Grid-based processing of high-volume meteorological data sets

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Outline

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

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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**

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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**

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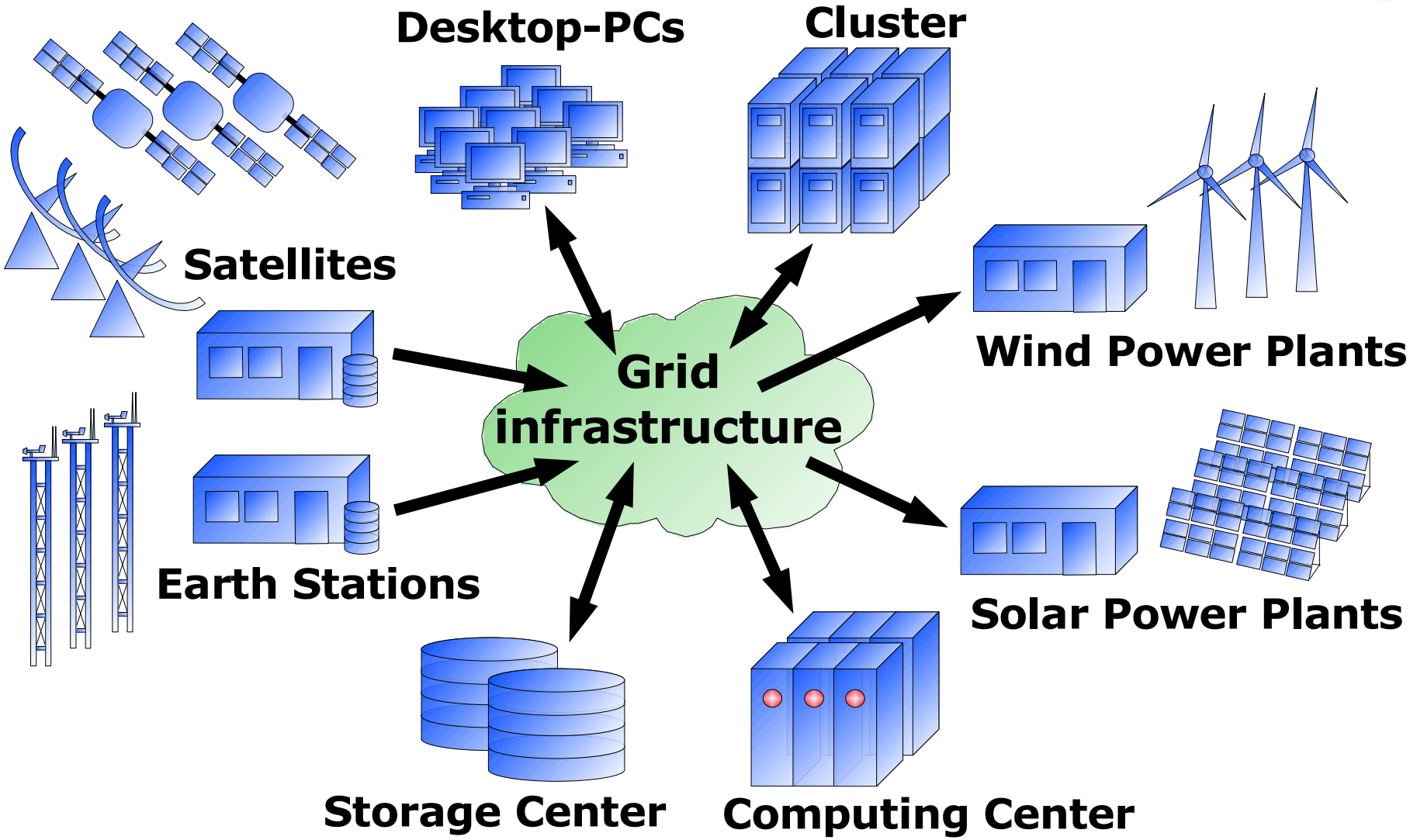
Planned Grid Infrastructure



