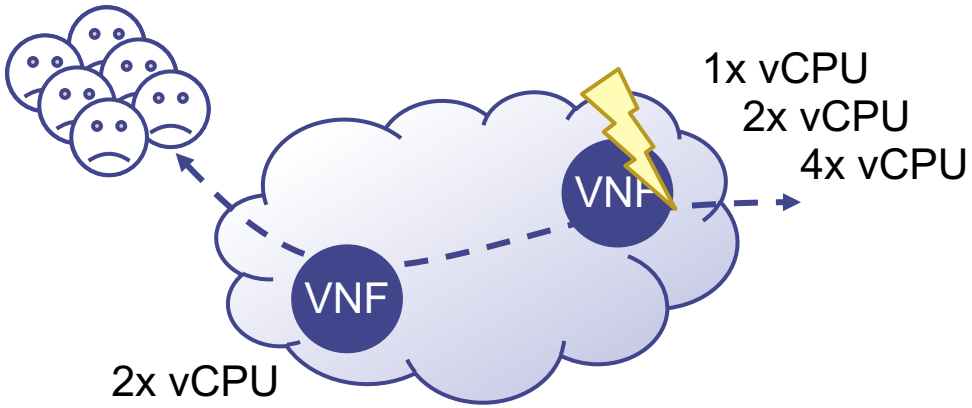
Towards Predicting Resource Demands and Performance of Distributed Cloud Services

Sevil Dräxler, Manuel Peuster, **Marvin Illian** and Holger Karl

Overview

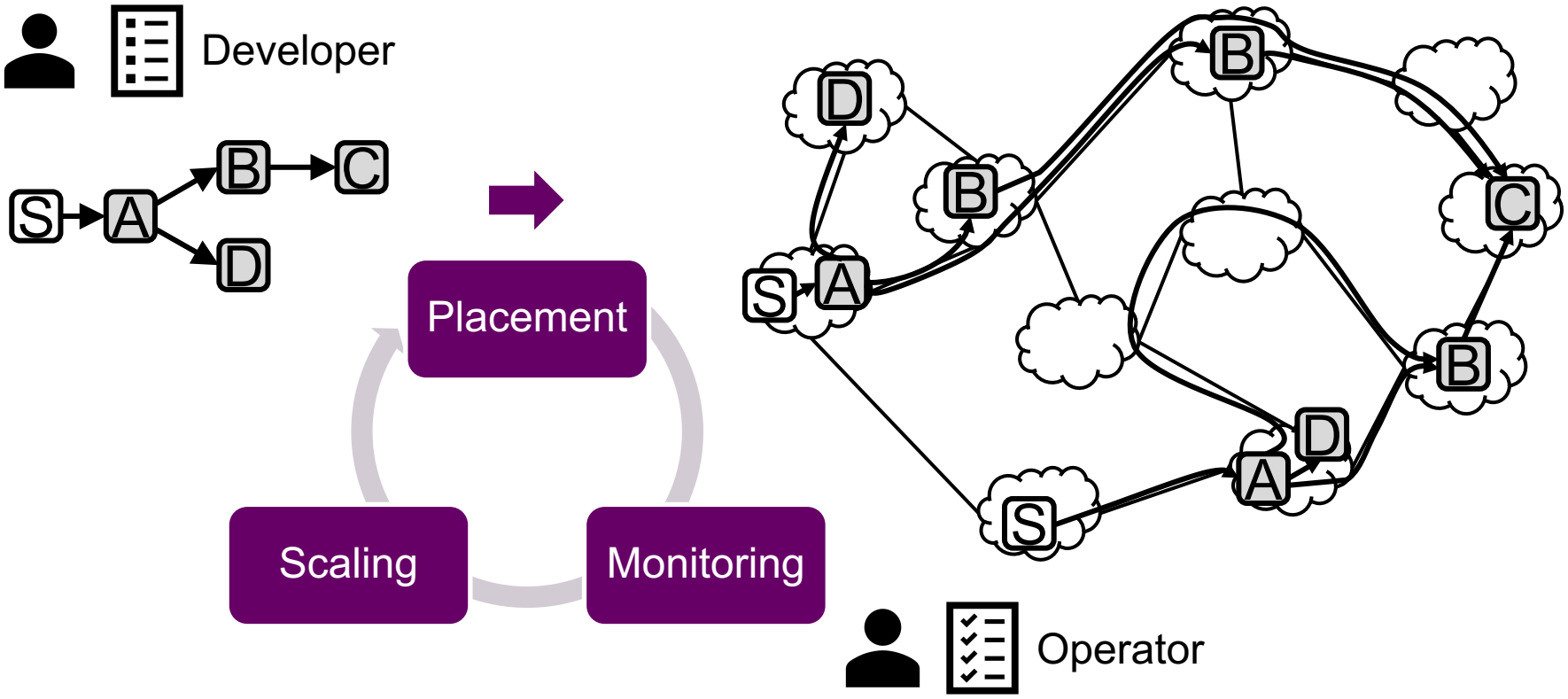
- ***Motivation***
- Experimental Setup
- Data Analysis
- Conclusion and Discussion

