ISC15

Frankfurt

July 2015

FUJITSU

shaping tomorrow with you

Fujitsu Cool-Central® Liquid Cooling Technology

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Efficient cooling of large PRIMERGY CX400 M1 HPC or cluster solutions

Fujitsu Cool-Central® Liquid Cooling Technology helps to reduce data center cooling costs by over 50 % and allows for 2.5-5x higher data center server density.

Why On-Chip Liquid Cooling?

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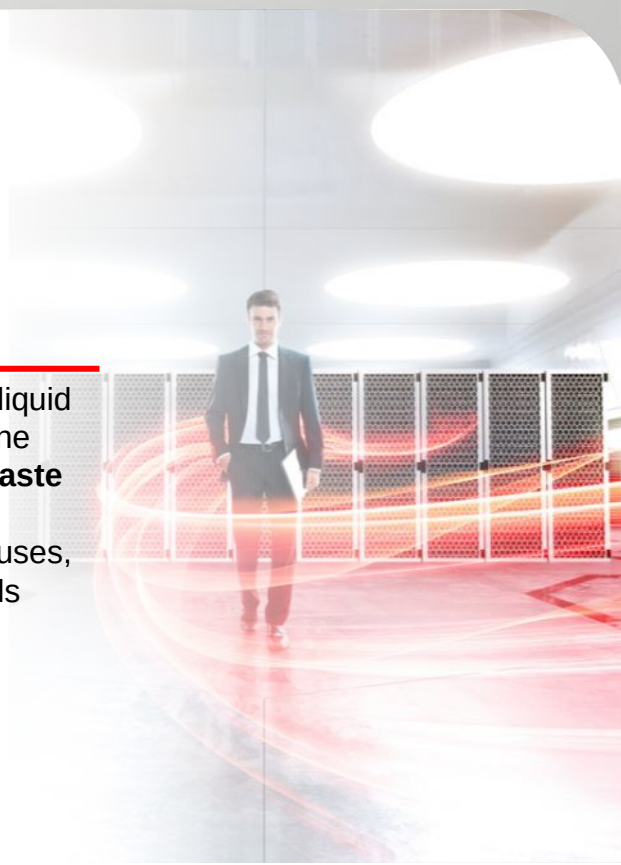
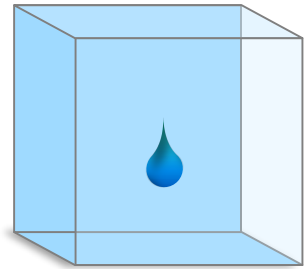
Maximum rack density	Less cooling power and costs	Lower investment needed for building new data centers	Lower overall energy consumption
Extreme dense HPC and cluster installations with more than 50 kW per rack are only possible with liquid cooling	Liquid cooling allows for up to **50% less cooling power and costs** through high efficient coolers with low operating costs	A hot water based liquid cooling infrastructure requires a **way lower investment** than traditional air cooled infrastructure	Hot water based liquid cooling enables the easy **usage of waste heat** for heating homes, green houses, or swimming pools



Water as a Medium for Heat Transfer

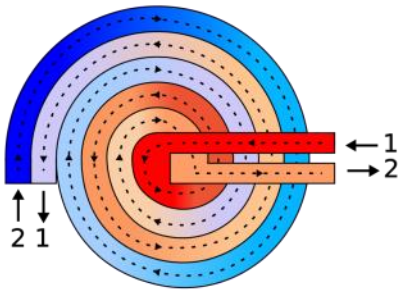


Removing the waste heat

For 1000 W, 10 K temperature difference:

- 325 m³/ h of air
- 0,09 m³/h water

➔ Small water tubes can transport more heat than a room full of air!

