

# **DATA IMPACT ON THE ENVIRONMENT**

ERIK RIEDEL, PHD  
CHIEF ENGINEERING OFFICER  
FLAX COMPUTING

MAY 2023

revision 7



# Reduce carbon footprint

focus on efficiency & results  
via carbon / performance

scope 1 & 2 operational carbon;  
scope 3 embodied carbon

# Reduce cost footprint

focus on efficiency & results  
via cost / performance

capex, opex, people-ex

A glass jar is tipped over on a light-colored, textured surface, spilling dark, chunky granules. The granules are piled up near the jar's opening and scattered across the surface. The word "THANKS" is overlaid in the center of the image in a bold, black, sans-serif font.

**THANKS**

# Understanding Customer Dissatisfaction With Underutilized Distributed File Servers

*Towards an Architecture for Network-Attached Storage*

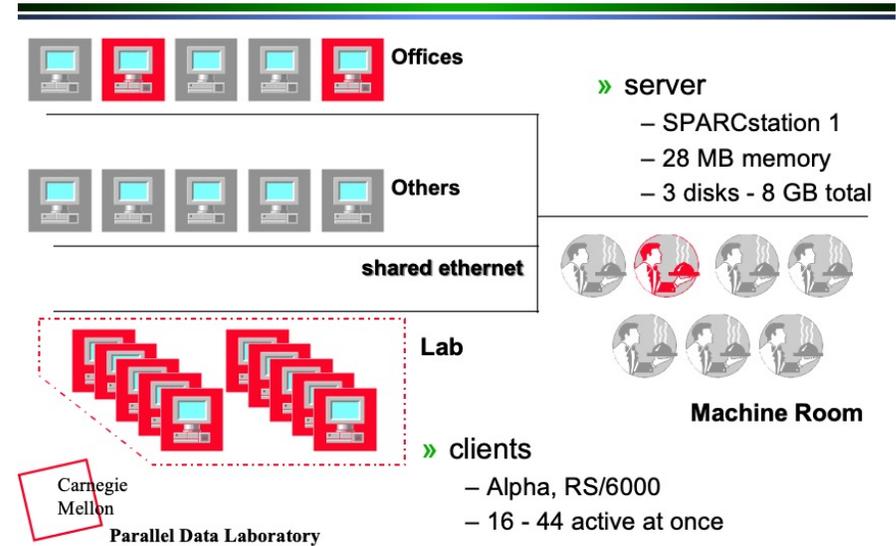
**Erik Riedel**

Carnegie Mellon University  
<http://www.cs.cmu.edu/~riedel>



ERIK RIEDEL AND GARTH GIBSON, "UNDERSTANDING CUSTOMER DISSATISFACTION WITH UNDERUTILIZED DISTRIBUTED FILE SERVERS" 5TH NASA GODDARD SPACE FLIGHT CENTER CONFERENCE ON MASS STORAGE SYSTEMS AND TECHNOLOGIES. COLLEGE PARK, MD. SEPTEMBER 1996.

## Environment



## Customer Dissatisfaction

- Are user complaints justified?
  - » Yes. Order of magnitude difference in response times





# SCALING STORAGE

# Proposal for a Common Parallel File System Programming Interface 1.0

Peter Corbett<sup>1</sup>, Jean-Pierre Prost<sup>1</sup>, Chris Demetriou,  
Garth Gibson, Erik Riedel, Jim Zelenka, Yuqun Chen<sup>2</sup>,  
Ed Felten<sup>2</sup>, Kai Li<sup>2</sup>, John Hartman<sup>3</sup>, Larry Peterson<sup>3</sup>,  
Brian Bershad<sup>4</sup>, Alec Wolman<sup>4</sup>, Ruth Aydt<sup>5</sup>

October 1996  
CMU-CS-96-193

School of Computer Science  
Carnegie Mellon University  
Pittsburgh, PA 15213-3891

Also appears as Tech. Report CACR-130, Scalable I/O Initiative, Caltech  
Center for Advanced Computing Research, Pasadena, CA, November 1996.

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University of Illinois at Urbana-Champaign  
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PETER CORBETT, JEAN-PIERRE PROST, CHRIS DEMETRIOU,  
GARTH GIBSON, ERIK RIEDEL, JIM ZELENKA, YUQUN CHEN,  
ED FELTEN, KAI LI, JOHN HARTMAN, LARRY PETERSON,  
BRIAN BERSHAD, ALEC WOLMAN, RUTH AYDT, **“PROPOSAL  
FOR A COMMON PARALLEL FILE SYSTEM  
PROGRAMMING INTERFACE”** *TECHNICAL REPORT CMU-CS-  
96-193. PRESENTED AT THE INTERNATIONAL CONFERENCE ON  
HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS  
(SUPERCOMPUTING '96). PITTSBURGH, PA. NOVEMBER 1996.*

GARTH GIBSON, DAVID NAGLE, KHALIL AMIRI, JEFF BUTLER, FAY CHANG, HOWARD GOBIOFF, CHARLES HARDIN, ERIK RIEDEL, DAVID ROCHBERG, JIM ZELENKA, “A COST-EFFECTIVE, HIGH-BANDWIDTH STORAGE ARCHITECTURE” CONFERENCE ON ARCHITECTURAL SUPPORT FOR PROGRAMMING LANGUAGES AND OPERATING SYSTEMS (ASPLOS VIII). SAN JOSE, CA. OCTOBER 1998.

