


A Ubiquitous Urgent Computing Framework for Ensembles of Flash Flood Forecasts



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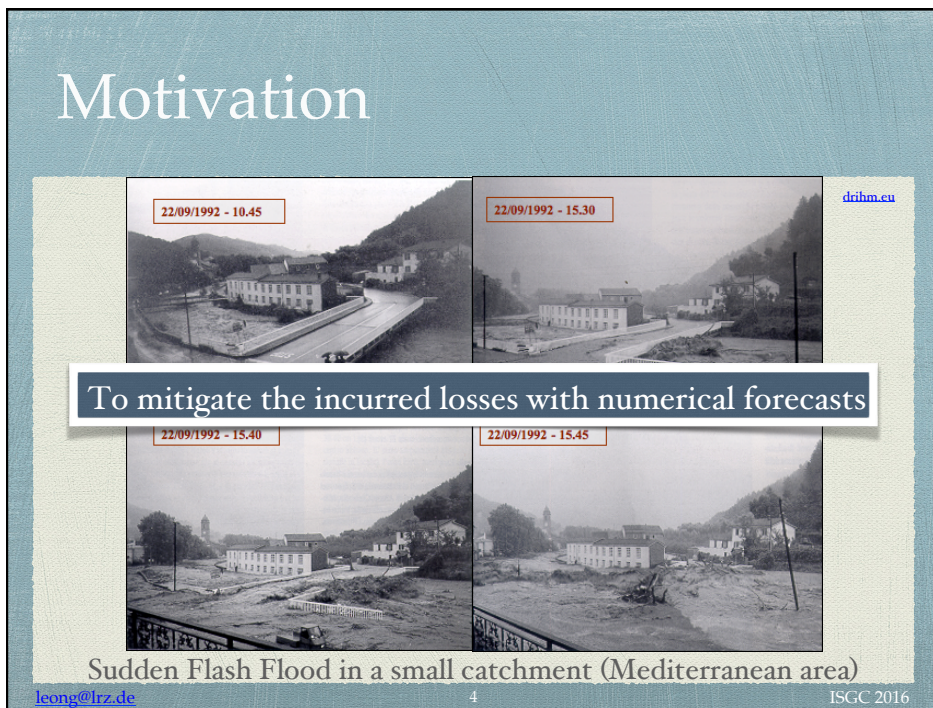
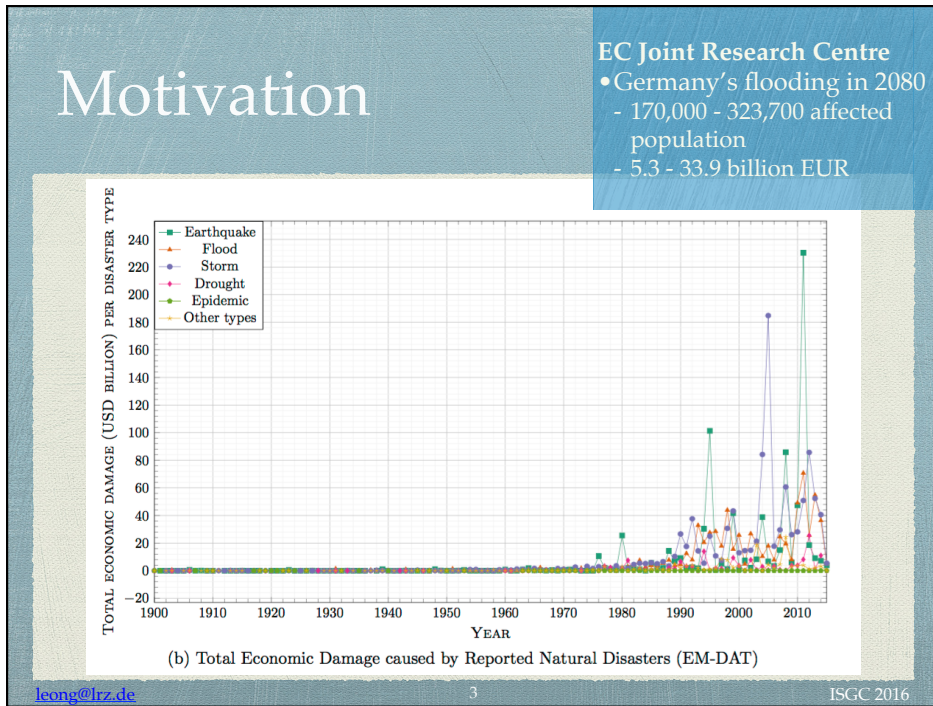
Urgent Computing

I have a really important paper with an impending deadline. I need urgent computing!

