



G-Lab - The German approach towards Future Internet research

<http://www.german-lab.de/>

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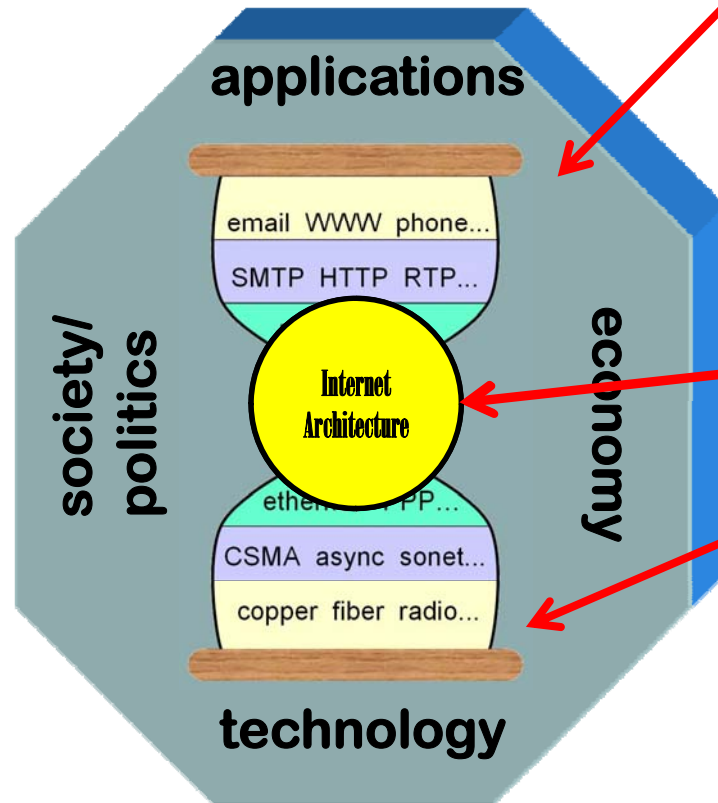
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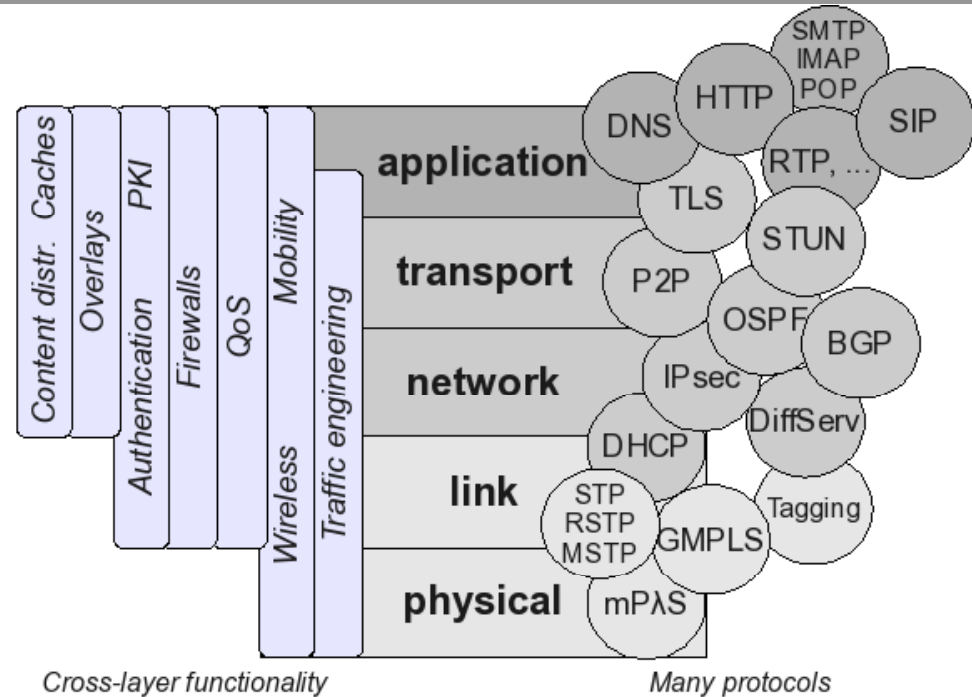
Internet Ecosystem



- Huge innovations in applications
 - the Web
 - P2P,...
 - **VoIP, Triple play, ...**
 - **...the future is Web2.0/3.0 ...**
- **Internet core architecture**
- Permanent evolution of the underlying technologies
 - Wireless / mobile
 - All over ethernet
 - Optical
 - **... the future is optical/mobile**
 - ...