Imagine you are a network service provider …



You want to know about a service's behavior prior its deployment!

Typical Network Service Orchestration



Problem: Limited Precision and Flexibility

- Network services and functions specified using descriptors

```
…

image: ubuntu-14.04-server-amd64-disk1
scale_in_out: 2
disk_size: 10 GB
mem_size: 2048 MB
num_cpus: 2

…
```

- Service developer should know or estimate:
  - Exact resource demands of service components
  - Number of required service component instances

➔Risk of over-/under-estimating resources

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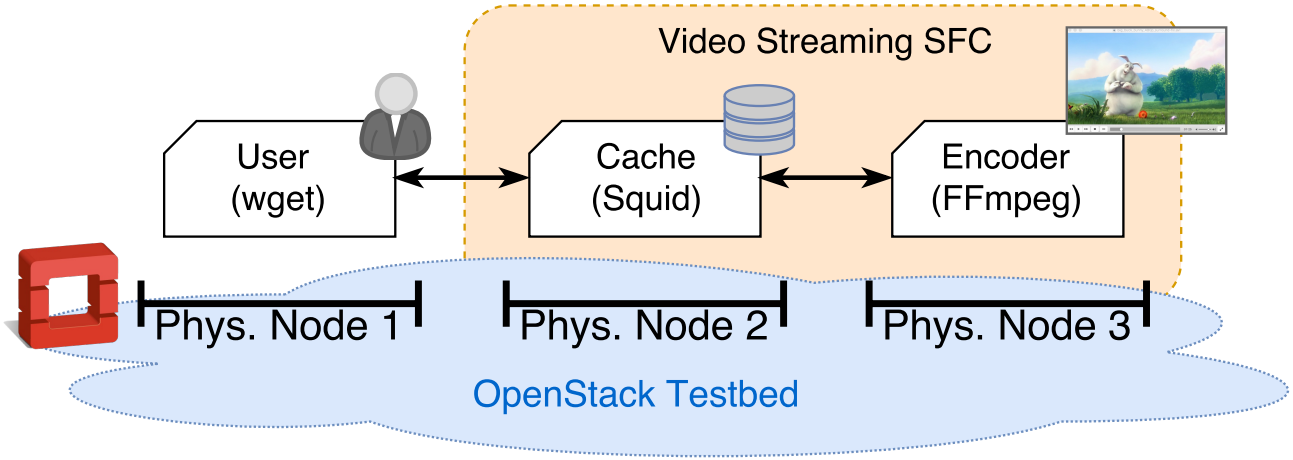
Testbed

- OpenStack testbed for measurements
- 1 controller node
- 3 compute nodes



Source videos

- 5 different videos (same duration)
- Resolution: 1920x1080 (“Full HD“)
- Frame rate: 25-60 frame/s
- Playback data rate: 3.5-14 Mbps
- Different characteristics
  - Colorful/black & white, fast/slow pacing, grainy picture, ...