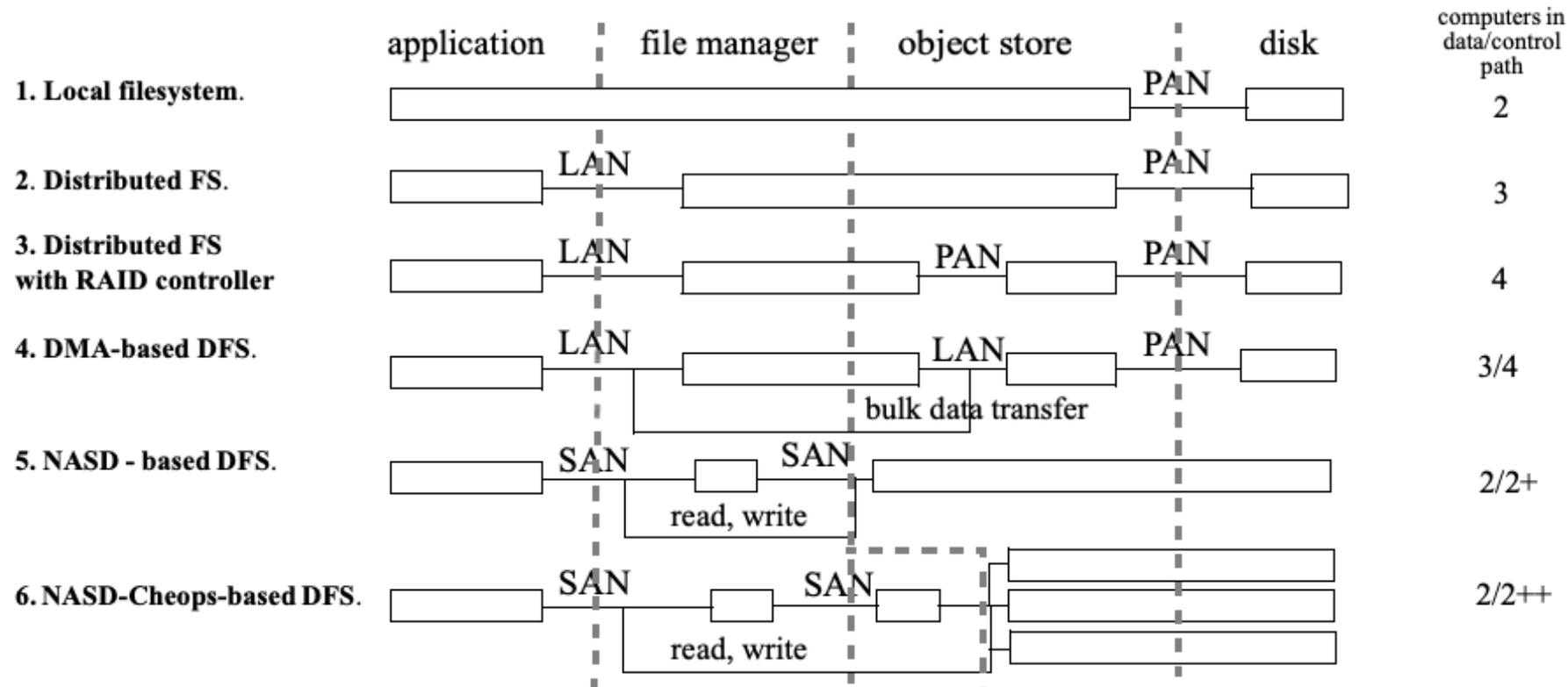


Figure 2: Evolution of storage architectures for untrusted networks and clients. Boxes are computers, horizontal lines are communication paths and vertical lines are internal and external interfaces. *LAN* is a local area network such as Ethernet or FDDI. *PAN* is a peripheral area network such as SCSI, Fibrechannel or IBM’s ESCON. *SAN* is an emerging system area network such as ServerNet, Myrinet or perhaps Fibrechannel or Ethernet that is common across clients, servers and devices. On the far right, a *disk* is capable of functions such as seek, read, write, readahead, and simple caching. The *object store* binds blocks into variable-length objects and manages the layout of these objects in the storage space offered by the device(s). The *file manager* provides naming, directory hierarchies, consistency, access control, and concurrency control. In NASD, storage management is done by recursion on the object interface on the SAN.

ERIK RIEDEL, GARTH GIBSON, CHRISTOS FALOUTSOS, “ACTIVE STORAGE FOR LARGE-SCALE DATA MINING AND MULTIMEDIA” 24TH INTERNATIONAL CONFERENCE ON VERY LARGE DATABASES (VLDB '98). NEW YORK, NY. AUGUST 1998.



# Active Storage For Large-Scale Data Mining and Multimedia

**Erik Riedel**

**Garth Gibson, Christos Faloutsos**

Parallel Data Laboratory,  
Center for Automated Learning and Discovery  
Carnegie Mellon University  
*[www.pdl.cs.cmu.edu/Active](http://www.pdl.cs.cmu.edu/Active)*



Parallel Data Laboratory  
Center for Automated Learning and Discovery

<http://www.pdl.cs.cmu.edu/Active>

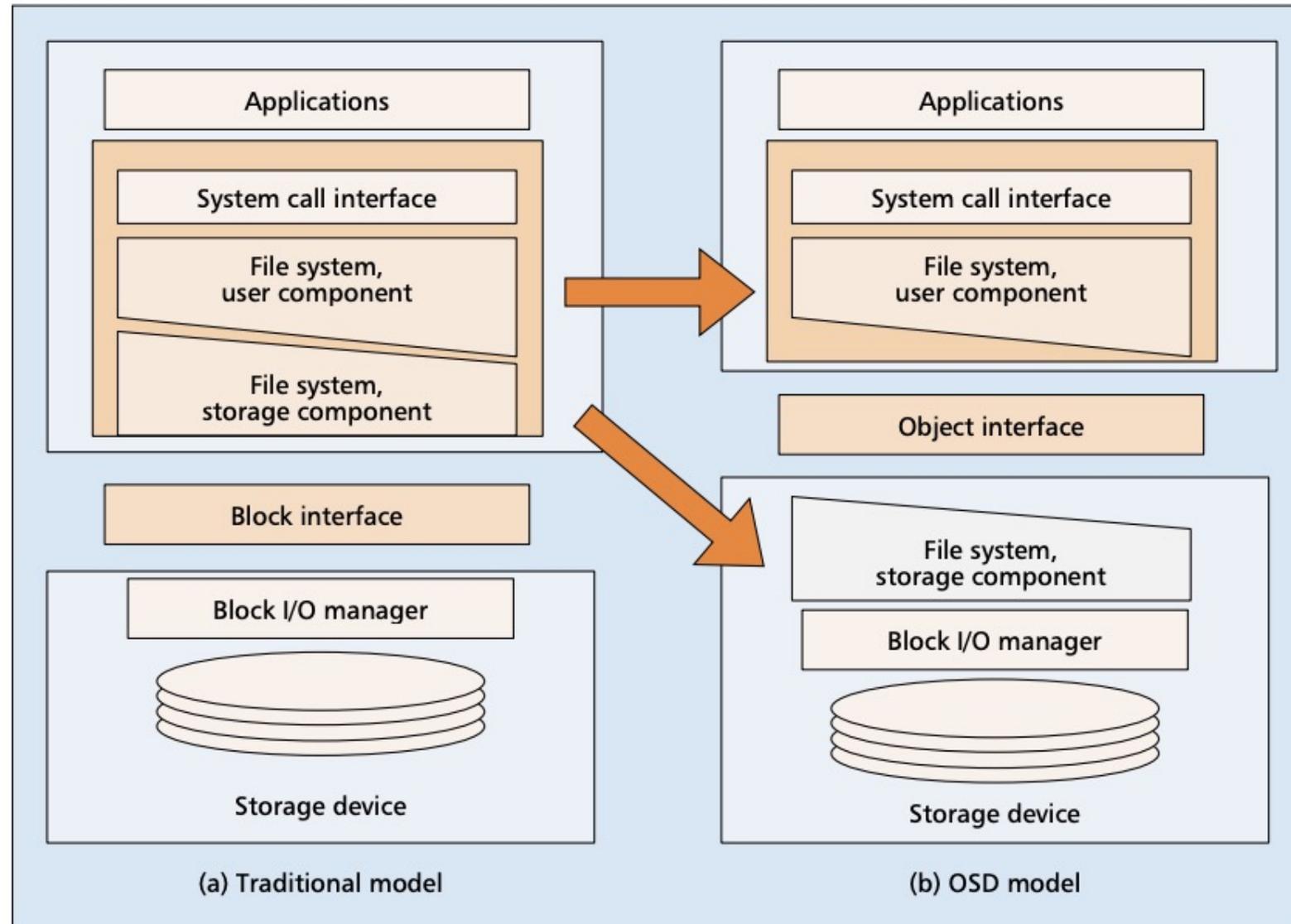
Active Disks  
for Data Mining



A glass jar is tipped over on a light-colored, textured surface, spilling a large quantity of small, dark, irregularly shaped objects. The objects are scattered across the surface, with a dense pile near the jar's opening and several smaller clusters and individual pieces further away. The scene is captured in a high-angle, slightly blurred perspective, emphasizing the texture of the surface and the chaotic arrangement of the spilled objects.

# OBJECTS

Unlike block I/O, creating objects on a storage device is accomplished through a rich interface similar to a file system. And, because objects can grow and shrink dynamically, the storage device is responsible for all internal space management of the object.



■ **Figure 3.** Offloading of storage management from the file system.

# OSD Commands

OSD-1 r10, as ratified

- Basic Protocol
  - READ } **very basic**
  - WRITE }
  - CREATE } **space mgmt**
  - REMOVE }
  - GET ATTR } **attributes**
    - timestamps
    - vendor-specific
  - SET ATTR }
- Specialized
  - FORMAT OSD
    - opaque
    - shared
  - APPEND – write w/o offset
  - CREATE & WRITE – save msg
  - FLUSH – force to media
  - FLUSH OSD – device-wide
  - LIST – recovery of objects
- Security
  - Authorization – each request
  - Integrity – for args & data
  - SET KEY } **shared**
  - SET MASTER KEY } **secrets**
- Groups
  - CREATE COLLECTION
  - REMOVE COLLECTION
  - LIST COLLECTION
  - FLUSH COLLECTION
- Management
  - CREATE PARTITION
  - REMOVE PARTITION
  - FLUSH PARTITION
  - PERFORM SCSI COMMAND
  - PERFORM TASK MGMT

## Object-Based Storage Devices Commands (OSD)

### [Object-Based Storage Device Commands \(OSD\)](#)

{Date: 2004/07/30, Rev: 10, Status: Published, BSR Number: INCITS 400}

PDF File: [osd-r10.pdf](#) (1296556 bytes)

The Object-Based Storage Device Commands (OSD) defines a command set that stores data objects instead of blocks of data. The purpose of this abstraction is to assign to the storage device more responsibility for managing the location of the data.

