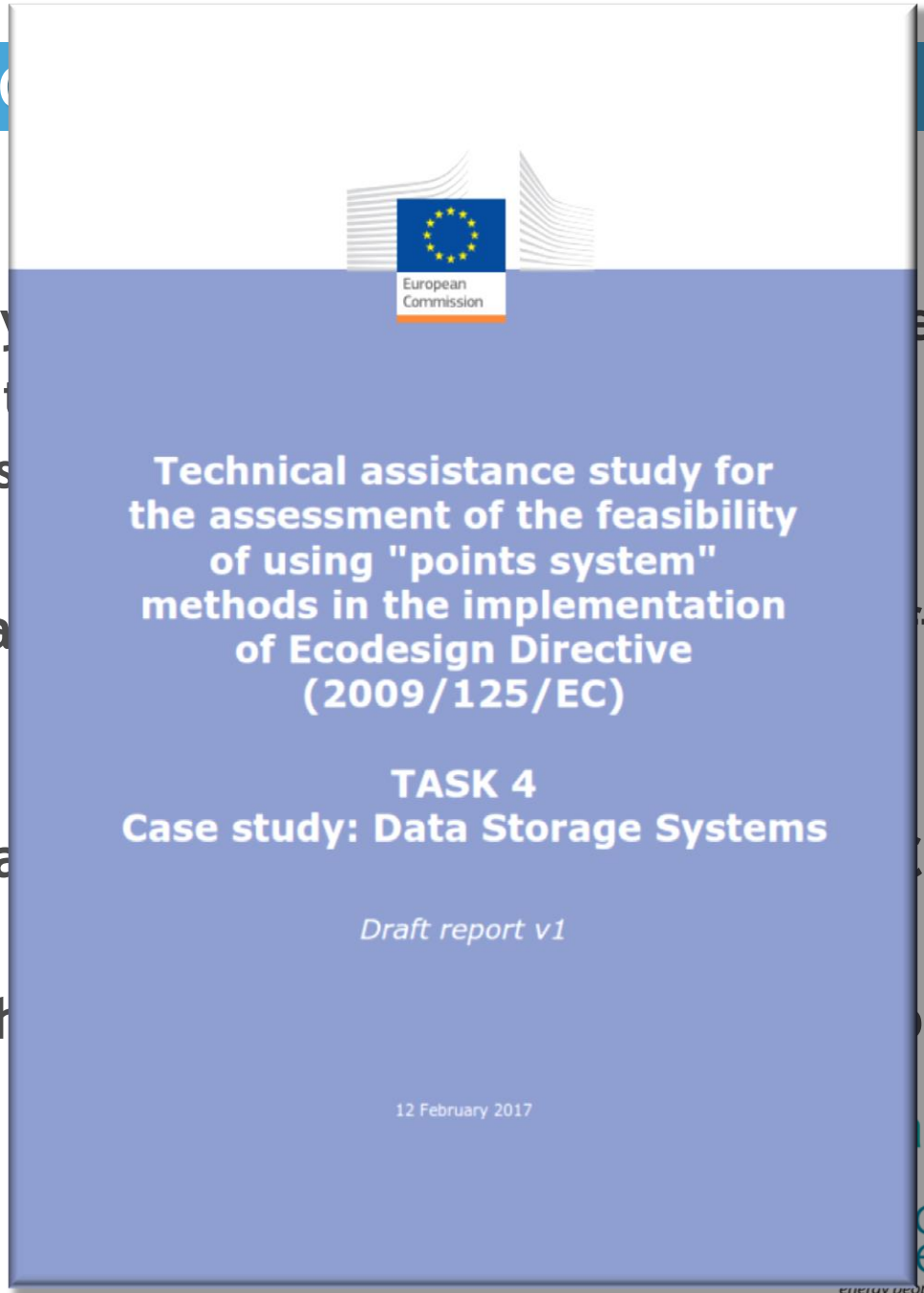
PRESENTATION OF DRAFT TASK 4 REPORT - CASE STUDY OF GENERIC POINTS METHODOLOGY APPLIED TO DATA STORAGE PRODUCTS