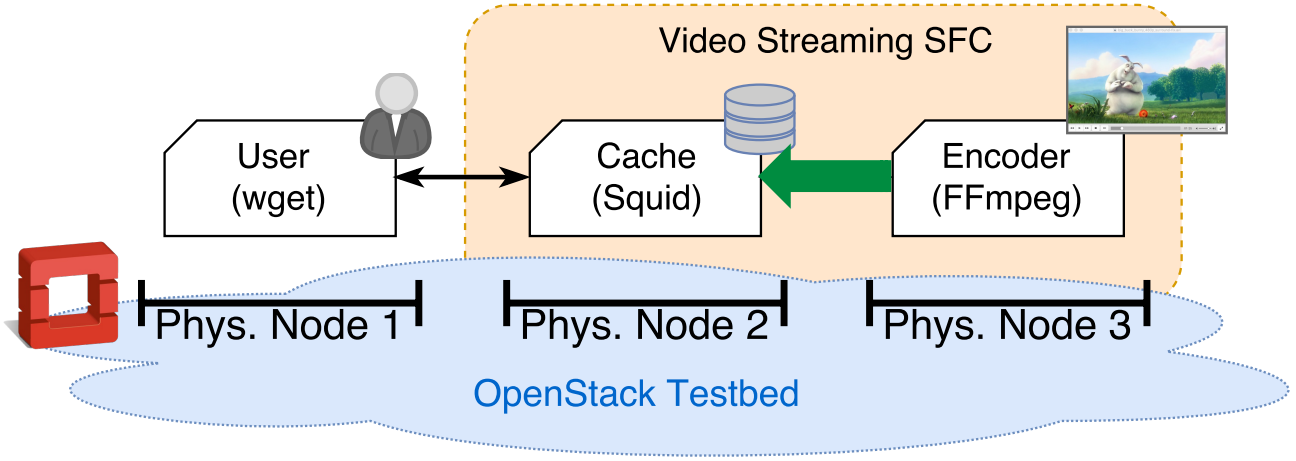
„Big Buck Bunny“, https://peach.blender.org/

Video encoding VNF

- Parameters
  - Source video files
  - Target resolutions
  - Target video playback data rates
  - Frame rates
  - Assigned CPU cores
- Models
  - Min. required CPU cores
  - Min. required memory
  - Achievable framerate

Cache VNF

- Parameter
  - Input data rate (determined by data rate of video encoding VNF)
- Models
  - CPU utilization
  - Memory utilization



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Model Extraction

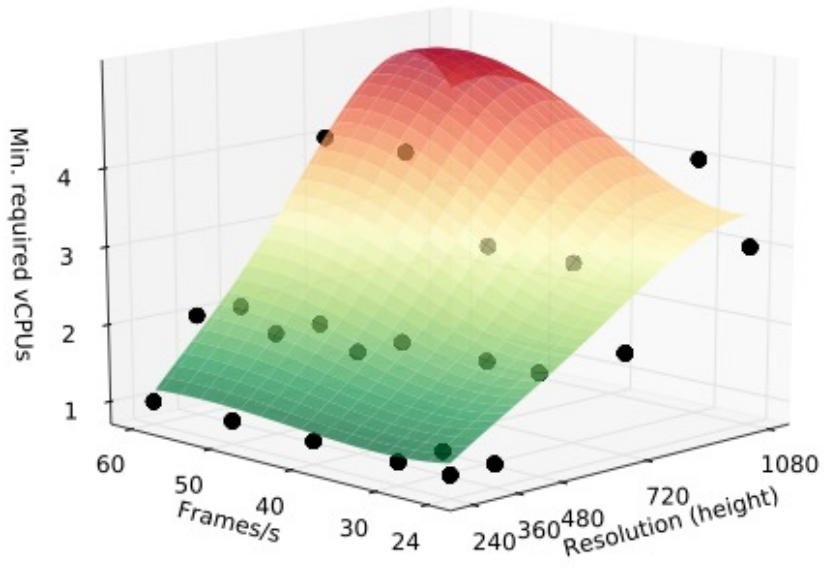
- Support vector regression
  - Supervised machine learning
  - Find flat function with small error
- Polynomial regression
  - Minimize sum of squared devations between predictions and observed values
  - Varying degrees
  - Visual inspection to avoid under-/over-fitting
- Metric for deviation from training data
  - Mean squared error:

$$\frac{1}{n}\sum_{i=1}^{n}(\hat{Y}_i - Y_i)^2$$

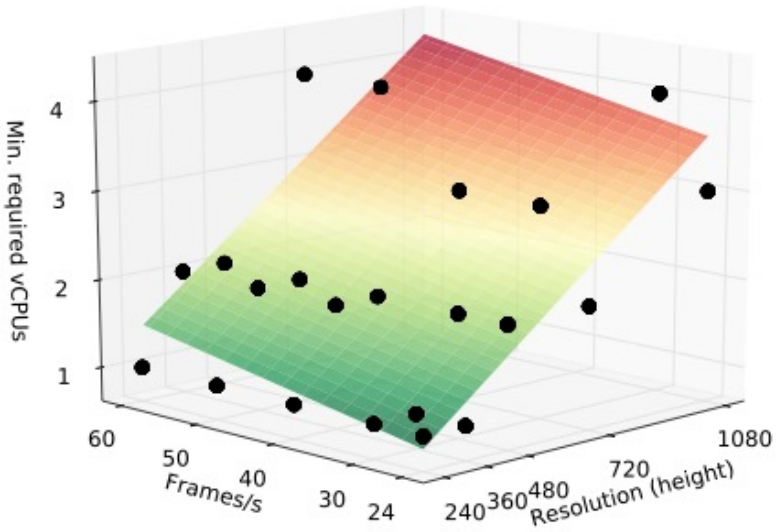
Model: Required CPU cores (video encoder)

Training data: Resolution, bitrate, framerate, min. vCPU

SVR (MSE=1.55)



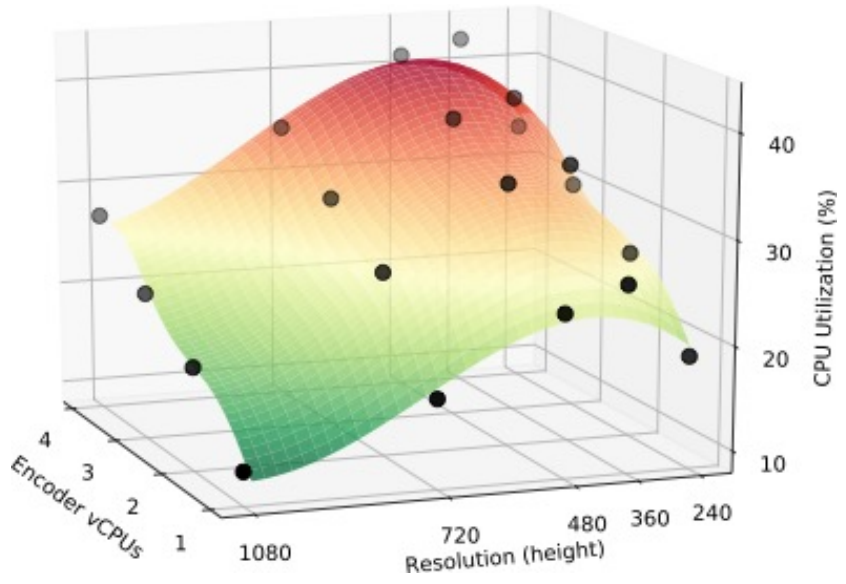
PR (MSE=1.8)



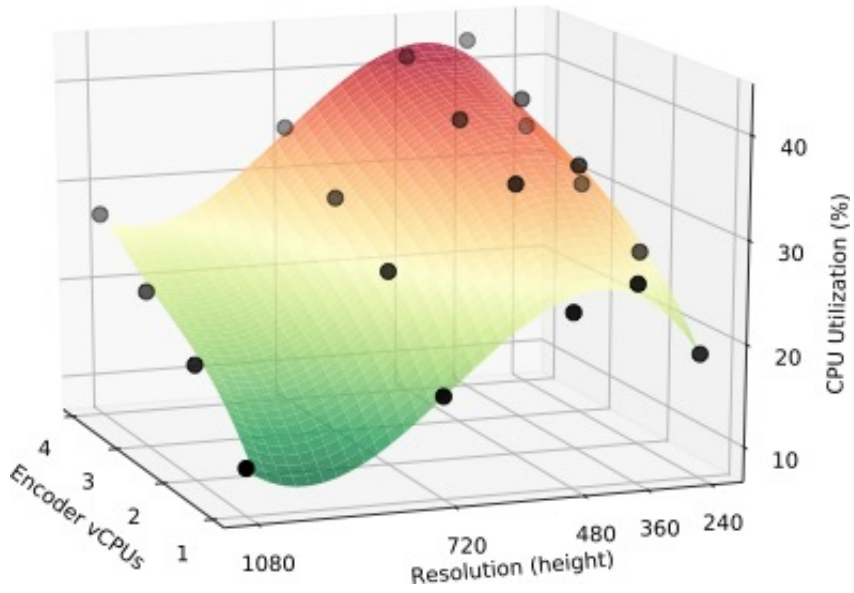
Model: CPU utilisation (cache)