*The above document is a final T10 committee working draft. **Only T10 members are permitted to access this document.** Other people may [purchase](#) the approved standard, ANSI INCITS 400-2004.*



US009002795B2

(12) **United States Patent**  
**Messinger et al.**

(10) **Patent No.:** **US 9,002,795 B2**  
(45) **Date of Patent:** **Apr. 7, 2015**

- (54) **OBJECT-BASED DATA STORAGE DEVICE** 6,745,285 B2 6/2004 Howard et al. .... 711/114
- 6,823,398 B1 11/2004 Lee et al. .... 710/5
- (75) **Inventors:** **Daniel Edward Messinger**, Waconia, MN (US); **Wilson M. Fish**, Yukon, OK (US); **Sami Iren**, Pittsburgh, PA (US); **Erik Riedel**, Pittsburgh, PA (US) 6,826,613 B1 11/2004 Wang et al. .... 79/227
- 6,850,969 B2 2/2005 Ladan-Mozes et al. .... 709/213
- 7,096,336 B2 8/2006 Furuhashi et al.
- 7,124,272 B1 \* 10/2006 Kennedy et al. .... 711/173
- 7,194,594 B2 3/2007 Asami et al.
- 2001/0018727 A1 \* 8/2001 Ando et al. .... 711/112
- 2002/0078066 A1 6/2002 Robinson et al. .... 707/104.1
- 2002/0095546 A1 \* 7/2002 Dimitri et al. .... 711/112
- 2002/0159362 A1 \* 10/2002 Yoshimoto et al. .... 369/53.21
- 2003/0088591 A1 5/2003 Fish .... 707/204
- (\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1194 days.

(Continued)

FOREIGN PATENT DOCUMENTS

- (21) Appl. No.: **11/339,991**
- (22) Filed: **Jan. 26, 2006**

- JP 2003153185 A 5/2003
- JP 2004086512 A 3/2004

(Continued)

OTHER PUBLICATIONS

Michael Borgwardt, Haruo Yokota, Treatment of Arbitrary-Size Data in Autonomous Disks, Information Processing Society of Japan, vol. 2001, No. 70, pp. 127-134.\*

(Continued)

*Primary Examiner* — Jason Liao  
(74) *Attorney, Agent, or Firm* — Westman, Champlin & Koehler, P.A.

(57) **ABSTRACT**

A data storage device includes storage media with multiple media zone attributes of storage performance. The storage device includes a data channel that is connectable to a host system that has a requested storage attribute attached to the object. The storage device comprises an object-based storage interface that couples between the data channel and the storage media. The object-based storage interface schedules the object for storage in a selected zone of the multiple media zones based on the attributes and requested attributes.

8 Claims, 5 Drawing Sheets



US007826161B2

(12) **United States Patent**  
**Riedel**

(10) **Patent No.:** **US 7,826,161 B2**  
(45) **Date of Patent:** **Nov. 2, 2010**

- (54) **OBJECT BASED STORAGE DEVICE WITH STORAGE MEDIUM HAVING VARYING MEDIA CHARACTERISTICS** 6,065,0 6,195,2 6,298,4 6,321,3 6,571,3 6,611,3 6,631,4 6,765,7 6,839,8 2002/00392 2002/01721 2003/00885 2003/01878 2003/01878 2003/01878 2005/00783 2006/01039
- (75) **Inventor:** **Erik Riedel**, Pittsburgh, PA (US)
- (73) **Assignee:** **Seagate Technology LLC**, Scotts Valley, CA (US)
- (\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 371 days.
- (21) Appl. No.: **11/480,049**
- (22) Filed: **Jun. 30, 2006**
- (65) **Prior Publication Data**  
US 2008/0002272 A1 Jan. 3, 2008
- (51) **Int. Cl.** *G1B 5/09* (2006.01)
- (52) **U.S. CL.** ..... **360/55, 360/48**
- (58) **Field of Classification Search** ..... None  
See application file for complete search history.
- (56) **References Cited**  
M. Messier e Maguire, Jr. \* cited by c Primary Ex (74) *Attora Benjamin T Raspani, LI*

(12) **United States Patent**  
**Iren et al.**

(10) **Patent No.:** **US 7,958,331 B2**  
(45) **Date of Patent:** **Jun. 7, 2011**

- (54) **STORAGE DEVICE WITH OPPORTUNISTIC ADDRESS SPACE** 5,802,599 A 9/1998 Cabrera et al. .... 711/170
- 6,449,689 B1 \* 9/2002 Corcoran et al. .... 711/113
- 6,954,876 B2 10/2005 Ogawa et al. .... 714/8
- 6,981,119 B4 12/2005 Lepik et al. .... 711/170
- 2002/0191692 A1 12/2002 Fallon et al. .... 375/240
- 2005/0086567 A1 \* 4/2005 Cronch ..... 714/746
- 2005/0257023 A1 \* 11/2005 Peng ..... 711/209
- 2006/0005069 A1 1/2006 Gaertner ..... 714/5
- 2006/0010151 A1 \* 1/2006 Star Sung ..... 707/102
- 2007/0174582 A1 \* 7/2007 Feldman ..... 711/202
- (75) **Inventors:** **Sami Iren**, Pittsburgh, PA (US); **Erik Riedel**, Pittsburgh, PA (US)
- (73) **Assignee:** **Seagate Technology LLC**, Scotts Valley, CA (US)
- (\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 983 days.
- (21) Appl. No.: **11/638,614**
- (22) Filed: **Dec. 13, 2006**
- (65) **Prior Publication Data**  
US 2008/0148004 A1 Jun. 19, 2008



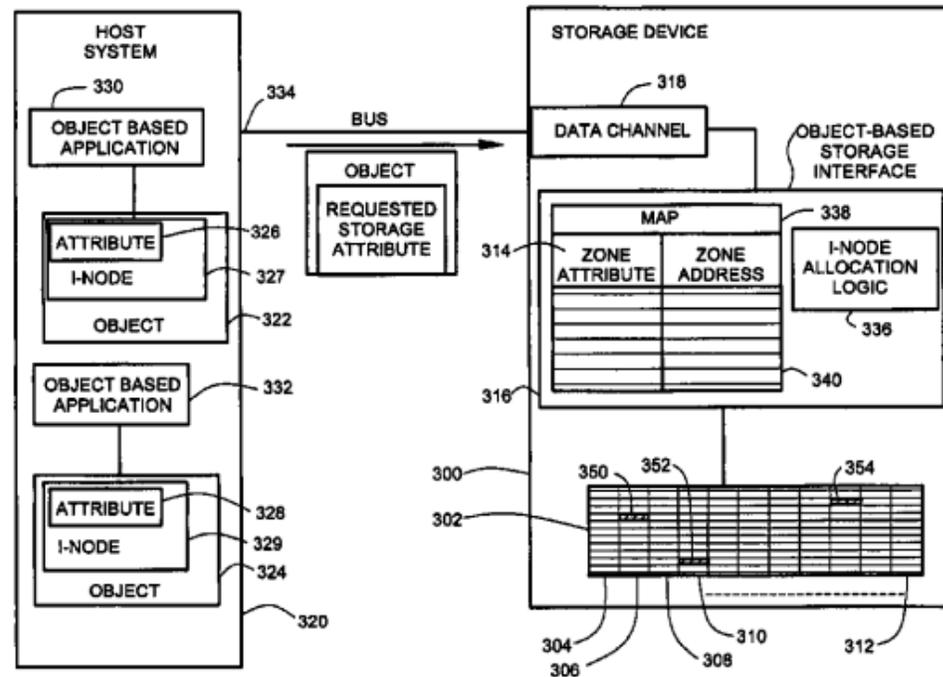
US007958331B2

OTHER PUBLICATIONS

Hai Huang, Wanda Hung and Kang G. Shin, "FS2: Dynamic Data Replication in Free Disk Space for Improving Disk Performance and Energy Consumption," 2005, 14 pages.

\* cited by examiner

*Primary Examiner* — Hashem Farrokh  
(74) *Attorney, Agent, or Firm* — Alan G. Rego; Westman, Champlin & Kelly, P.A.