- ◆ Requires computations (**disasters**)
 - ✓ – Commence in short order 
 - ✓ – Complete before a stipulated **deadline** 
 - ✗ – Support mitigation activities 
 - ✗ – From events that requires immediate attention 

[8] S. H. Leong and D. Kranzlmüller. Towards a General Definition of Urgent Computing. In *ICGS Proceedings*, volume 51 of *Procedia Computer Science*, pages 2337 – 2346. Elsevier, 2015.

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Problems & Proposed Solutions

Inaccuracy in observational data

Limitations of forecast models

Coordinate Multiple Forecasts under Timing Constraints in a Chaotic Environment

Chaotic environment

Ubiquitous Framework with Resource Allocation Heuristic

Leverage on zero hour data

Stochastic forecast methods

Redrawn from NWS
Forecast Uncertainty: Years, Seasons, Months, 6-10 Days, 1-5 Days, 6-12 hours, 1-4 hours, 1-2 hours, 1-42 hours
The French / German storms (surface pressure) December 1999 - Forecast time T+42 hours

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Task-based Ubiquitous (TbU) Approach

UC Requirements

Operator

Event Requirements

Anytime

Ubiquitous Process Orchestrator

Activity & Task Manager

Information Manager

Resource & Environment Manager

Schedule Manager

Fault Manager

Subtask Coordinator

Anywhere

PRACE

HPCs

HTCs

ESI

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TbU Approach

The screenshot shows a web browser window with a resource allocation interface. On the left, there's a sidebar with 'Certified Use Cases' and 'New Resource'. The main area has 'Certified Use Case' and 'Available Resources' sections. A 'SuperMUC, SuperMUC_Phase_2, CoolMUC, CoolMUC2' resource is highlighted. To the right, a blue box lists 'HPC Resources: SuperMUC, SuperMUC Phase 2, CoolMUC, CoolMUC2'. Below this, a weather visualization tool displays a map with a color-coded area and a data table.

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Resource Allocation Heuristic Objectives

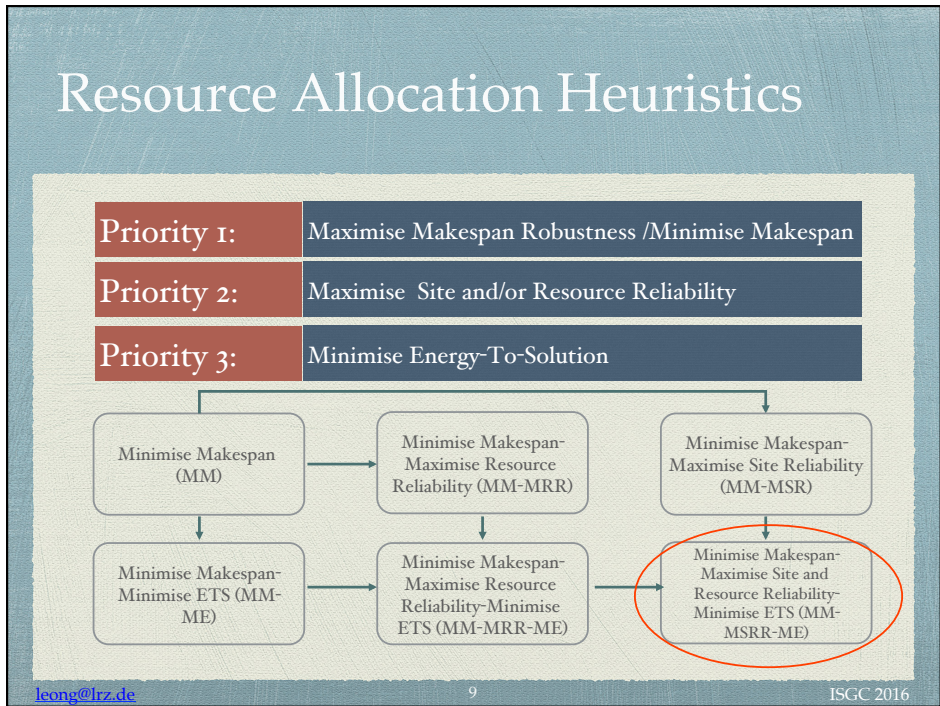
The diagram illustrates heuristic objectives for resource allocation. A central box lists three objectives: (i) Maximise Makespan Robustness, (ii) Minimise Energy Usage, and (iii) Maximise Reliability across Sites and/or Resources. A callout box points to the third objective, stating 'Reliability across resources and/or sites' and 'Maximise Reliability'. A blue box at the top states 'Meeting the stipulated deadline'.