Training data: Resolution, encoder vCPUs, CPU utilization

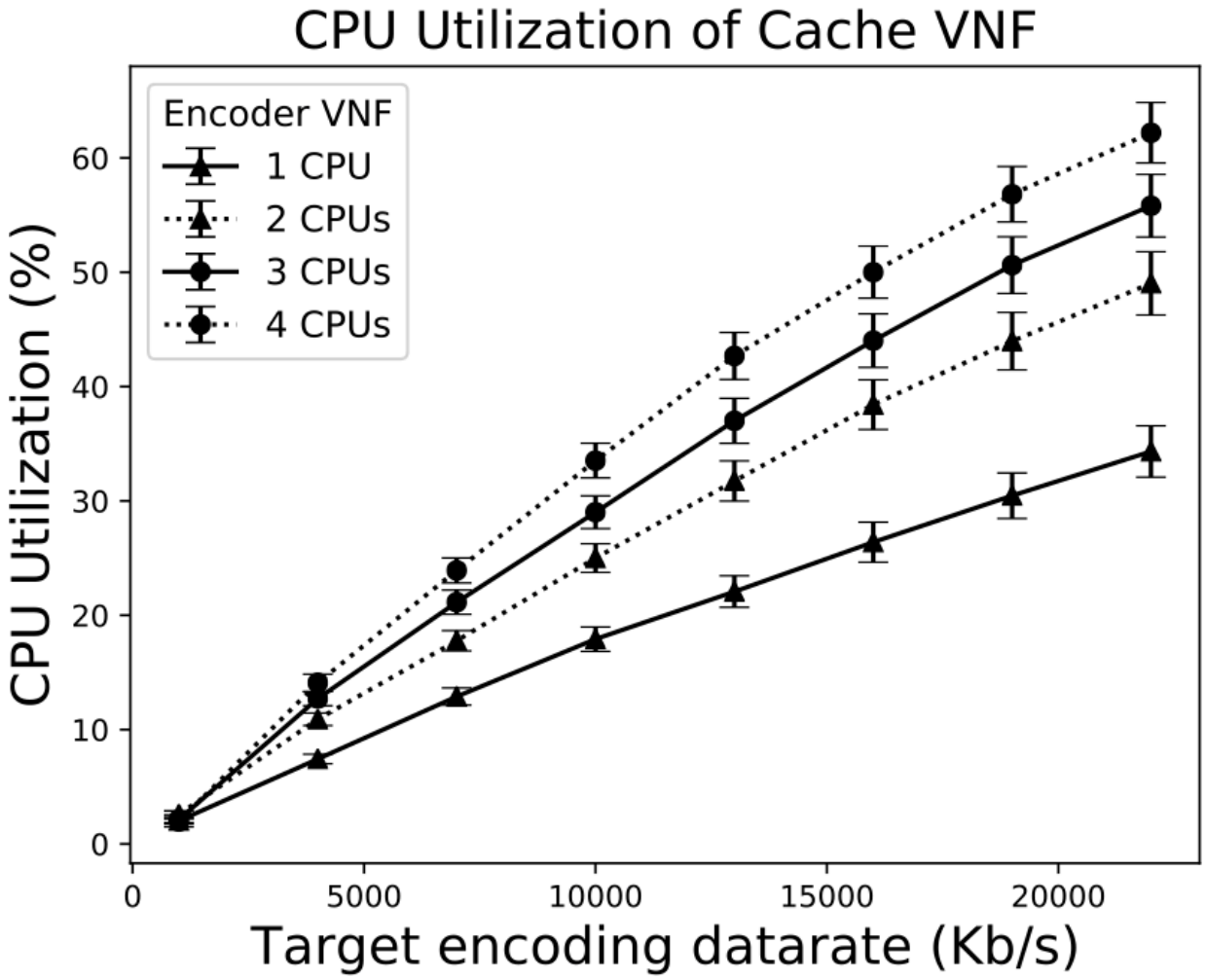
SVR (MSE=2.7)



PR (MSE=0.7)



