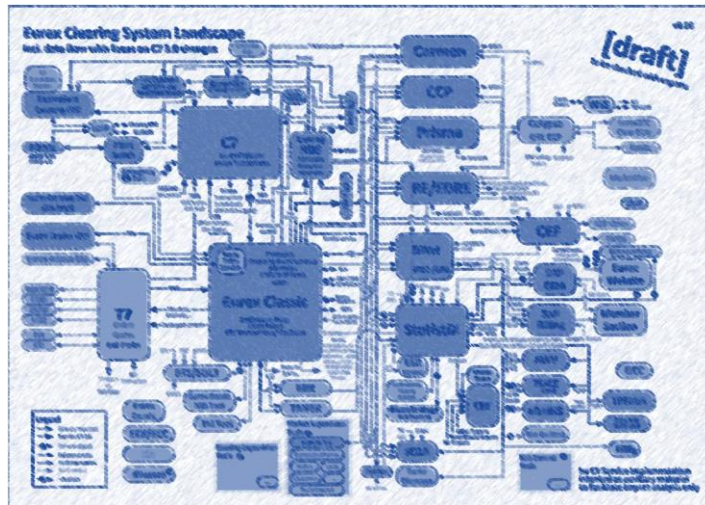


Cloud Resource Optimization using AI OPS

Cloud resource observability and optimization with
smart Machine Learning AI

9/27/2024

Applications run well for the following 2 reasons



Microservices increase **Complexity**



Applications run well for the following 2 reasons

The developer writes
good code.

```
document.getElementById(div).innerHTML += " ";  
else if (i==2)  
{  
  var atpos=inputs[1].indexOf("#");  
  var dotpos=inputs[1].lastIndexOf(".");  
  if (atpos<1 || dotpos<atpos+2 || dotpos<atpos+1)  
    document.getElementById("errmsg").innerHTML += " ";  
  else  
    document.getElementById(div).innerHTML += " ";  
  var atp=inputs[1].lastIndexOf("#");  
  var dotp=inputs[1].lastIndexOf(".");  
  if (atp<1 || dotp<atp+2 || dotp<atp+1)  
    document.getElementById("errmsg").innerHTML += " ";  
  else if (i==5)  
    document.getElementById("errmsg").innerHTML += " ";  
}
```

Applications get the
resources they need,
when they need
them.



INSTANA

IBM Turbonomic

IBM Turbonomic + IBM Instana | Proof of value @ Deutsche Börse

5

Resource congestion as a cause of poor application performance

The VM may not be receiving sufficient network throughput from the host.

Memory latency may occur with the VM.

The container POD suffers from CPU throttling due to too low CPU limits.

The cloud instance type may not provide enough IOPS.

The Java heap might be exhausted.

The datastore may not be getting enough IOPS from the storage array.

A resource congestion anywhere in the stack can affect any application that depends on it.

The application may not be getting enough CPU from the VM.

The database connection pool may be exhausted.

How to keep IT continuously in the desired state:

What is the problem to be solved?

Ensure the application performance

while

IT infrastructure is used as efficiently as possible.



Data ~

API-driven discovery

Applications

Databases

Kubernetes

Virtualizations

Public Cloud

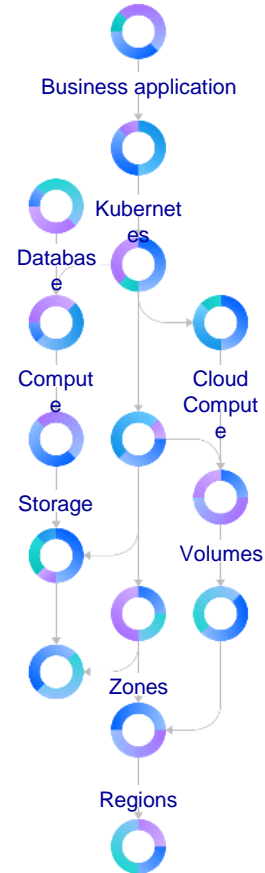
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



...to generate trustworthy actions



Intelligent sizing



Continuous placement



Dynamic scaling



Start/stop



What-If-Scenario Planning

Automation ~

Execute & Integrate Actions



Manually (with a click)



Scheduled



Pipelines & Workflows



Real-time

Initiatives & Goals

Addressing Current DBG Initiatives

Data Center Efficiency
(Performance, Capacity Planning, cross Stack)

Application Modernization
(K8, OCP, Cloud Native)

Multi-Cloud Transformation
(Dyn. Cap.Mgmt., xTeam Visibility)

FinOps
(Cost Mgmt., License Compliance)

Sustainable IT
(e.g. reducing power consumption)

Other (tbd)



Improved **capacity** management and planning for future hardware, software and platform changes, including multi-cloud transformation planning



Eliminate complexity and manual processes where possible in the current operational process



Improve **Performance** Engineering, Stability and Resilience with performance assurance capabilities



Enable and future proof DBG's strategic decisions through a consistent and agnostic management platform (on-prem, public cloud, containerization)



Scalability through automation (built-in automatable actions with sufficient policy control features for DBG)



Enable DBG to **optimize inefficiency & reclaim over-allocation** of resources in various staging environments

Data ~

API-driven discovery



Applications



Databases



Kubernetes

Virtualizations



Public Cloud



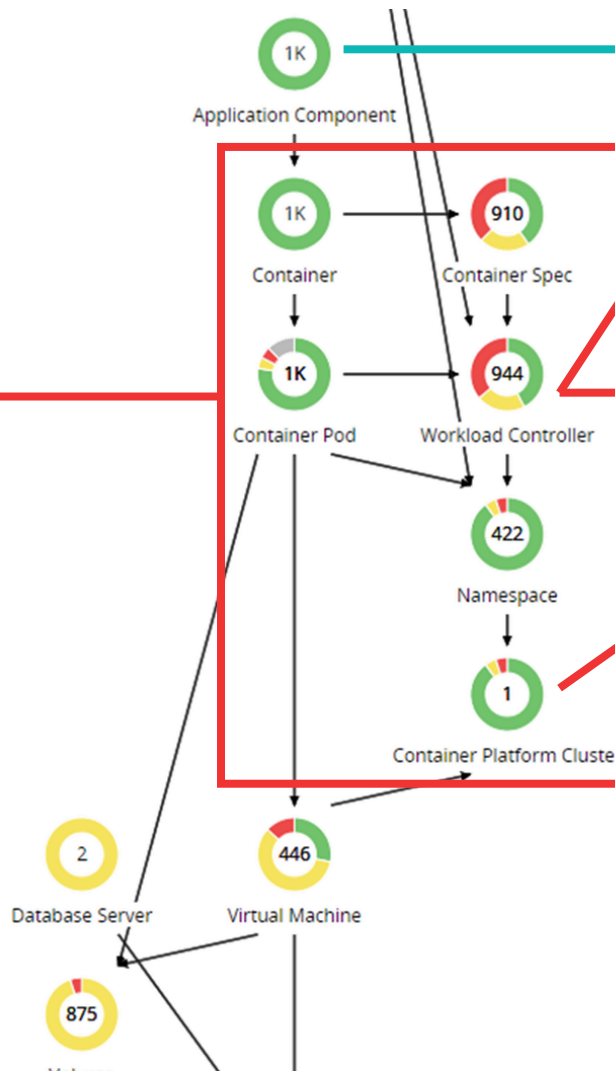
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to generate actions at all layers of the stack to optimize Kubernetes.

