

# Polish Contribution to WLCG

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# LHC

- After 10 years of construction at CERN a new tool for High Energy Physics is almost ready. It is called Large Hadron Collider
- Experiments at LHC will study collisions of elementary particles and nuclei at the highest energies but also at very high collision rates
- This is needed in order to allow studies of some very rare new processes not happening at other smaller accelerators in the past
- High collision rates and large amounts of data coming from detectors with each collision event that need to be stored and analysed demand large computing resources
- Estimated needs reach the level of 20 PB/year of total disk space for storing data and 100M SpecInt2000 computing power in order to analyse it
- This is roughly equivalent to 100,000 hard disks and cpu units
- And these needs will increase with each year of LHC operations

# The LCG Project

LCG provides a computing environment for LHC experiments

- Infrastructure
  - PC farms – effective for HEP
  - Network Services - LCG will be one of the most demanding applications of national research networks such as GÉANT
- Grid Software (middleware)
  - Globus, Condor and VDT provide key components of the middleware used. Key members participate in OSG and EGEE.
  - Contributions from Enabling Grids for E-scienceE (EGEE) project
- Operations (experiment VOs, operation and support centers)
- WLCG: Grid Operational Groupings
  - EGEE Grid provides majority of the resources (~180 sites)
  - The US LHC programmes depend on the Open Science Grid (OSG)
  - Nordic Data Grid Facility (NDGF)

# Schedules

- **September 2001:** LCG project approved by the CERN Council
  - Phase 1 (2001-2004): Development and prototyping a distributed production prototype
  - Phase 2 (2005-2007): Installation and operation of the full world-wide initial production Grid system
- Since 2005 a series of Service Challenges (SC) was set out to successively approach the production needs of LHC
  - Started in June SC4 is the last in the series of Service Challenges
  - Aims to demonstrate that all requirements from raw data taking to analysis can be met
- September 2006: LHC Service in Operation - ramp up to full operational capacity
- **April 2007:** LHC Service commissioned

# LCG Hierarchical Model

- Tier-0 at CERN
  - Record RAW data (1.25 GB/s ALICE)
  - Distribute second copy to Tier-1s
  - Calibrate and do first-pass reconstruction
- Tier-1 centers
  - Manage permanent storage – RAW, simulated, processed
  - Capacity for reprocessing, bulk analysis
- Tier-2 centers
  - Monte Carlo event simulation
  - End-user analysis
- Tier-3
  - Facilities at universities and laboratories
  - Access to data and processing in Tier-2s, Tier-1s

# Polish Tier-2

- Poland is a Federated Tier-2
- HEP LHC community: ~60 people
- Each of the computing centers naturally will support mainly 1 experiment
  - ❖ Kraków – ATLAS, LHCb
  - ❖ Warsaw – CMS, LHCb
  - ❖ Poznań – ALICE
- Each center will probably be about 1/3 of the average/small Tier-2 for a given experiment
- Partner Tier-1 center is FZK Gridka, Germany

# ATLAS Tier-2

- Role of Tier-2 centers in ATLAS
  - Run simulations
  - Run calibration/alignment procedures
  - Keep current versions of AODs (analysis objects) on disk
  - Run user analysis jobs
- The sum of 30-35 Tier-2s will provide ~40% of the total ATLAS computing and disk storage capacity
- Full size Tier-2 site will provide by 2008
  - 1000 kSi2000 CPU and 200 TByte disk space
  - 20 MB/s AOD simulation transfers to Tier-1
- Tier-2s are not running any particular service for ATLAS in addition to providing the Grid infrastructure (CE, SE, etc.)
  - All data management services are run from Tier-1s

# CMS Tier-2

- Role of Tier-2 centers in CMS
  - Designed to support 40 active physicists it is a primary resource for users doing **analysis** in the experiment
  - Also it is the only experiment controlled resource for event **simulation**
- Tier-2 capacity by 2008 - current plans
  - 900 kSi2000 of computing power (100-125 dual CPU nodes)
  - 200 TB of disk
    - Mostly used for staging space for local analysis with small quantities for MC staging for transfer to archiving centers
    - Approximately 200 MB/s of IO serving capability for applications from mass storage
  - 1-10 Gb/s of networking



# LHCb Tier-2

- Prime role for LHCb Tier-2 center is MC production
  - Already successfully exploiting Tier-2 sites for MC production
  - In 2006 65% of resources came for non Tier-1 sites.  
Polish sites had a significant contribution (2.5% total)  
Used ~100 sites for MC production
  - Tier-2 sites essential for LHCb
- Large Tier-2 centers wish to support analysis:
  - Minimum 200 TB of disk storage
    - At least 5% of analysis CPU requirements  
(total: 1.3 MSI2k.years in 2008)
  - Support ~50 MB/s for data distribution
  - Support same Grid services as Tier-1 centers