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

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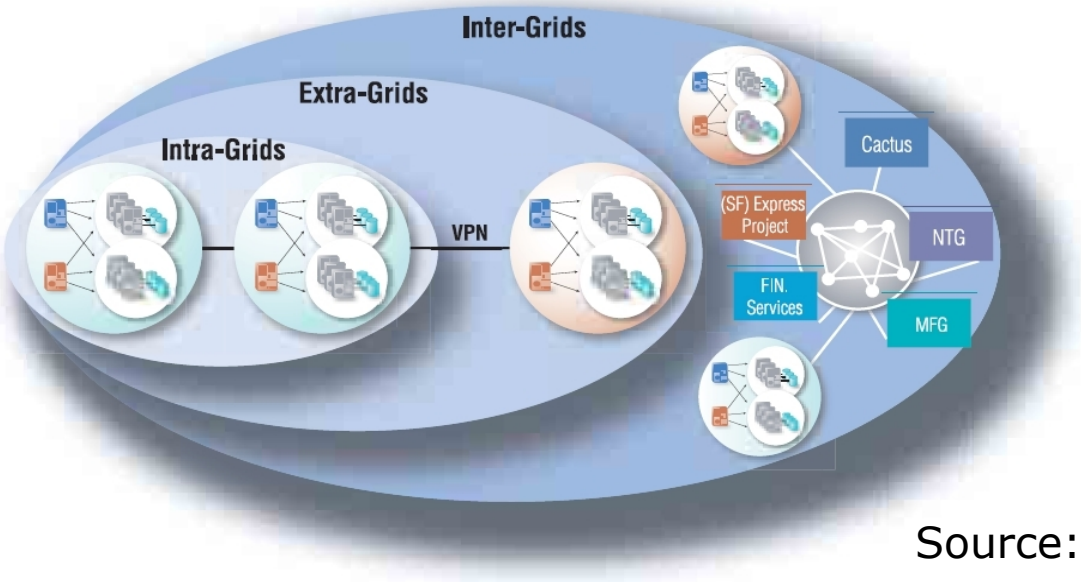
Data transfers

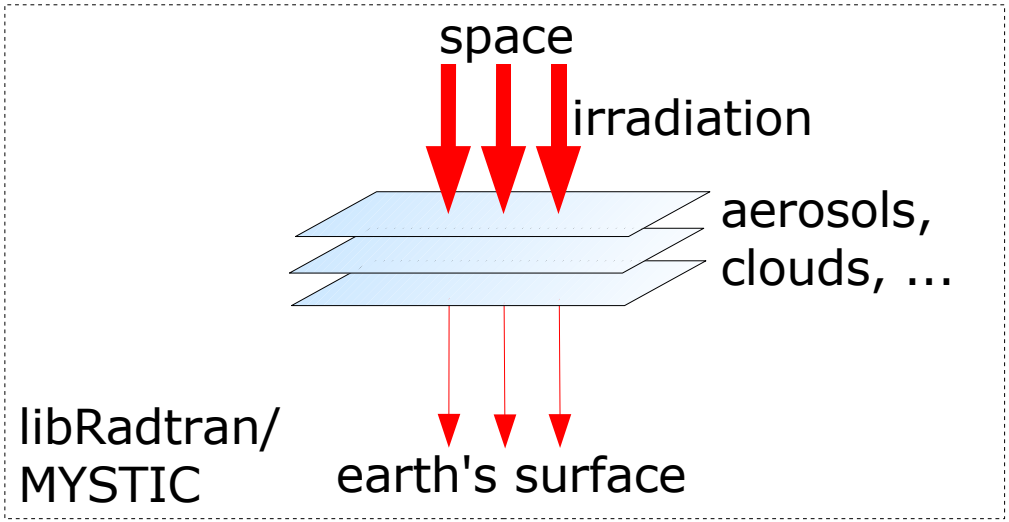
- **Status:**
  - Multiple (~ 100) data-transfers per day (periodically/on demand)
  - Size ranges from a few kilobytes up to several hundred megabytes
  - Number and size will increase in future
  - Often FTP-based transport with manual error recovery in case of failures
- **Objective:**
  - Security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

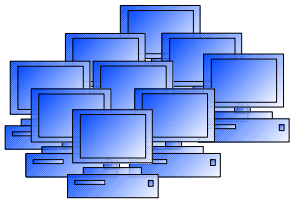
Bottom-up approach



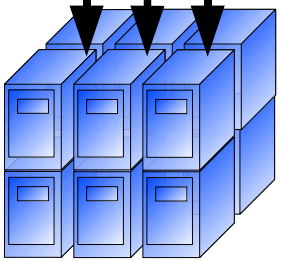
Source: IBM

Parallelization scenario

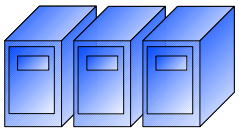




~15 desktop PCs



Cluster (16 Nodes)



Several Servers

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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?

