Interconnecting our Life –
The Role of Software for Everyone Everywhere

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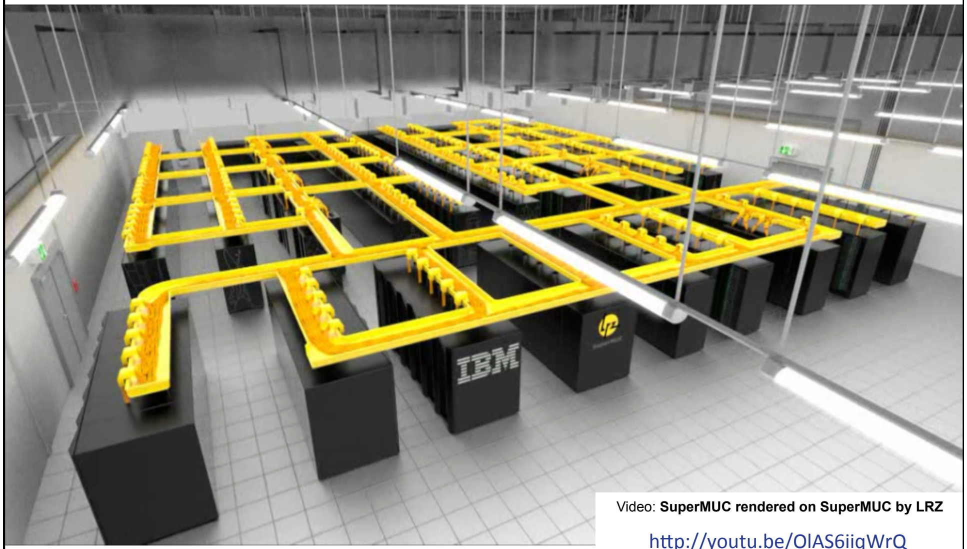
Leibniz Supercomputing Centre
of the Bavarian Academy of Sciences and Humanities

Picture: Ernst A. Graf

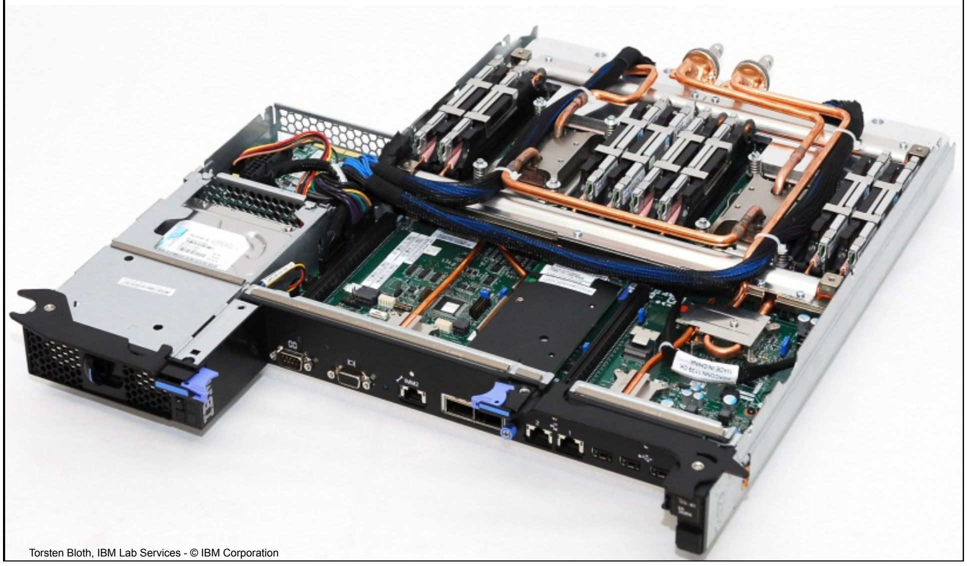
SuperMUC @ Leibniz Supercomputing Centre



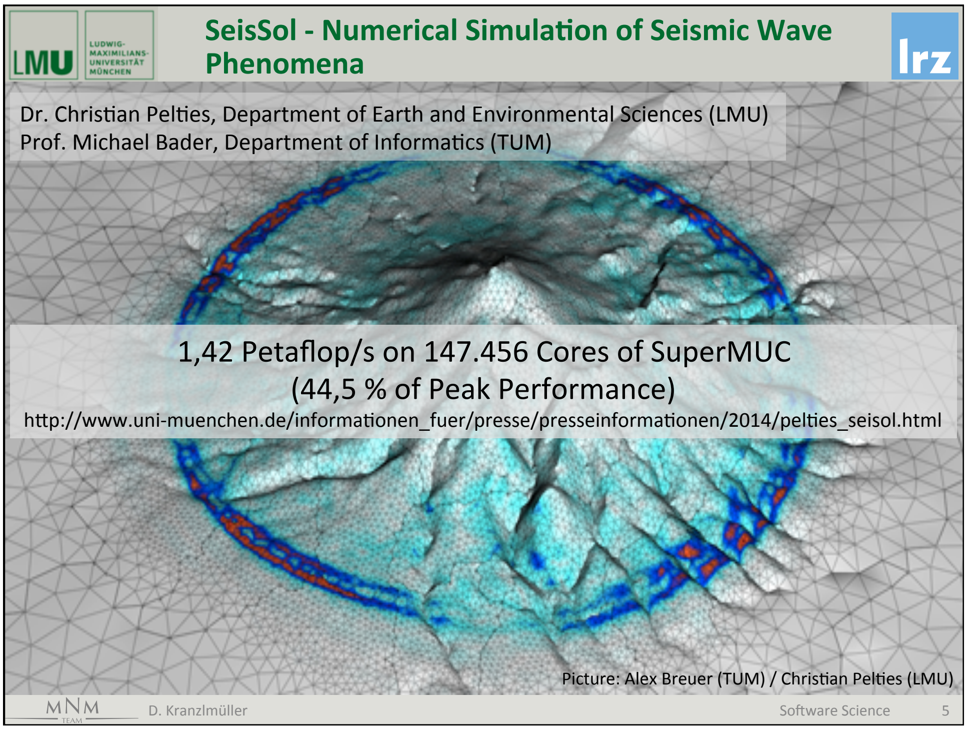
Video: **SuperMUC rendered on SuperMUC by LRZ**