Jan Viegand, 10/03/2017

INTRODUCTI

- Aim: Apply … ecific product
  - 1: Test …
  - 2: Asses … storage products
- Data stora … fficult to apply theory on …
- Many itera …
- Large tech … ert



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DATA STORAGE PRODUCTS AND THEIR ENVIRONMENTAL IMPACT

The Data Centre

Servers

The data centre

UPS (battery backup)

Storage equipment

Network equipment

Data center cooling

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The Data Storage Product

- Storage media
- Storage controllers
- Network interfaces
- Software

Scope: Online 2, 3, 4: Typical enterprise and data centre storage

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DATA STORAGE PRODUCTS AND THEIR ENVIRONMENTAL IMPACT

Environmental impact of data storage

Material for the production and the production processes

UPS (battery backup)

Storage equipment

Network equipment

Data centre cooling

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DATA STORAGE PRODUCTS AND THEIR ENVIRONMENTAL IMPACT

Environmental impact of data storage products

Energy consumption of the product

UPS (battery backup)

Storage equipment

Network equipment

Data centre cooling

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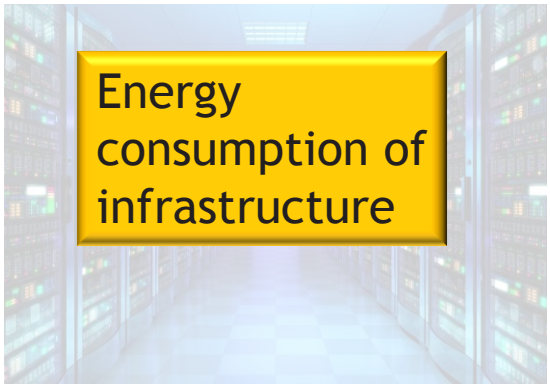
DATA STORAGE PRODUCTS AND THEIR ENVIRONMENTAL IMPACT

Environmental impact of data storage products



Servers

UPS (battery backup)

Storage equipment

Network equipment

Data centre cooling

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Environmental impact

- In-use electricity consumption:
  - Now: 15 TWh/year (incl. infrastructure 27 TWh/year)
  - 2030: 30 TWh/year (incl. infrastructure 47 TWh/year)

- Material environmental impact

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WHY DATA STORAGE PRODUCTS FOR POINTS SYSTEM

- Mix of quantifiable and qualitative product ecodesign features - smaller and larger
- Difficult to translate each ecodesign feature into regulation
- Complex to apply a rigorous performance assessment method

- Point system to provide a compromise for an improved eco-design product

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DG GROW Lot 9 - Enterprise servers, data storage and ancillary equipment - Potential ecodesign requirements

- PSU efficiency and power factor
- Material efficiency
- Operation Condition Class

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DG GROW Lot 9 - Enterprise servers, data storage and ancillary equipment - Potential ecodesign requirements

- PSU efficiency and power factor
  - Requirements: Min. efficiency at 20%, 50%, 100 % & min. PW
  - Information: Eff. at 10%, 20%, 50%, 100% & PW
- Material efficiency
- Operation Condition Class

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DG GROW Lot 9 - Enterprise servers, data storage and ancillary equipment - Potential ecodesign requirements

- PSU efficiency and power factor

- Material efficiency
  - Requirement:
    - Joining or sealing technique
    - Documenting the sequence of dismantling operations
    - Built-in software based data deletion tool(s)
    - Latest version of firmware available
  - Information
    - Disassembly, recycling and disposal at end-of-life
    - Instructions on how to remove components
    - The data deletions tool(s)
    - The latest firmware version
    - Weight and where of 3 critical raw materials

- Operation Condition Class

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DG GROW Lot 9 - Enterprise servers, data storage and ancillary equipment - Potential ecodesign requirements

- PSU efficiency and power factor
- Material efficiency
- Operation Condition Class
  - Information: A1-A4 (temperature, humidity etc. intervals)