<input type="checkbox"/>	Application Component Name	Risk	Resize Direction	Current Value	New Value	Resize Attribute	Cost Impact	Action Category	Action
<input type="checkbox"/>	JBoss Modules 1.11.0.Final-redhat-000	Heap	Downsize	4 GB	3.5 GB	Capa...	\$0.00/mo	SAVINGS	DETAILS

Move Actions (23)							EXECUTE ACTIONS	⚙️	📄
<input type="checkbox"/>	Container Pod Name	Container Cluster	Namespace	From	To	Risk	Action Category	Action	
<input type="checkbox"/>	fd173-selenium/scs-repo-corporate-	Kubernetes-AWS Clearir	fd173-selenium	scs-dev-static-c-4v7sv	scs-dev-static-a-rqjpn	scs-dev-static-c-4v7sv can...	SAVINGS	DETAILS	
<input type="checkbox"/>	jee149/scs-trade-loader-868c955b-vl	Kubernetes-AWS Clearir	jee149	scs-dev-static-c-4v7sv	scs-dev-static-b-2pvpm	scs-dev-static-c-4v7sv can...	SAVINGS	DETAILS	

Resize Actions (784)							EXECUTE ACTIONS	⚙️	📄
<input type="checkbox"/>	Workload Controller Name	Container Cluster	Namespace	Risk	Action Category	Action			
<input type="checkbox"/>	scs-master-data-loader	Kubernetes-AWS Clearir	golden-replica01	Underutilized VMem Limit & Underutilized VCPU ...	SAVINGS	DETAILS			
<input type="checkbox"/>	scs-dm-event-manager	Kubernetes-AWS Clearir	golden-replica02	Underutilized VMem Limit & Underutilized VCPU ...	SAVINGS	DETAILS			
<input type="checkbox"/>	scs-repo-trade-manager	Kubernetes-AWS Clearir	sfr-perf-test	Underutilized VMem Limit & VCPU Throttling Con...	PERFORMANCE	DETAILS			

Suspend Actions (1)						EXECUTE ACTIONS	⚙️	📄
<input type="checkbox"/>	Virtual Machine Name	VMem Capacity	VCPU Capacity	VStorage Capacity	Action Category	Action		
<input type="checkbox"/>	scs-dev-static-c-4v7sv	124.46 GB	49.56 GHz	299.47 GB	SAVINGS	DETAILS		

Performance Risks

Kubernetes-AWS Clearing IT

489 Risks

- 17 Virtual CPU Risks
- 2 Virtual Memory Risks
- 1 IO Throughput Risks
- 469 Other risks

Efficiency Optimizations

Kubernetes-AWS Clearing IT

265 Optimizations

- 36 Heap Optimizations
- 24 Storage Access Optimizations
- 24 IO Throughput Optimizations
- 1 Cluster boundaries Optimizatio
- 1 Label Optimizations
- 179 Other Optimizations

Data ~

API-driven discovery



Applications



Databases

Kubernetes



Virtualizations



Public Cloud



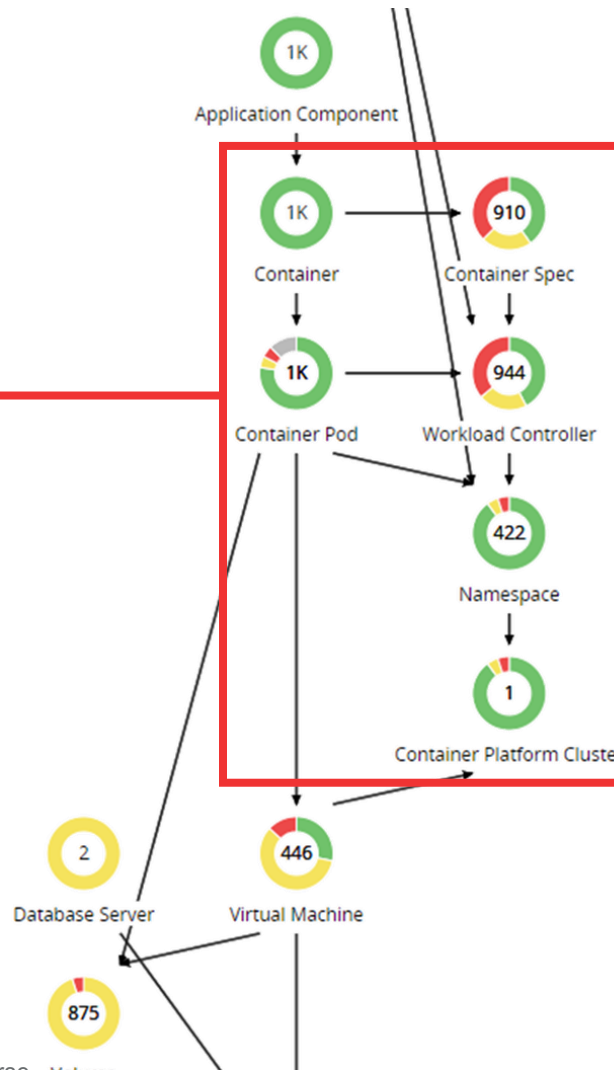
Hyperconverged

Compute

Storage

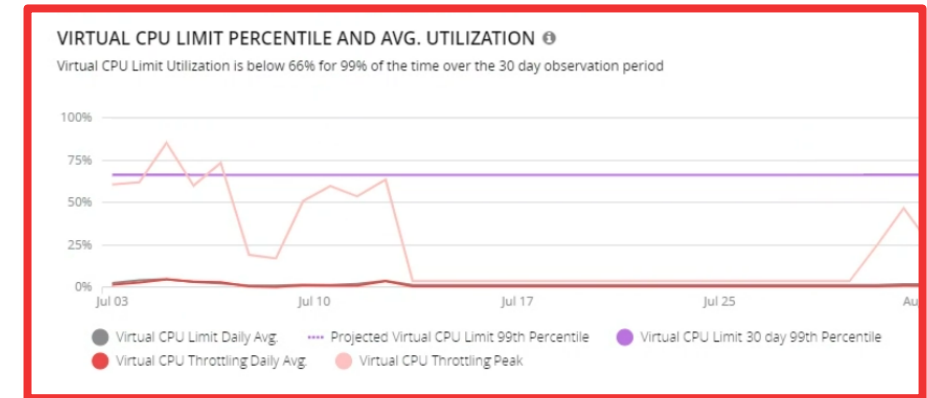
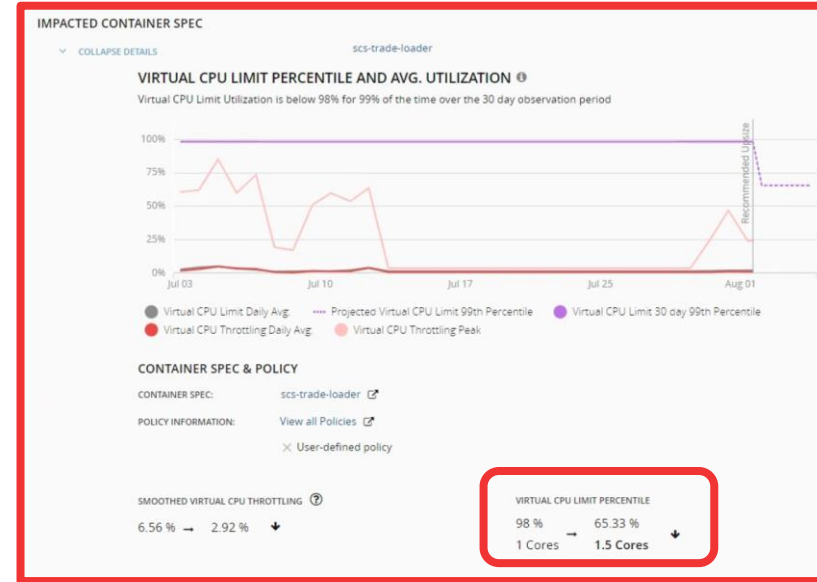
Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to generate trustworthy actions.