http://youtu.be/OlAS6iiqWrQ

IBM iDataplex dx360 M4



Torsten Bloth, IBM Lab Services - © IBM Corporation



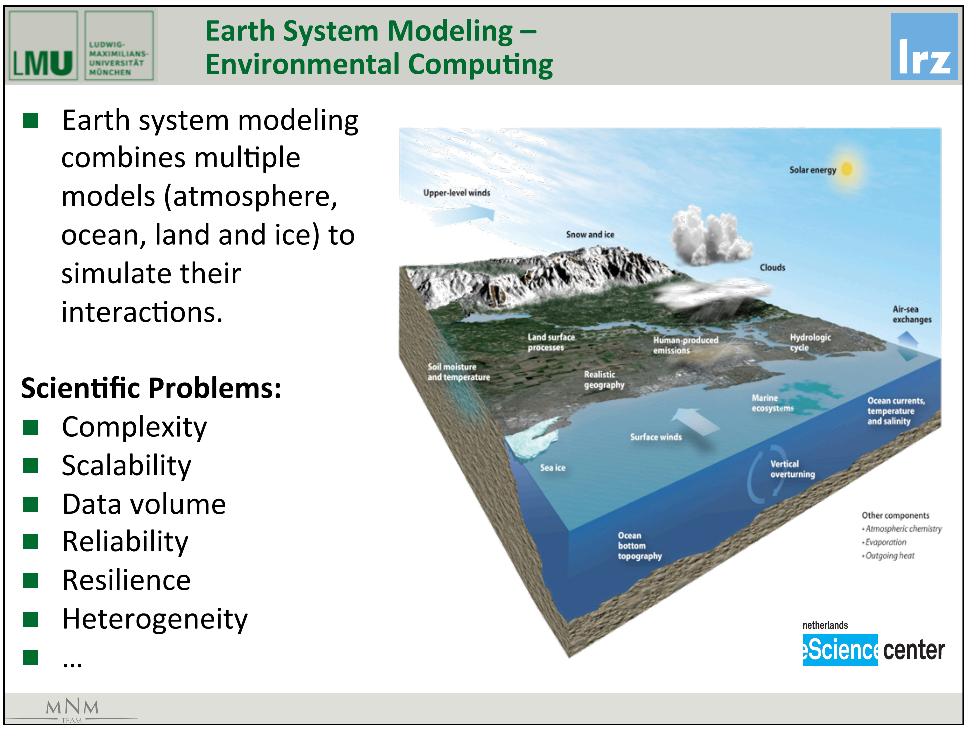
SeisSol - Numerical Simulation of Seismic Wave Phenomena

Dr. Christian Pelties, Department of Earth and Environmental Sciences (LMU)
Prof. Michael Bader, Department of Informatics (TUM)

1,42 Petaflop/s on 147.456 Cores of SuperMUC
(44,5 % of Peak Performance)

http://www.uni-muenchen.de/informationen_fuer/presse/presseinformationen/2014/pelties_seisol.html

Picture: Alex Breuer (TUM) / Christian Pelties (LMU)



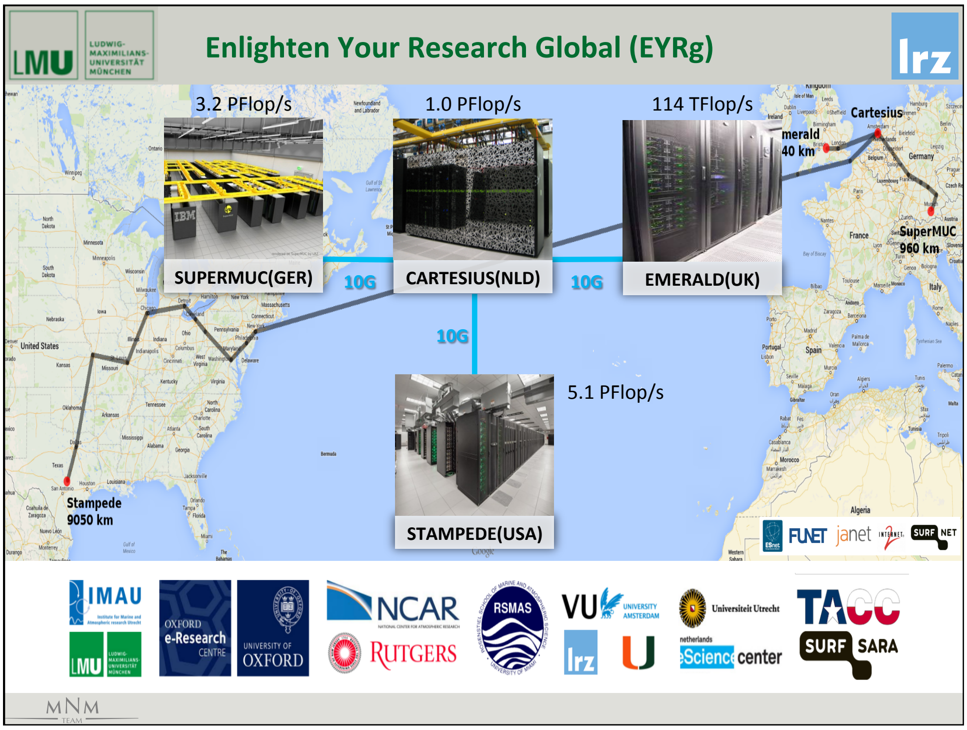
Earth System Modeling – Environmental Computing

