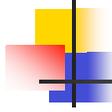
- **Function placement** among the modules of a distributed system
 - Functions placed at **low** levels may be redundant or worthless
 - Placing functions at low levels are justified only as performance enhancements

E2E argument: against low-level function implementation



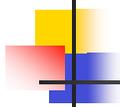
Rationale supported by e2e

- Moving a function **upward** in a layered system closer to **the application that uses the function**
- The function can completely and correctly be implemented only with the knowledge and help of the application
- Incomplete version at low level may be useful as a performance enhancement



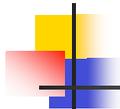
Communication systems

- Reliable data transmission
- Encryption
- Duplicate message detection
- Message sequence
- Many more ...



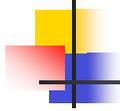
Reliable file transfer

- Objective: correctly moving a file from host A to host B
- Five threats (low in probability):
 - Hardware faults in disk
 - Software bugs of the file system, file transfer program and data delivery systems
 - Hardware errors in buffering and copying
 - Errors during data delivery
 - Hosts may crash



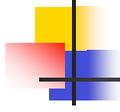
Solution

- End-to-End check and retry
 - Each file is stored with checksum
 - File is delivered with checksum
 - Compare the received checksum with the recalculated one
- A real story happened at MIT
- Should low levels play **no** part in reliability?



Performance aspect

- The probability of a file being corrupted **exponentially** increases with its length
- Retransmit the whole file is expensive, but retransmit a corrupted packet is cheap
- A reliable data delivery at low levels can significantly improve application performance



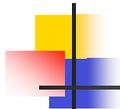
Reliability at low-level

- No need for “perfect” reliability
- E2E checksum is still needed no matter how reliable at the low levels
- Placing functions at low-level should be carefully designed



It may cost more

- Some high-level applications may not need the function, but have to pay for it anyway
- Low levels may not have as much information as the higher levels to do the job



Comments

- E2E argument is not an absolute rule, but rather a guideline for system design
- We must carefully identify **the end** to which the argument should be applied