

Deutsches Forschungsnetz

GRIDs and Networks

Complementary Infrastructures for the Scientific Community

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GRIDs - networked applications

- GRIDs as network application
- User requirements on GRIDs
- D-GRID

The network - basis for GRIDs

- Status G-WiN
- Challenge X-WiN
- Technology Options X-WiN
- The Market for Dark Fibre
- International Developments
- Roadmap X-WiN
- Engineering Issues X-WiN

- GRIDs: Set of network based applications, using distributed resources (compute services, storage services, common data repositories,...), „owned“ by a specific group of users („Virtual Organisation“)
- Example: large scale physics experiments organise their data evaluation in a distributed fashion

GRIDs as network application (2)

LHC GRID

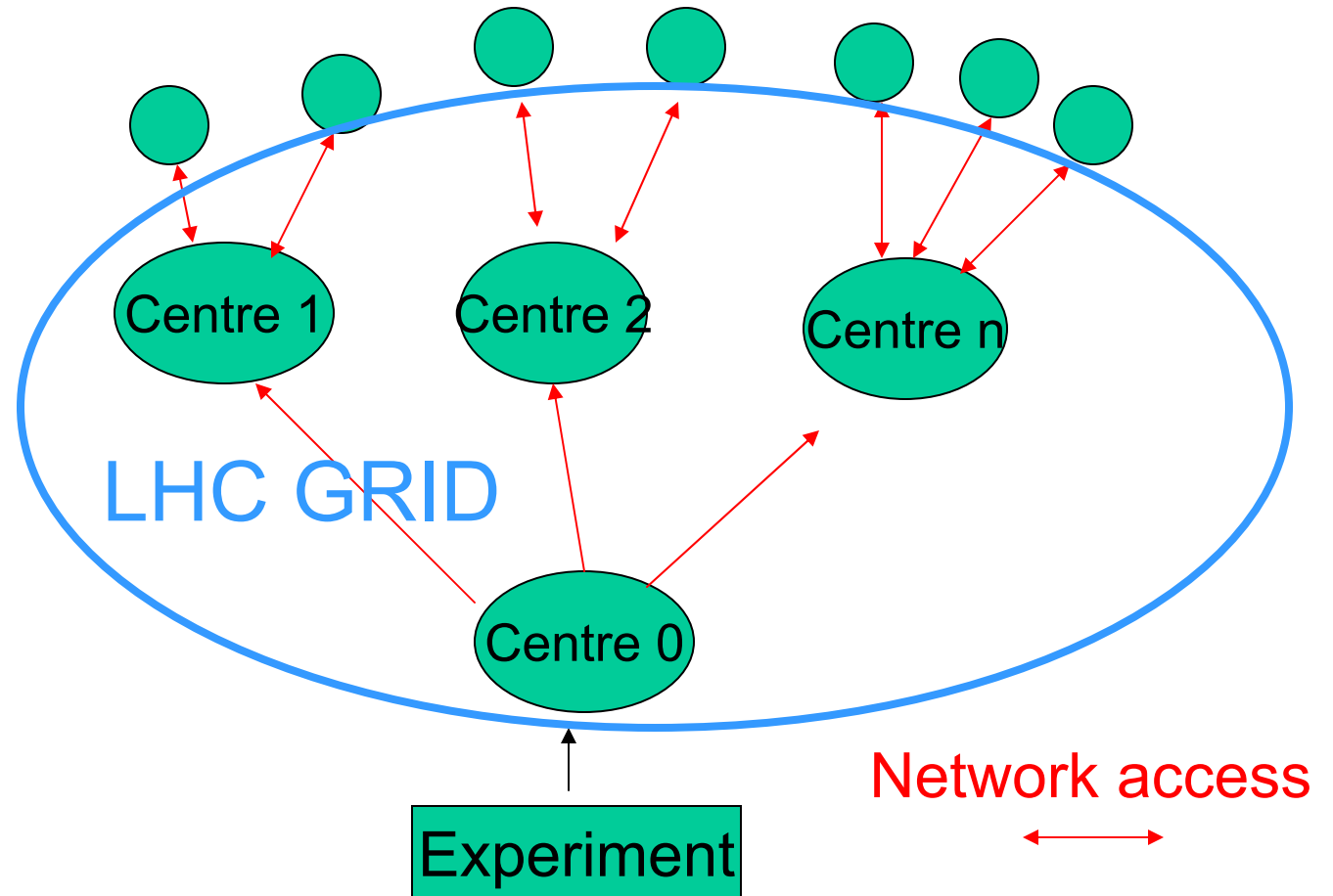
TIER 2 - n

user

TIER 1

Data- and
Compute-
resources

TIER 0



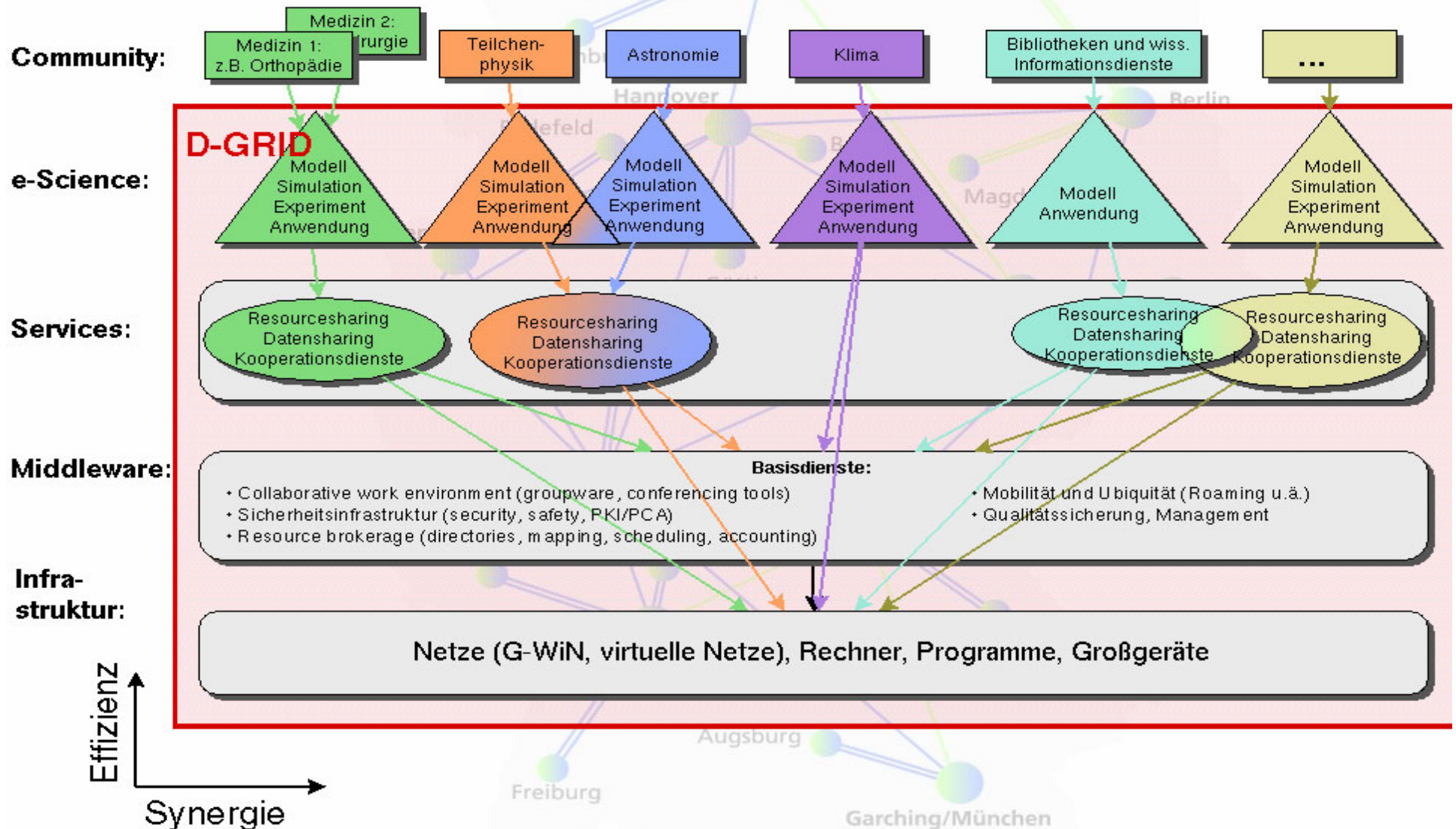
- 4 experiments, start: 2007
- 11 PBytes/year
- LHC Community: 5000 physicists, 300 research institutes in 50 countries
- lifetime: 15 years

- Middleware Services like Authentication and Authorisation for resource access („I want to restrict access to my data to users from my experiment only“)
- reliable and (sometimes) SLA guaranteed network access („I want to contribute data from my repository to an evaluation algorithm at site x with guaranteed minimum delay“)

- directories describing resources
- unique user interfaces
- scheduling and monitoring facilities for using resources
- facilities for error correction
- user support and hotline services
- dissemination and training of „GRID know how“

- such user requirements clearly lead to the notion of a GRID infrastructure because
 - services are for multiple use (for many user groups / GRIDs)
 - services have to be reliable (and not experimental)
- implication: Services have to be „engineered“
 - *looks simple but it isn't due to ongoing technology changes*