- Earth system modeling combines multiple models (atmosphere, ocean, land and ice) to simulate their interactions.

Scientific Problems:

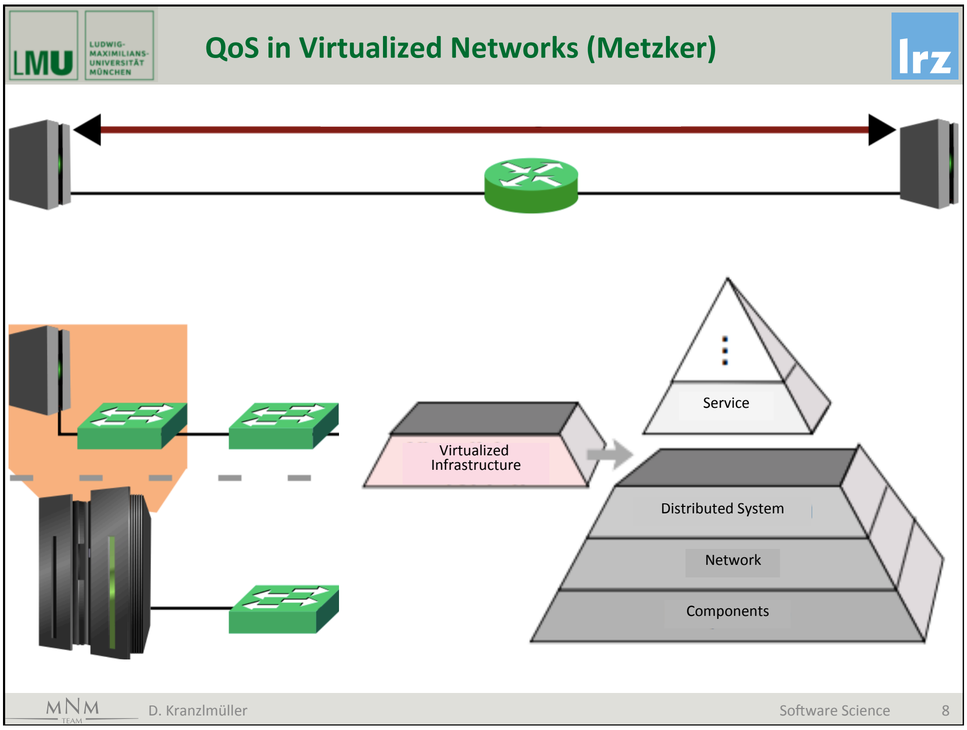
- Complexity
- Scalability
- Data volume
- Reliability
- Resilience
- Heterogeneity
- …

Upper-level winds
Solar energy
Snow and ice
Clouds
Air-sea exchanges
Land surface processes
Human-produced emissions
Hydrologic cycle
Soil moisture and temperature
Realistic geography
Marine ecosystems
Ocean currents, temperature and salinity
Surface winds
Sea ice
Vertical overturning
Other components
• Atmospheric chemistry
• Evaporation
• Outgoing heat
Ocean bottom topography
netherlands eScience center



Enlighten Your Research Global (EYRg)

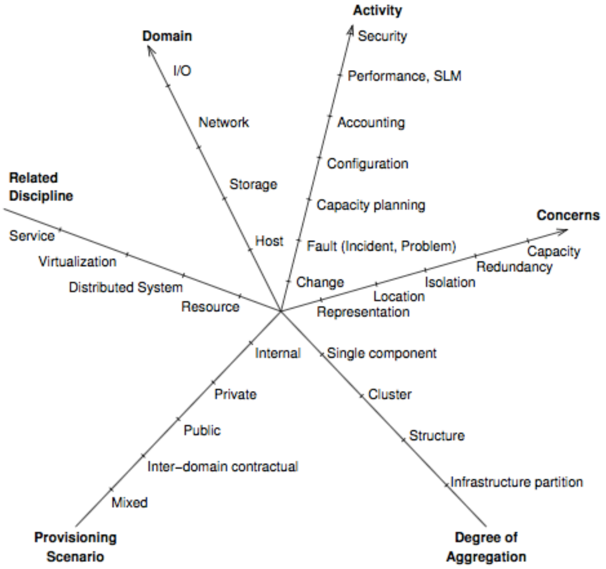
3.2 PFlop/s
1.0 PFlop/s
114 TFlop/s
Cartesius
merald
40 km
SuperMUC
960 km
SUPERMUC(GER)
10G
CARTESIUS(NLD)
10G
EMERALD(UK)
10G
5.1 PFlop/s
Stampede
9050 km
STAMPEDE(USA)



QoS in Virtualized Networks (Metzker)