Non-trivial proportionalities



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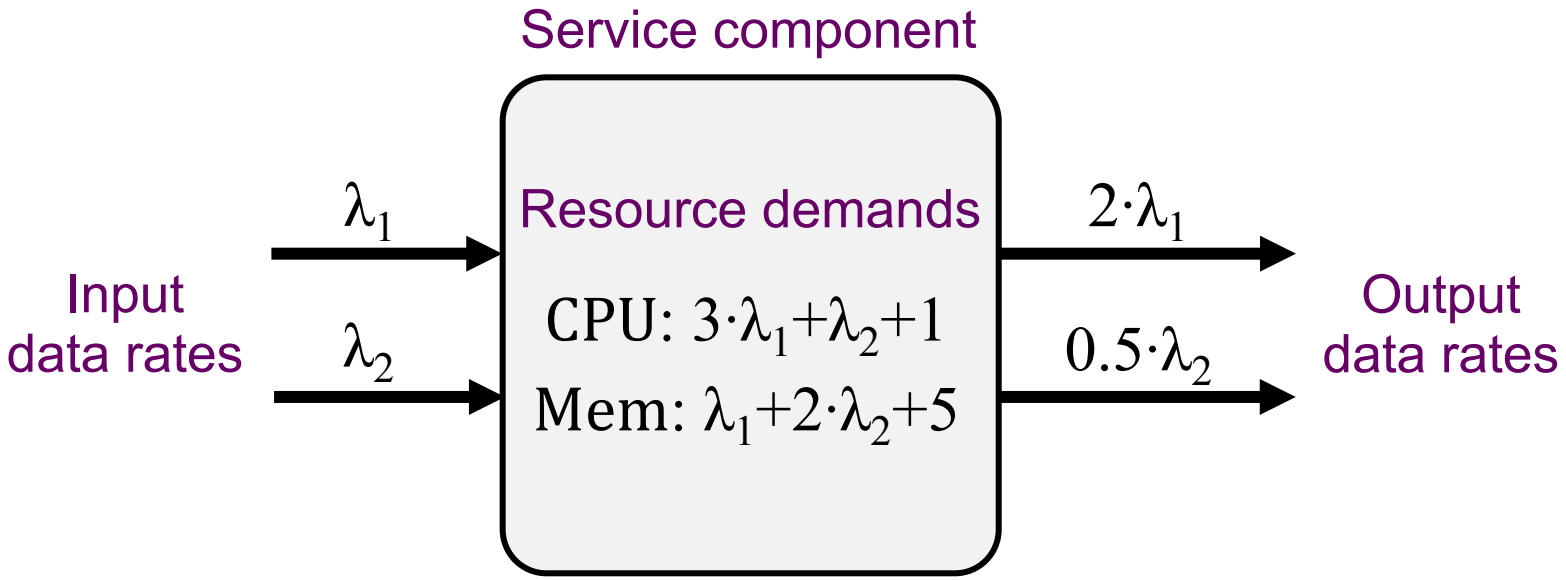
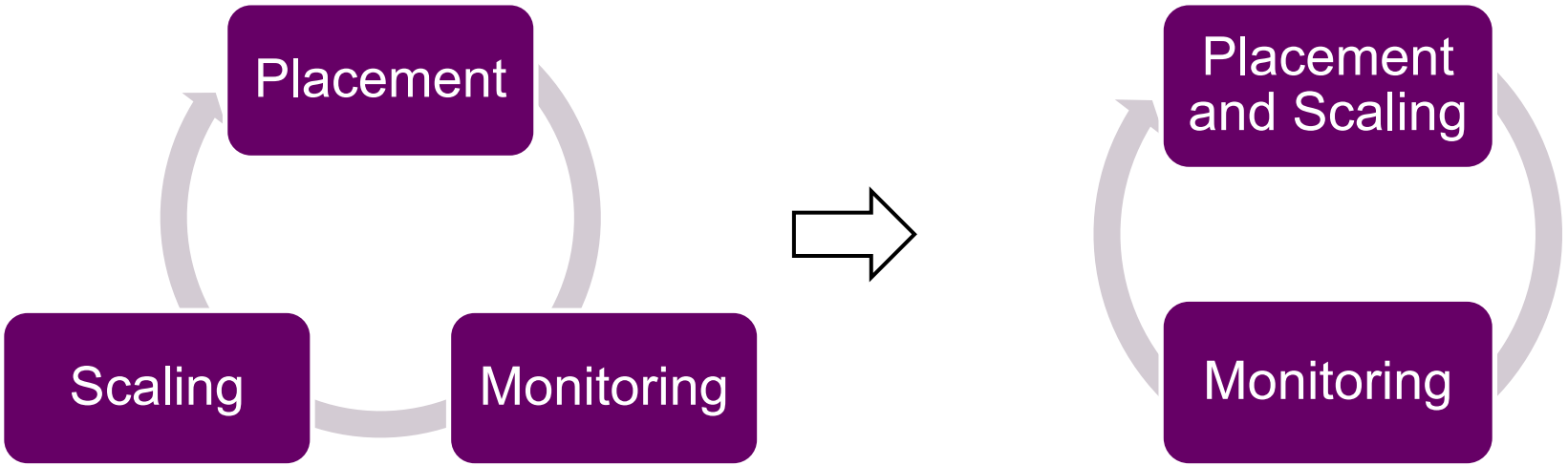
Conclusion