D-Grid: e-Science Framework

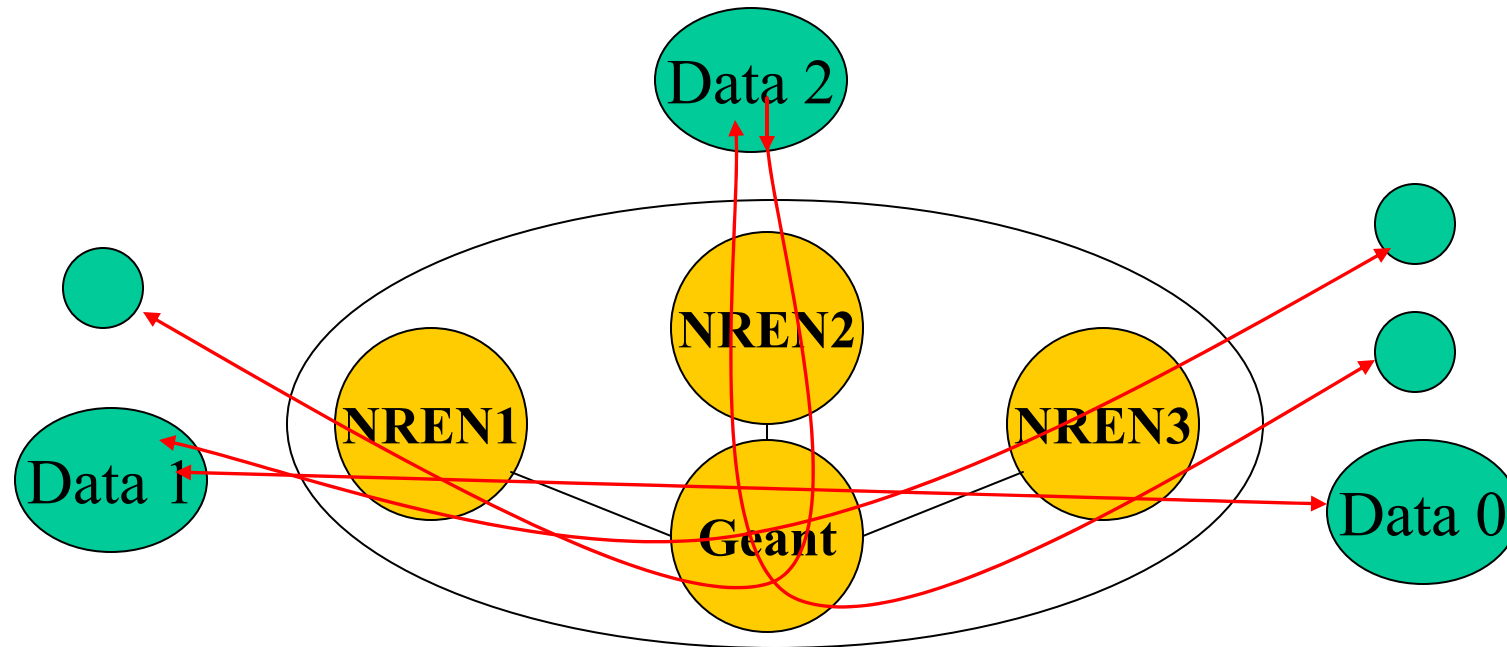


- Same questions:
 - Single sign on for services and network access
 - AAA-Services
 - Migration of existing directories
 - PKI, LDAP, /etc/usr/passwd files
- Coordination is a big challenge!
- Chance for generating benefit for all communities
- Component of eScience

- Provide network and the generic bundle of GRID related middleware services
 - Reasons:
 - end users will (potentially) be on multiple GRIDs
 - economy
 - NRENs used to offer this sort of infrastructure
- problem not trivial (multi domain problem)

D-GRID (3a) - NRENs tasks

multi domain problem



Both application problem and network problem are multi domain and have an international dimension

International activities:

- USA: Cyberinfrastructure programme 12 Mio\$/y
- UK: eScience 100 Mio £/4 Years
- NL: Virtual Lab
- EU: 6th framework projects (EGEE 32 Mio€/2y)

Actual state in DE (until beginning of 2003):

- several single projects
- low coordination between communities and funding bodies
- low representation of common interests of German Research Community

- 3 meetings of representatives of all involved research institutes + DFN + industry + BMBF

- Goal of D-GRID:

Bundle activities for global, distributed and enhanced research collaboration based on internet-services

====> build an e-science-framework

- D-GRID Board: Hegering (LRZ), Hiller (AWI), Maschuw(FZK, GRIDKa), Reinefeld (ZIB), Resch (HLRS)
- Tasks:
 - to prepare a political strategic statement of the German research community
 - to build up WGs, to plan MoU
 - to develop a working program

- Role of DFN:
 - to provide network resource for GRIDs (special GRID-Access to G-WiN)
 - to provide and support Middleware-Services (i.e. PKI, AAA)
 - to participate in developing work program for the next years
 - to participate in international projects like EGEE and GN2

- BMBF expects common commitment and co-funding from research organisations and industry
- in Q3/04 tender for e-science-projects
- BMBF funding announced:
5 - 10 Mio €/y in 2005 - 2008

GRIDs - networked applications

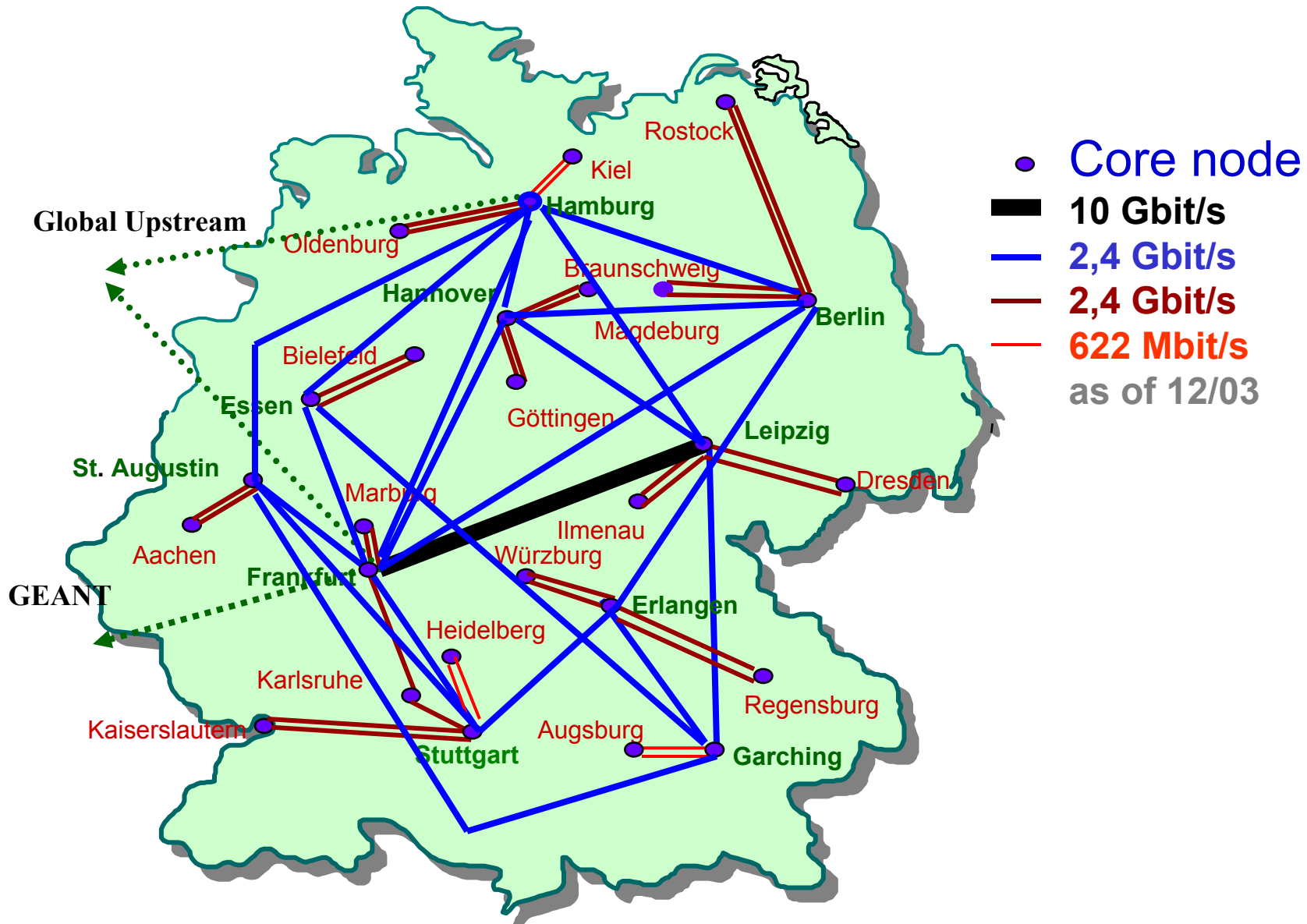
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The Network - basis for GRIDs