Virtualized
Infrastructure
Service
Distributed System
Network
Components

The Problem Space



Domain: I/O, Network, Storage, Host

Activity: Security, Performance, SLM, Accounting, Configuration, Capacity planning, Fault (Incident, Problem), Change

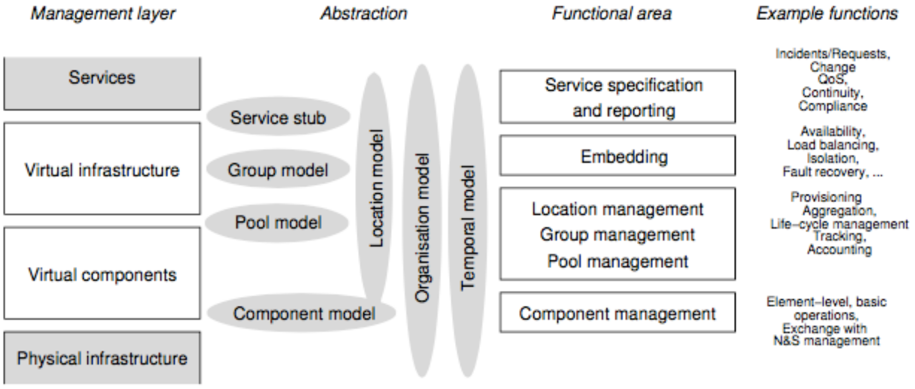
Concerns: Capacity, Redundancy, Isolation, Location, Representation

Degree of Aggregation: Single component, Cluster, Structure, Infrastructure partition

Provisioning Scenario: Internal, Private, Public, Inter–domain contractual, Mixed

Related Discipline: Service, Virtualization, Distributed System, Resource

A New Management Infrastructure (Danciu)



Management layer
- Services
- Virtual infrastructure
- Virtual components
- Physical infrastructure

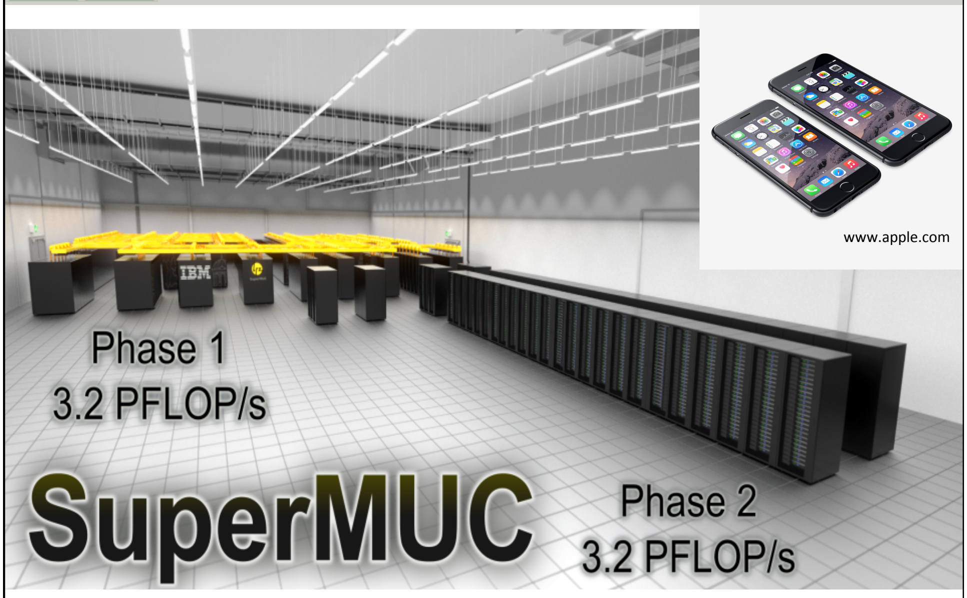
Abstraction
- Service stub
- Group model
- Pool model
- Component model
- Location model
- Organisation model
- Temporal model

Functional area
- Service specification and reporting
- Embedding
- Location management
- Group management
- Pool management
- Component management

Example functions
- Incidents/Requests, Change QoS, Continuity, Compliance
- Availability, Load balancing, Isolation, Fault recovery, ...
- Provisioning Aggregation, Life–cycle management Tracking, Accounting
- Element–level, basic operations, Exchange with N&S management

Non-technical issues: policies, legal aspects, ...

SuperMUC Phase 2 (2015)



