Database Group

Combining Data Independence and Realtime in Media Servers

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The goal: data independence *and* realtime

Situation however:

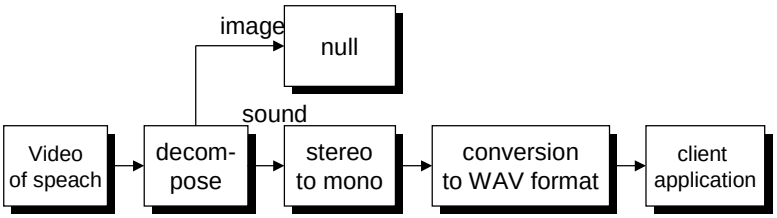
- **Object-oriented and object-relational database systems**
  with their extensions
  (classes, user-defined data types)
  offer
  data independence, but not realtime support
- **Media servers**
  offer
  (soft) realtime support, but not data independence

Data independence

- Playout of media objects
  - output format ≠ storage format
- Media-object types, or classes, resp.
  - encapsulation
- Access operations
  - "present image as GIF in black and white, 4 x 3"
- Conversions
- **VirtualMedia** project
  - expressions to define result, view
- Converter graphs

Converter graphs

- Marder, Univ. of Kaiserslautern, 1998



Converter graphs (2)

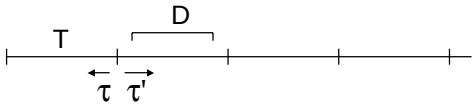
- Implementation of **access operation** on a media-data object
- For an operation, *several equivalent* filter graphs conceivable
- **Selection** by the server with consideration of:
  - the set of available filters
  - their resource requirements

Realtime

- Placement on secondary storage
  - striping, interleaving, ...
  - RAID
- Scheduling for input/output operations
  - EDF, Scan, Group Sweeping, ...
- Admission control
- Quality of service, reservation
- Open: shared use of resources, non-exclusive reservation, process structures

Jitter-constrained periodic streams

- Hamann, TU Dresden, 1996
- Description:
  - period
  - maximum deviation or lateness (too early, too late)
  - minimum distance



- allows to compute several values (e.g. max. burst rate)
- use for converter input and output, meta data

Statistical rate-monotonic scheduling

- Azer Bestavros, Boston University, 1998
- Task description:
  - period
  - probability distribution function for resource requirements per period (per job)
  - quality of service (= percentage of jobs that finish in time)
- Scheduler sets *allowance* (budget frame) depending on other tasks
- Admission control

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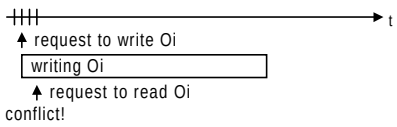
Probabilities of conflict

Berthold and Meyer-Wegener, TU Dresden, 1998

A conflict occurs, if during an access operation the same object is accessed again.



- P(DBK) – DB conflict
- P(PNK) – concurrent-use conflict

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Probabilities of conflict (2)

- Database conflict

$$P(DBK) = P(S) \cdot (1 + P(L)) \cdot \sum_{i=1}^{M} P(ZO_i) \cdot (1 - (1 - P(ZO_i))^{ZWZ})$$

- Concurrent-use conflict

$$P(PNK) = P(L)^2 \cdot \sum_{i=1}^{M} P(ZO_i) \cdot (1 - (1 - P(ZO_i))^{ZWZ})$$

with $ZWZ = \frac{N \cdot t}{t + t_D}$

$$t = \sum_{i=I,II,III,IV} \frac{P(L_i)}{P(L)} t_{L_i} + \sum_{i=I,II,III,IV} \frac{P(S_i)}{P(S)} t_{S_i}$$

$$P(ZO_i) = 1 \Big/ i \sum_{k=1}^{M} 1/k$$

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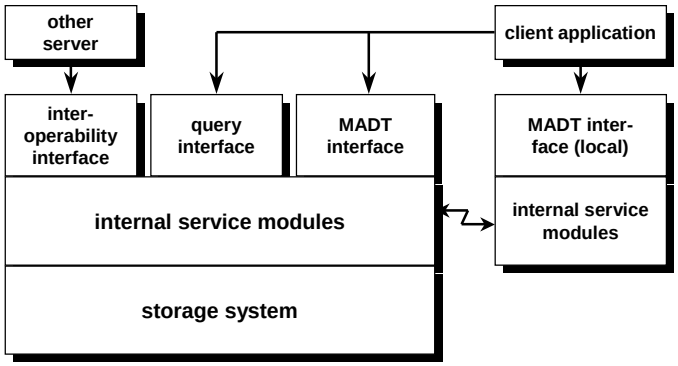
KANGAROO