Architecture of the Current Internet

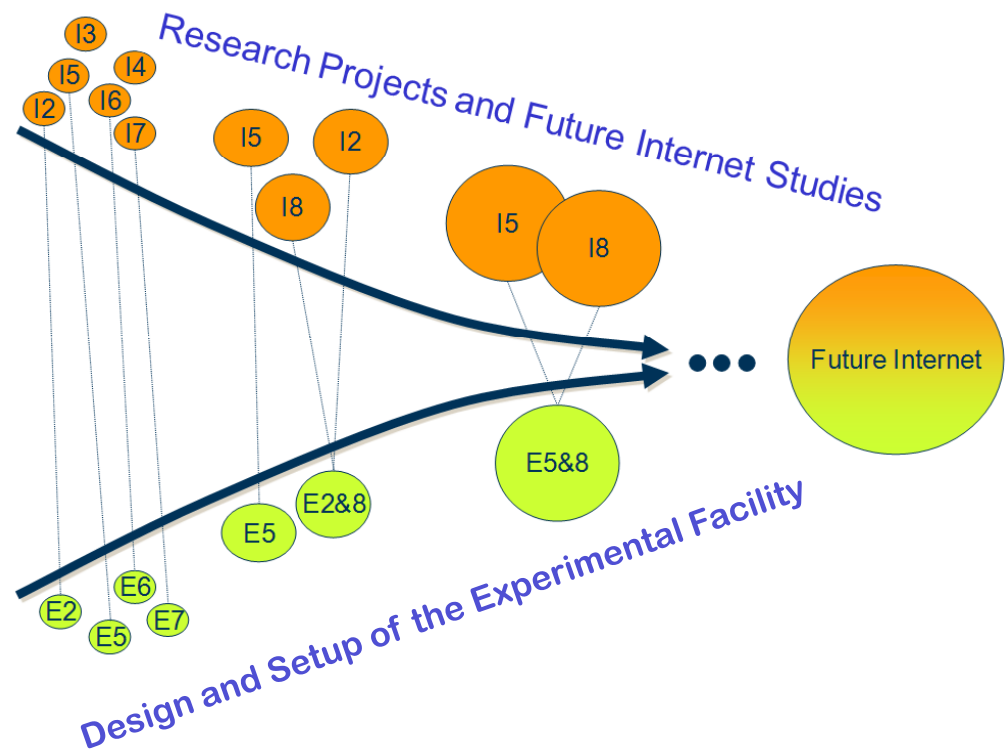
“The Internet only just works”
Mark Handley



- ▶ Original architecture is violated
 - Growing demands/ requirements of ever new applications
 - Ever new capabilities of transport networks (optical/mobile)
- ▶ Increasing interdependencies hinder innovation
 - Cross layer functionalities
- **Complexity is still rising ...**

G-Lab: Vision of the Future Internet

- ▶ Closing the loop between *research* and *real-world experiments*
- ▶ Provide an **experimental facility** for studies on architectures, mechanisms, protocols and applications towards Future Internet
- ▶ Investigate interdependency of theoretical studies and **prototype development**



G-Lab Organization

G-Lab Phase I (Oct. 2008)

- ▶ **Coordination:**
 - **WP0:** Coordination and Consolidation
- ▶ **(Prototype) Studies:**
 - **WP1:** Architecture of the Future Internet
 - **WP2:** Routing and Address Schemes
 - **WP3:** Wireless Networks and Mobility
 - **WP4:** Monitoring and Management Concepts
 - **WP5:** QoS, QoE and Security
 - **WP6:** Architecture and Composition of Services
- ▶ **Experimental Facility:**
 - **WP7:** Platform for Experiments

G-Lab Phase II (since Sept. 2009)

- ▶ **COMCON** (Control and Management of Coexisting Networks)
- ▶ **VirtuRAMA** (Network Virtualization)
- ▶ **FoG** (Forwarding on Gates)
- ▶ **NETCOMP** (Network-Computing for the Service Internet of the Future)
- ▶ **CICS** (Convergence of Internet and Cellular Systems)
- ▶ **HAMcast** (Hybrid Adaptive Mobile Multicast)
- ▶ **Deep** (Deepening G-Lab for Cross-Layer Composition)
- ▶ **Real-World G-Lab**
- ▶ **Ener-G** (Energy Efficiency in G-Lab)

G-Lab Organizational Structure

► Tasks

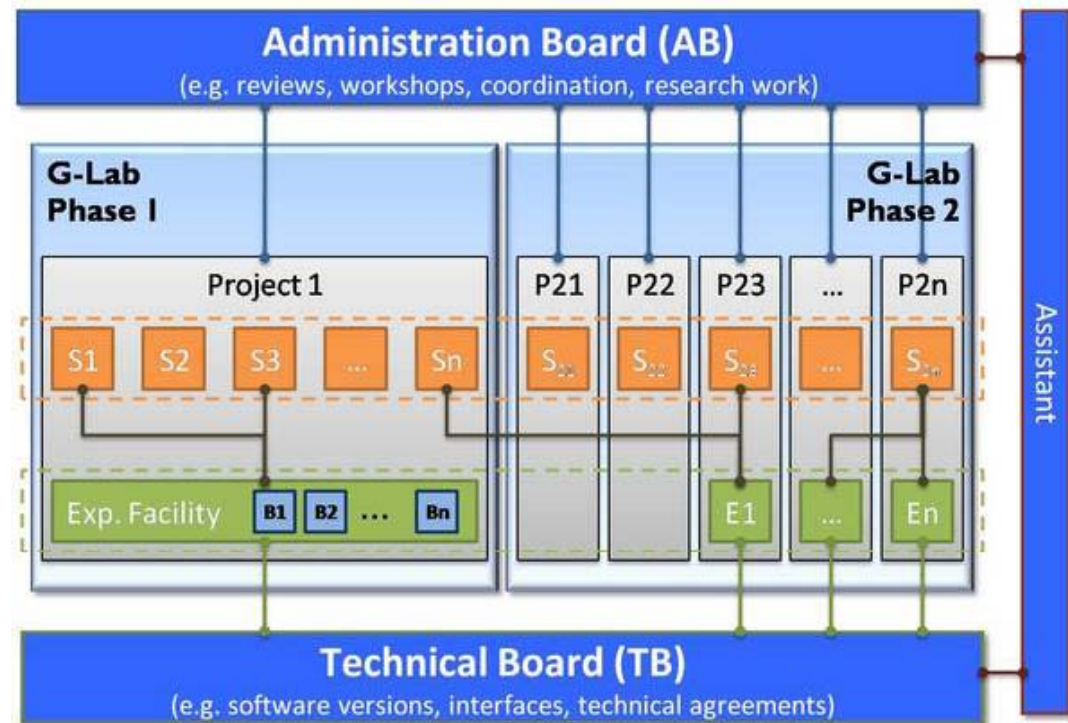
- Access for phase 2 members to phase 1 hardware
- Integrate phase 2 hardware
- Extend platform