www.apple.com

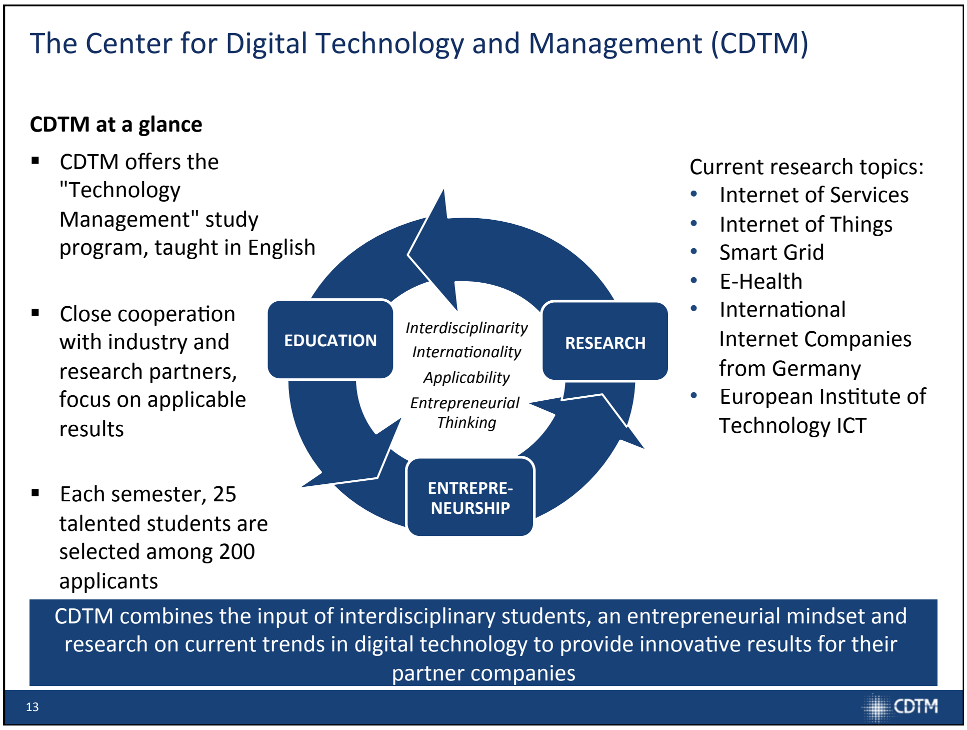
Computer Science Problems

www.bmw.de

- Complexity / Scalability
- Data volume / Volatility
- Reliability / Resilience
- Heterogeneity / Federations
- Energy Consumption / Efficiency
- Security / Safety
- …

- Marc Andreesen (2011): „Software is Eating the World“
  - Software revolutionizes technology and computer industry (Value is generated through software much more than hardware)
  - Software will dramatically change entire industries (e.g. how digital content changes print media)
  - Software will fundamentally change all industries (economic value will be described with software)

http://www.wsj.com/articles/SB10001424053111903480904576512250915629460



The Center for Digital Technology and Management (CDTM)

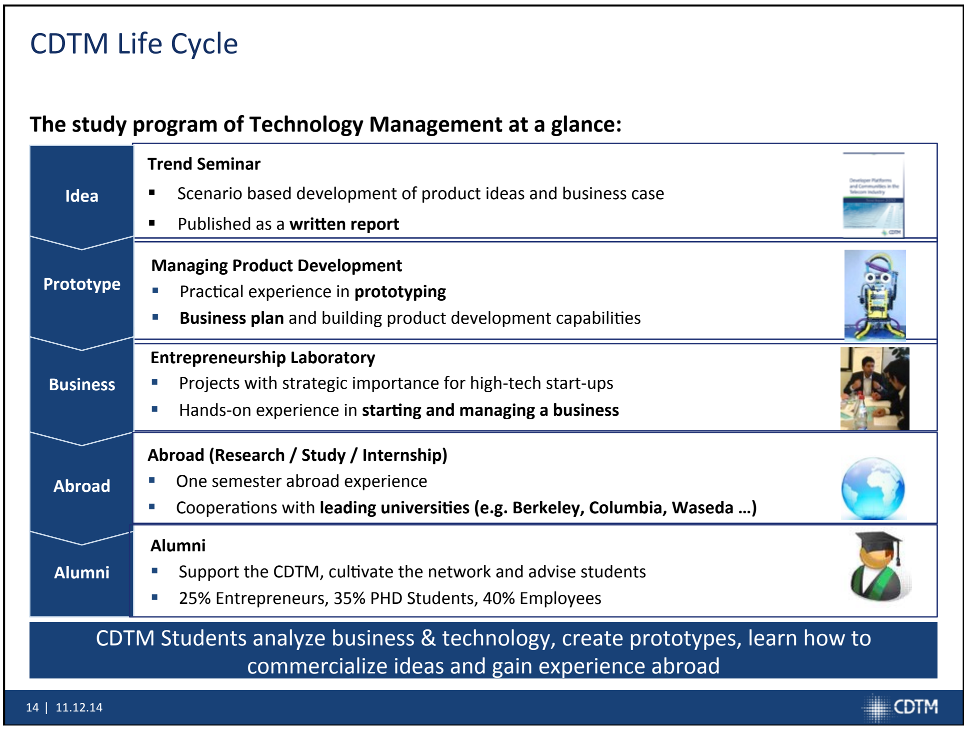
CDTM at a glance

- CDTM offers the "Technology Management" study program, taught in English
- Close cooperation with industry and research partners, focus on applicable results
- Each semester, 25 talented students are selected among 200 applicants

EDUCATION
RESEARCH
ENTREPRE-NEURSHIP
Interdisciplinarity
Internationality
Applicability
Entrepreneurial Thinking

Current research topics:
- Internet of Services
- Internet of Things
- Smart Grid
- E-Health
- International Internet Companies from Germany
- European Institute of Technology ICT

CDTM combines the input of interdisciplinary students, an entrepreneurial mindset and research on current trends in digital technology to provide innovative results for their partner companies



CDTM Life Cycle

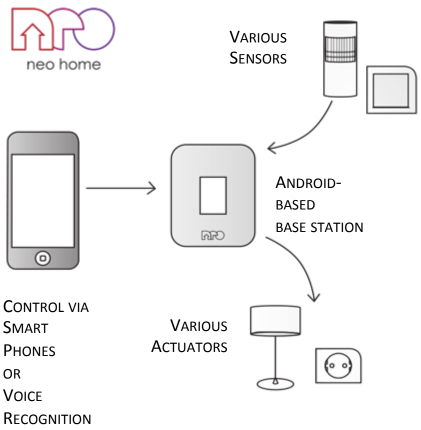
The study program of Technology Management at a glance:

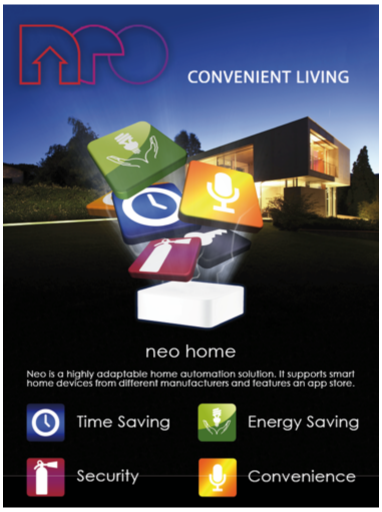
Idea	**Trend Seminar** Scenario based development of product ideas and business case Published as a **written report**
Prototype	**Managing Product Development** Practical experience in **prototyping** **Business plan** and building product development capabilities
Business	**Entrepreneurship Laboratory** Projects with strategic importance for high-tech start-ups Hands-on experience in **starting and managing a business**
Abroad	**Abroad (Research / Study / Internship)** One semester abroad experience Cooperations with **leading universities (e.g. Berkeley, Columbia, Waseda …)**
Alumni	**Alumni** Support the CDTM, cultivate the network and advise students 25% Entrepreneurs, 35% PHD Students, 40% Employees

CDTM Students analyze business & technology, create prototypes, learn how to commercialize ideas and gain experience abroad

NEO – A smart home solution that connects sustainability with convenience for everybody

Project Example


neo home
Various Sensors
Android-based base station
Control via Smart Phones or Voice Recognition
Various Actuators


CONVENIENT LIVING
neo home

Neo is a highly adaptable home automation solution. It supports smart home devices from different manufacturers and features an app store.

Time Saving
Energy Saving
Security
Convenience

NEO – A smart home solution that connects sustainability with convenience for everybody

Project Example

Neo Home Basestation
Manufactured using a 3D printer

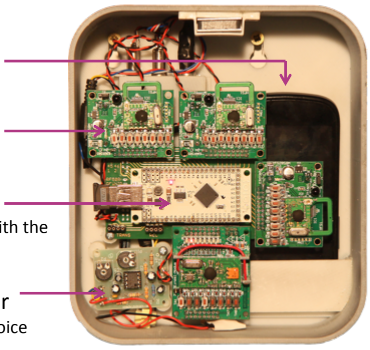
Cap with iPhone Interface
Connected to android phone via WLAN

Android Smartphone
Computation

FS20 Radio Modules
Communicate with sensors & actors

IOIO Board
Connects android phone with the FS20 radio modules

Microphone Amplifier
External microphone for voice control



Entrepreneurship – CDTM alumni have founded more than 70 companies since 2000

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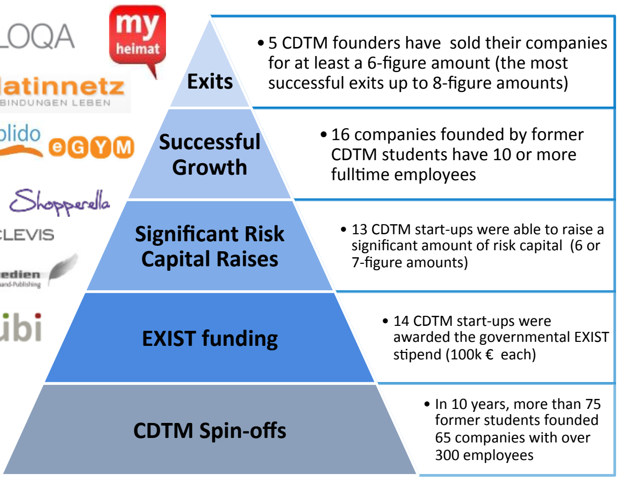

Exits
- 5 CDTM founders have sold their companies for at least a 6-figure amount (the most successful exits up to 8-figure amounts)

Successful Growth
- 16 companies founded by former CDTM students have 10 or more fulltime employees

Significant Risk Capital Raises
- 13 CDTM start-ups were able to raise a significant amount of risk capital (6 or 7-figure amounts)

EXIST funding
- 14 CDTM start-ups were awarded the governmental EXIST stipend (100k € each)

CDTM Spin-offs
- In 10 years, more than 75 former students founded 65 companies with over 300 employees

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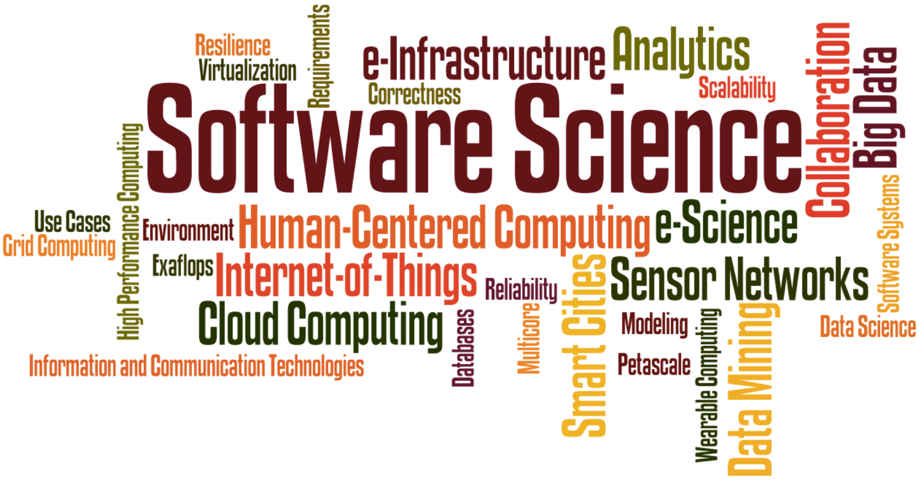
Summary

