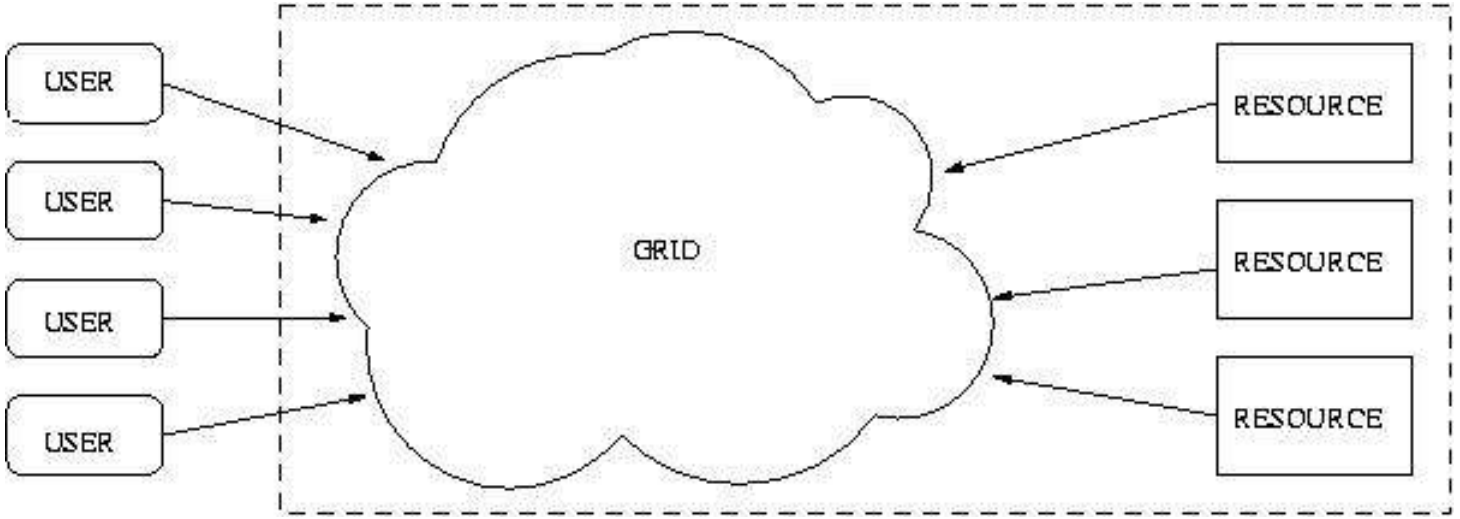
Transparent Remote On-demand File Access

Introduction

- MiG model:



- This project deals with file access from the resource
- All users own a home catalog residing on MiG servers

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Motivation

- Huge input files incur a number of problems:
  - Download time vs. total execution time
  - Job execution on the resource is delayed
  - Storage requirements on resources
- Often only small scattered fragments of input files are needed
- How about automatic on-demand download of needed data?

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Example

```
int fd = open(“inputfile”, O_RDONLY);
while ((i=read(fd, &buffer, 2000)) >0){
      /* process buffer */
}
```

- User applications need not be recompiled or rewritten using a custom MiG API

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Objectives

- A file transfer protocol supporting range requests
- Catch file access routines
  - Direct them to the server holding the inputfile
  - Direct local file access to the native file system
- Ensure minimum intrusion on the resource

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File Transfer Protocol

- HTTP supports a “range” parameter in get request:

```
GET /inputfile HTTP/1.1
HOST: MiG_server.imada.sdu.dk
Range: bytes=2000-3000
```

- No range support in put requests
- In order to support writing to remote files, a custom web server is developed

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File Access

- Override a subset of file manipulating routines:
  - open, close, read, write, seek, dup, sync, etc.
- Preload this library using the **LD_PRELOAD** environment variable (requires user apps to be dynamically linked)
- Forward local file access to the native file system using the **dlfcn** library with the **RTLD_NEXT** handle

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Minimum Intrusion

- “Minimum intrusion” implies:
  - No root install of software on the resource
  - No requirements on the firewall configuration
- All we need is a local grid user and an ssh-connection
- Thus everything must run in user space

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Block size

- Simple solution: general purpose block size based on n/2-analysis
- Advanced solution: depends on the user application:
  - The nature of the application (sequential vs non-sequential file access)
  - The block size used in the application
- Introduce prefetching (1 block read-ahead)
- Adjust the block size dynamically based on the prefetching and the time taken to transfer a block

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Experiments

- 4 experiments:
  1) Overhead: read a one byte file
  2) I/O intensive application: Checksum a 1 GB file
  3) I/O balanced application: Process a 1 GB file
  4) Partial file traversal: Search a 360 MB B+ tree for a random key
- 3 test setups:
  1) Local execution
  2) Copy model
  3) Remote access model

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Results

Experiment	Local execution	Copy model	Remote access model
1 byte file	0.0002	0.1520	0.0080
Checksum	50.1100	130.1000	108.5800
Fibonacci	638.8300	721.2200	708.7200
B+ tree	0.0002	30.6920	0.0186

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Conclusion

- Download time of input files is eliminated; the job is started immediately
- Only needed data is transferred
- Jobs previously impeded from grid submission due to huge input files are now ready for the grid
- The model outperforms a standard copy-model
- The library is entirely user-level