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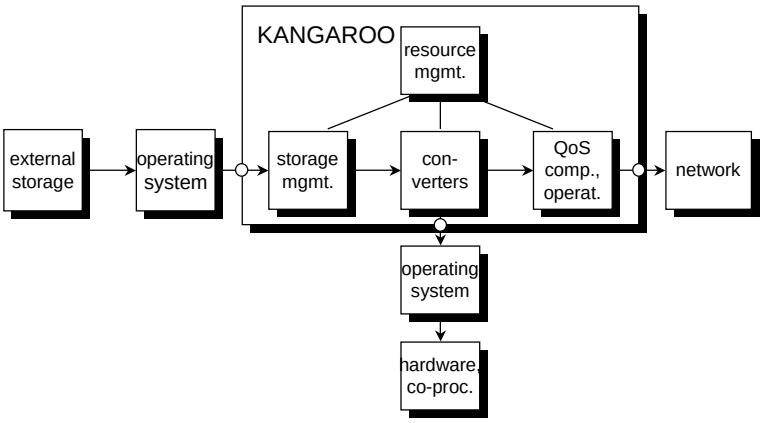
SFB project G3: Memo.real



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Project goal

- (Embedded in group of projects on system design automation)
- Specify and implement **building blocks** of a server architecture that can be composed to form particular media servers
- Focus: building blocks with **realtime support**
- Data independence of applications requires **conversions** of data, if necessary in realtime

Project goal (2)

- Running example: video stored without compression (lossless), play out in MPEG-2 or H.263 format
- Utilize **converter** building blocks, if necessary in combination
- Represented as **converter graphs** (see above)

Converter description

- **Functional capabilities:**
  - input format (e.g. MPEG)
  - output format (e.g. WAV)
- **Resource requirements:**
  - jitter-constrained periodic streams
  - probability distribution function
  - each for input and output
- **Data structure** holds all properties of a converter
- **Meta data** for the media objects stored

Converter description (2)

Sketch of inquiry functions (for resource management):

conversion_capability: → { (source_format, {destination_format}) }
scale_type = { resolution, precision, frequency }
scaling_capability: → { (format, scale_type) }
composition_capability: → { ({source_format}, destination_format) }
decomposition_capability: → { (source_format, {destination_format}) }
compression_capability: → { encoding }
decompression_capability: → { encoding }
internal_buffer_needed: (source_quality_descriptor,
target_quality_descriptor) → buffer_size

Converter descriptions (3)

Sketch of inquiry functions (cont.):

change_of_data_volume: (source_quality_descriptor, target_quality_descriptor) → scaling_factor

complexity: (source_quality_descriptor, target_quality_descriptor) → "O(f(n))"

cpu_usage: (source_quality_descriptor, target_quality_descriptor) → usage_factor

Operating-system interface

- Map converters to **processes or threads**
- Cooperating resource managers (concept introduced by OS group)
  - mapping of resources
  - number of processor cycles must be known
- Access data via **storage manager**: "virtual-format storage system" (VFSS) of KANGAROO
- cooperation with OS file system

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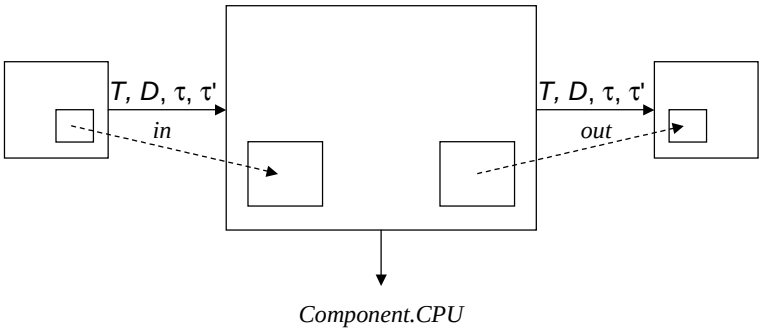
Resource managers



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Storage manager

- Reservation for a media data object:
  access_mode = { create, read, update }
  book: (OID, external_quality_descriptor, access_mode) → reservation
- Accepting a reservation:
  accept: reservation → reservation
- Fixing the data in buffer:
  fix: (reservation, start_unit, count) → iterator
- Iterator:
  pause: blocking a data stream
  resume: deblocking a data streams
  bulk_copy: for copying on block-level
  dereferencing
  diverse pointer arithmetic

Storage manager (2)

- Cancel a reservation:
  cancel: reservation →
- Remove a fixing:
  unfix: (iterator, only) →
  only the fixing or the reservation as well
- Change the reservation:
  rebook: (reservation, external_quality_descriptor, access_mode)
  → reservation

Summary and outlook

- Goal: Data independence and realtime
- Conversions
- Converter graphs
- Towards mathematical models:
  - jitter-constrained periodic streams
  - statistical rate-monotonic scheduling
  - probabilities of conflict
- Prototype systems KANGAROO and Memo.real
- Scheduling on the basis of converter descriptions