Data ~

API-driven discovery



Applications



Databases



Kubernetes



Virtualizations

Public Cloud



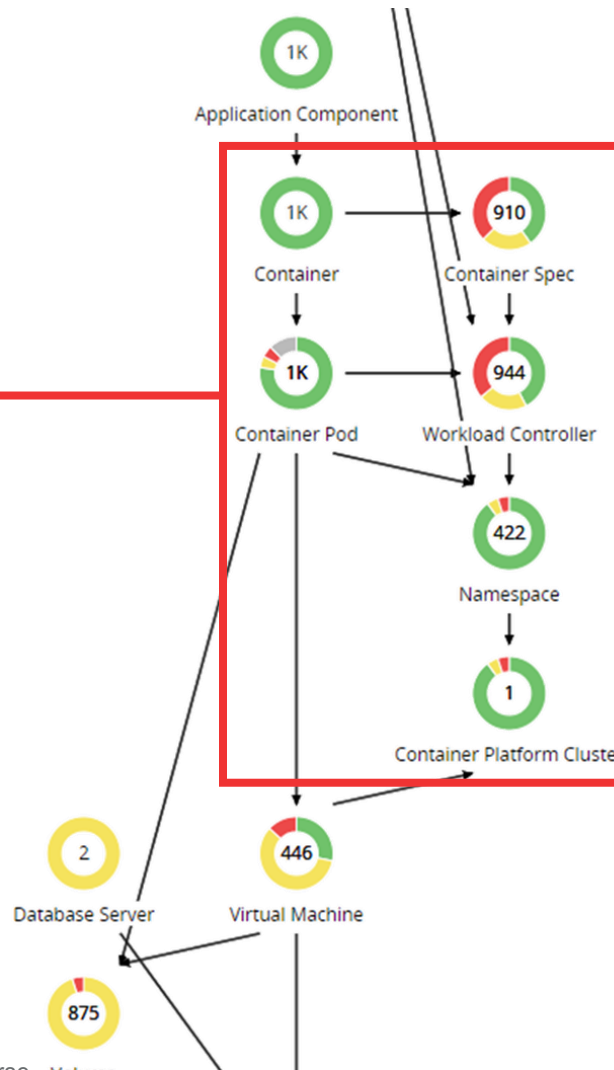
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...

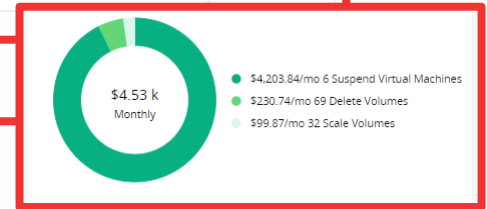


POV Extracts ~

...to PLAN Kubernetes capacity.

Optimize Container Cluster Summary
Kubernetes-AWS Clearing IT

	Current	After Plan	Difference	%
Container Pods	1387	1297	90	▼ 6.5 %
Virtual Machines	24	18	6	▼ 25 %
Pod Density	57.8 : 1	72.1 : 1	14 : 1	▲ 24.7 %
Cluster CPU Capacity	324 Cores	228 Cores	96 Cores	▼ 29.6 %
Cluster CPU Allocatable	321.51 Cores	226.17 Cores	95.3 Cores	▼ 29.7 %
Cluster CPU Overcommitment	290.2 %	430.3 %	140.1 %	▲ 48.3 %
Cluster Memory Capacity	1.82 TB	1.33 TB	496 GB	▼ 26.7 %
Cluster Memory Allocatable	1.67 TB	1.23 TB	457.5 GB	▼ 26.7 %
Cluster Memory Overcommitment	79.3 %	55.3 %	24 %	▼ 30.3 %



Data ~

API-driven discovery



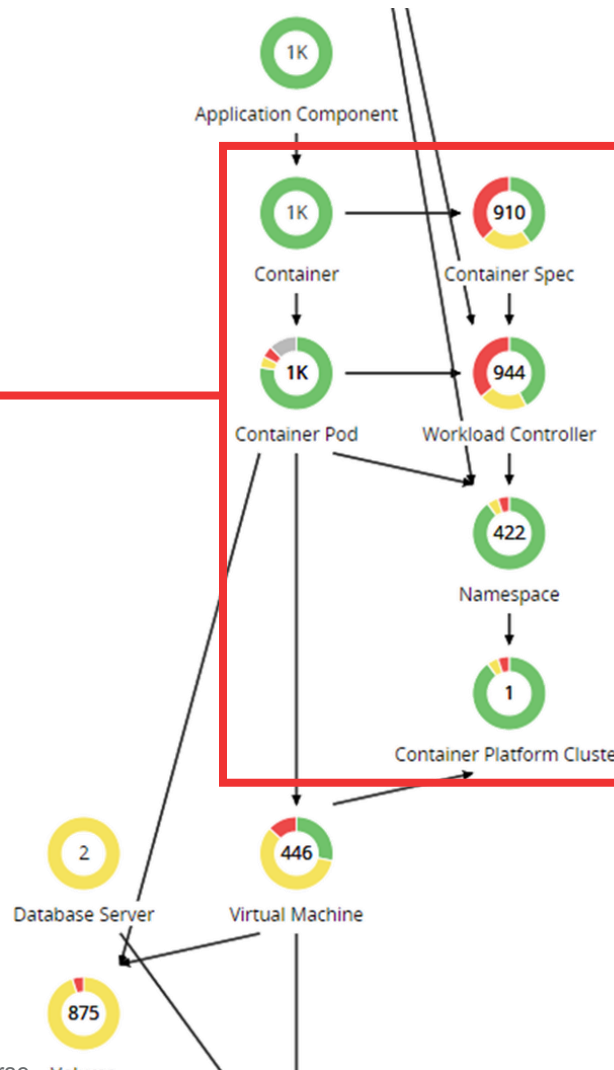
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to PLAN workload migrations.