# ALICE Tier-2

- No specific requirements for resources at Tier-2s
  - They are providing additional resources
- Sites are operated through the VO-box framework
  - All ALICE sites should provided one
  - Installation and maintenance is entirely ALICE responsibility
- Data management
  - xrootd as disk pool manager on all site SEs
- Data replication (FTS)
  - Lower-level service for point-to-point data transfers

# Kraków

- **Cyfronet - Academic Computer Center in Kraków**
  - Computing center servicing needs of scientific community in Kraków: Institute of Nuclear Physics, Jagellonian University ...
  - Managing metropolitan network for the city of Kraków
- **GRID projects**
  - winit, crossgrid, pellucid, gidstart, proaccess, egee, coregrid, K-Wf Grid, BalticGrid + national projects
- **Wide experience in GRID technology**
  - Cyfronet is a Regional Operations Center for Central European Federation
- **LCG/EGEE: Atlas (LHCb)**

Services for ATLAS: Configured and initial tests successfully finished  
Manpower: 3 FTEs

# Resources at Cyfronet

- Year 2005
  - 38x2 dual Xeon + 16x2 Itanium2 + 2 TB small disk array
- Year 2005/2006
  - Improved power supply infrastructure and cooling system
  - Purchase of 120x2 dual Xeon 2.8 GHz, 2MB cache, 2GB RAM
  - Purchase of HP XP12000 disk array, 40TB FC + EVA disks
- Year 2006 current status
  - 270 CPUs working
  - 70 TB disk available + 50 TB just arriving
- Year 2007 plans
  - 40 new 4-core machines
  - Expansion of HP XP12000 storage to 200 TB
- Declared resources for LCG at the startup
  - 200 kSI2000 CPU, 50 TB Disk
  - External Network Connection: 1 Gbit/s

# Poznań

- PCSS - Poznań Supercomputing and Networking Center
  - Operation Center for Polish academic network PIONIER
- GRID projects: magic, compchem, voce, geant4, balticgrid
  - Active in European and Global Grid Forum + national projects
- LCG/EGEE: Alice (Atlas, CMS)
  - Services for ALICE: finishing configuration and tests
  - Manpower: 0.5 FTEs

# Resources at PCSS

- Poznań LCG Cluster: 2005/2006
  - 20 IA64 machines
  - Storage: 2 SE (1TB and 50GB) with SRM access via DPM software
- Hardware upgrades: soon 50 new 4-core nodes  
A part of them will be assigned to WLCG/EGEE
- Planned resources for LCG startup:
  - CPU: 200 kSI2000
  - Disk: 50TB
  - External Network Connection: 2 Gbps

# Warsaw

- Resources hosted by ICM
  - Interdisciplinary Center for Mathematical and Computational Modelling
  - main computing facility of Warsaw University
- Grid projects
  - eurogrid, grip, crossgrid, egee, unigrids, atvneu-gp + national projects
- LCG/EGEE: CMS (LHCb)
  - Services for CMS: finishing configuration and tests
  - Manpower: 2 FTEs