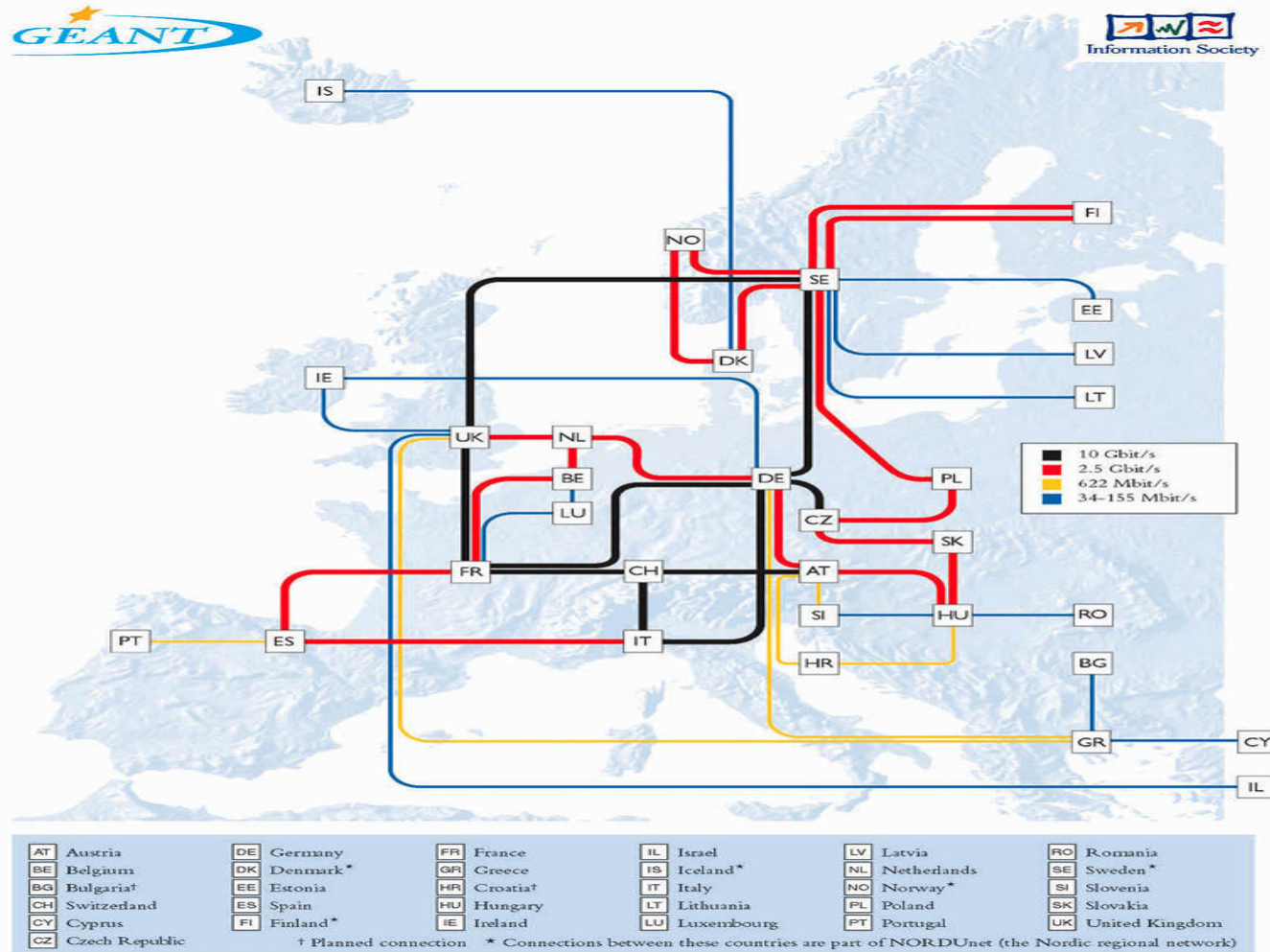
- **Status G-WiN**
- **Challenge X-WiN**
- **Technology Options X-WiN**
- **The Market for Dark Fibre**
- **International Developments**
- **Roadmap X-WiN**
- **Engineering Issues X-WiN**

- 27 nodes distributed in Germany mostly in universities / research labs
- core: flexible SDH platform (2,5 G; 10 G)
- ~ 500 access lines 128K - 622 M
- occasional lambda-links and „dark fiber“
- own IP NOC
- special customer driven solutions (VPNs, accesses etc.) are based on the platform
- diverse access options including dial-up and dsl (dfn@home)