Migrate 6 Workload Controllers

- argocd/argocd-redis (Kubernetes-se-lab-openshift) - 1 + x
- argocd/argocd-application-controller (Kubernetes-se-lab-openshift) - 1 + x
- argocd/argocd-dex-server (Kubernetes-se-lab-openshift) - 1 + x
- argocd/argocd-operator-controller-manager (Kubernetes-se-lab-openshift) - 1 + x
- argocd/argocd-server (Kubernetes-se-lab-openshift) - 1 + x
- argocd/argocd-repo-server (Kubernetes-se-lab-openshift) - 1 + x



Migrate Container Workloads Summary

	BEFORE MIGRATION	LIFT & SHIFT	OPTIMIZED
Workload Controllers	34	40	40
Container Pods	90	103	75
Virtual Machines	7	8	4
Pod Density	12.9 : 1	12.9 : 1	18.8 : 1
Cluster CPU Capacity	20 Cores	24 Cores	16 Cores
Cluster CPU Allocatable	19.18 Cores	23.04 Cores	15.44 Cores
Cluster CPU Request	13.59 Cores	15.78 Cores	11.09 Cores
Cluster CPU Limit	39.4 Cores	43.9 Cores	39.01 Cores
Cluster CPU Overcommitment	197 %	182.9 %	243.8 %
Cluster Memory Capacity	62.26 GB	77.9 GB	62.54 GB
Cluster Memory Allocatable	45.34 GB	57.64 GB	49.21 GB
Cluster Memory Request	11.8 GB	14.74 GB	9.01 GB
Cluster Memory Limit	45.39 GB	48.61 GB	27.02 GB
Cluster Memory Overcommitment	72.9 %	62.4 %	43.2 %

Data ~

API-driven discovery



Applications



Databases

Kubernetes



Virtualizations



Public Cloud



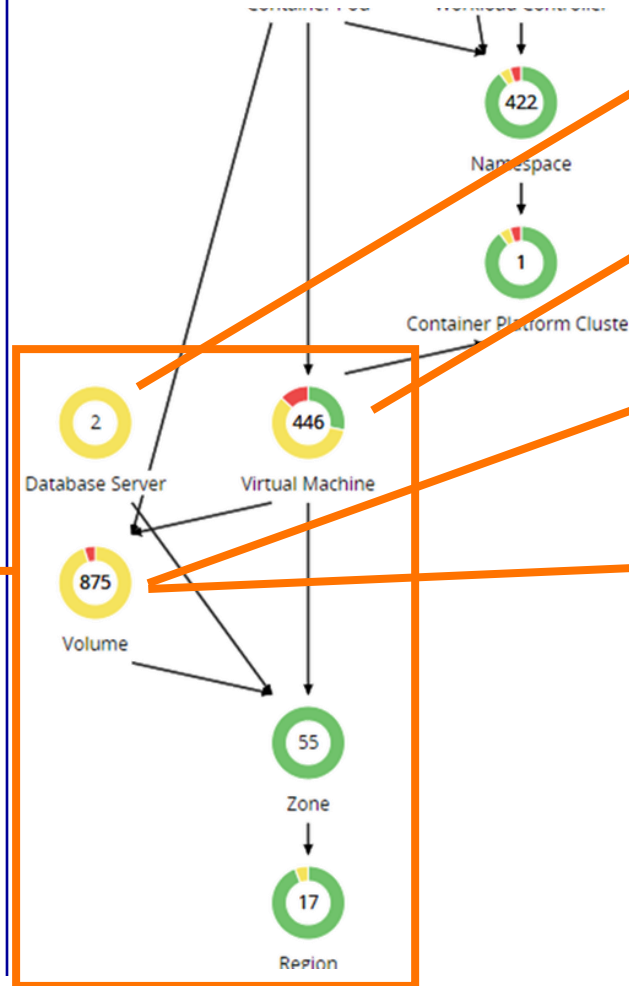
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to generate actions at all layers of the stack to optimize Public Cloud.

Scale Actions (2)		TOTAL SAVINGS								EXECUTE ACTIONS
Database Server Name	Account	Non-Destructive	Reversible	Instance Type	On-Demand Cost	New Instance Type	New On-Demand Cost	Action Category	Cost Impact	Action
turbopov	DBG Clearing Development	✗	✓	db.m5.large-gp2	\$0.391/h	db.M5.large-standard	\$0.312/h	SAVINGS	↓ \$7.42/mo	DETAILS
scs-dev-openshift-authenti	DBG Clearing Development	✗	✓	db.M5.small-gp2	\$0.082/h	db.M5.small-standard	\$0.081/h	SAVINGS	↓ \$0.700/mo	DETAILS

Scale Actions (372)		TOTAL SAVINGS	TOTAL INVESTMENTS								EXECUTE ACTIONS
Virtual Machine Name	Account	Instance Type	Discount Coverage	On-Demand Cost	New Instance Type	New Discount Coverage	New On-Demand Cost	Action Category	Cost Impact	Action	
edcops-R685	DBG Clearing Developer	t3a.2xlarge	0%	\$0.476/h	z1d.xlarge	0%	\$0.510/h	PERFORMANCE	↑ \$25.11/mo	DETAILS	
scs-windoes-powerbi	DBG Clearing Developer	t3.large	0%	\$0.124/h	t3a.large	0%	\$0.114/h	SAVINGS	↓ \$7.01/mo	DETAILS	
edcops04	DBG Clearing Developer	t3.2xlarge	0%	\$0.384/h	r5a.xlarge	0%	\$0.274/h	SAVINGS	↓ \$80.30/mo	DETAILS	

Delete Actions (46)		TOTAL SAVINGS								EXECUTE ACTIONS
Volume ID	Account	Tier	Size	State	Days Unattached	Disk Image	Last VM	Action Category	Cost Impact	Action
scs-dev-g85p-dynamic-pvc	DBG Clearing Development	GP2	1 GiB	Unattached	1	-	-	SAVINGS	↓ \$0.119/mo	DETAILS
scs-dev-g85p-dynamic-pvc	DBG Clearing Development	GP2	1 GiB	Unattached	1	-	-	SAVINGS	↓ \$0.119/mo	DETAILS
scs-dev-g85p-dynamic-pvc	DBG Clearing Development	GP2	1 GiB	Unattached	1	-	-	SAVINGS	↓ \$0.119/mo	DETAILS

Scale Actions (831)		TOTAL SAVINGS								EXECUTE ACTIONS					
Name	Account	Non-Destructive	Reversible	Attached VM	Tier	Disk Size	IOPS	Cost	New Tier	New Disk Size	New IOPS	New Cost	Action Category	Cost Impact	Action
edcops007	DBG Clearing De	✓	✓	edcops007	GP2	30 GB	100	\$3.57/mo	Standard	30 GB	180	\$2.21/mo	PERFORMANCE	↓ \$1.37/mo	DETAILS
edcops024	DBG Clearing De	✓	✓	edcops024	GP2	92 GB	276	\$10.95/mo	GP3	92 GB	3000	\$8.76/mo	PERFORMANCE	↓ \$2.19/mo	DETAILS
edcops101	DBG Clearing De	✓	✓	edcops101	GP2	20 GB	100	\$2.38/mo	Standard	20 GB	180	\$1.33/mo	SAVINGS	↓ \$1.05/mo	DETAILS
edcops01	DBG Clearing De	✓	✓	edcops01	GP2	40 GB	120	\$4.76/mo	Standard	40 GB	180	\$3.08/mo	SAVINGS	↓ \$1.67/mo	DETAILS