- Characterizing resource demands and performance metric values of VNFs is feasible



Conclusion

- Characterizing resource demands and performance metric values of VNFs is feasible
  - Can be used for efficient and flexible placement and scaling of services



S. Dräxler, H. Karl and Z. Á. Mann, "**Joint Optimization of Scaling and Placement of Virtual Network Services**," *17th IEEE/ACM CCGRID 2017*.

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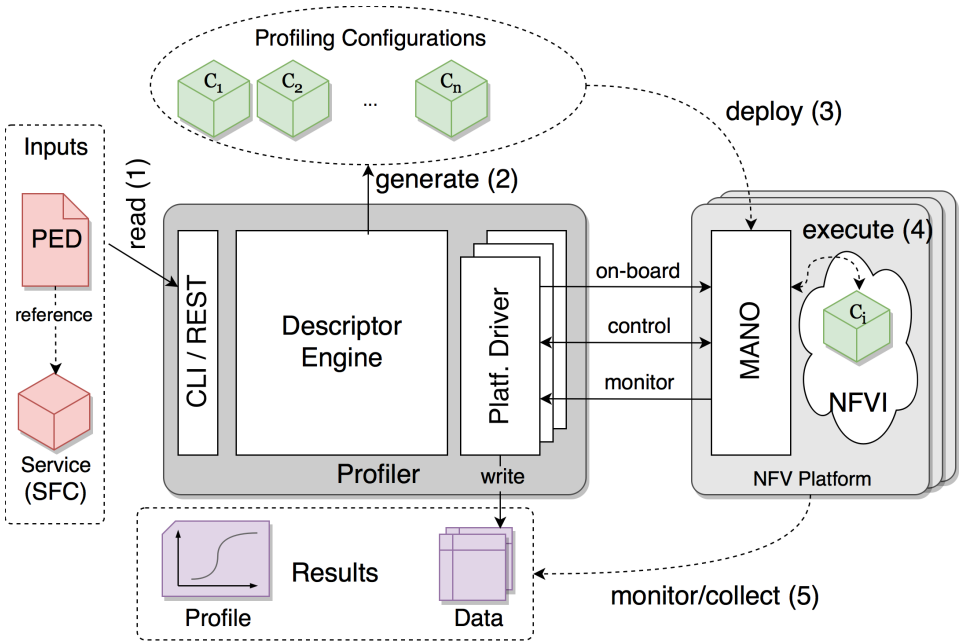
- Characterizing resource demands and performance metric values of VNFs is feasible
- VNFs have to be profiled in their final SFC setup
  - Challenges: test specification, automatic profiling of SFCs



Manuel Peuster and Holger Karl. "**Profile Your Chains, Not Functions: Automated Network Service Profiling in DevOps Environments,**" *IEEE NFV-SDN 2017.*

References

- Our experimental is data available online
  - https://uni-paderborn.sciebo.de/s/G9q2hmUNg4n8LEg

- S. Dräxler, H. Karl and Z. Á. Mann, "**Joint Optimization of Scaling and Placement of Virtual Network Services**," *17th IEEE/ACM CCGRID 2017*.
- M. Peuster and H. Karl, "**Profile Your Chains, Not Functions: Automated Network Service Profiling in DevOps Environments,**" *IEEE NFV-SDN 2017*.