G-WiN (2) - Topology



G-WiN (2b) - Geant



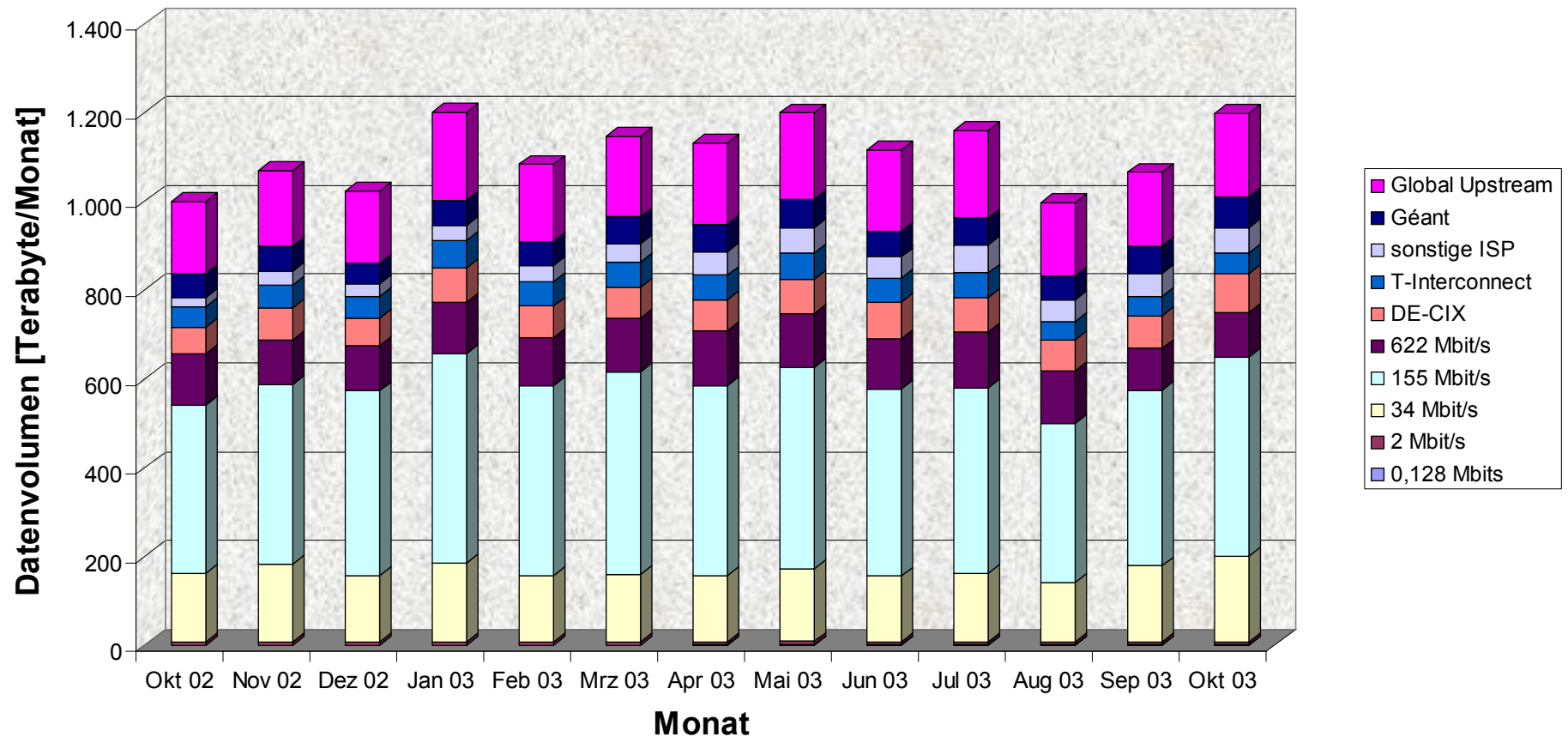
Multi-Gigabit pan-European Research Network
Backbone topology February 2002