# Resources at ICM

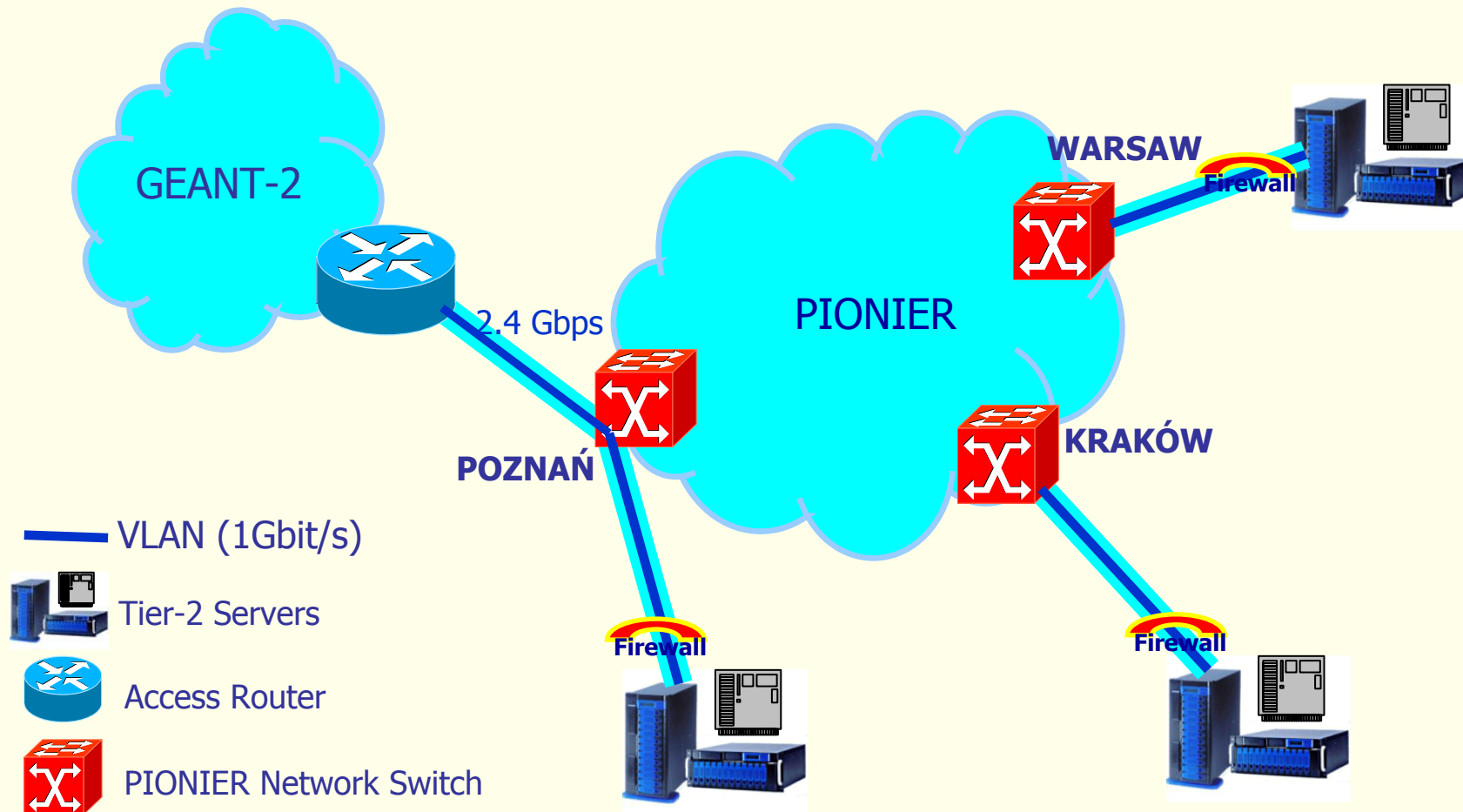
- Current cluster resources
  - 180 AMD Opteron 252 + 44 Opteron 275 (dual core)  
= 268 effective CPUs (about 400 kSi2000)
  - 2 GB of memory per CPU and 73 GB SCSI HDD per node
- 15 TB of disk space in SATA HDDs connected to 4 Sun StorEdge 3500 RAID arrays
- Storage currently served via Classic SE (3.5T) & DPM
  - 3.5T + 3.5T dedicated for CMS
- 1 Gbps Ethernet for internal communication