## *A variety of Object-based Storage Devices being built today*



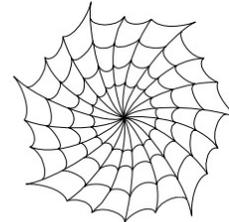
- Disk array/server subsystem
- E.g. LLNL units with Lustre
- “Smart” disk for objects
- E.g. Panasas storage blade
- Highly integrated, single disk
- E.g. prototype Seagate OSD

### ➤ **File/ Security Manager**



- Orchestrates system activity
- Balances objects across OSDs
- Called clustered MDS in Lustre
- Called Mgmt Blade by Panasas
- Called ST server cluster by IBM

### ➤ **Scalable Network**



- Connectivity among clients, managers, and devices
- Shelf-based GigE (Panasas)
- Specialized cluster-wide high-performance network (Lustre)
- Storage network (IBM)

A glass jar is tipped over, spilling dark, irregularly shaped particles onto a light-colored surface. The particles are scattered in a fan shape from the opening of the jar. The word "CLOUDS" is overlaid in the center of the image in a bold, black, sans-serif font.

**CLOUDS**

ERIK RIEDEL “EFFICIENT & CONVENIENT - HOW TO BUILD BIG STORAGE AS A CLOUD”, *MSST CONFERENCE* PACIFIC GROVE, CA. APRIL 2012.

## Efficient & Convenient

How To Build Big Storage  
As A Cloud

Erik Riedel, PhD  
Technology & Architecture  
Cloud Infrastructure Group  
EMC



Cloud is not about technology change, it's about organizational change

(not new to HPC users)

# The Big Disconnect

How can it be  
I am so **powerful** as a consumer  
And so **LAME** as an employee!!??

How disruptive do you think Consumer IT  
will be to Enterprise IT?



# SCALABLE STORAGE CLOUDS



$\$/\text{TB}$

- high capacity drives  
(as many as possible)
- x86 servers/controllers  
(as few as possible)
- SAS backplanes/cables  
(not too many, not too few)

$\$/\text{TB}/\text{month}$



8.6 drives/U

## SGI® CloudRack™ C2



12 drives/U

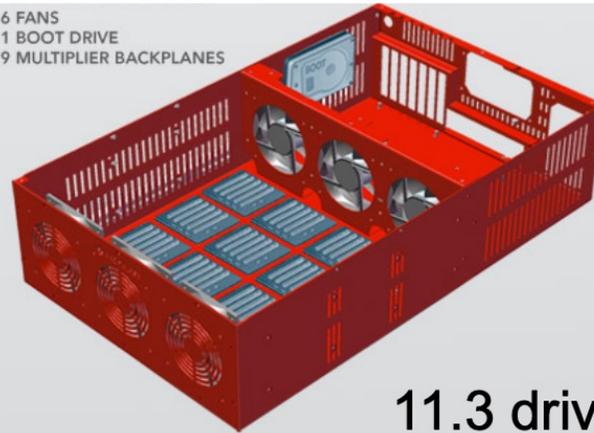
## Dell

6 drives/U



## Backblaze

- 6 FANS
- 1 BOOT DRIVE
- 9 MULTIPLIER BACKPLANES



11.3 drives/U

## Supermicro

11.3 drives/U



- high capacity drives (as many as possible)
- x86 servers/controllers (as few as possible)
- SAS backplanes/cables (not too many, not too few)

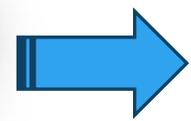
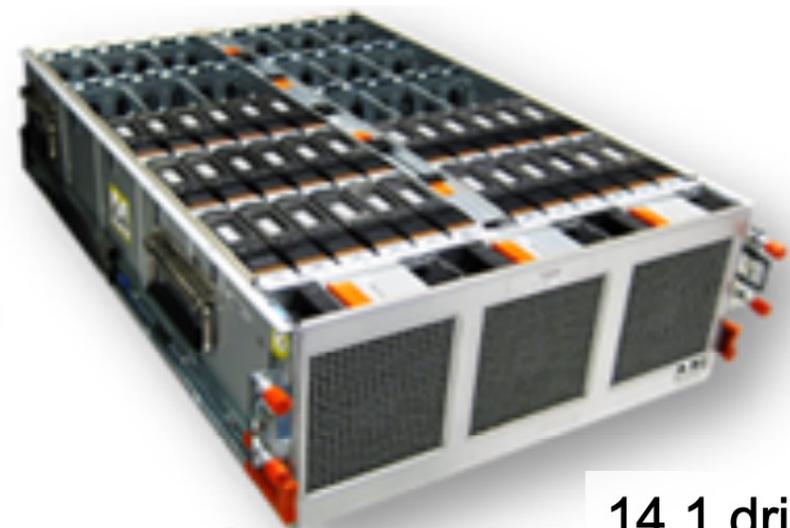
ATMOS (2008)

>1,000 CUSTOMERS  
>1 EXABYTE DEPLOYED

ECS (2013)

>>1,200 CUSTOMERS  
>1 EXABYTE DEPLOYED

OVER \$2B LIFETIME  
CUSTOMER REVENUE



14.1 drives/U

22.7 drives/U

816x drives  
4x servers  
2x switches  
18x cables

# The Google File System

Sanjay Ghemawat, Howard Gobioff, and Shun-Tak Leung

Google\*

SOSP 2003

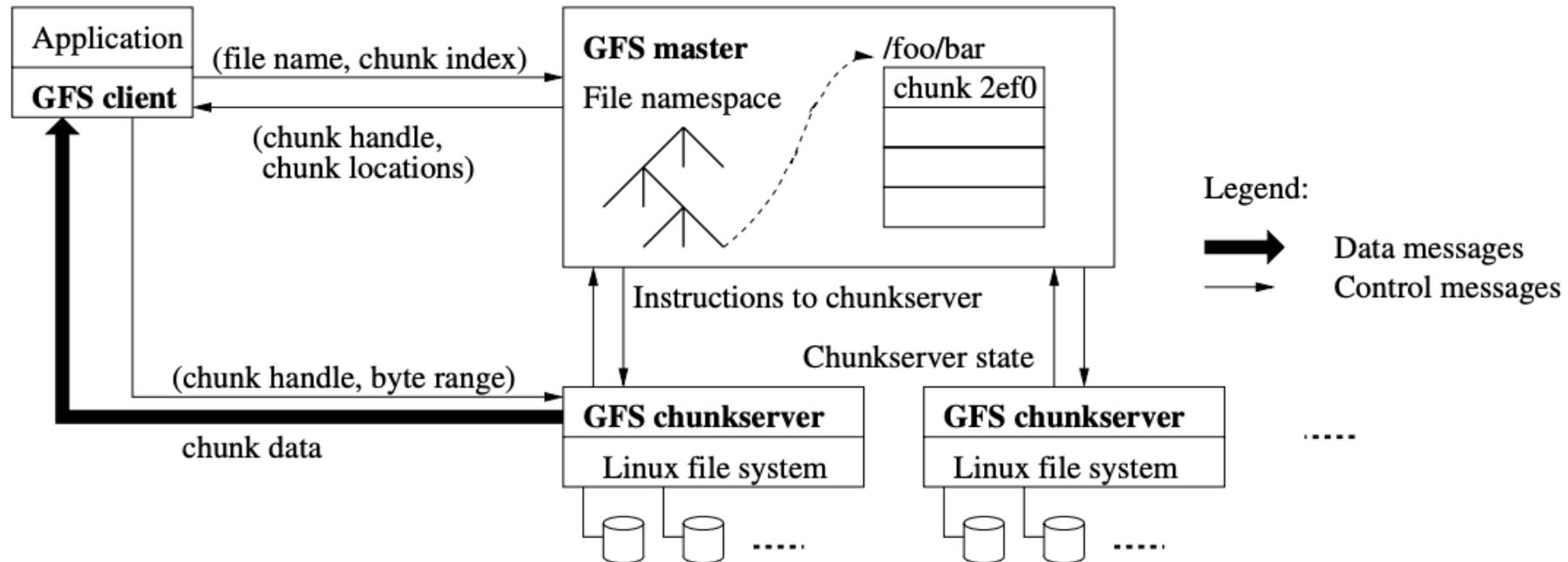
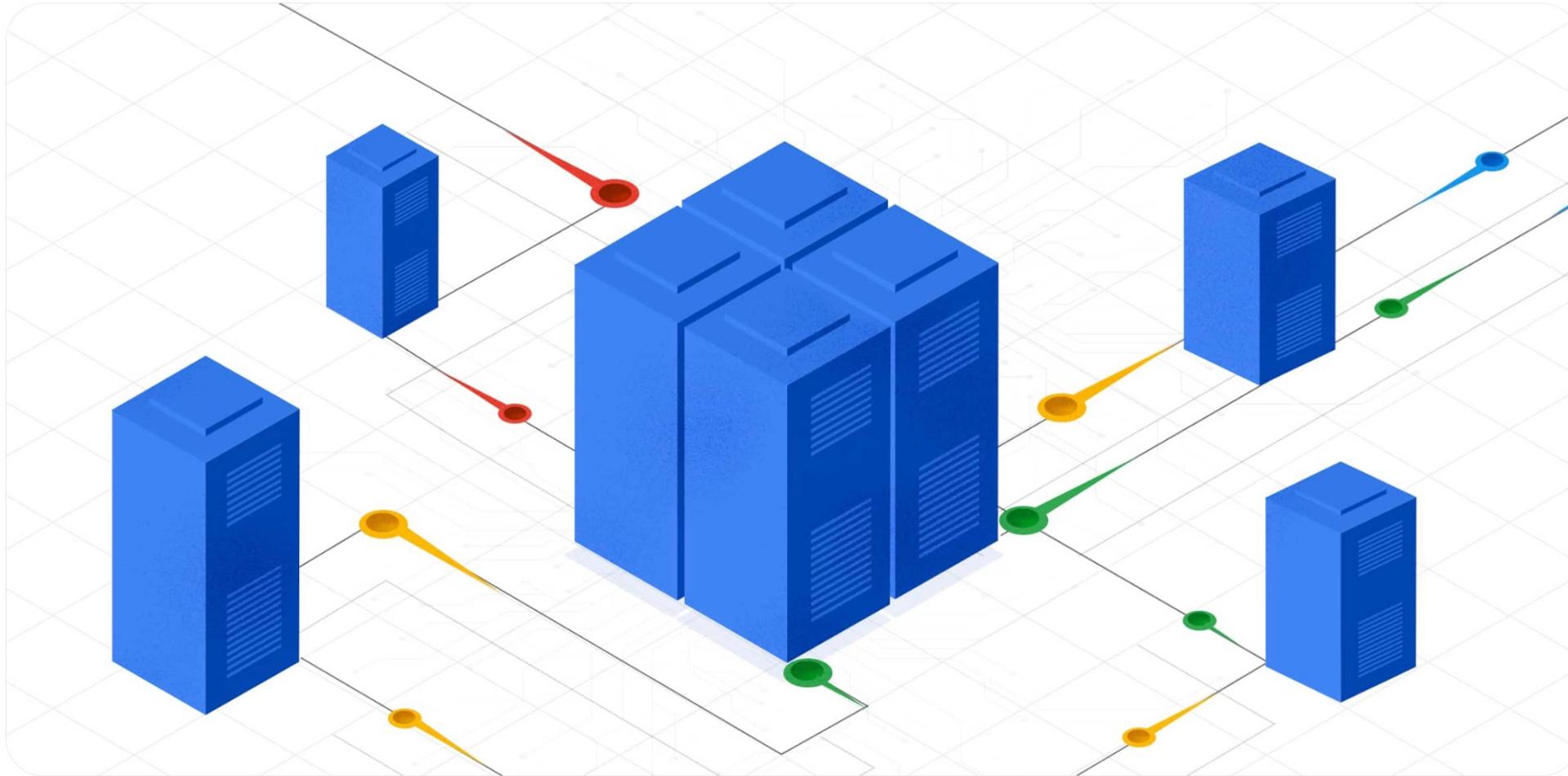