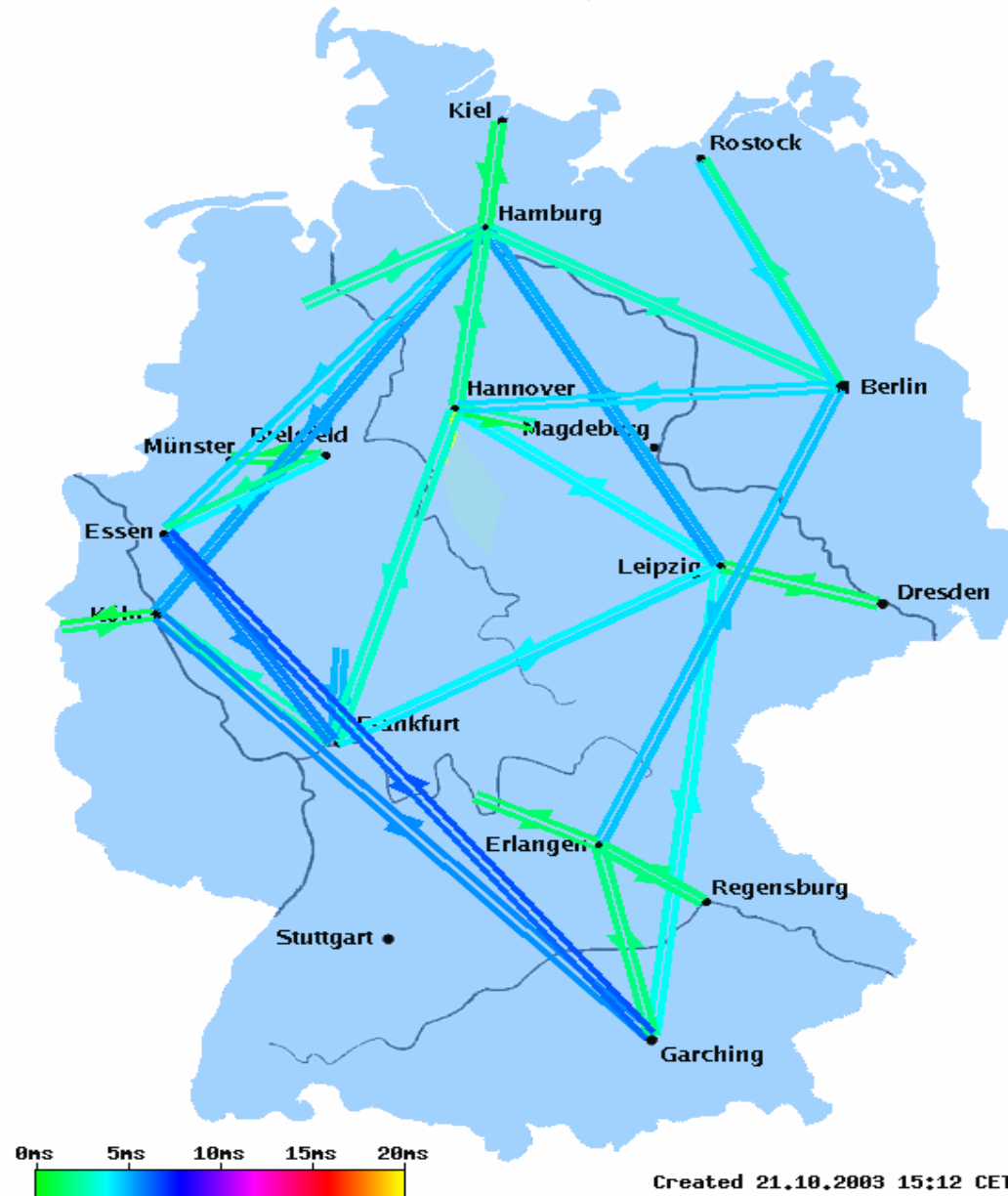
- New Demands:
 - GRID: „(V)PN“ + Middleware + Applications
 - „value added“ IP-Services
- Examples for new usage patterns:
 - computer-computer link H-B
 - Videoconference Service
- Volume and growth rate see figure

G-WiN (4) Usage figures

Entwicklung des importierten Datenvolumens

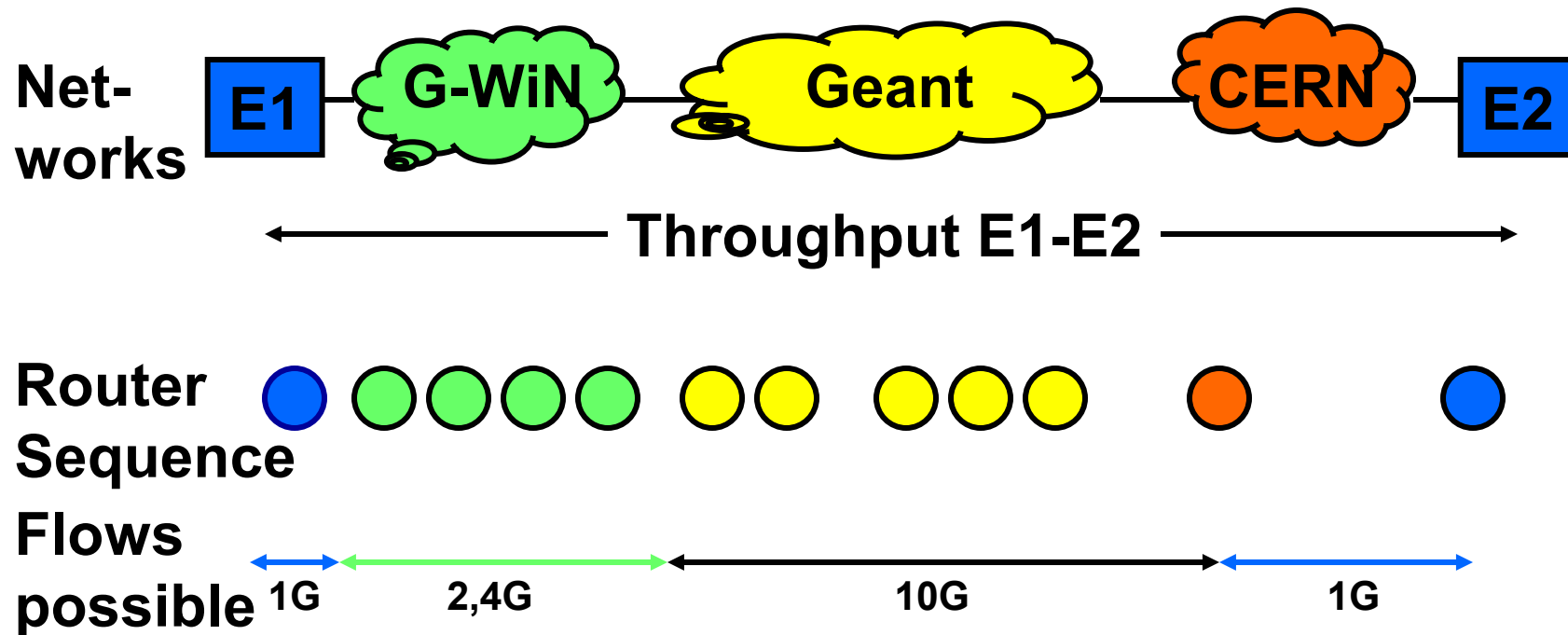


G-WiN (5) - QoS (core)



G-WiN (6) - QoS measurements

Performance measurements for particle physics community:
TCP (GRIDKa/G-WiN/Geant/CERN) between E1 and E2



Results

	<u>Src-Sink</u>	<u>Rate send</u>	<u>Rate rec.</u>
UDP-3	Ka - CERN	980Mbit/s	956Mbit/s
UDP-4	CERN-Ka	Dto.	954Mbit/s
TCP-1	Ka-CERN	Dto.	510Mbit/s
TCP-8	Ka-CERN	Dto.	923Mbit/s