► Problem

- No legal relationship between phase 1 and phase 2
- We need a contract !

► Legal Contract

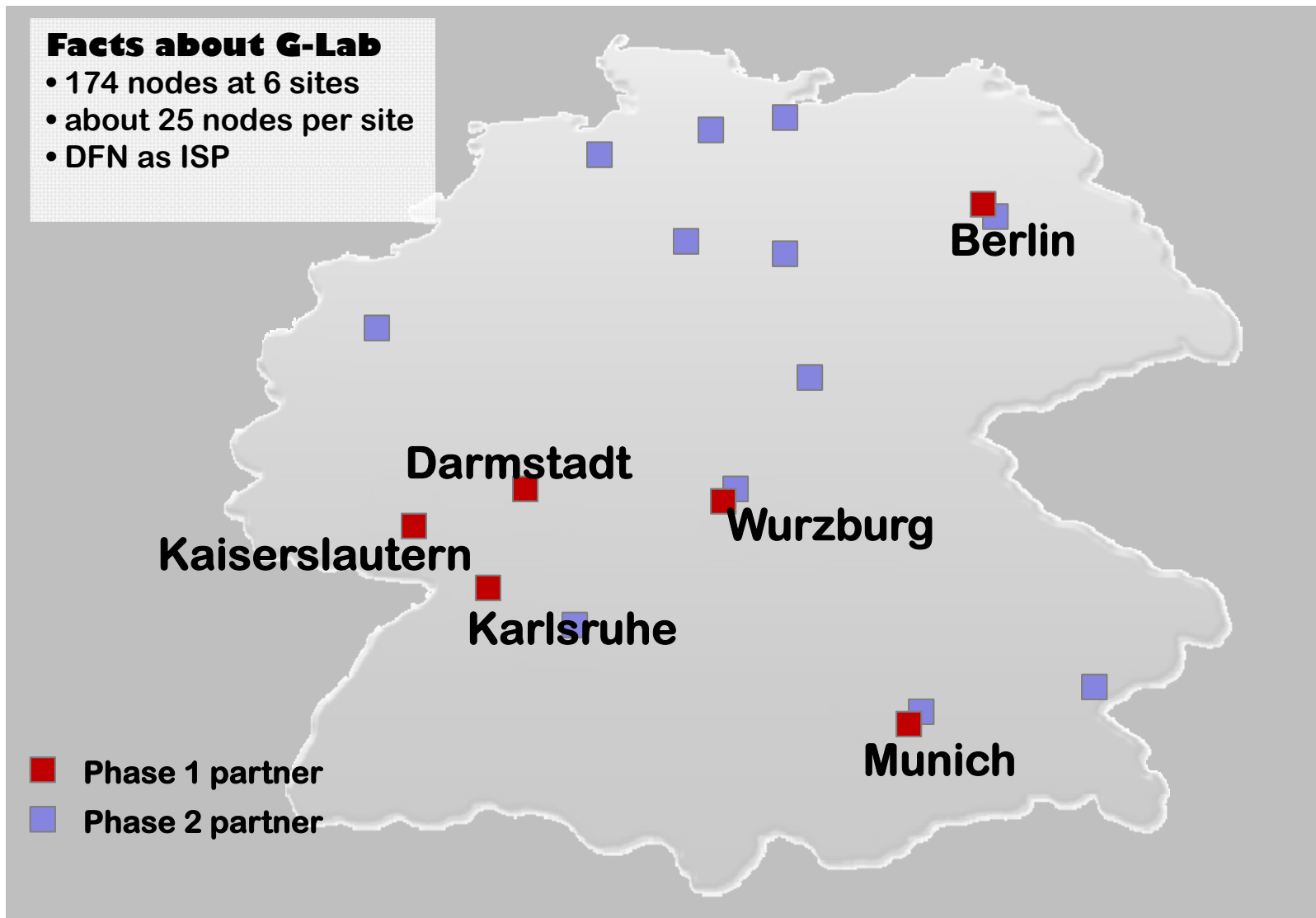
- Between all platform providers
- Between each partner and the platform



Partner Locations

Facts about G-Lab

- 174 nodes at 6 sites
- about 25 nodes per site
- DFN as ISP



G-Lab Environment

▶ **Testbed:**

- Real not simulated
- Specific purpose
- Focused goal
- Known success criteria
- Limited scale