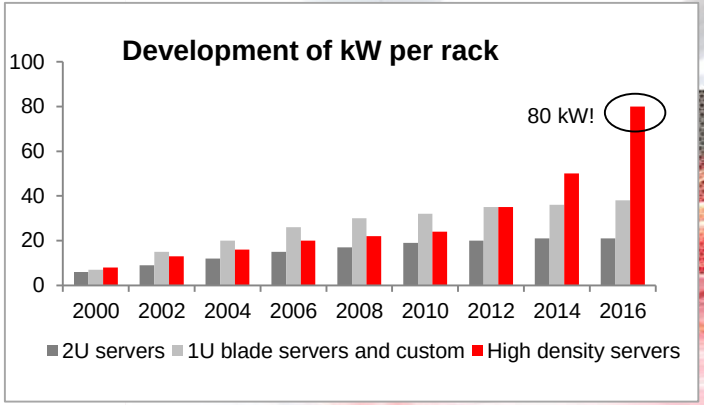


Heat transfer

- Heat transfer from water-to-water is better by a factor of 1,000 than water-to-air
- Cold plate and pump units are the same size or even smaller than regular heat sinks

Fujitsu‘s Liquid Cooling Offering

- Future-proofing the Fujitsu PRIMERGY portfolio
  - KW per rack will further rise and traditional air cooling will not be sufficient for future developments
  - Liquid Cooling will allow for higher-performant, denser and more energy efficient PRIMERGY servers per rack
- The liquid cooling solution out of one hand
  - Cool-Central® Liquid Cooling Technology offers professional liquid cooling tested and designed for Fujitsu Server PRIMERGY CX400 M1 systems
  - Liquid cooling equipment already pre-installed ex factory
  - Easy management: integration of the cooling solution into Fujitsu‘s ServerView management software
  - Professional services to evaluate the customers cooling infrastructure



High density servers will reach up to 80 kW per rack by 2016

Fujitsu PRIMERGY Server for Liquid Cooling

Fujitsu PRIMERGY CX400 M1

- Condensed 4-in-2U density
  - Features up to 4 half-wide dual socket server nodes plus up to 24 storage drives
  - 50% less rack space in comparison with standard rack servers for highest performance per rack unit
- Server nodes for every scenario
  - Different dual socket server nodes featuring latest Intel® Xeon® processor E5-2600 v3 product family to best match particular scale-out solution stacks
  - PRIMERGY CX2550 M1: Standard server node, 16 DIMMs (1U)„
  - PRIMERGY CX2570 M1: Enhanced HPC node with up to two GPGPU or co-processor cards, 16 DIMMs (2U)

Usage Scenarios

Scale-out cloud infrastructure

Hyper-converged computing

HPC server farms

Air Cooled Data Center

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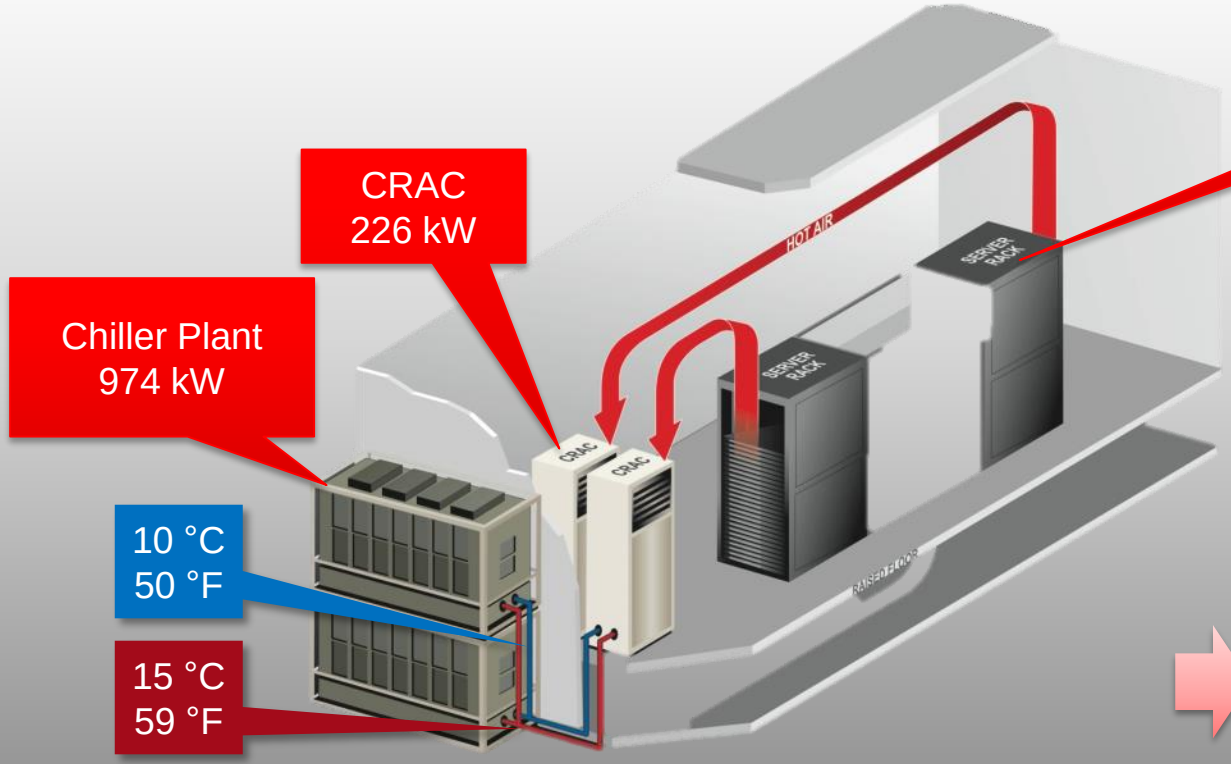