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ENERGY STAR

Data Centre Storage v1.0, March 2014 (not adopted EU)

- Power supply (efficiency & power factor)
- Power modelling presale tool (selected systems)
- Energy efficiency feature:
  - Adaptive active cooling
  - For online 3 and 4 products, at least 1 COM (Capacity Optimizing Method)
- Information Reporting (technical data, test data, EE performance)
- Performance data measurement & output

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SNIA Green Storage Initiative

- Storage Networking Industry Association
- SNIA Emerald™ Program (test energy & performance)
- Developed in collaboration with ENERGY STAR

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ASHRAE thermal guidelines for data centers

Thermal classes (+ humidity etc.)

- A1: 15-32 ºC
- A2: 10-35 ºC
- A3: 5-40 ºC
- A4: 5-45 ºC

- Data on reliability, energy consumption, noise vs temp.

- Less restrictions, more free cooling, reduced energy cons.

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CASE STUDY DISCLAIMER

This is an illustrative case study - not final proposal

- Used existing limited data for Data Storage
- We have made assumptions
- We propose weightings... based on judgements
- We present briefly the methodology
  - there are many details
- We had limited resources, but we have a result for discussions

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Target

- Award points to the product relative to a reference product
- Based on calculation of environmental impact budget for the product
- Points can be used for regulation

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 1 Assessment of key lifecycle stages

- In-use electricity consumption for the storage system
- In-use electricity consumption for DC (cooling, UPS, network equipment and power distribution units)

- Material for the production and the production processes
- End-of-life treatment

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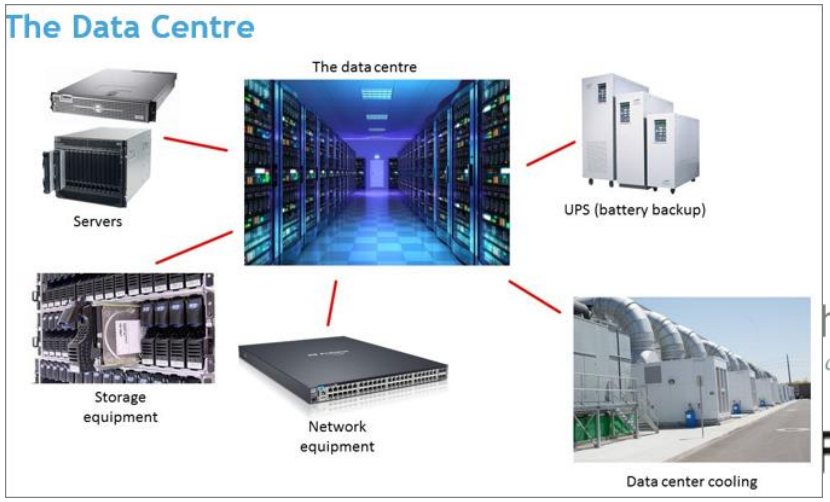
Step 2 Assessment of product scope boundaries and associated impacts at the wider (extended product or product-system) level

- Extended product
  - Varying loads on the data storage directly related to usage pattern
- Product-system
  - Impact on the DC (cooling, UPS, network equipment and power distribution units)



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Step 3 Selection of environmental impact criteria

Step 4 Determination of the phases at which product design may influence lifecycle impacts

Most important criteria:

- **Electricity consumption during the use phase on the product system level**

- **Material efficiency are the most important environmental impact criteria the points-system should target**

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Step 5 Assessment of whether a points system approach is potentially merited or not

- Q: Mix of quantifiable (cardinal) and more qualitative product eco-design features?
- A: Yes. E.g. energy performance & minimum operating condition

- Q: Difficult to determine the relative importance of benefit of ecodesign features?
- A: For some of the features yes such as min. oper. condition

- Q: Performance assessment method too complex, but a points-based system could provide compromising requirements?
- A: DS systems are complex and difficult to test for all use patterns. Points-system may be a way forward

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Step 6 Assessment of the implications of product modularity

- Mainly size and configuration
- For size modularity, points to be allocated for modules

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Step 7 Assessment of the implications of product performance sensitivity to the final application

- Main application: Store and retrieve data

- Main sub-category applications (DS optimised for these):
  - Transactional applications: Most common: Small, random data transactions. E.g. databases, web servers
  - Streaming applications: Reading and writing large files and blocks of data in sequence. E.g. backup/recovery, streaming media files
  - Capacity applications: Store very large amount of data. E.g. less accessed backup etc.