Not sufficient for clean slate design

▶ **Experimental facility:**

- Purpose:
 - explore yet unknown architectures
 - expose researchers to real thing
 - breakable infrastructure
- Larger scale (global?)
- Success criteria: unknown

G-Lab Environment

▶ Full control over the resources

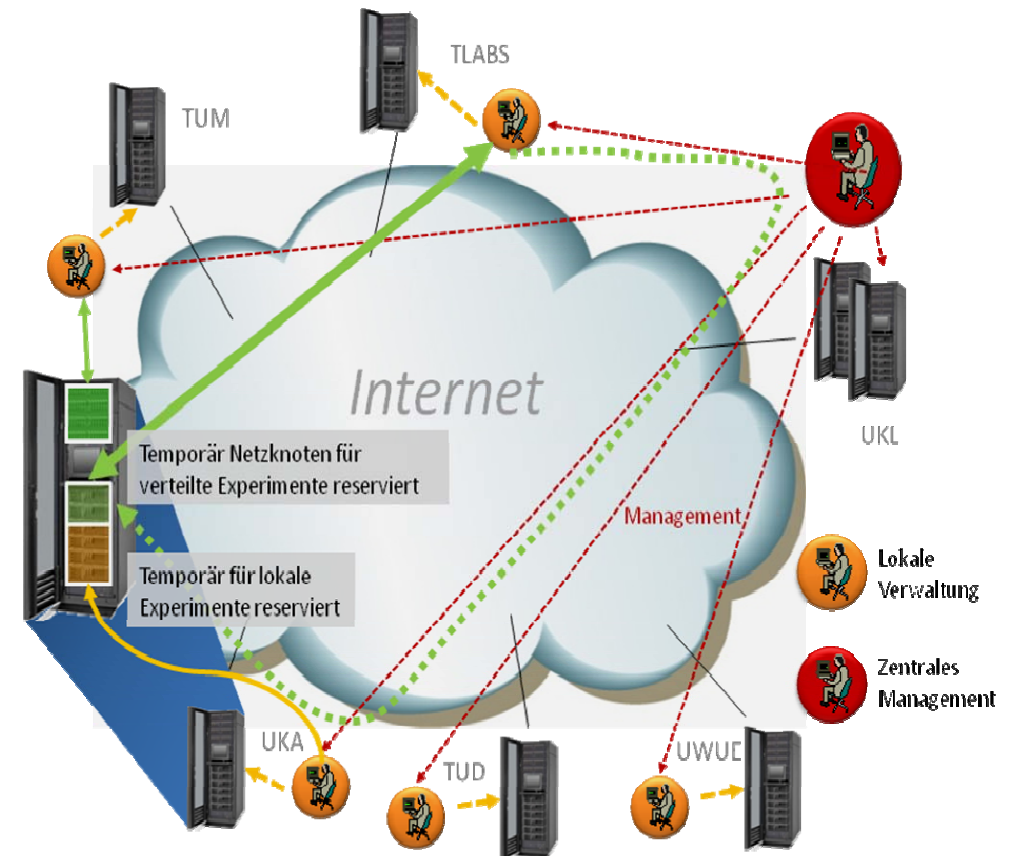
- Reservation of single resource should be possible
- Elimination of side effects
- Testing scalability

▶ Exclusive resource reservation

- Testing QoS / QoE
- Decentralized Resources can be independently used
- Tests on the lower layers of the network without affecting the “life” network

▶ Extended functionality

- New technologies (Wireless, Sensor,...)
- Interfaces to other testbeds (GENI, PlanetLab Japan, WinLab, ...)



Hardware Equipment (1)

▶ Normal Node

- 2x Intel L5420 Quad Core 2,5 GHz
- 16 GB Ram
- 4x Gbit-LAN
- 4x 146 GB disk
- ILOM Management Interface (separate LAN)