Data ~

API-driven discovery



Applications



Databases

Kubernetes



Virtualizations



Public Cloud



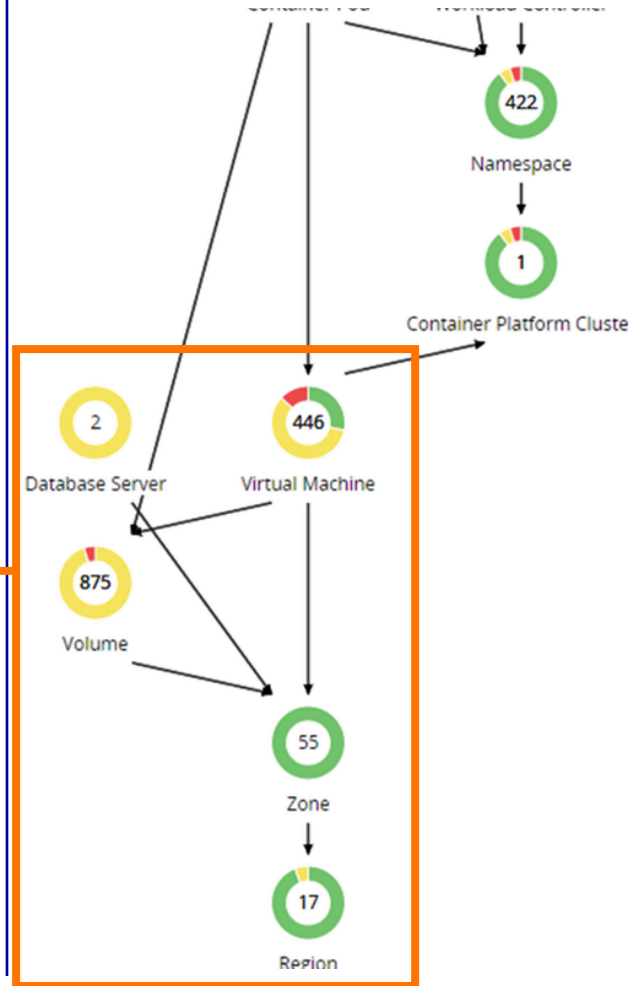
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to generate trustworthy actions.

Scale Volume scs-dev-static-a-xdbq8 in DBG Clearing Development from GP3 to STANDARD
Underutilized IOPS, IO Throughput ↓ \$9.38/mo SAVINGS

IOPS PERCENTILE AND AVG. UTILIZATION

IOPS Utilization is below 1% for 95% of the time over the 30 day observation period

THROUGHPUT PERCENTILE AND AVG. UTILIZATION

Throughput Utilization is below 1% for 95% of the time over the 30 day observation period

ACTION ESSENTIALS

State: Non-Disruptive, Reversible

✔ Action is successfully executed
✔ Downtime is not required to execute.
✔ Action can be manually reverted.

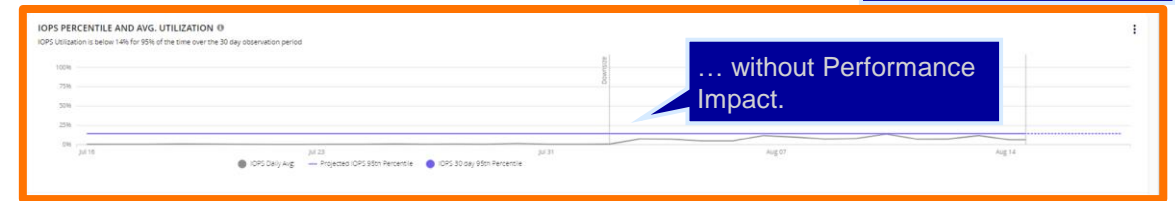
VOLUME DETAILS

Name: scs-dev-static-a-xdbq8
 Id: vol-06cc3ffc504c0e392
 Account: DBG Clearing Development
 Region: aws-EU (Frankfurt)
 Virtual Machine: scs-dev-static-a-xdbq8
 Billed I/O Requests: 25.03M
 Tags: kubernetes.io/cluster/scs-dev-g885p: owned, Owner: i3212, CostCenter: 0001/B1-80304

RESOURCE IMPACT	CURRENT	AFTER ACTIONS	
Storage Tier	GP3	Standard	
IOPS, Capacity	3000 IOPS	160 IOPS	↓ 2840 IOPS
IOPS, P95th Utilization	1%	18.75%	↑ 17.75 %
Disk Size, Capacity	300 GB	300 GB	-
Disk Size, Utilization	N/A	N/A	-
Throughput, Capacity	125 MB/s	90 MB/s	↓ 35 MB/s
Throughput, P95th Utilization	1%	1.39%	↑ 0.39 %

COST IMPACT	CURRENT	AFTER ACTIONS	
Storage Cost	\$28.56/mo	\$19.18/mo	↓ \$9.38/mo
Total Cost	\$28.56/mo	\$19.18/mo	↓ \$9.38/mo
Total Savings		\$9.38/mo	

Changed tier from GP3 to Standard ...



Data ~

API-driven discovery



Applications



Databases



Kubernetes

Virtualizations



Public Cloud



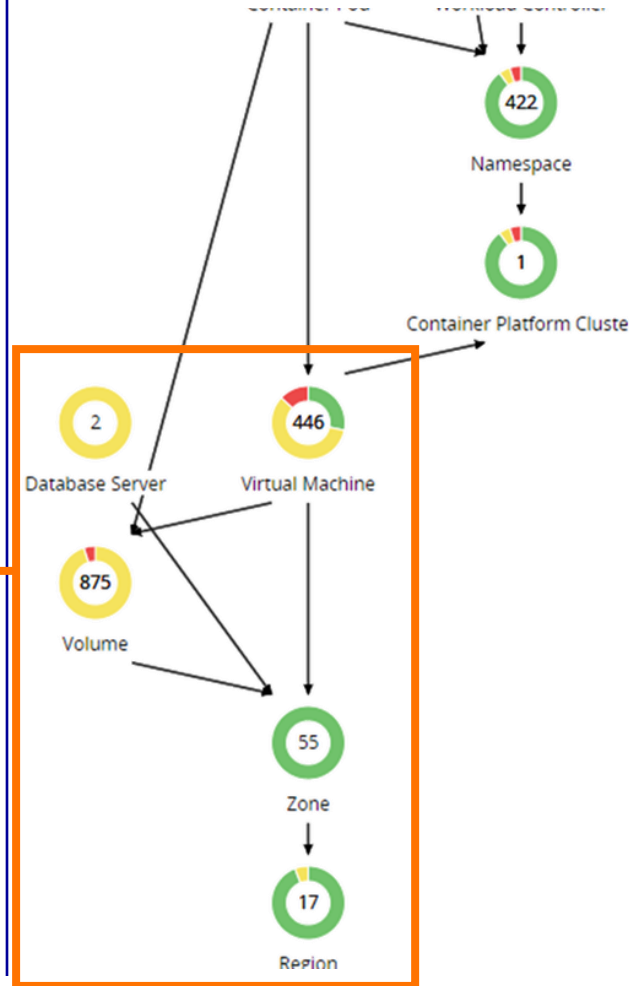
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to PLAN (simulate) Cloud optimization incl. Reservations/Discounts.