- Different applications and different performance definitions and measurement methods

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 7 Assessment of the implications of product performance sensitivity to the final application

- Transactional applications
- Streaming applications
- Capacity applications

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

ENERGY STAR Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	ENERGY S	ENERGY S	Brand Nan	Model Nar	Model Nur	Additional	Storage M	Product Ty	Physical D	Storage Cc	Storage Cc	Storage Cc	Storage Cc	Storage Cc	Capacity C	Workload	Qualificati	Automate	Automate	Software C
2	2206733	Dell Inc.	DELL	PS4110XV	E04J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Yellow-Mc	Module 17	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
3	2210329	Dell Inc.	DELL	PowerVau	E03J	PowerVau	Block I/O	Online 3	No	Scale-Up S	Dell	Dell MD38	DPN 0XCV	RAID	Delta Snap	Transactio	Fixed Size	No	No	EQL Real-T
4	2210347	Dell Inc.	DELL	PowerVau	E04J	PowerVau	Block I/O	Online 3	No	Scale-Up S	Dell	MD38 Seri	DPN 09J1X	RAID	Delta Snap	Transactio	Fixed Size	No	No	EQL Real-T
5	2210381	Dell Inc.	DELL	PowerVau	E08J	,E08J,	Block I/O	Online 3	No	Scale-Up S	Dell	MD38 Seri	DPN 0T46I	RAID	Delta Snap	Transactio	Fixed Size	No	No	EQL Real-T
6	2210382	Dell Inc.	DELL	PowerVau	E08J	,E08J,	Block I/O	Online 3	No	Scale-Up S	Dell	MD38 Seri	DPN 014Y4	RAID	Delta Snap	Transactio	Fixed Size	No	No	EQL Real-T
7	2212683	Dell Inc.	DELL	SC8000SC2	E14S		Block I/O	Online 3	No	Scale-Up S	Dell	Compellen	SC8000	RAID	Delta Snap	Transactio	Fixed Size	No	No	EQL Real-T
8	2212733	Dell Inc.	DELL	SC8000SC2	E14S	SC8000SC2	Block I/O	Online 3	No	Scale-Up S	Dell	Compellen	SC8000	RAID	Delta Snap	Transactio	Fixed Size	No	No	EQL Real-T
9	2231227	Dell Inc.	DELL	PS4210E	E03J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 19	Module 19	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
10	2238819	Dell Inc.	DELL	PS6610XS	E11J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 18	Module 18	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
11	2238908	Dell Inc.	DELL	SCv2000	E09J		Block I/O	Online 4	No	Scale-Up S	Dell	1G-iSCSI-	1G-iSCSI-	RAID	Delta Snap	Transactio	Fixed Size	No	No	Storage Ce
12	2239321	Dell Inc.	DELL	SCv2020	E10J		Block I/O	Online 4	No	Scale-Up S	Dell	10G-iSCSI-	10G-iSCSI-	RAID	Delta Snap	Transactio	Fixed Size	No	No	Storage Ce
13	2239322	Dell Inc.	DELL	SCv2080	E11J		Block I/O	Online 4	No	Scale-Up S	Dell	10G-iSCSI-	10G-iSCSI-	RAID	Delta Snap	Transactio	Fixed Size	No	No	Storage Ce
14	2241233	Dell Inc.	DELL	SC4020	E10J		Block I/O	Online 4	No	Scale-Up S	Dell	10G-iSCSI-	10G-iSCSI-	RAID	Delta Snap	Transactio	Fixed Size	Yes	Yes	Storage Ce
15	2252091	Dell Inc.	DELL	SC9000	E31S		Block I/O	Online 3	Yes	Scale-Up S	Dell Comp	Dell Comp	Compellen	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
16	2283534	Dell Inc.	DELL	SC7020 wi	E03T, SP-2584		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Dell SC70	Dell SC70	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
17	2283545	Dell Inc.	DELL	SC7020 wi	E03T, E03J	SC7020 wi	Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Dell SC70	Dell SC70	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
18	2231228	Dell Inc.	DELL	PS4210X	E03J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 19	Module 19	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
19	2231233	Dell Inc.	DELL	PS4210XS	E03J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 19	Module 19	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
20	2231234	Dell Inc.	DELL	PS4210XV	E03J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 19	Module 19	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
21	2231235	Dell Inc.	DELL	PS4210XV3	E03J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 19	Module 19	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
22	2238813	Dell Inc.	DELL	PS6610E	E11J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 18	Module 18	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
23	2238816	Dell Inc.	DELL	PS6610E	E11J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 18	Module 18	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
24	2238817	Dell Inc.	DELL	PS6610X	E11J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 18	Module 18	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
25	2238818	Dell Inc.	DELL	PS6610X	E11J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Module 18	Module 18	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
26	2205661	Dell Inc.	DELL	PS4100	E04J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Purple-Mo	Module 12	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T
27	2205667	Dell Inc.	DELL	PS4100X	E04J		Block I/O	Online 3	Yes	Scale-Out	Dell Equall	Purple-Mo	Module 12	RAID	Delta Snap	Transactio	Fixed Size	Yes	No	EQL Real-T