- DFNInternet
 - low delay (<10 ms) and jitter (< 1 ms)
 - packet loss extremely low (see measurements)
 - Throughput per user stream >1 Gbit/s possible
 - priority option for special applications
 - Disaster recovery

- Special solutions on demand should be possible
- distributed data processing, i.e. GRIDs (radio astronomy, particle physics, biology, data storage, computing ...)
- dedicated source - sink characteristic of streams

Challenges for X-WiN (3)

- 10 G links between all nodes
- Flexible reconfiguration (<7d)
- cheap ethernet - expensive routers !?
- High MTBF, MTTR in core and components
- 24/7 operation of platform
- Bandwidth on demand if technically and economically feasible

General

- There is nothing „magic“
- diverse approaches possible
- optimal value adding - options:
 - SDH/Ethernet as basic platform?
 - managed lambdas?
 - managed dark fiber and own WDM?
- 24/7 operation of the platform

- Package containing
 - Flexibility for reconfiguration
 - operation staff with 24/7 availability
 - SLAs with legal bindings
- tool box model
 - n SDH/Ethernet links
 - specified time lines for reconfiguration
 - functional extension of tool box possible

Technology Options X-WiN (3)

Managed Lambdas

- Service contains
 - Lambdas as service
 - SDH/Ethernet „do it yourself or by others“
 - Switched 10G network ("L2-WiN")
 - Switching in L2-WiN according to user needs
 - operation L2-WiN 24/7
 - Advantage: Shaping according to own needs possible

Managed dark fiber

- like managed lambdas, but...
 - Buy own managed dark fiber (L1-WiN)
 - WDM „self-made“ value-adding
 - Filter, optical MUX, EDFA, 3R
 - 24/7 operation as service?
- Advantage: additional bandwidth rather cheap and scalable

Market for dark fibre (example)

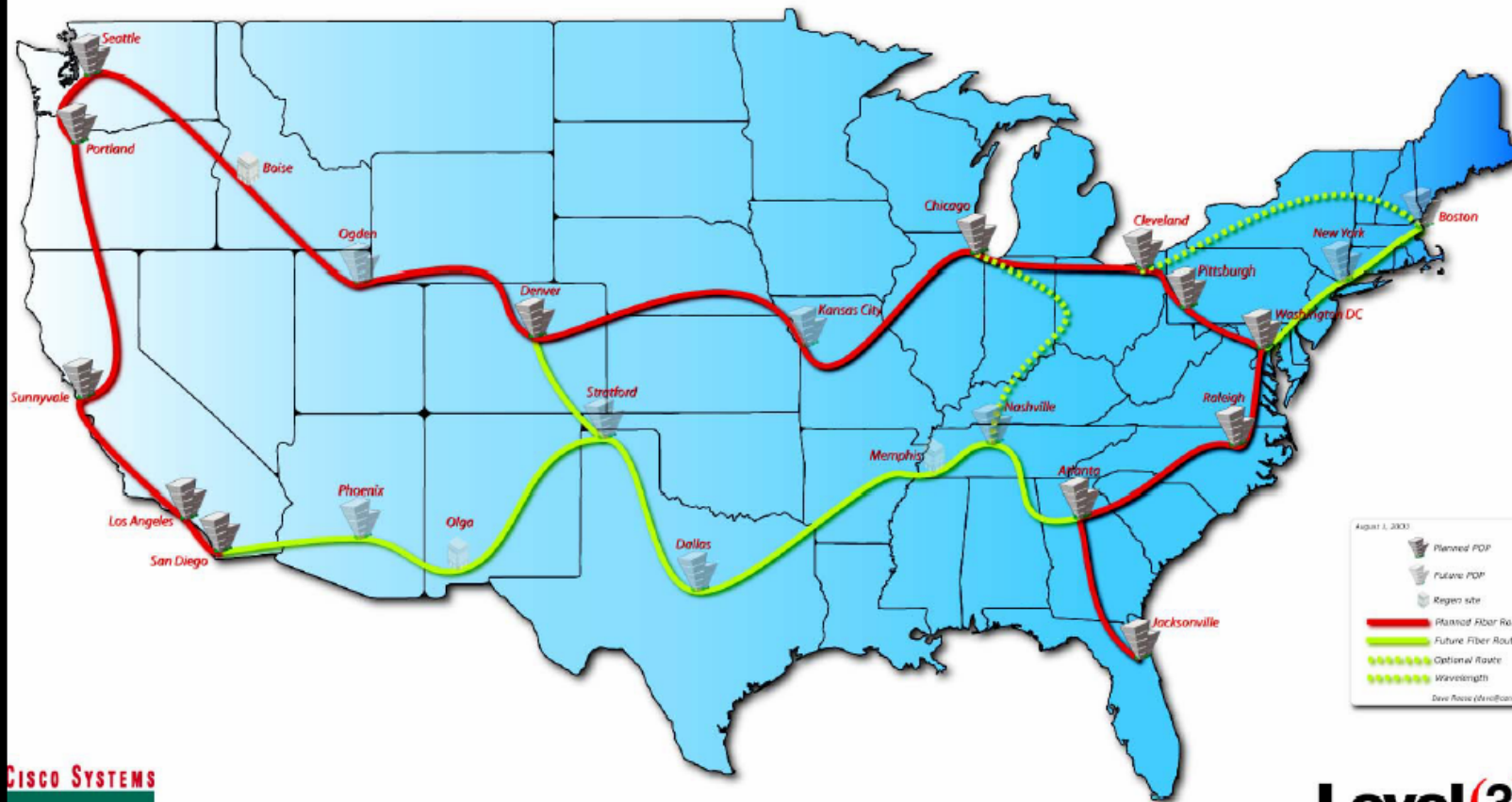
- Example GasLine
- LWL along gas pipelines
- very high MTBF
- Budget offer looks interesting
- Lot of user sites along the links
- business model possible...