Figure 1: GFS Architecture

# Colossus under the hood: a peek into Google's scalable storage system

April 19, 2021



**Dean Hildebrand**

Technical Director, Office of the CTO, Google Cloud

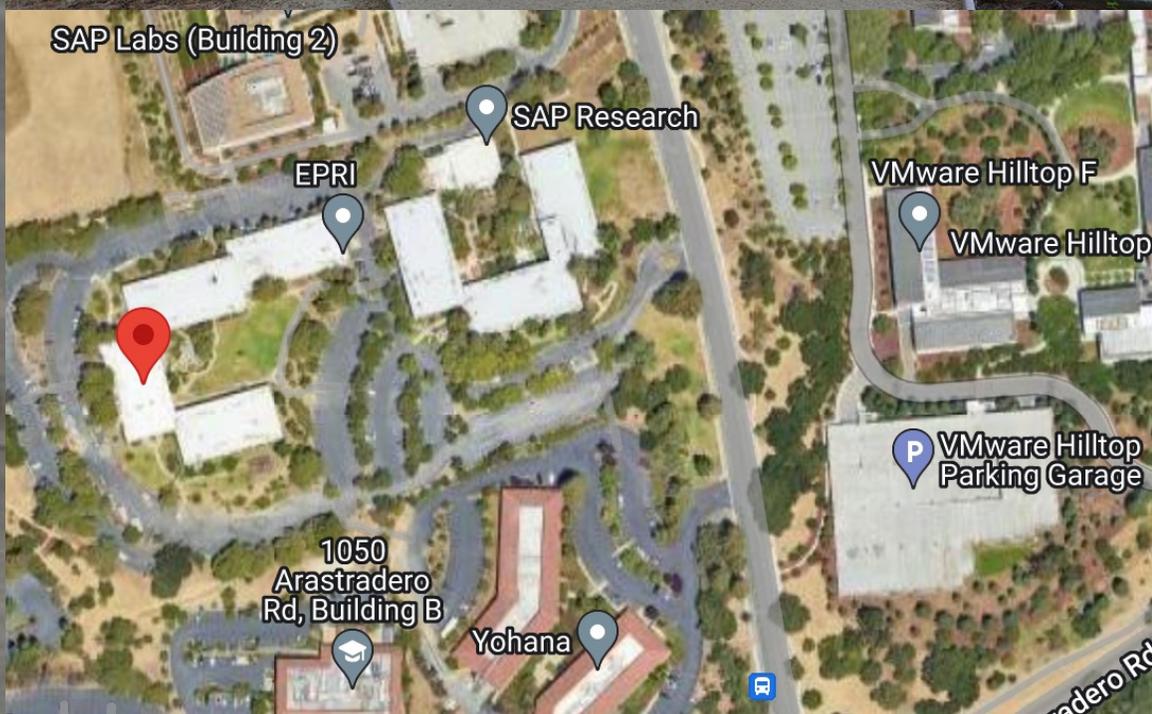
**Denis Serenyi**

Tech Lead, Google Cloud Storage

A glass jar is tipped over on a light-colored, textured surface, spilling dark, irregular carbon granules. The granules are piled up in a mound on the left and scattered across the surface. The word "CARBON" is written in bold, black, uppercase letters in the center of the image.

# CARBON





- ❑ Current state of affairs and industry trends
- ❑ Power measurement
  - ❑ storage subsystems
  - ❑ idle and active modes
  - ❑ power supply loading / efficiencies
  - ❑ power measurement & monitoring equipment
- ❑ Green metrics and taxonomy
  - ❑ measuring green-ness
  - ❑ storage product categories
- ❑ ENERGY STAR™ for Data Center Storage
  - ❑ update and overview
- ❑ SNIA green storage efforts
  - ❑ unplugged fests, green standards, workshops, alliances



natural resources



carbon



demand



footprint

growth



# TECHNOLOGY ADVANCES

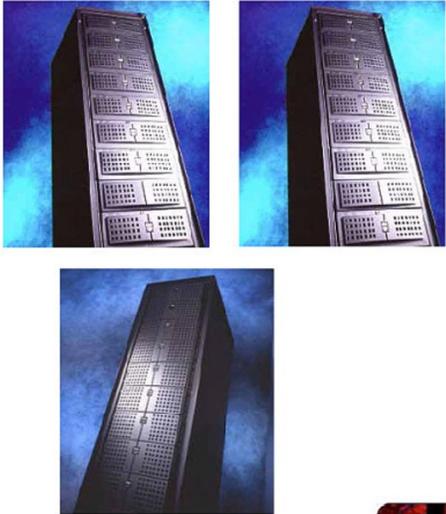
# Technology Constantly Advances

hardware, software, operations,  
applications, methods,  
methodologies

Computing Technology has  
advanced in leaps & bounds.

Makes sense to regularly  
consider updates & refreshes.