126 products
289 fields

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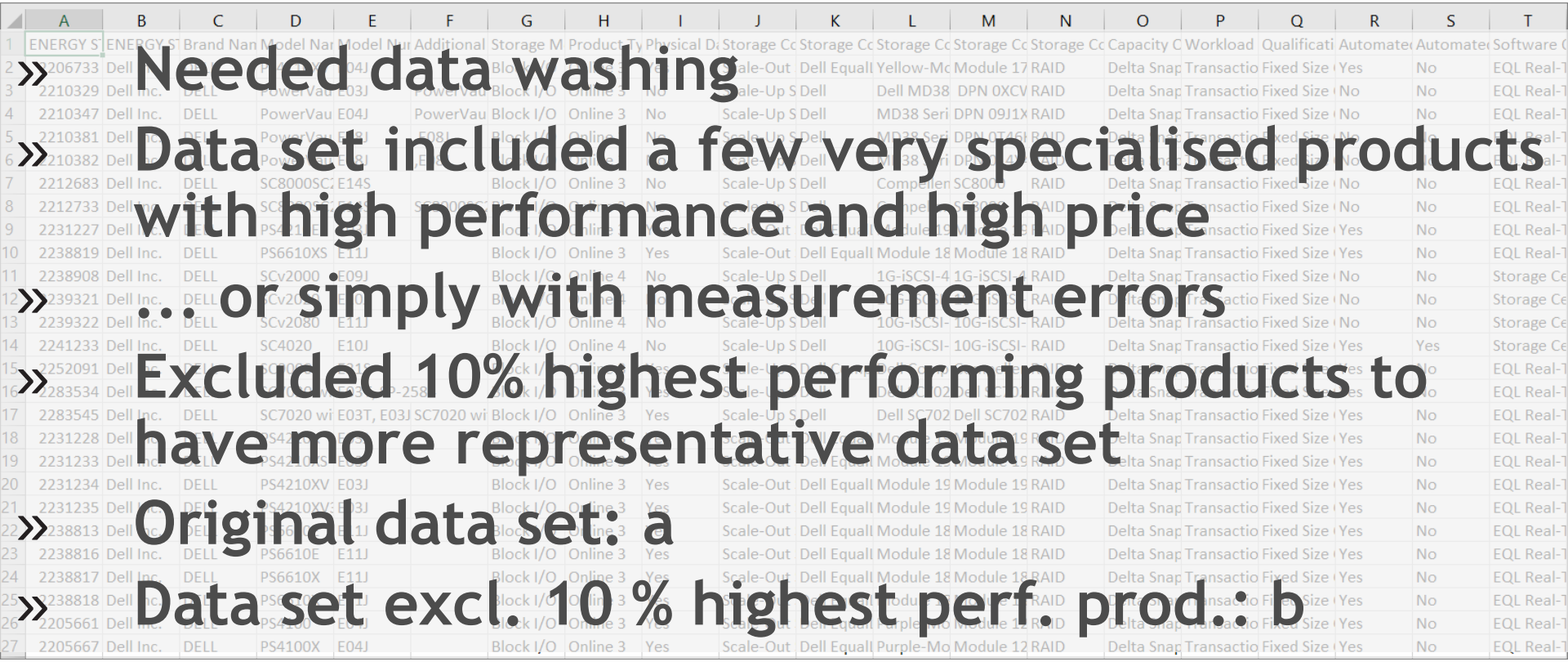
PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