- Hypothesis: "Ethernet-Switches with 10 G Interfaces are stable and cheap."
- New generations for research networks
 - USA (Abilene)
 - Poland (Pionier)
 - Czech Republic (Cesnet)
 - Netherlands (Surfnet)
 - Canada (Canarie)
 -

International Developments (2)

NLR National Fiber Network



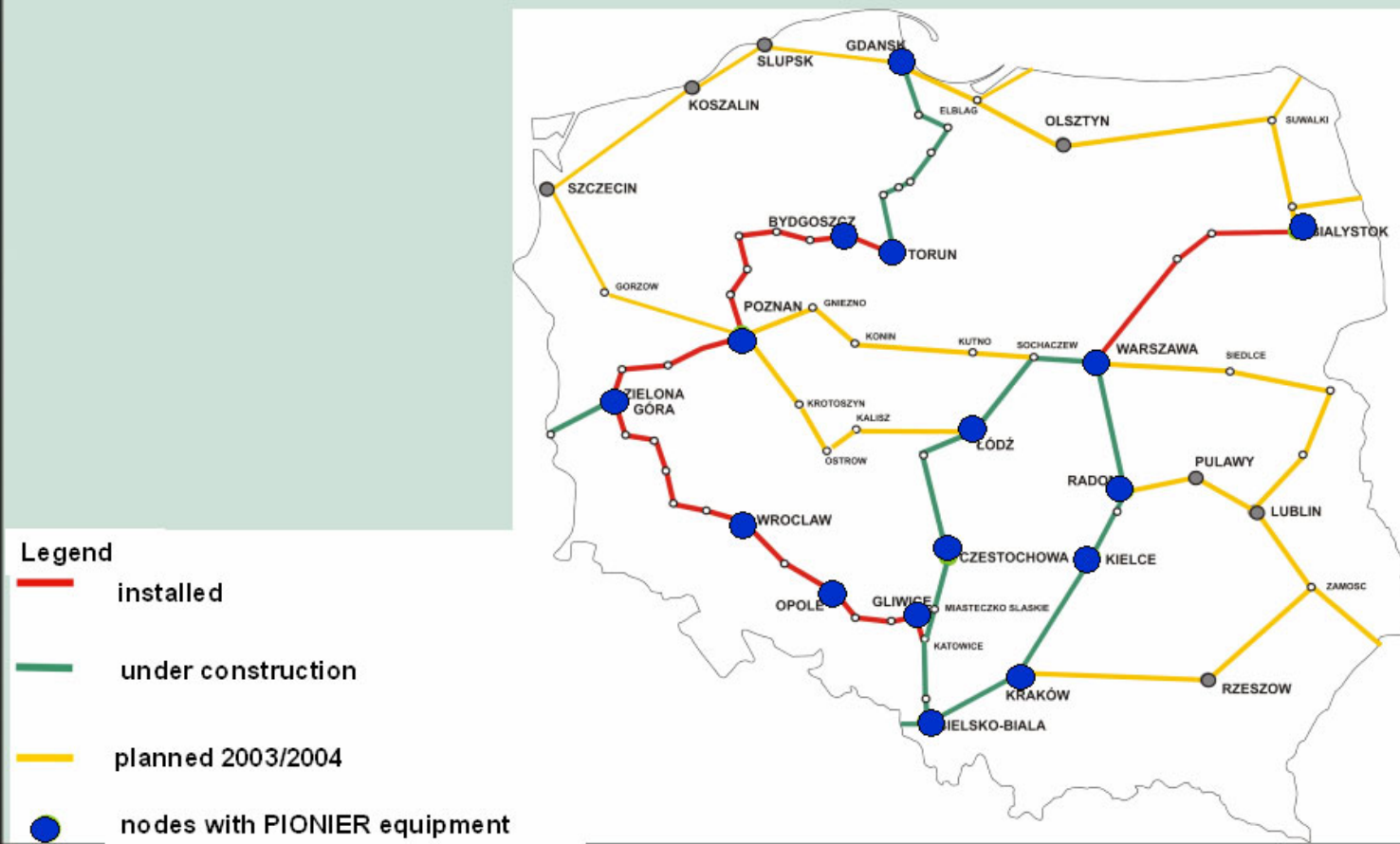
Initial Coordinating Participants



International Developments (3)

Poznan Supercomputing and Networking Center

PIONIER fibre topology



- A network can engineering-wise be described by a **traffic matrix T** where $T(i,j)$ describes the traffic flow requirements between network end points (i) and (j)
- $T(i,j)$ (can) map user requirements directly
- Every network has an underlying T (explicitly in case of engineered networks or implicitly by „grown“ networks)

- G-WiN: Assumption of statist. traffic mix (FT, Visualisation etc.); $T(i,j)$ describes load at peak usage time; bandwidth of a (network) link described by $T(i,j)$ is always 4 times higher than the peak load.
- Video Conferencing network: specific requirements in respect to jitter

- Experiment evaluation facilities must be available in the middle of the decade
- due to a couple of technology dependencies of the evaluation systems the 2005/2006 perspective of T not exactly known today
- compromise: T has to be iterated on a 1-2 years basis
- ongoing e2e measurements
- close cooperation for example in the EGEE context

- Testbed activities (optical testbed „Viola“)
(network technology tests in (real) user environments, design input for X-WiN)
- At present: meetings with suppliers of
 - dark fiber, operation, technical components
 - feasibility study (ready early 2004)
- road map
 - market investigation Q1/04
 - Concept until Q3/04; CFP Q4/04
 - 2005: Migration G-WiN -> X-WiN: Q4/05