- High Performance Computing on SuperMUC – Seismic simulation
- World-wide Earth System Modeling – Interconnecting supercomputers for high-resolution climate simulation
- Virtualization of e-Infrastructures
  - Quality of Service (QoS) in wide-area networks
  - A new mangement structure for virtualization
- Software at the Core of all Activities
- The Center for Digital Technolgy and Management (CDTM)


Resilience
Virtualization
Requirements
e-Infrastructure
Analytics
Correctness
Scalability
Collaboration
Big Data
Software Science
High Performance Computing
Use Cases
Grid Computing
Environment
Human-Centered Computing
e-Science
Software Systems
Exaflops
Internet-of-Things
Reliability
Smart Cities
Sensor Networks
Cloud Computing
Databases
Multicore
Modeling
Wearable Computing
Data Mining
Data Science
Information and Communication Technologies
Petascale

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LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

MNM TEAM
MUNICH NETWORK MANAGEMENT TEAM

lrz

On the Role of Models in Software Systems Development

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Assumptions / Preliminaries

- 50-100 Students
- 1st Year Bachelor Degree in Computer Science
- For a concrete lecture, it would be necessary to study existing lectures on software engineering and adapt corresponding modeling techniques
- A blackboard is available for drawing and steering interactive discussions

Why do we need models?

- Models support the communication of important concepts within groups and to the outside world
- Models can clarify concepts of architectures, designs, requirements …
- Models Models contain less ambiguities than natural language (The language of Mathematics)
- Models help to identify inconsistences
- Models can sometimes directly generate code or artifacts
- Models can lead to new knowledge

Brian Greene – Keynote at SC14

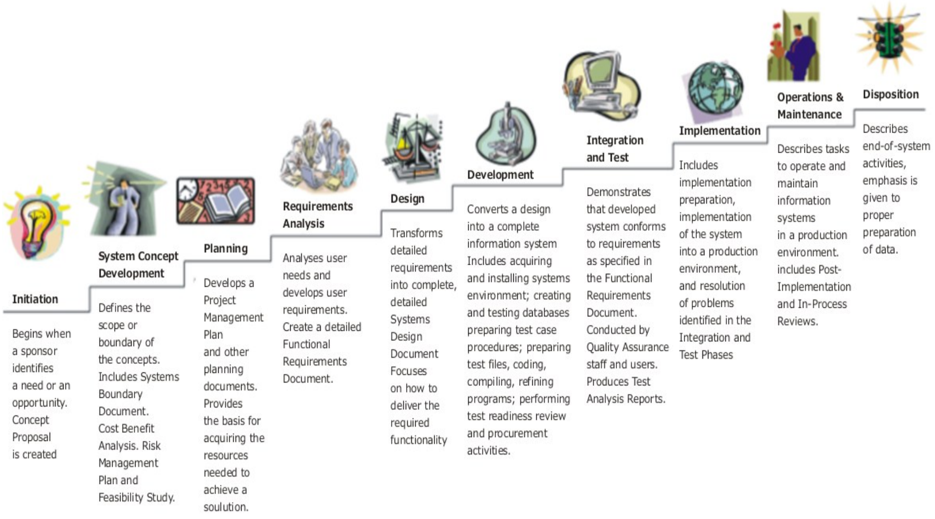
- Professor of Physics and Mathematics at Columbia University
- Physicist, string theorist, and best-selling author
- „As researchers and engineers push the boundaries of their professions in the pursuit of a better future for all, they are rapidly moving into areas in which physical experiments are not practical, or even possible.“
- Models are needed to describe our world.
- Computers are (often) the only instrument capabale of proofing models.

http://sc14.supercomputing.org/blog/keynote

Restrictions of models

- Models are tools for expressing certain characteristics, but not all characteristics can be described in models
- Models use abstraction and reduce from the “real world” to simplify
- Models need to be taken in the context in which they have been developed

SDLC – Systems Development Life Cycle



Initiation
Begins when a sponsor identifies a need or an opportunity. Concept Proposal is created

System Concept Development
Defines the scope or boundary of the concepts. Includes Systems Boundary Document. Cost Benefit Analysis. Risk Management Plan and Feasibility Study.

Planning
Develops a Project Management Plan and other planning documents. Provides the basis for acquiring the resources needed to achieve a soulution.

Requirements Analysis
Analyses user needs and develops user requirements. Create a detailed Functional Requirements Document.

Design
Transforms detailed requirements into complete, detailed Systems Design Document Focuses on how to deliver the required functionality

Development
Converts a design into a complete information system Includes acquiring and installing systems environment; creating and testing databases preparing test case procedures; preparing test files, coding, compiling, refining programs; performing test readiness review and procurement activities.