▶ Network Node

- 4 extra Gbit-Lan

▶ Headnode

- 2x Intel E5450 Quad Core 3,0 GHz
- 12x 146 GB disk

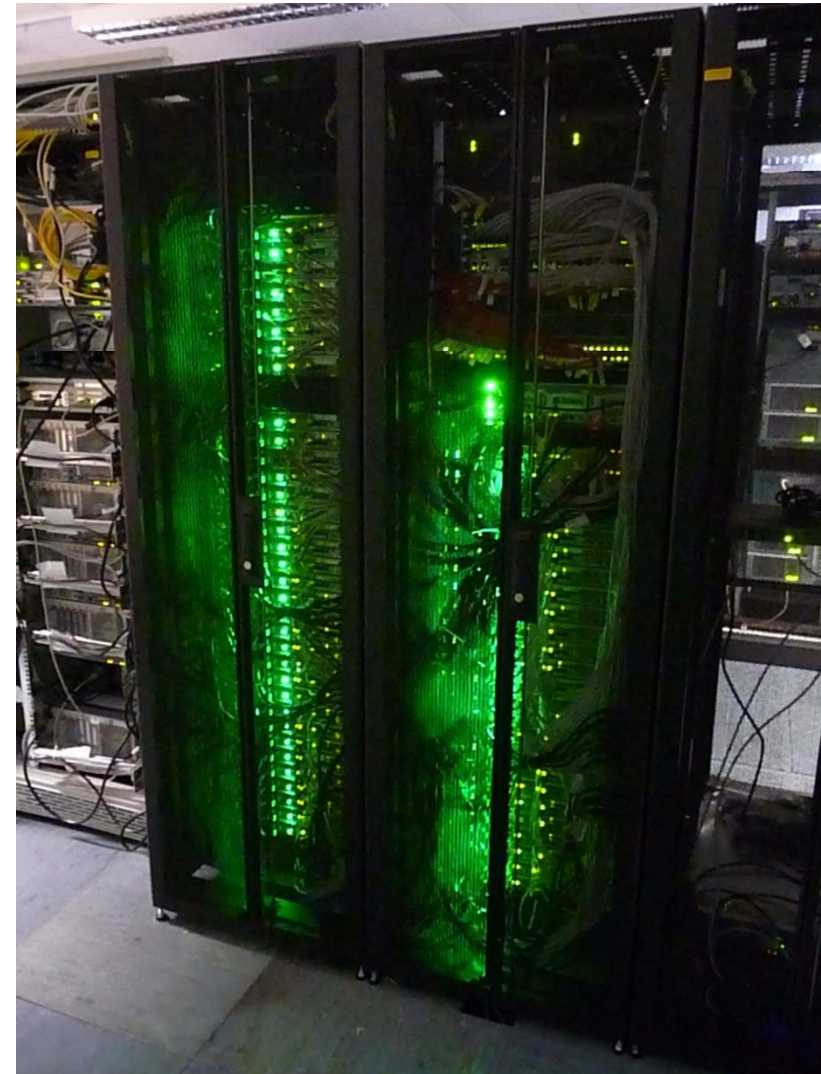
▶ Nodes per Site

Site	Head	Network	Normal
Kaiserslautern	1	2	47+9
Würzburg	1	2	22
Karlsruhe	1	2	22
München	1	2	22
Darmstadt	1	2	22
Berlin	1	2	12

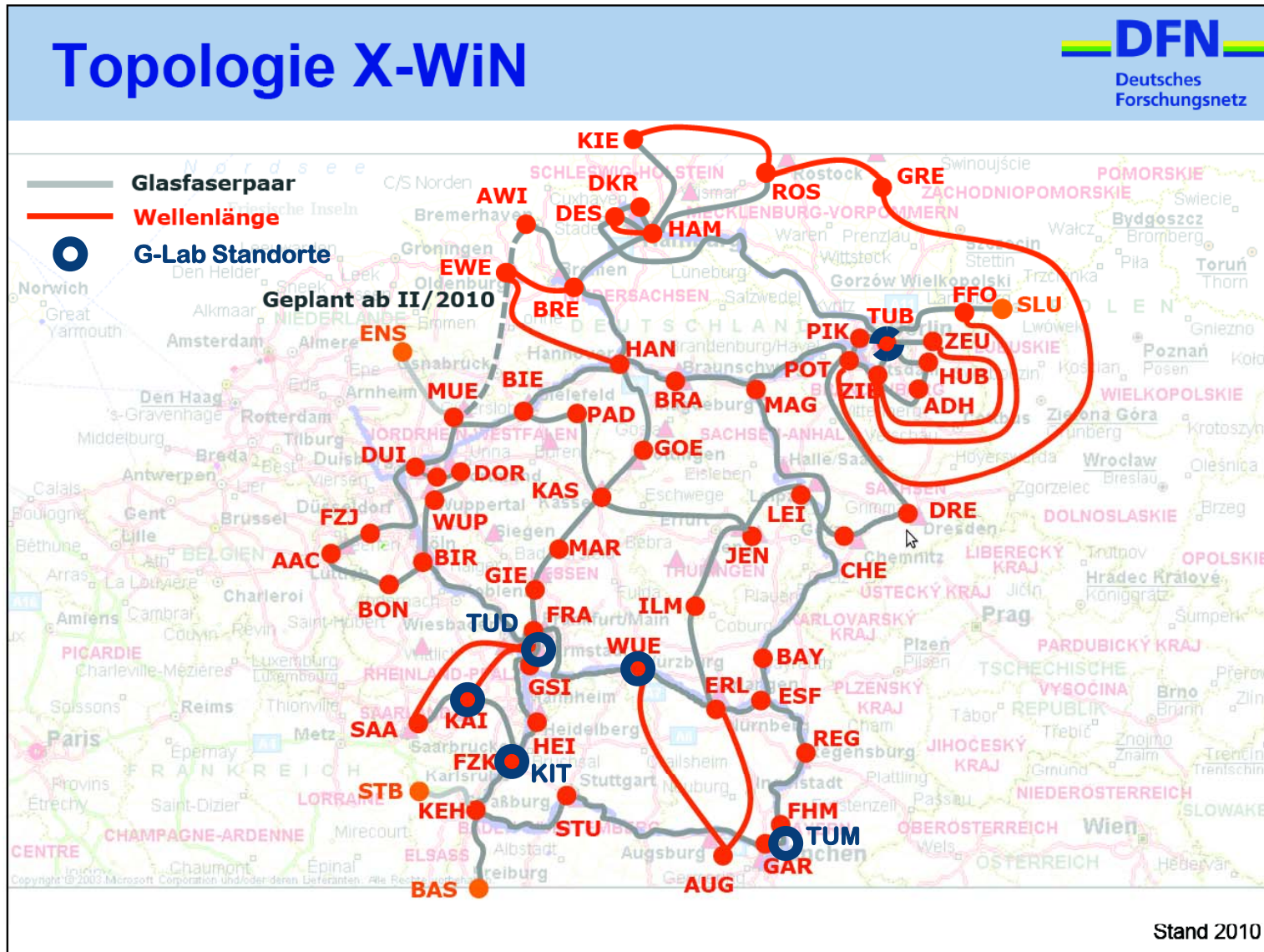
▶ 174 Nodes in total (1392 cores total)