CONFIGURATION

RI Settings

- Purchase RIs: ENABLED
- AWS Offering Class: STANDARD
- AWS Term: 1 YEAR
- AWS Payment: ALL UPFRONT
- Discount Inventory: 0 OUT OF 0 ACTIVE

Virtual Machine Action Settings

- Scale for Virtual Machines: ENABLED

RESULTS OVERVIEW PLAN ACTIONS (1214)

Cloud Cost Comparison

	CURRENT	OPTIMIZED	DIFFERENCE
Workloads with performance risks	58 out of 448	0 out of 448	58
Workloads with efficiency opportunities	275 out of 448	0 out of 448	275
Workloads out of compliance	0 out of 448	0 out of 448	0
RI Coverage	0 %	52 %	+100 %
RI Utilization	0 %	100 %	+100 %
On-Demand Compute Cost	\$59,091.00 /mo	\$22,140.00 /mo	-\$36,951.00 /mo
Reserved Compute Cost	\$0.00 /mo	\$20,979.00 /mo	\$20,979.00 /mo
On-Demand Database Cost	\$345.00 /mo	\$287.00 /mo	-\$58.00 /mo
Storage Cost	\$4,918.00 /mo	\$2,828.00 /mo	-\$2,090.00 /mo
Total Cost	\$64,354.00 /mo	\$46,234.00 /mo	-\$18,120.00 /mo

Workload Mapping

Current

448 Workloads

- 143 t3a.large
- 96 t3.2xlarge
- 57 t3.xlarge
- 21 t3a.large
- 21 t3.medium
- 110 Other Instance Types

Optimized

448 Workloads

- 111 r5a.large
- 106 r5a.xlarge
- 54 r6i.large
- 35 t3a.large
- 30 t3a.large
- 112 Other Instance Types

[SHOW CHANGES >](#)

Data ~

API-driven discovery



Applications



Databases



Kubernetes

Virtualizations



Public Cloud



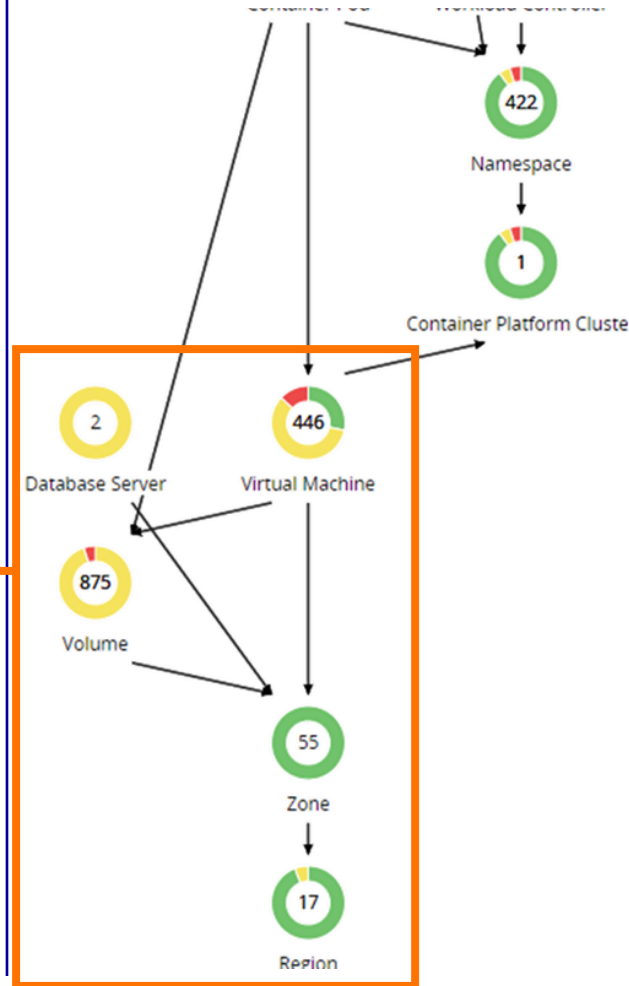
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

...to PLAN (simulate) Lift&Shift migrations to or between Cloud Providers.



Cloud Cost Comparison
Pay-As-You-Go - Product Management/azure-Norway East

	LIFT & SHIFT	OPTIMIZED	DIFFERENCE
Virtual Machines with performance risks	0 Out Of 1	0 Out Of 1	
Virtual Machines with efficiency opportunities	1 Out Of 1	0 Out Of 1	
On-Demand Compute Cost	\$78.00 /mo	\$39.00 /mo	-\$39.00 /mo ▼ 50 %
Reserved Compute Cost	\$0.00 /mo	\$0.00 /mo	\$0.00 /mo 0 %
Storage Cost	\$2.00 /mo	\$1.00 /mo	-\$1.00 /mo ▼ 50 %
Total Cost	\$80.00 /mo	\$40.00 /mo	-\$40.00 /mo ▼ 50 %

Virtual Machine Mapping
Pay-As-You-Go - Product Management/azure-Norway East

LIFT & SHIFT

OPTIMIZED

CONFIGURATION

1 Licensing

Include OS cost

RI Settings

Azure: Term 1 YEAR

Discount Inventory 0 OUT OF 0 AC...

Migrate 1 Virtual Machine

weblogicAWS
Migrated to Pay-As-You-Go - Product...

Data ~

API-driven discovery



Applications



Databases

Kubernetes



Virtualizations



Public Cloud



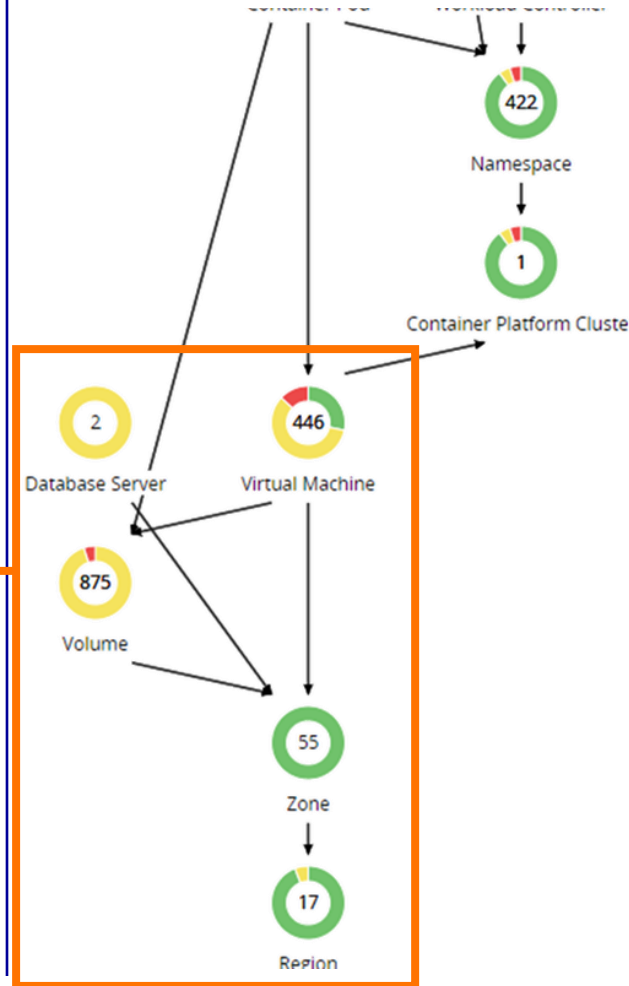
Hyperconverged

Compute

Storage

Optimization ~

Map applications to infrastructure...