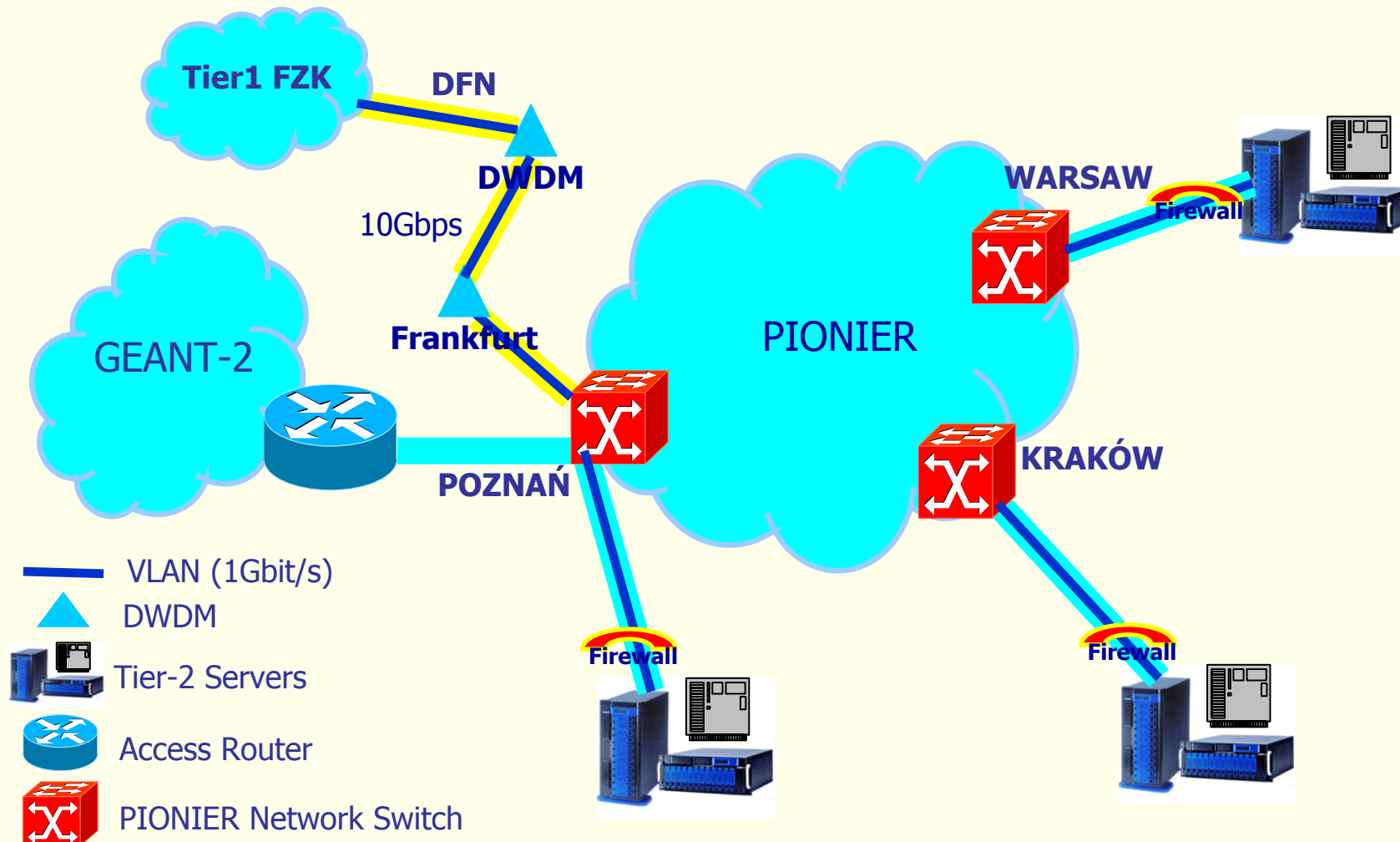
# Network

- Inter connections between Polish sites
  - based on Polish academic network - Pionier
  - 1-2x10 Gbps links between major cities
  - Tier-2 uses a dedicated VLAN link to Poznań (1 Gbps)
- Experience from tests
  - Pionier network based on Black Diamond BD6800 switches
  - Unable to run more than 300 Mbps TCP/IP single stream transfers due to switch architecture limitations
  - Currently using a separate lambda for Kraków-Poznań transfers (10Gbps)
- Pionier upgrade plans
  - Purchase of Foundry XMR switches
  - Replacing old BD6800 switches
  - Soon to be introduced on Poznań-Kraków link
- External route
  - Currently via public Geant-2 network
  - Separate 1 Gbps VLAN Kraków – FZK Gridka (under setup)

# Polish Tier-2 Network



# Polish Tier2 Network



# SC4 Activities: 2006

- SRM preparations

- May 2006: SRM at Kraków, Poznań, Warsaw ready on VLAN network
- Tested for inter-Polish transfers of up to 40 MB/s on a single stream
- Tested transfers to/from FZK, CERN and other sites with file transfers requested by local users at Kraków

- ATLAS FTS

- June 2006: Kraków SRM configured and ready for SC4 tests
  - Transfer speed up to 100 MB/s with multiple file transfers to FZK
  - Transfers slower by 50% in FZK – Kraków direction
- September 2006: Poznań SRM configured
  - delayed by hardware relocation

- ATLAS DDM software

- Kraków SRM info introduced in July
- Poznań ready for configuration

# ATLAS SC4: 2006

- T0->T1 tests

- Started June 15 2006
- DQ2 software used for distribution datasets to T1 sites
- Transfers to Tier-2s enabled later in July
- CYFRONET participated in this first phase of SC4 tests
  - succeeded in having several fully successful transfers
- Data transfers on requests from INP users

- T1<->T2 integration

- Data transfer tests started September 10
- FZK T1 Cloud participating sites:  
DESY-ZN, DESY-HH, CYF, WUP, FZU, CSCS
- CYFRONET SRM stable working all the time during summer
- Friday, September 15 network hardware failure in a distant site,  
connection broken, **repaired on the next day!**

# Conclusions

- All 4 LHC experiments will have Tier-2 support in Poland
- Polish Tier-2 centers actively participate in preparations leading to the buildup of stable WLCG services for LHC experiments
- Working in cooperation with Tier1 FZK team and with experiments individual services are being configured and tested before they are declared ready for operations in WLCG service
- The total planned resources to be provided by Polish Federated Tier-2 at the startup of LHC are at the level of 1000 kSpecInt2k processing power and 250 TB disk space satisfying basic requirements from experiments supported and LCG design
- A fast 1-2 Gbps VLAN connection to Tier-1 FZK should make Polish Tier-2 usefull both for simulations and for user analysis
- Tier-3 centers planned in Kraków and Warsaw are in organization