Hardware Equipment (2)

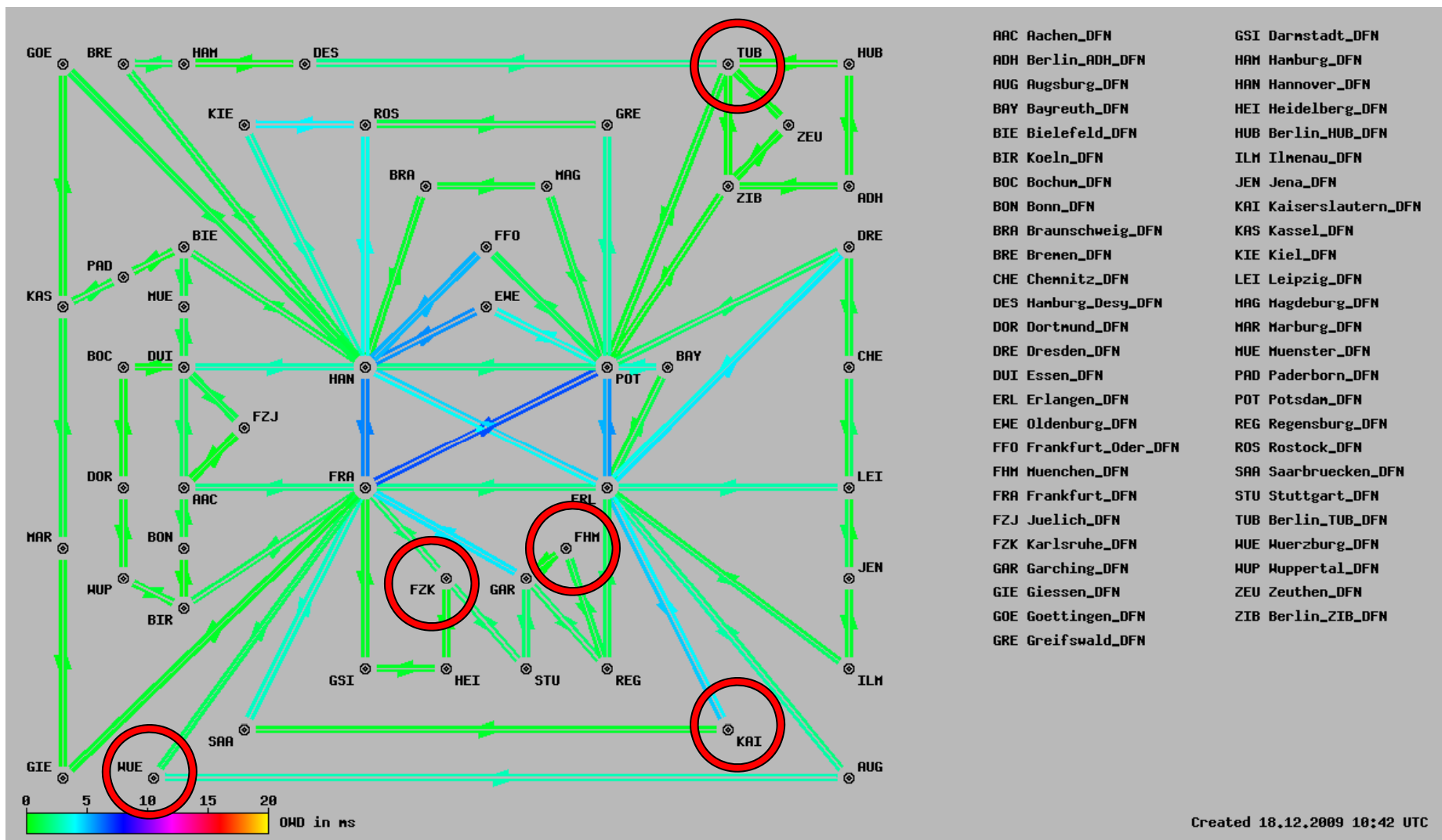
- ▶ Site requirements
 - 1 public IP address per Node
 - Not all sites have IPv6, so nodes should have IPv4 addresses.
 - Virtualized nodes need additional addresses
 - Direct Internet access
 - No firewall or NAT
 - Nodes must be able to communicate with each others
 - Nodes must be able to use public services (NTP, public software repositories)



