Grid-based processing of high-volume meteorological data sets
Outline

- **Introduction**
  - Energy meteorology, WISENT
- **Challenges**
  - Parallel processing, Data transfers
- **Utilizing Grid technologies**
  - Condor, Globus Toolkit 4, UNICORE
- **Future Work**
Energy meteorology

- Research on the influence of weather and climate on the transformation, transport, and utilization of energy from renewable energy sources
  - Forecast models of energy production
  - Finding optimal locations for power plants
- Interdisciplinary field of research (meteorology, physics, engineering, ...)
- Large and heterogeneous data sources (satellites, earth stations, ...)
- Compute-intensive applications on high-volume data sets
wisent.d-grid.de

- German e-Science project in the domain of energy meteorology
- Associated with D-Grid (German Grid initiative)
- Started in October 2005 (duration for 3 years)
- Distributed resources (CPUs, data storages)
- ~ 1 TB new data per month (increasing)
  - Mostly raw or post-processed satellite images
  - Archived in the “Data and Information Management System” (DIMS)
    - ~ 300 TB; planned extension to 3 PB
- Objective: Build Grid infrastructure based on these resources to support (large) data transfers and distributed processing
Planned Grid Infrastructure

- Desktop-PCs
- Cluster
- Satellites
- Earth Stations
- Storage Center
- Computing Center
- Wind Power Plants
- Solar Power Plants
Parallelization

- **Status:**
  - Most applications run on one single machine
  - Parallelization is achieved with Parallel virtual machine (PVM) / ppmake
  - Most applications can be parallelized at data level

- **Objective:**
  - Parallelization of each application utilizing existing CPU resources (desktop PCs, clusters, etc)
  - Recognizing user activity on desktop PCs
  - Authentication and authorization
  - Easy access to computing resources via the Grid infrastructure
Data transfers

- **Status:**
  - Multiple (~ 100) data-transfers per day (periodically/on demand)
  - Size ranges from a few kilobytes up to several hundred megabytes
  - Number and size will increase in future
  - Often FTP-based transport with manual error recovery in case of failures

- **Objective:**
  - Security
    - Encrypted data transfers
    - Authentication and authorization
  - Reliable data transfers with automatic recovery
  - Monitoring for accounting and billing
  - Easy initiation of data transfers within the Grid infrastructure
Bottom-up approach

Source: IBM
Parallelization scenario

- libRadtran/MYSTIC
- aerosols, clouds, ...
- earth's surface
- irradiation
- space

- PVM/ppmake

- Cluster (16 Nodes)
- Several Servers

- ~15 desktop PCs
Condor

- **Parallelization of each application utilizing existing CPU resources**
  - “Cycle scavenging” - using idle-periods of computational resources
  - Very suitable for applications using data parallelization
  - Rudimentary support for MPI
  - Scheduling strategy sufficient to adequately utilize resources

- **Authentication and authorization**
  - Possible but not tested
  - Not necessarily needed at Intra-Grid level
  - Sandbox approach is sufficient

- **Recognizing user activity on desktop PCs**
  - Tracking user's activity (mouse, keyboard, etc)
  - Migration of jobs to other nodes on user's demand

- **Easy access to computing resources via the Grid infrastructure**
  - Text-based interface is not very user-friendly?
Condor

**Pros:**
- Good approach for pooling CPUs at Intra-Grid level
- Capable of construction of “desktop-Grids”
- Solid documentation and long development history
- Wide user base

**Cons:**
- No Open Source project
- Large number of configuration settings (but well-documented)
- Demands on network connectivity
Data transfer scenario

Utilizing Grid technologies
Globus Toolkit 4

- **Security**
  - Certificates based on X.509 (SSO) for authentication
  - Community Authorization Service (CAS) for authorization (not evaluated)

- **(Reliable) Data transfers**
  - GridFTP as enhanced FTP
    - GridFTP uses no data channel encryption per default
    - Encryption modes “Safe” and “Private” reduce data throughput
    - New port assigned for each data channel
  - Reliable File Transfer (RFT)
    - Does not support GridFTP-based encryption

- **Monitoring for accounting and billing**
  - Monitoring and discovering service (MDS) (not evaluated)

- **Easy initiation of data transfers within the Grid infrastructure**
  - Text-based interface is not very user-friendly?
Globus Toolkit 4

- **Pros:**
  - Support of WSRF and most services proposed in OGSA
  - Comprehensive data services
  - Interoperability with Condor

- **Cons:**
  - Dynamic port assignment conflicts with current firewall policies
    - Open a whole port range (only temporary solution)
    - DLR develops Application Level Gateway (Proxy in the DMZ)
  - Use of encryption in RFT is currently not possible
Currently little experience with UNICORE 5 and evaluation is ongoing

**Pros:**
- Complete encryption of communication
- Gateway uses only one port
  - Location of Gateway in DMZ could possible
- Graphical client for job submission and monitoring
  - Possible automation?
- Workflow language for modelling process chains
  - Which capabilities?
- UNICORE 6 has promising extensions
  - Support of Grid standards

**Cons:**
- Execution of a workflow element must be assigned to a specific VSite
  - Optional dynamic VSite-selection
- UPL-based data transfers are not sufficient for large data sets
Future work

- UNICORE (6) seems very interesting for fulfilling many requirements in WISENT
- We still need more experience with UNICORE
- Evaluation of other Grid middleware as gLite, Sun N1 Grid Engine, etc
- More investigation of interoperability
Questions?