ENERGY STAR Data



- Needed data washing
- Data set included a few very specialised products with high performance and high price
- … or simply with measurement errors
- Excluded 10% highest performing products to have more representative data set
- Original data set: a
- Data set excl. 10 % highest perf. prod.: b

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 8 Determination of environmental impact budgets

Included:

1. Energy performance of the product
2. Energy efficiency feature - COMs
3. Energy efficiency feature - Minimum operating condition
4. Energy efficiency feature - Good Commissioning Guidance

Not included:

» Power supply efficiency (proposed Lot 9)
» Power modelling presale tool available (typical)
» Energy efficiency feature - Adaptive active cooling (standard)
» Material efficiency (proposed Lot 9)

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 8 Determination of environmental impact budgets
Step 9 Normalisation and awarding of points

1. For each application (transactional, streaming, capacity)
2. Results of each workload test are weighted to total performance
3. Adjusted for EE features (COMs, oper. cond., commissioning)
4. Inverted figures to correspond to index
5. Normalisation (reference: EEI = 100 %)
6. Points (EEI = 100% > 0 points)
7. All above for excl. 10 % highest performing products (assumed to be cost-ineffective)

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 8 Determination of environmental impact budgets - Energy performance

- Reference case (average energy performance)
- Ecodesign option 1 – optimised for hot band performance (transactional applications)
- Ecodesign option 2 – optimised for sequential read performance (streaming applications)
- Ecodesign option 3 – optimised for sequential write performance (streaming applications)
- Ecodesign option 4 – optimised for ready idle performance (all applications)
- Ecodesign option 5 (BAT) – highest overall performance

- Calculation of total performance (our weightings)
  1. Transactional
  2. Streaming
  3. Capacity

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Workload test

- Transactional applications:
  - Hot band workload test IOPS/W
  - Ready idle capacity GB/W
- Streaming applications
  - Sequential read workload test MiBPS/W
  - Sequential write workload test MiBPS/W
  - Ready idle capacity GB/W
- Capacity applications
  - Ready idle capacity GB/W

IOPS = input output operations per second
MiBPS = 1,048,576 bytes per second

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Workload test weighting

	Hot band workload test IOPS/W	Seq read workload test MiBPS/W	Seq write workload test MiBPS/W	Ready Idle workload test GB/W
Transactional applications	37.5%	0%	0%	62.5%
Streaming applications	0%	22%	11%	67%
Capacity applications	0%	0%	0%	100%

IOPS = input output operations per second
MiBPS = 1,048,576 bytes per second

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Calculation of energy budget

Transactional Applications

	Hot band workload test (IOPS/W)	Seq read workload test (MiBPS/W)	Seq write work-load test (MiBPS/W)	Readly idle capaci-ty workload test (GB/W)	Total performance
Reference case	6.6			97.1	63.2
Ecodesign option 1a (BAT Hot band workload test)	157.0			94.5	117.9
Ecodesign option 2a (BAT Seq read workload test)					n/a
Ecodesign option 3a (BAT Seq write workload test)					n/a
Ecodesign option 4a (BAT Ready idle workload test)	8.4			588.1	370.7
Ecodesign option 5a (BAT Total Perfor-mance Score)	8.4			588.1	370.7