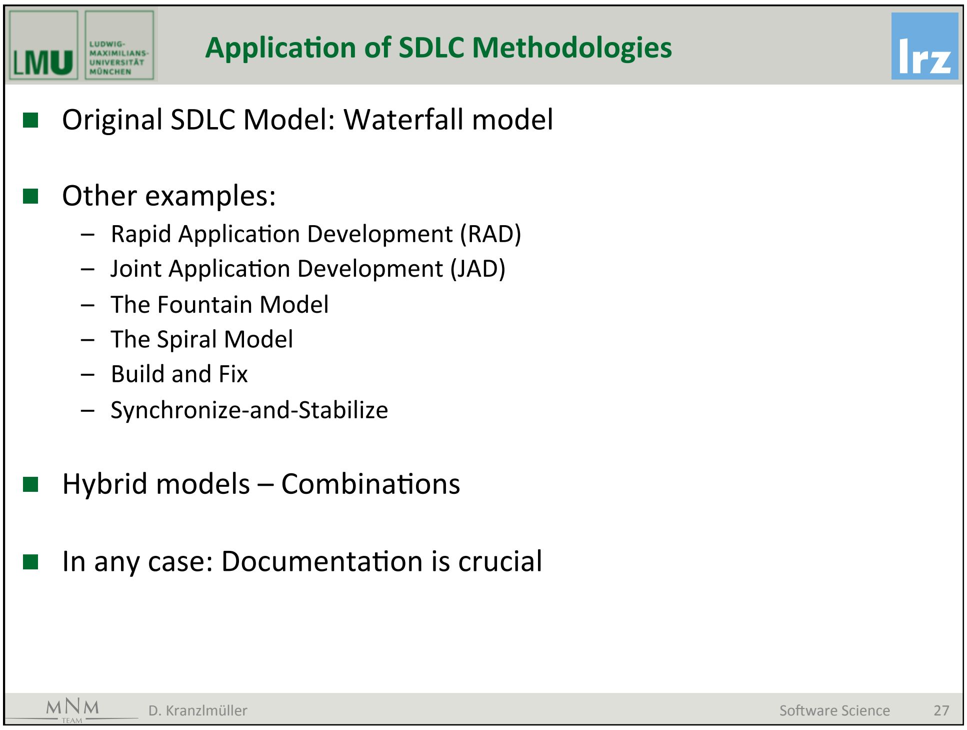
Integration and Test
Demonstrates that developed system conforms to requirements as specified in the Functional Requirements Document. Conducted by Quality Assurance staff and users. Produces Test Analysis Reports.

Implementation
Includes implementation preparation, implementation of the system into a production environment, and resolution of problems identified in the Integration and Test Phases

Operations & Maintenance
Describes tasks to operate and maintain information systems in a production environment. includes Post-Implementation and In-Process Reviews.

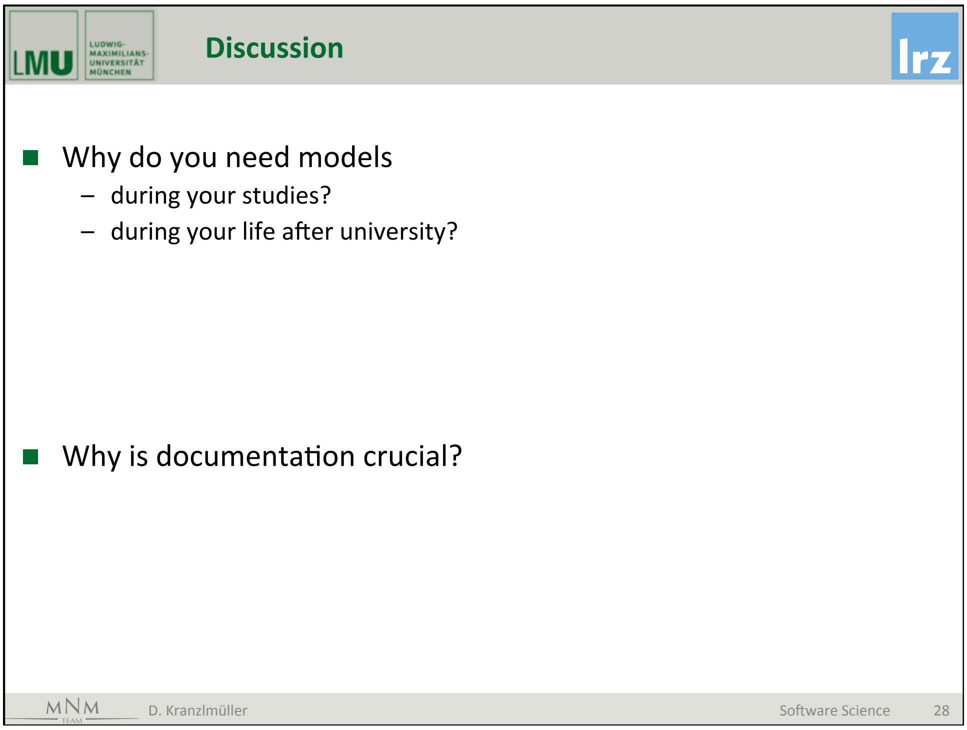
Disposition
Describes end-of-system activities, emphasis is given to proper preparation of data.

http://en.wikipedia.org/wiki/Systems_development_life_cycle



Application of SDLC Methodologies

- Original SDLC Model: Waterfall model
- Other examples:
  - Rapid Application Development (RAD)
  - Joint Application Development (JAD)
  - The Fountain Model
  - The Spiral Model
  - Build and Fix
  - Synchronize-and-Stabilize
- Hybrid models – Combinations
- In any case: Documentation is crucial



Discussion

- Why do you need models
  - during your studies?
  - during your life after university?
- Why is documentation crucial?

Home work

- Desribe the IT processes involved in ordering food at a vegetarian fast food restaurant
- Extract one process and describe its requirements and activities in more detail
- Submit your final work as PDF to
  Professor_X@jku.at
- Deadline: 20 April 2015