IT Power:	2.0 MW
Cooling Power:	1.2 MW
Other:	0.4 MW
Total Energy:	**3.6 MW**

PUE: 1.8

74% of overhead power used for cooling

Cool-Central® LCT Cooled Data Center

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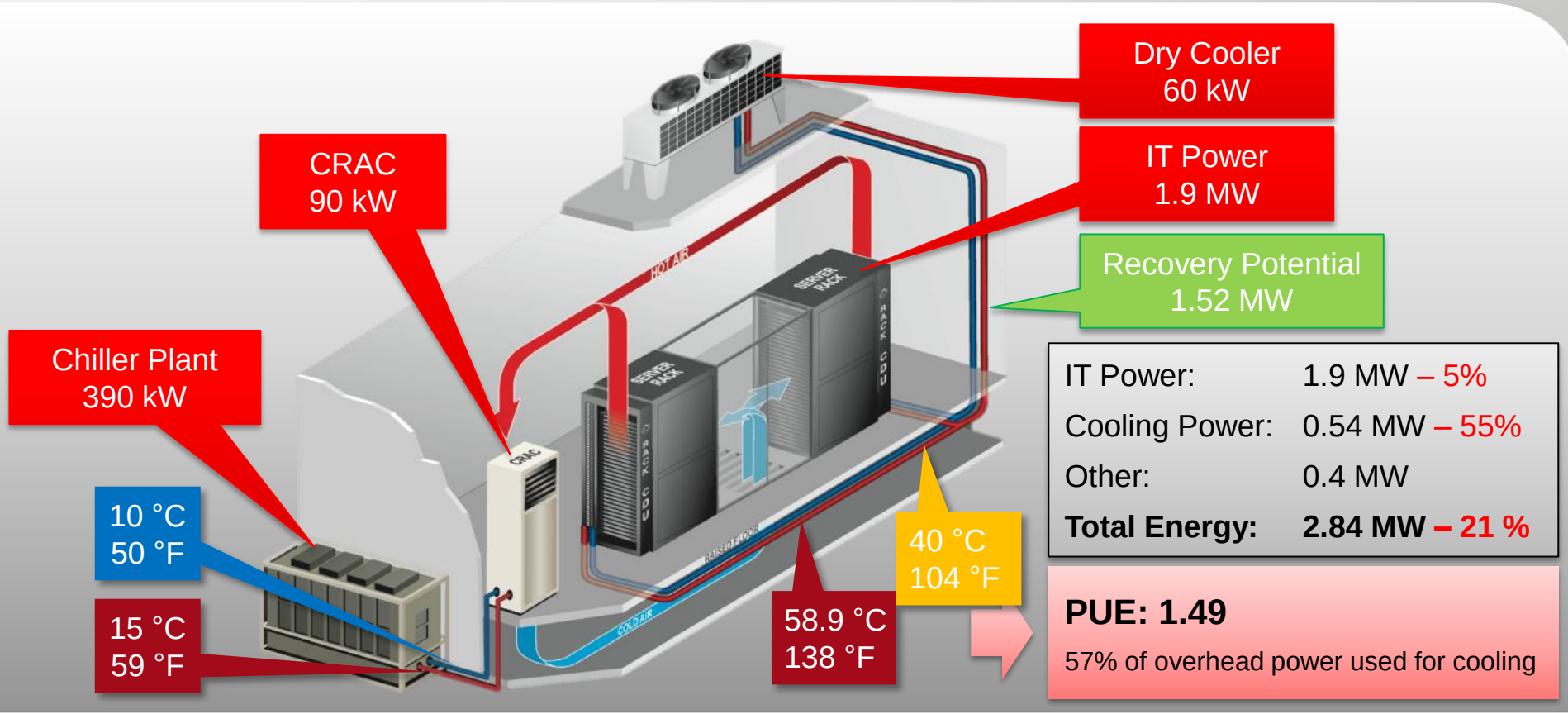


