Interconnecting our Life – The Role of Software for Everyone Everywhere

Dieter Kranzlmüller

Munich Network Management Team
Ludwig-Maximilians-Universität München (LMU) & Leibniz Supercomputing Centre (LRZ)
of the Bavarian Academy of Sciences and Humanities
SuperMUC @ Leibniz Supercomputing Centre

Video: SuperMUC rendered on SuperMUC by LRZ
http://youtu.be/OIAS6iqWryQ

IBM iDataplex dx360 M4

Torsten Böhm, 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
- ...

Picture: Regional Mathematics Network (LMU) / Sciencecenter
Enlighten Your Research Global (EYRg)

- STAMPEDE (USA): 3.2 PFlop/s
- SUPERMUC (GER): 1.0 PFlop/s
- CARTESIUS (NLD): 1.0 PFlop/s
- EMERALD (UK): 114 TFlop/s

QoS in Virtualized Networks (Metzker)

D. Kranzlmüller
Software Science
The Problem Space

A New Management Infrastructure (Danciu)

Management layer | Abstraction | Functional area | Example functions
--- | --- | --- | ---
Services | Service stub | Service specification and reporting
Virtual infrastructure | Group model | Embedding
Pool model | Location management
Virtual components | Component model | Group management
Physical Infrastructure | Location model | Pool management

Temporal model

Component management

Non-technical issues: policies, legal aspects, ...
SuperMUC Phase 2 (2015)

Phase 1
3.2 PFLOP/s

SuperMUC
Phase 2
3.2 PFLOP/s

Computer Science Problems

- 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/SB100014240531119034809045765612250915629460
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.

**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:

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

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 Basestation
Manufactured using a 3D printer

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

Cap with iPhone Interface
Connected to android phone via WLAN
Entrepreneurship – CDTM alumni have founded more than 70 companies since 2000

- **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 full-time 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

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 management structure for virtualization
- Software at the Core of all Activities
- The Center for Digital Technology and Management (CDTM)
Dieter Kranzlmüller - dieter@kranzlmueller.eu
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 contain less ambiguities than natural language (The language of Mathematics).
- Models help to identify inconsistencies.
- 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 capable 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.

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**SDLC – Systems Development Life Cycle**

- **Software Science**

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### 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?**
Describe 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