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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

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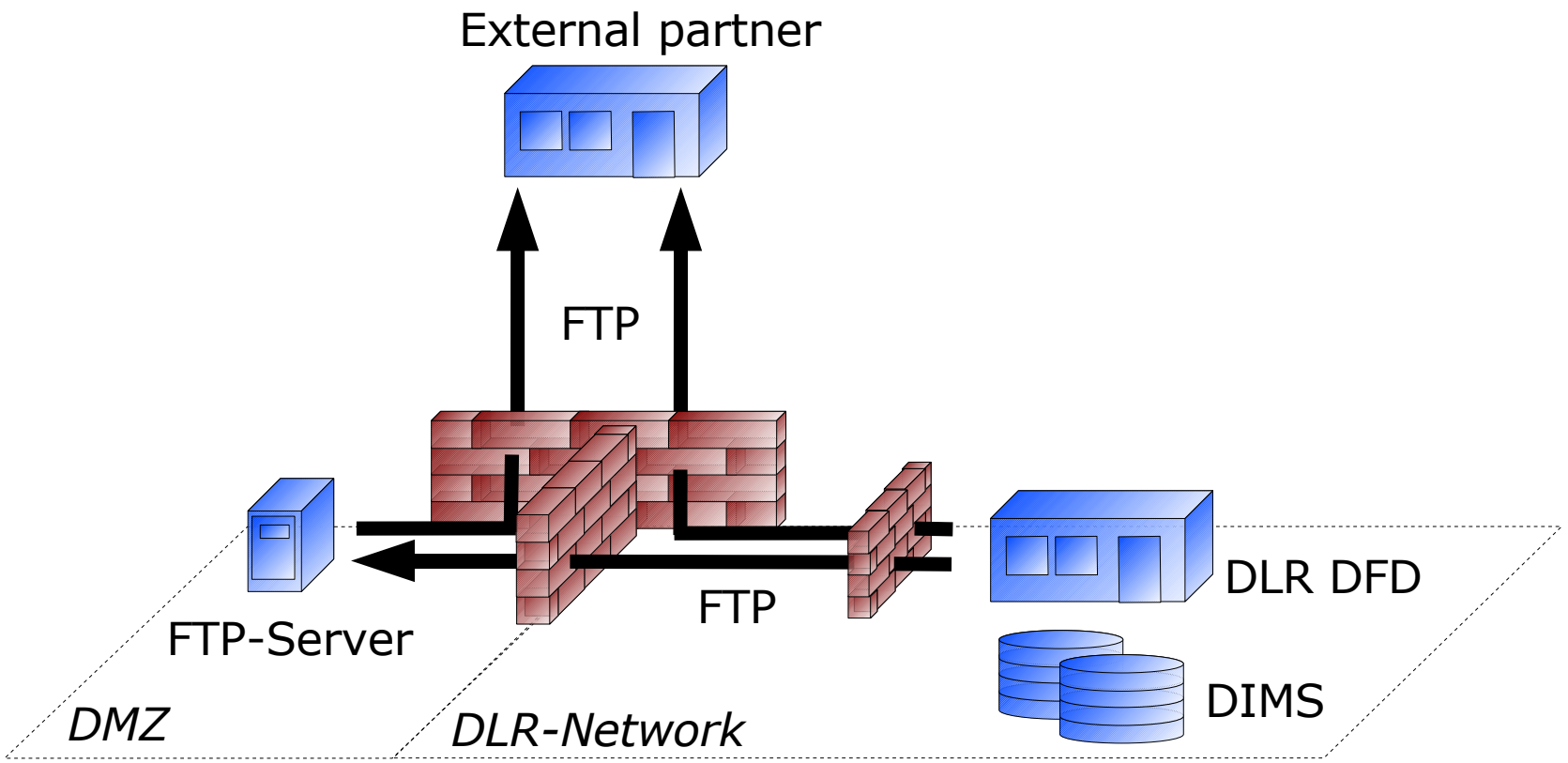
Data transfer scenario



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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?

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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

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UNICORE

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

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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**

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Questions?

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