# Network “Appliances” Can Win Today



## *Dell PowerEdge & PowerVault System*

Dell PowerVault 650F	\$40,354 x 12 = 484,248
512 MB cache, dual link controllers, additional 630F cabinet, 20 x 9 GB FC disks, software support, installation	
Dell PowerEdge 6350	\$11,512 x 12 = 138,144
500 MHz PIII, 512 MB RAM, 27 GB disk	
3Com SuperStack II 3800 Switch	7,041
10/100 Ethernet, Layer 3, 24-port	
Rack Space for all that	20,710

## *NASRaQ System*



Cobalt NASRaQ	\$1,500 x 240 = 360,000
250 MHz RISC, 32 MB RAM, 2 x 10 GB disks	
Extra Memory (to 128 MB each)	\$183 x 360 = 65,880
3Com SuperStack II 3800 Switch	\$7,041 x 11 = 77,451
240/24 = 10 + 1 to connect those 10	
Dell PowerEdge 6350 Front-End	11,512
Rack Space (estimate 4x as much as the Dells)	82,840
Installation & Misc	50,000

## *Comparison*

	<b>Dell</b>	<b>Cobalt</b>
<i>Storage</i>	2.1 TB	4.7 TB
<i>Spindles</i>	240	480
<i>Compute</i>	6 GHz	60 GHz
<i>Memory</i>	12.3 GB	30.7 GB
<i>Power</i>	23,122 W	12,098 W
<i>Cost</i>	\$650,143	\$647,683

Slide from my PhD  
thesis defense in  
1999

**Today**

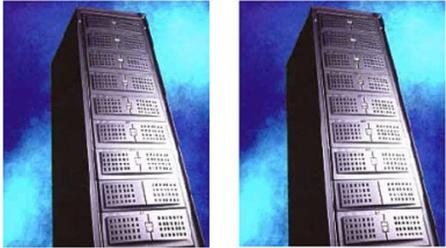
100G networking

PB storage

THz computing

TB memory

# Network “Appliances” Can Win Today



## Dell PowerEdge & PowerVault System

Dell PowerVault 650F \$40,354 x 12 = 484,248

512 MB cache, dual link controllers, additional 630F cabinet,  
20 x 9 GB FC disks, software support, installation

Dell PowerEdge 6350 \$11,512 x 12 = 138,144

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3Com SuperStack II 3800 Switch 7,041

10/100 Ethernet, Layer 3, 24-port

Rack Space for all that 20,710



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250 MHz RISC, 32 MB RAM, 2 x 10 GB disks

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Rack Space (estimate 4x as much as the Dells) 82,840

Installation & Misc 50,000

## Comparison

1999

	Dell	Cobalt
<i>Storage</i>	2.1 TB	4.7 TB
<i>Spindles</i>	240	480
<i>Compute</i>	6 GHz	60 GHz
<i>Memory</i>	12.3 GB	30.7 GB
<i>Power</i>	23,122 W	12,098 W
<i>Cost</i>	\$650,143	\$647,683

2022

8,640 TB	storage
480	spindles
1,152 GHz	compute
122,880 GB	memory
76,800 W	power
\$650,000	cost

A grayscale background image showing a pile of dark, irregularly shaped particles (possibly seeds or small stones) on a light-colored, textured surface. A clear glass jar is tipped over, with some particles spilling out. The overall scene suggests a cycle of reuse or recycling.

# CIRCULAR ECONOMY



**OCP**  
REGIONAL  
SUMMIT

# A Global Circular IT Hardware Industry

Opportunity and Imperative



**2019 OCP Regional Summit | September 26–27, 2019**

**RAI Exhibition & Convention Center | Amsterdam, Netherlands**





# OCP REGIONAL SUMMIT

## Are Our Heads in the Clouds?



Computer Power consumption  
forecast to exceed global  
energy production in 2040

(Semiconductor Ind. Assoc., 2015)



2016 ewaste = 49m tons,  
growing to 57 million tons in  
2021

(United Nations University)



"The future of electronics may  
depend on deep sea mining  
for minerals"

(All About Circuits)



Datacenters powering AI  
could account for 10% of  
global electricity demands  
by 2025

(MIT)



CO2 emissions of digital  
increased by 450m tons  
since 2013 in OECD countries,  
while globally, overall CO2  
emissions decreased by 250  
tons over the same period.

(Shift Project)



GHG of digital on track to go  
from 4% to 8%

(UMass)

2019 OCP Regional Summit | September 26-27, 2019

RAI Exhibition & Convention Center | Amsterdam, Netherlands





**OCP**  
REGIONAL  
SUMMIT

## Data Center IT Growth is Explosive

Servers Deployed, 2019-2023:

$$65 + (14 * 4) = 121$$



Open. Together.

2019 OCP Regional Summit | September 26-27, 2019

RAI Exhibition & Convention Center | Amsterdam, Netherlands



**OCP**  
REGIONAL  
SUMMIT

## And... Data Center IT ~~Growth~~ Waste is Explosive

Servers Deployed, 2019-2023:

$$65 + (14 * 4) = \del{121} 75$$

→ 46M servers to be "EOL'ed" between 2019 and 2023



Open. Together.

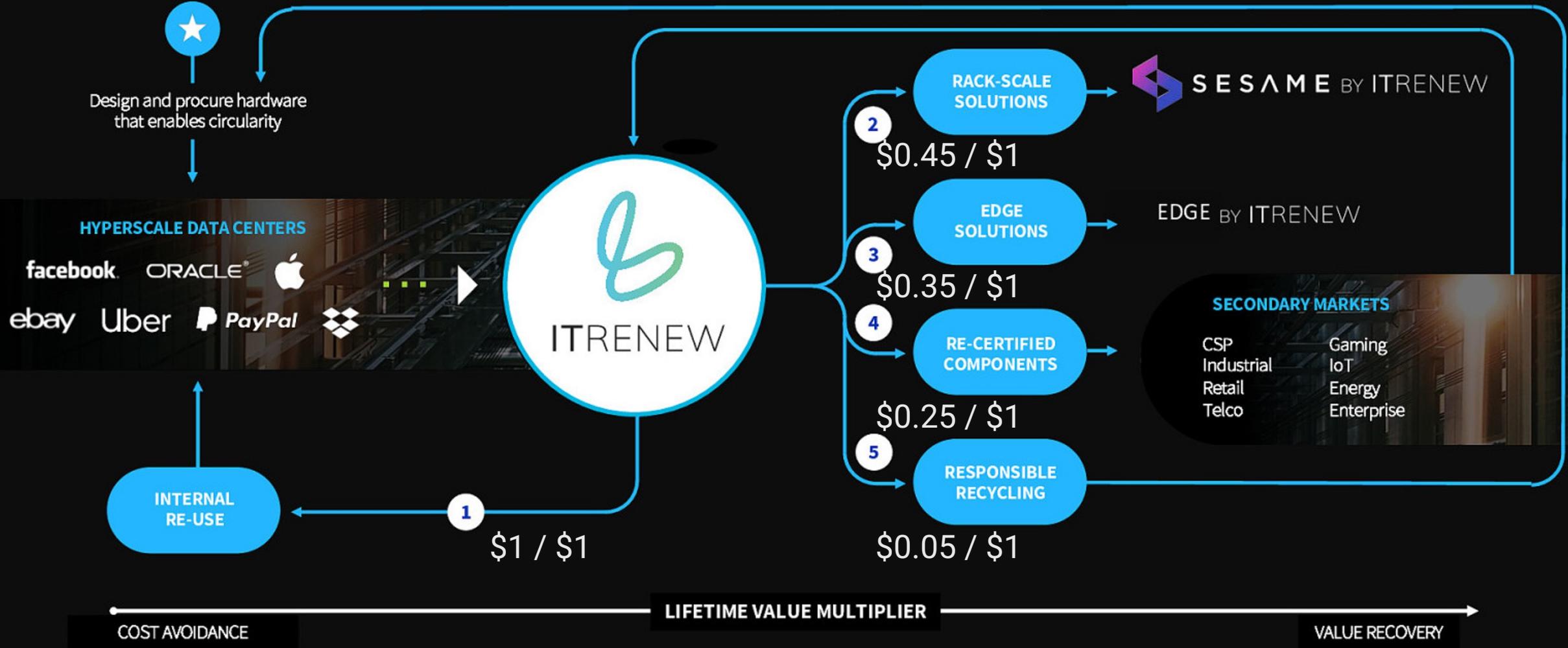
2019 OCP Regional Summit | September 26-27, 2019