Meeting the stipulated deadline

(i) Maximise Makespan Robustness
(ii) Minimise Energy Usage
(iii) Maximise Reliability across Sites and/or Resources

Reliability across resources and/or sites
Maximise Reliability

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Genoa flash flood October 2014

Flash flood: one of the the most dangerous type of floods as it can form swiftly with little or no prior warning.

- Forecast heavy rain and storm
- No warning about flood

- Two rivers overflow the banks
- More than one metre of water and mud
- Electricity cut, school closed, train derailed



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Test & Results

* Case Study

- Forecast Genoa flash Flood (9 Oct. 2014)
- Loss: ~303 million USD and one death (EM-DAT)
- Deadline: 3 hours

* WRF-ARF Model

- Eight ensemble forecasts with different microphysics options
- Each forecast: 640 cores to generate a 24 hours forecast with 2 domains (5km and 1 km)

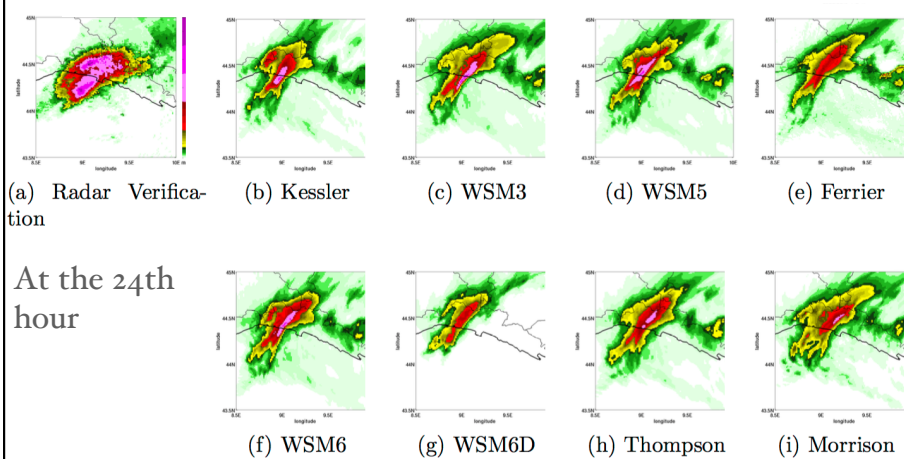
| Resource | Available cores | Default Freq (GHz) | Freq Scaling | Site | Availability | Performance | ETS |
|------------------|-----------------|--------------------|--------------|------|--------------|-------------|--------|
| SuperMUC | 131,072 | 2.3 | yes | LRZ | 0.85 | High | Medium |
| SuperMUC Phase 2 | 71,680 | 2.2 | yes | LRZ | 0.85 | High | Low |

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11

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Test & Results



Conclusion

- ◆ TbU approach
 - ◆ 3-layer architecture
 - ◆ Ubiquitous access from anywhere and at anytime
 - ◆ Realise urgent computing and event requirements
- ◆ Resource Allocation Heuristic
 - ◆ Manage resource allocation swiftly
 - ◆ Fulfil three objectives
 - * Minimise Makespan-Maximise Site and Resource Reliability-Minimise ETS

Future Work

- ◆ Cost of Urgent Computing
 - ◆ Preemption
- ◆ Prediction Models
- ◆ Advanced Visualisation

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