Reference: 6.6 IOPS/W (hotband) + 97.1 GB/W (ready idle)
>> 37.5% x 6.6 + 62.5% x 97.1 = 63.2

Hot band workload test: 1 IOPS/W corresponds to 1 point
Ready idle capacity workload test: 1 GB/W corresponds to 1 point

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 8 Determination of environmental impact budgets - Energy efficiency feature - COMs

- COMs: Deduplication, thin provisioning, delta snapshots, compression (all assumed applied)
- Increase capacity for same raw capacity = same power consumption > improves ready idle performance

- Improvement of eco-design options 1-5 (estimated):
  1. Transactional: 40% (like cap., but also I/O)
  2. Streaming : 17% (often incompr. data)
  3. Capacity: 45% (largest optimisation, cap. only output factor)

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Energy budget with COMs

Transactional Applications

	Hot band workload test (IOPS/W)	Seq read workload test (MiBPS/W)	Seq write work-load test (MiBPS/W)	Readly idle capaci-ty workload test (GB/W)	Total performance
Reference case	6.6			97.1	63.2
Ecodesign option 1a (BAT Hot band workload test)	157.0			94.5	117.9
Ecodesign option 2a (BAT Seq read workload test)					n/a
Ecodesign option 3a (BAT Seq write workload test)					n/a
Ecodesign option 4a (BAT Ready Idle workload test)	8.4			588.1	370.7
Ecodesign option 5a (BAT Total Perfor-mance Score)	8.4			588.1	370.7
Ecodesign option 6a (case 5a including COMS)	8.4			823.3	517.7

PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Energy budget with COMs - Inverted

Transactional Applications

	Total performance	Inverted total performance
Reference case	63.2	0.01583
Ecodesign option 1a (BAT Hot band workload test)	117.9	0.00848
Ecodesign option 2a (BAT Seq read workload test)	n/a	n/a
Ecodesign option 3a (BAT Seq write workload test)	n/a	n/a
Ecodesign option 4a (BAT Ready Idle workload test)	370.7	0.00270
Ecodesign option 5a (BAT Total Performance Score)	370.7	0.00270
Ecodesign option 6a (case 5a including COMS)	517.7	0.00193

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 8 Determination of environmental impact budgets - Energy efficiency feature - Minimum operating condition

- Technical improvement of data storage
- Wider range of temperature and humidity
- > More free cooling – less mechanical cooling
- Average reduction 4 %

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Energy budget incl. power and cooling

Transactional Applications (excl. top 10%)			
	Product perfor-mance	**Power and cooling performance**	**Combined total (sum of the values of prod perf + pow. and cool perf)**
Reference case	0.01583	0.01055	0.02639
Ecodesign option 1b (BAT Hot band workload test)	0.02306	0.01537	0.03843
Ecodesign option 2b (BAT Seq read workload test)	n/a	n/a	n/a
Ecodesign option 3b (BAT Seq write workload test)	n/a	n/a	n/a
Ecodesign option 4b (BAT Ready Idle workload test)	0.00949	0.00633	0.01581
Ecodesign option 5b (BAT Total Performance Score)	0.00994	0.00663	0.01657
Ecodesign option 6b (case 5b including COMS)	0.00725	0.00483	0.01208
Ecodesign option 7b (case 6b but with higher Minimum Operating Condition)	0.00725	0.00464	0.01189

PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Step 8 Determination of environmental impact budgets - Energy efficiency feature - Good Commissioning Guidance

» **Estimated 3 % improvement**

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Energy budget incl. good commissioning guidance