Network Topology



DFN IP Topology



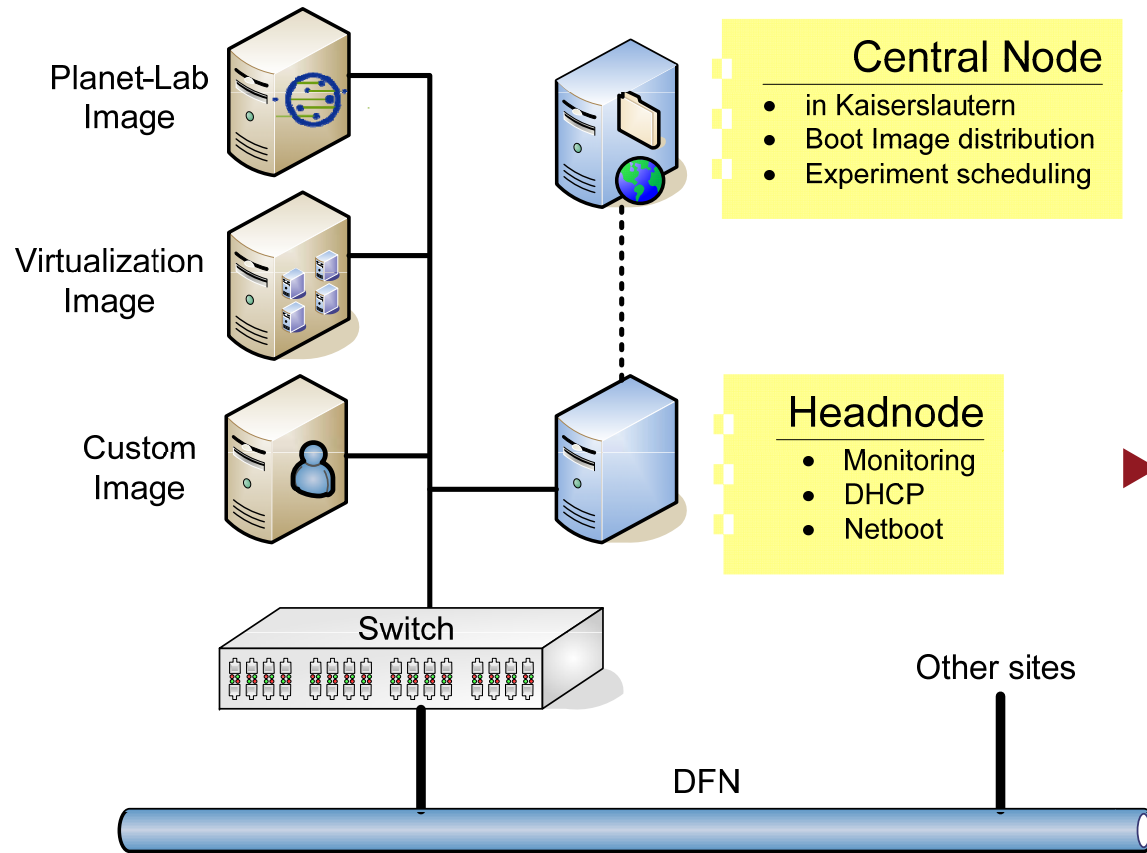
Flexibility

- ▶ Experimental Facility is part of research experiments
 - Facility can be modified to fit the experiments needs
 - Researchers can run experiments that might break the facility
 - Experimental facility instead of a testbed
- ▶ Research is not limited by
 - Current software setup
 - Current hardware setup
 - Restrictive policies
- ▶ Experimental Facility is evolving
 - Cooperative approach
 - „When you need it, build it“
 - Core team helps
 - Cooperation with other facilities (e.g. Planet-Lab, GENI)
 - Federation

Boot Images

- ▶ Researchers can run any software on the nodes
 - Software comes as boot image
 - Either booted directly on hardware or in virtualization
- ▶ Three types of boot image
 1. Planet-Lab
 - Access for everybody
 - Easy to manage
 - Restricted hardware access
 2. Hypervisor virtualization image
 - Access for everybody
 - Unrestricted access to virtual hardware
 3. Custom boot image
 - Access can be restricted to specific research group
 - Unrestricted access to real hardware
- ▶ Access regulated by policy
 - Will favor generic images with open access over specific images with restricted access
 - Policy will not over-regulate

German-Lab Structure



▶ Central Node

- Resource management
 - Experiment scheduling
 - Resource provisioning
- Boot Image management
 - Distributes Images
 - Assigns Images to nodes

▶ Each site has a Headnode

- Manages local nodes
 - DHCP
 - Netboot
 - Monitoring
 - ILOM access
- Executes orders from Central node
 - Local overrides possible

Monitoring (<http://nagios.german-lab.de>)

► Nagios

- Central monitoring in Kaiserslautern
- Obtain information from other sites via NRPE proxy on the head-node
- Checks
 - Availability of Nodes
 - Status of special services
 - Hardware status (via ILOM)