POV Extracts ~

+ option for scheduled parking of Cloud Resources.



P Parking

WORKLOADS ^ AWS AZURE GCP

Virtual Machines (589)

Database Servers (23)

SCHEDULE Select Action STOP START

Type to search

Name	Schedule	State	Scheduled By	Account	Region	Instance Type	Cost	Tags
<input checked="" type="checkbox"/> ee-test-qfhp-infra-us-west-2a-62hw4	Working Hours Only	● RUNNING	-	Advanced Engineering	aws-US West (Oregon)	r5.xlarge	\$194.91mo	
<input type="checkbox"/> ee-test-qfhp-infra-us-west-2a-76kt5	-	● RUNNING	-	Advanced Engineering	aws-US West (Oregon)	r5.xlarge	\$194.91mo	
<input type="checkbox"/> ee-test-qfhp-master-0	-	● RUNNING	-	Advanced Engineering	aws-US West (Oregon)	m5.2xlarge	\$277.13mo	

SCHEDULE NAME *

Working Hours Only

DESCRIPTION

TIME ZONE Europe/London

SCHEDULE RESOLUTION 1 Hour

HOURS UP: 50h HOURS DOWN: 118h STATE: ● RUNNING ● STOPPED ● DO NOTHING

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MON	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
TUE	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
WED	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
THU	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
FRI	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SAT	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SUN	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Summary

Visibility

Single Platform for Hybrid-
/Multi-Cloud and Kubernetes

- API-based
- Application centric
- Contextual views + option for scoped & user defined views

Efficiency

Smart analytics of current and history data to spot trends and trigger alerts

- Rightsizing
- Cost efficiency
- Optimized incident handling
- Reduced Time-2-Market

Automation

Actionable: changes can be managed and automated honoring ownership and responsibilities by implementing SOD with roles and permissions.

- Automatable resource decisions
- Dynamization of IT resource usage

Openess

Connects to existing INSTANA and CLOUDABILITY information

- Easy setup
- using industry standards (Webhooks)

Initiatives & Goals

Addressing Current DBG Initiatives

Data Center Efficiency
(Performance, Capacity Planning, cross Stack)

Application Modernization
(K8, OCP, Cloud Native)







Multi-Cloud Transformation
(Dyn. Cap.Mgmt., xTeam Visibility)

FinOps
(Cost Mgmt., License Compliance)

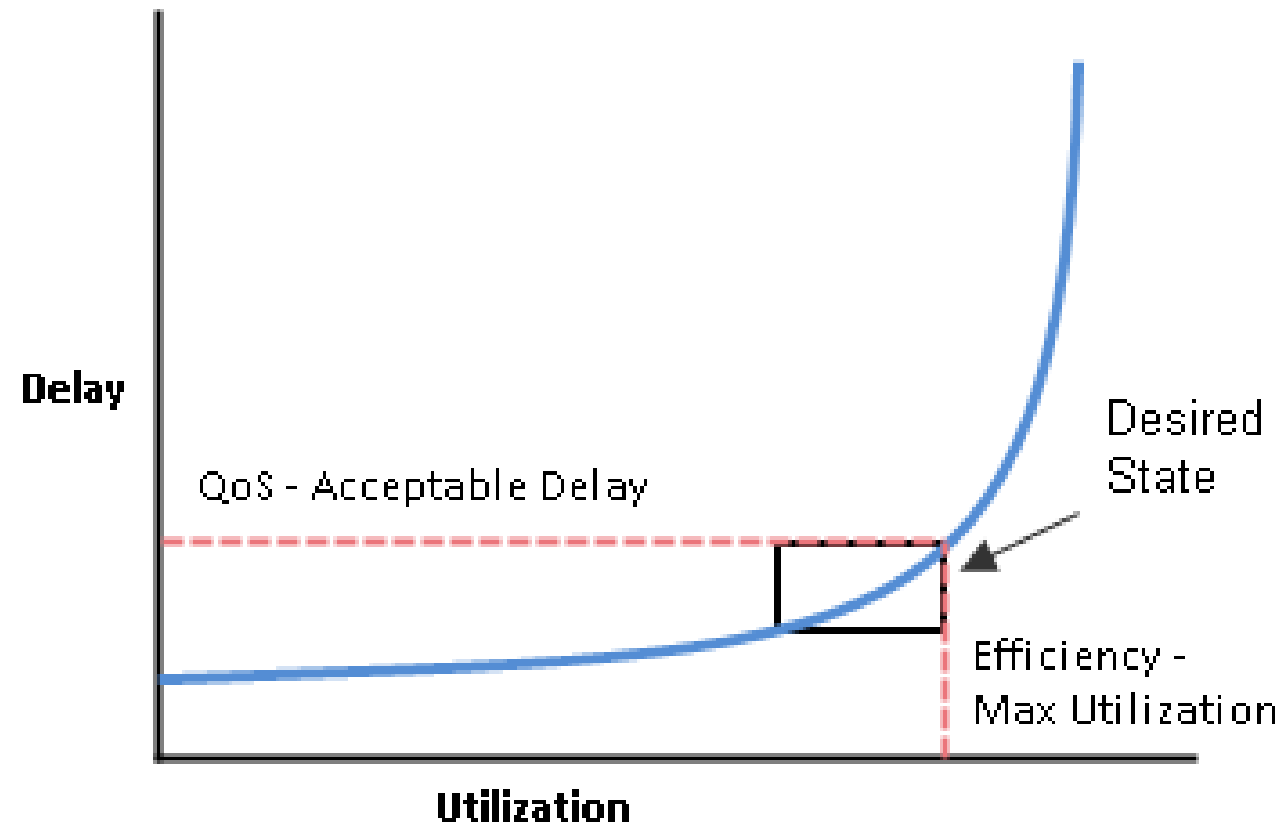
Sustainable IT
(e.g. reducing power consumption)

Other (tbd)