Transactional Applications (excl. top 10%)	
	Energy
Reference case	0.02639
Ecodesign option 1b (BAT Hot band workload test)	0.03843
Ecodesign option 2b (BAT Seq read workload test)	n/a
Ecodesign option 3b (BAT Seq write workload test)	n/a
Ecodesign option 4b (BAT Ready Idle workload test)	0.01581
Ecodesign option 5b (BAT Total Performance Score)	0.01657
Ecodesign option 6b (case 5b including COMS)	0.01208
Ecodesign option 7b (case 6b but with higher Minimum Operating Condition)	0.01189
Ecodesign option 8b (case 7b but with good commissioning guidance)	0.01153

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Normalisation and points - Results

Transactional Applications (excl. top 10%)		
	EEI	**Points**
Reference case	100%	0
Ecodesign option 1b (BAT Hot band workload test)	146%	-45.7
Ecodesign option 2b (BAT Seq read workload test)	n/a	n/a
Ecodesign option 3b (BAT Seq write workload test)	n/a	n/a
Ecodesign option 4b (BAT Ready Idle workload test)	60%	40.1
Ecodesign option 5b (BAT Total Performance Score)	63%	37.2
Ecodesign option 6b (case 5b including COMS)	46%	54.2
Ecodesign option 8b (case 6b but with higher Minimum Operating Condition)	45%	55.0
Ecodesign option 10b (case 8b but with good commissioning guidance)	44%	56.3

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Normalisation and points - Results

Streaming Applications (excl. top 10%)		
	EEI	**Points**
Reference case	100%	0
Ecodesign option 1b (BAT Hot band workload test)	n/a	n/a
Ecodesign option 2b (BAT Seq read workload test)	175%	-75.2
Ecodesign option 3b (BAT Seq write workload test)	175%	-75.2
Ecodesign option 4b (BAT Ready Idle workload test)	26%	74.1
Ecodesign option 5b (BAT Total Performance Score)	51%	48.7
Ecodesign option 6b (case 5b including COMS)	44%	56.0
Ecodesign option 8b (case 6b but with higher Minimum Operating Condition)	43%	56.7
Ecodesign option 10b (case 8b but with good commissioning guidance)	42%	58.0

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PROPOSAL FOR AN ECO-DESIGN POINTS SYSTEM

Normalisation and points - Results

Capacity Applications (excl. top 10%)		
	EEI	**Points**
Reference case	100%	0
Ecodesign option 1b (BAT Hot band workload test)	n/a	n/a
Ecodesign option 2b (BAT Seq read workload test)	n/a	n/a
Ecodesign option 3b (BAT Seq write workload test)	n/a	n/a
Ecodesign option 4b (BAT Ready Idle workload test)	52%	47.9
Ecodesign option 5b (BAT Total Performance Score)	52%	47.9
Ecodesign option 6b (case 5b including COMS)	36%	64.1
Ecodesign option 8b (case 6b but with higher Minimum Operating Condition)	35%	64.7
Ecodesign option 10b (case 8b but with good commissioning guidance)	34%	65.7

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CALCULATION GUIDE

1. **Product performance**
    1. SNIA Emerald / ENERGY STAR test results
    2. COMs: Adjust Ready Idle test
    3. Calculate weighted arithmetic mean
       = Prod. perf. for transactional, streaming, capacity
2. **Product energy budget**
    1. Inverse of the product performance = 1/prod. perf.
3. **Total energy budget including power and cooling**
    1. PUE x energy budget
       PUE = 5/3 for ASHRAE 1 or 2
       PUE = 5/3 x 0.96 for ASHRAE 3 or 4
4. **Guidance total energy budget**
    1. Yes: Total energy = Step 3 total energy x 0.97
5. **EEI and points**
    1. EEI = Total energy / reference case total energy
    2. Points = 1- EEI

MARKET SURVEILLANCE

3 levels:

- Technical Documentation
- Calculate based on SNIA / ES data
- Test the products
  - SNIA recognised tester program

- Good Commissioning Guidance: Subjective judgement

- Market Surveillance is possible

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CONCLUSION

- Think it is possible to develop it into a real points system
- More test data for varied selection of data storage
  - using existing test methodology
- Look more into the weightings
  - with industry input and expert judgements

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