RAI Exhibition & Convention Center | Amsterdam, Netherlands

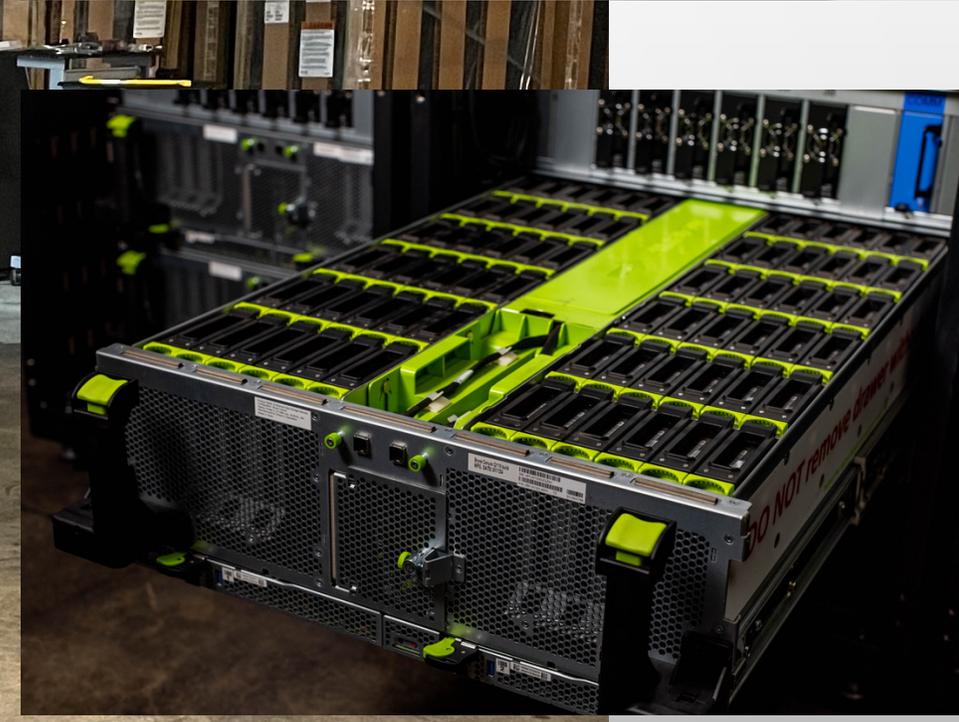








25,000 to 95,000 servers / month



A top-down photograph of a wooden table with a pile of coffee beans spilled from a glass jar. The word "REDUCE" is printed in bold black letters across the center of the image. The scene is dimly lit, with shadows cast by the jar and the pile of beans.

**REDUCE**

# Reduce carbon footprint

focus on efficiency & results  
via carbon / performance

scope 1 & 2 operational carbon;  
scope 3 embodied carbon

# Reduce cost footprint

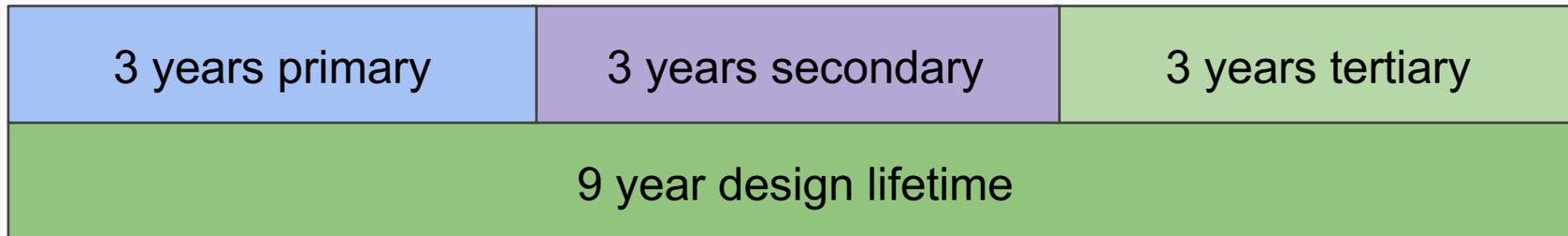
focus on efficiency & results  
via cost / performance

capex, opex, people-ex



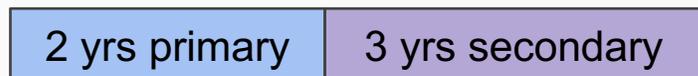
**EXTEND**

# Why it works



Recertified hardware approach – facilitate secondary and potentially tertiary use stages for technology assets in various forms

# Why it works



In fact, anything that keeps technology running longer will be beneficial, as long as the technology is still **useful** for something by somebody, plus **maintainable** & **serviceable**. SO use those actual criteria to evaluate ALL technology: workload performance, ongoing maintenance complexity & ongoing service costs.

# How it works (2)

## Step 1 - Audit

Audit systems, servers, and applications.

## Step 2 - Quantify

Match per-unit, per-device carbon inventory, performance, and capacity.

## Step 3 - Optimize

Report, review, and optimize - changes might be hardware, software, operations, or design.

buy new hardware \$\$-

extend life of existing hw \$0

re-purpose existing hw \$+

add recertified hardware \$-



# A WIDER LOOK



TED RADIO HOUR

LISTEN &amp; FOLLOW

## &lt; Shoham Arad: Ideas Into Action

October 22, 2021 · 12:01 AM ET

51-Minute Listen

PLAYLIST

WATCH

DISCOVER

ATTEND

PARTICIPATE

ABOUT



TED Speaker TED Fellow TED Attendee

**Mundano**

Graffiti artist + activist

[PimpMyCarroca.com](http://PimpMyCarroca.com) [@Mundano\\_sp](https://twitter.com/Mundano_sp) [Flickr: Artetude](https://www.flickr.com/photos/artetude/)

*Mundano's bold, colorful street art isn't just eye candy. His projects call attention to social, environmental and political issues, while raising chuckles from passersby.*

**Why you should listen**

Mundano is a Brazilian street artist and activist whose work makes people stop and think about the issues swirling around them everyday. In 2007, he began using his graffiti skills to paint "carroças," the wooden and metal carts used by the trash collectors throughout Brazil who haul off junk and recyclables. He painted 200 carroças and in the process made these invisible superheroes visible—not only in the streets, but also in the media. The effort led to "[Pimp My Carroça](http://Pimp My Carroça)," which made this initiative do-it-yourself, crowdfunded and global. It has brought in 170 trash collectors in cities around the world, teaming them up with 200 street artists and 800 volunteers. It is quickly becoming a movement.

TED Speaker

TED Fellow

Personal profile

**Trash cart superheroes**

1,085,571 views | Mundano • TEDGlobal 2014

[Share](#) [Add](#) [Like \(32K\)](#)[Read transcript](#)

In Brazil, "catadores" collect junk and recyclables. But while they provide a vital service that benefits all, they are nearly invisible as they roam the streets. Enter graffiti artist Mundano, a TED Fellow. In a spirited talk, he describes his project "Pimp My Carroça," which has transformed these heroic workers' carts into things of beauty and infused them with a sense of humor. It's a movement that is going global.

**About the speaker****Mundano**

Graffiti artist + activist

[See speaker profile >](#)<https://www.npr.org/transcripts/1048050024>

Mundano's bold, colorful street art isn't just eye candy. His projects call attention to social, environmental and political issues, while raising chuckles from passersby.

# CATADORES



26 likes  
fermetalmacae .