ADPTIO
Cloudability
IBM Turbonomic

 <p>Improved capacity management and planning for future hardware, software and platform changes, including multi-cloud transformation planning</p>	 <p>Improve Performance Engineering, Stability and Resilience with performance assurance capabilities</p>	 <p>Scalability through automation (built-in automatable actions with sufficient policy control features for DBG)</p>
<p>~ Change from static to dynamic capacity management.</p>	<p>~ Ensure application performance while IT infrastructure is used as efficiently as possible.</p>	<p>~ Take advantage of the variable cost model of the cloud.</p>
 <p>Eliminate complexity and manual processes where possible in the current operational process</p>	 <p>Enable and future proof DBG's strategic decisions through a consistent and agnostic management platform (on-prem, public cloud, containerization)</p>	 <p>Enable DBG to optimize inefficiency & reclaim over-allocation of resources (e.g., in various staging environments)</p>
<p>~ Trustworthy resource decision you can automate</p>	<p>~ Support the full application stack in Hybrid and multi cloud incl. Kubernetes</p>	<p>~ Usually cut cloud costs by 33% and achieve ROI in first year</p>

The Desired State



Reference: <https://www.ibm.com/docs/en/tarm/8.13.5?topic=works-desired-state>

The Market and Virtual Currency

Turbonomic uses two sets of abstraction to model the environment:

- Modeling the physical and virtual IT stack as a service supply chain
- The supply chain models your environment as a set of managed entities. These include applications, VMs, hosts, storage, containers, availability zones (cloud), and data centers. Every entity is a buyer, a seller, or both. A host machine buys physical space, power, and cooling from a data center. The host sells resources such as CPU cycles and memory to VMs. In turn, VMs buy host services, and then sell their resources (VMem and VCPU) to containers, which then sell resources to applications.
- Using virtual currency to represent delay or QoS degradation, and to manage the supply and demand of services along the modeled supply chain
- The system uses virtual currency to value these buy/sell transactions. Each managed entity has a running budget — the entity adds to its budget by providing resources to consumers, and the entity draws from its budget to pay for the resources it consumes. The price of a resource is driven by its utilization — the more demand for a resource, the higher its price.

Disclaimer

© Deutsche Börse Group 2024

This content is for informational purposes only. None of the information constitutes investment advice or an offer to sell or the solicitation of an offer to buy any contract, share or other financial instrument. This content is only for use as general information and all descriptions, examples and calculations contained are for illustrative purposes only.

Deutsche Börse AG, Frankfurter Wertpapierbörse (FWB®, the Frankfurt Stock Exchange), Eurex Frankfurt AG, Eurex Deutschland and Eurex Clearing AG and Deutsche Börse Digital Exchange do not represent that the information in this publication is comprehensive, complete or accurate and exclude liability for any consequence resulting from acting upon the contents of this or another publication, in so far as no willful violation of obligations took place or, as the case may be, no injury to life, health or body arises or claims resulting from the Product Liability Act are affected.

Securities traded on the Frankfurt Stock Exchange and Eurex derivatives (other than EURO STOXX 50® Index Futures contracts, EURO STOXX® Select Dividend 30 Index Futures contracts, STOXX® Europe 50 Index Futures contracts, STOXX® Europe 600 Index Futures contracts, STOXX® Europe Large/Mid/Small 200 Index Futures contracts, EURO STOXX® Banks Sector Futures contracts, STOXX® Europe 600 Banks/Industrial Goods & Services/Insurance/Media/Personal & Household Goods/Travel & Leisure/Utilities Futures contracts, Dow Jones Global Titans 50 IndexSM Futures contracts, DAX® Futures contracts, MDAX® Futures contracts, TecDAX® Futures contracts, SMIM® Futures contracts, SLI Swiss Leader Index® Futures contracts, RDXxt® USD - RDX Extended Index Futures contracts, Eurex inflation/commodity/weather/property and interest rate derivatives) are currently not available for offer, sale or trading in the United States nor may they be offered, sold or traded by persons to whom US tax laws apply.

The fund shares listed in XTF Exchange Traded Funds® are admitted for trading on the Frankfurt Stock Exchange. Users of this information service who legally reside outside Germany are herewith advised that sale of the fund shares listed in XTF Exchange Traded Funds may not be permitted in their country of residence. The user makes use of the information at their own risk.

Legal validity of this disclaimer

In the event that individual parts of or formulations contained in this text are not, or are no longer, legally valid (either in whole or in part), the content and validity of the remaining parts of the document are not affected.

Trademarks

The following names and designations are registered trademarks of Deutsche Börse AG or an affiliate of Deutsche Börse Group:

1585®, A7®, Buxl®, C7®, CDAX®, CEF®, CEF alpha®, CEF ultra®, CFF®, Classic All Share®, Clearstream®, CX®, D7®, DAX®, DAXglobal®, DAXplus®, DB1 Ventures®, DBIX Deutsche Börse India Index®, Deutsche Börse®, Deutsche Börse Capital Markets Partner®, Deutsche Börse Commodities®, Deutsche Börse Venture Network®, Deutsches Eigenkapitalforum®, DivDAX®, eb.rexx®, eb.rexx Jumbo Pfandbriefe®, ERS®, eTriParty®, Eurex®, Eurex Bonds®, Eurex Clearing Prisma®, Eurex Improve®, Eurex Repo®, Euro GC®, ExServes®, EXTF®, F7®, FDAX®, FWB®, GC Pooling®, GCPI®, GEX®, Global Emission Markets Access – GEMA®, HDAX®, iNAV®, L-DAX®, L-MDAX®, L-SDAX®, L-TecDAX®, M7®, MDAX®, N7®, ODAX®, ÖkoDAX®,PROPRIS®, REX®, RX REIT Index®, SCHATZ-FUTURE®, SDAX®, ShortDAX®, StatistiX®, T7®, TecDAX®, Technology All Share®, TRICE®, USD GC Pooling®, VDAX®, VDAX-NEW®, Vestima®, Xgreen®, Xemac®, Xentric®, Xetra®, Xetra-Gold®, Xpect®, Xpider®, XTF®, XTF Exchange Traded Funds®, We make markets work®

The names and trademarks listed above do not represent a complete list and, as well as all other trademarks and protected rights mentioned in this publication, are subject unreservedly to the applicable trademark law in each case and are not permitted to be used without the express permission of the registered owner. The simple fact that this publication mentions them does not imply that trademarks are not protected by the rights of third parties.

The STOXX® indices, the data included therein and the trademarks used in the index names are the intellectual property of STOXX Ltd., Zug, Switzerland and/or its licensors. Eurex' derivatives based on the STOXX indices are in no way sponsored, endorsed, sold or promoted by STOXX and its licensors and neither STOXX nor its licensors shall have any liability with respect thereto.

STOXX iSTUDIO® is a registered trademark of STOXX Ltd., Zug, Switzerland.

EEX® is a registered trademark of European Energy Exchange AG.

TRADEGATE® is a registered trademark of Tradegate AG Wertpapierhandelsbank.

Flexible is better.® is a registered trademark of Axioma, Inc.

Thank you!

Alexander Buschmann

VP Clearing & Risk IT Architects Office

Deutsche Börse AG
Mergenthalerallee 61
65760 Eschborn

Phone +49 69 21118984

Fax +49 69 21118984

E-mail alexander.buschmann@deutsche-boerse.com

OpenDay 2024



DEUTSCHE BÖRSE
GROUP