► CoMon

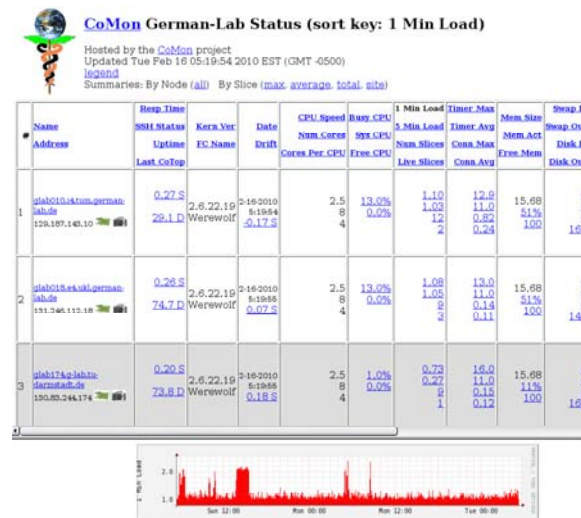
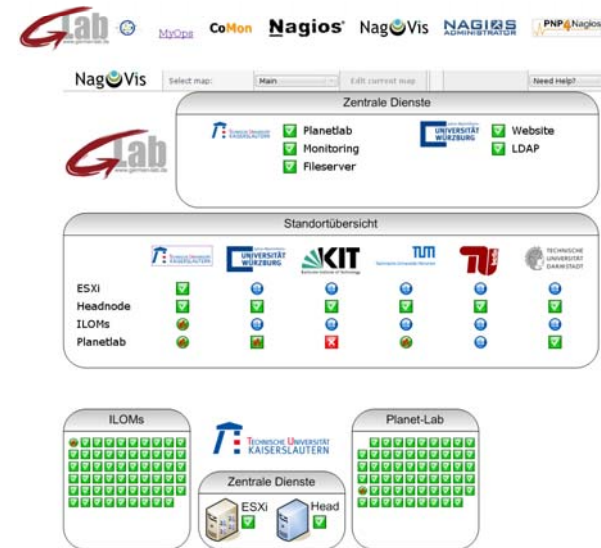
- Planet-Lab specific monitoring
- In cooperation with Planet-Lab, Princeton
- Monitors nodes from within
 - CPU, Memory, IO
- Slice centric view
 - Monitors experiments

► MyOps

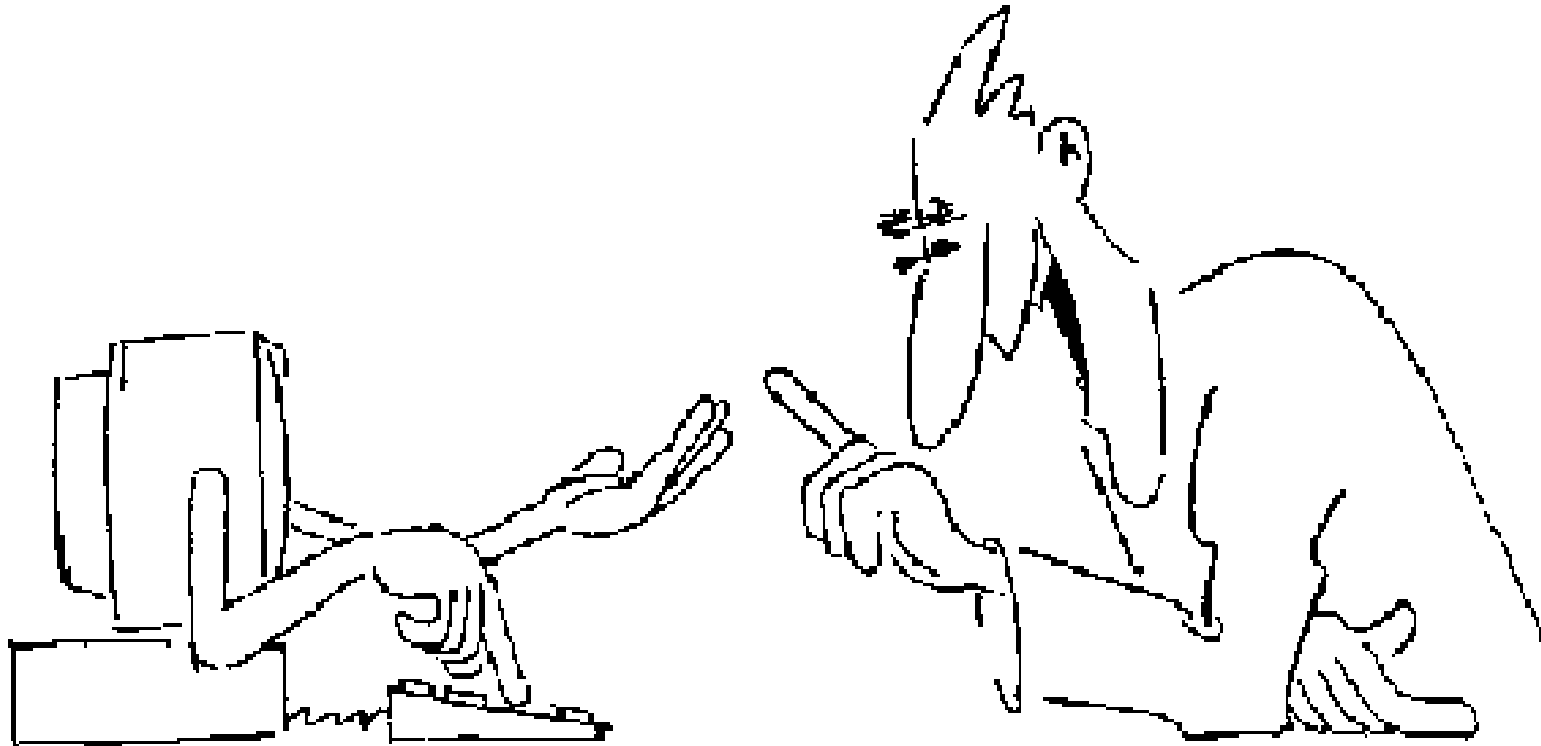
- Planet-Lab specific tool
- In cooperation with Planet-Lab, Princeton

Detects common Planet-Lab problems

Reacts to problems



Questions?



► <http://www.german-lab.de/>