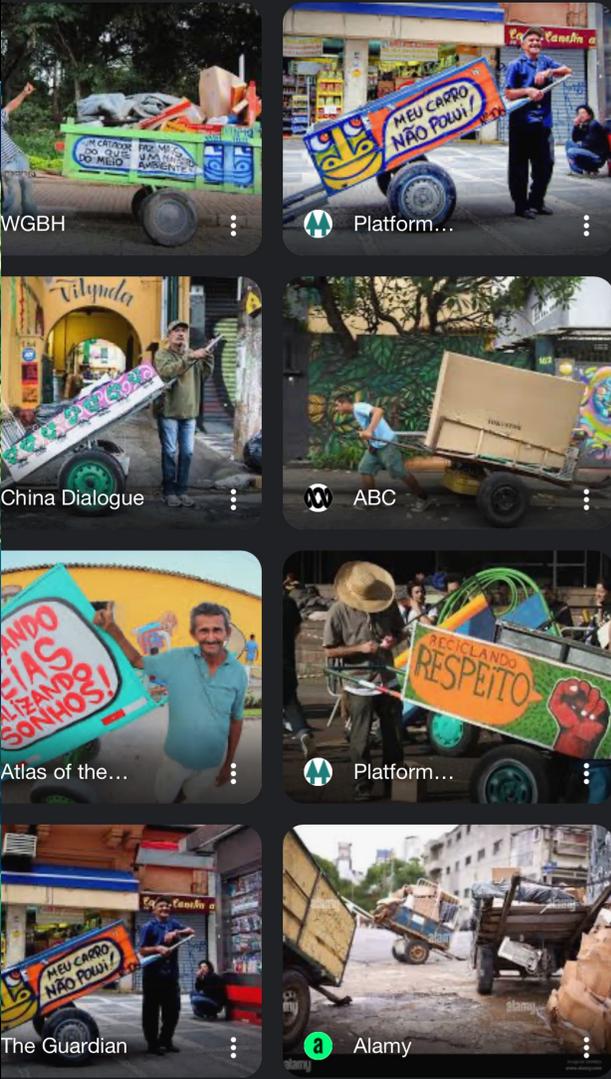
A importância do catador para reciclagem se destaca... more  
March 7 · See translation



Liked by catakiaapp and 360 others

pimpmycarroca Consumir de maneira consciente e reciclar somente o que é necessário. A gente apoia essa ideia... more

View all 2 comments  
October 8, 2020 · See translation



NPR  
<https://www.npr.org> · 2015/01/17  
Pimps Cars, Brazil Pimps Trash Carts : s and Soda



**LIXO**

**GARBAGE**



**RESÍDUO**

**WASTE**



Liked by [catakiapp](#) and 711 others

**pimpmycarroca** How many times haven't we thrown "trash in the trash" and thought we were doing something great for the planet?

But do u wanna know? Trash doesn't exist!

The word garbage perpetuates a super negative image for the pickers! The raw material of these professionals is WASTE! Remember: waste is resource.

Collectors are the true environmental agents who collect our



Liked by [mundano\\_sp](#) and 3,973 others

**pimpmycarroca** Yes: 90% of everything Brazil recycles is collected by pickers. Yes: that's a lot of work for little recognition.

One simple way to help change this scenario is voting for Catakí in the global innovation award that the app is competing for. Only 1 day left for voting to end, so go to [vote.cataki.org](http://vote.cataki.org) [clickable link there in our bio] and do your part!









A glass jar is tipped over on a light-colored, textured surface, spilling a dark, granular substance. The jar is on the left side of the frame, and the granules are scattered across the surface, forming a large pile and some smaller clumps. The text "CLOSE THE CARBON LOOP" is overlaid in the center of the image.

**CLOSE THE CARBON LOOP**



👤 SIGN IN

🛒 NPR SHOP

❤️ DONATE



PLANET MONEY

LISTEN & FOLLOW 🎧 🎵 🎧

# < Sell Me Your Climate Bombs

September 25, 2020 · 6:41 PM ET

<https://www.npr.org/transcripts/917060248>

Tim & Gabe

▶️ **26-Minute Listen** + PLAYLIST ⬇️ ⏪ ⏸️

# GET PAID TO FIGHT CLIMATE CHANGE.

**(HINT: LOOK AT YOUR AIR CONDITIONER...)**

Your company may be sitting on some of the most potent greenhouse gases ever created: old refrigerants. These climate-warming gases often go unnoticed in chillers, air conditioning, and refrigerated systems.

We've teamed up with Intuit, the global financial platform, to help more businesses take positive steps to reduce their carbon emissions.

**Ensure that your climate commitment includes monitoring these greenhouse gases – and get paid to see them destroyed or recycled.**

**Contact Tradewater**





**Get paid for your existing refrigerant, with no-cost shipping**

Includes chlorofluorocarbon (CFC) refrigerants



**Free recovery services of refrigerants in building chillers and other systems**

Includes chlorofluorocarbon (CFC) refrigerants



**Up to 50% off on recovery, reclamation, and recycling services**

Includes hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbon (HFC) refrigerants

224	Lyme Mountaineer Timberlands II, LLC	3,921,355
225	Passamaquoddy Joint Tribal Council	4,513,042
226	Mescalero Apache Tribe	4,569,074
227	Green Diamond Resource Company	4,666,739
228	Tradewater, LLC	4,846,851
229	Reclamation Technologies, Inc.	5,130,894
230	EOS Climate, Inc.	5,726,319
231	Usal Redwood Forest Company, LLC	5,943,301

## How it Works

Tradewater is an EPA-certified organization reclaimer with the technical expertise to handle refrigerant safely and responsibly. Unlike others who purchase refrigerant, however, we do this work to fight climate change.

We first aggregate the dangerous greenhouse gases we collect. Depending on the refrigerant type, we either destroy the gases through incineration or send them through a regulated recycling process.

**Tim & Gabe**

**Tradewater  
Refridgerant Finders**





OUR TECHNICIANS ARE EPA-CERTIFIED

# We Buy Your Old Refrigerant



## Get Your Free Quote



Refrigerant Finders Nationwide Buyback Program Pays Competitive Prices For Your Old Or Used Refrigerants.

Our Mail-In Program Makes It Easier Than Ever To Sell Your Freon. We Offer **Free Nationwide Shipping** To Ensure You Get Paid Even Quicker For Your Refrigerant.

First Name

Last Name

Phone \* 

Email Address \*

Refrigerant Type

Refrigerant Container

Approximate Quantity (Lbs) \* 

Zip Code \*

Security code



Enter code \*





**THANK YOU**

## OCP Experience Center - Nautilus (Stockton, CA) - hosted by Flax Computing

OCP Experience Center - Nautilus (Stockton, CA) - hosted by Flax Computing The Sustainable Server Lab (SSL) center for open hardware i...

**Solution Provider:** Flax Computing

**Model #:** OCP Experience Center - Nautilus (Stockton, CA)



## OCP Experience Center - MGHPCC (Holyoke, MA) - hosted by Flax Computing

OCP Experience Center - MGHPCC (Holyoke, MA) - hosted by Flax Computing The Sustainable Server Lab (SSL) center for open hardware i...

**Solution Provider:** Flax Computing

**Model #:** OCP Experience Center - MGHPCC (Holyoke, MA)



## Efficient Computing and Energy Reduction Test Center - Hosted by Flax Computing

The Recertification for Efficient Computing and Energy Reduction Test (RECERT) design and manufacturing center hosts a range of activities related to advancing ...

**Solution Provider:** Flax Computing

**Model #:** N/A



## Carbon Footprint Analysis and Reduction (CFAR) Center - Hosted by Flax Computing

The Carbon Footprint Analysis and Reduction (CFAR) analysis and design process allows everyone to succinctly and accurately measure the carbon footprint of thei...

**Solution Provider:** Flax Computing

**Model #:** Carbon Footprint Analysis and Reduction Center



# Call to Action

- Reach out to us to get involved
- Engage us to evaluate / quantify your data center, systems, and server carbon footprints
  - [www.flaxcomputing.com](http://www.flaxcomputing.com)
- Evaluate your own servers, share the results with us [data @ flaxcomputing.com](mailto:data@flaxcomputing.com)
- If you have servers you don't want any more, send to:  
Flax Computing, Suite A2  
530 West Street  
Braintree, MA 02184
- If you want us to arrange a pickup instead, contact us at [servers @ flaxcomputing.com](mailto:servers@flaxcomputing.com)



Erik Riedel, PhD, Chief Engineering Officer, Flax Computing  
Twitter: @er1p, @RiedelAtWork email: erik @ flaxcomputing.com



OCP  
REGIONAL  
SUMMIT

APRIL 19-20, 2023  
PRAGUE, CZ

EMPOWERING OPEN.

# CATCH US AGAIN SOON

OCP REGIONAL SUMMIT – PRAGUE, CZ – 19-20 APRIL 2023

KUBECON EUROPE – AMSTERDAM, NL – 18-21 APRIL 2023

MASS STORAGE SYSTEMS & TECH – SANTA CLARA – 21-23 MAY 2023

STORAGE DEVELOPER CONFERENCE – 18-21 SEPTEMBER 2023

OCP GLOBAL SUMMIT – SAN JOSE, CA – 17-19 OCTOBER 2023

KUBECON NORTH AMERICA – CHICAGO, IL – 6-9 NOVEMBER 2023