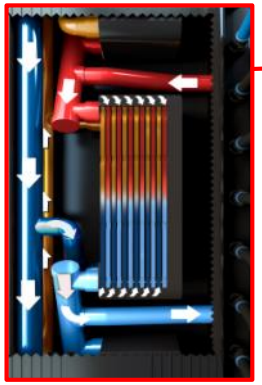
IT Power:	1.9 MW – 5%
Cooling Power:	0.54 MW – 55%
Other:	0.4 MW
Total Energy:	**2.84 MW – 21 %**

PUE: 1.49

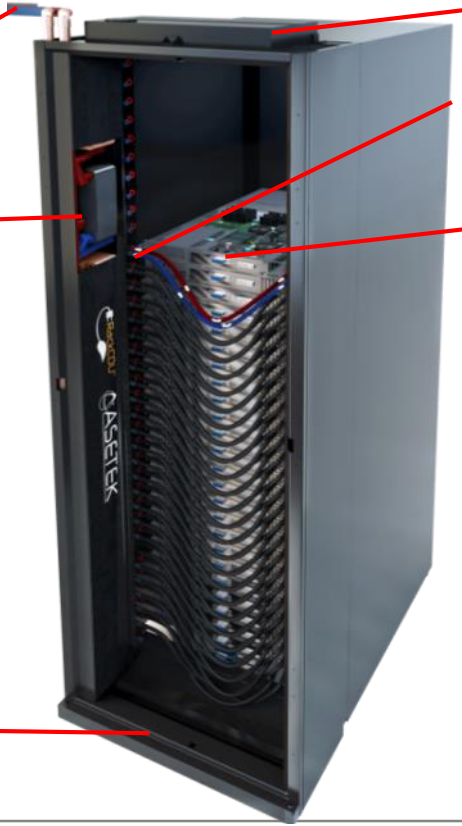
57% of overhead power used for cooling

Cool-Central® LCT: How it Works

Hot water from facilities dry cooler or cooling tower enters RackCDU, hotter water returns



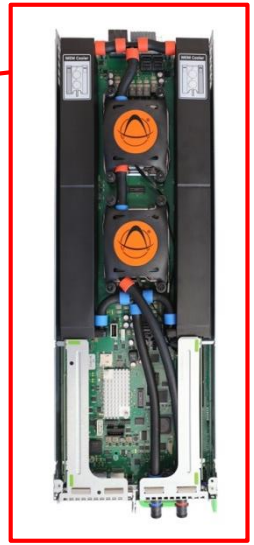
Heat exchanger
Liquid-to-liquid heat exchanger between facilities liquid loop and server liquid loops. Facilities and server liquids are kept separate and never mix.



Leak Detection Panel
(not shown)

Coolant reservoir and control

Tubes move cooling liquid to and from RackCDU to servers



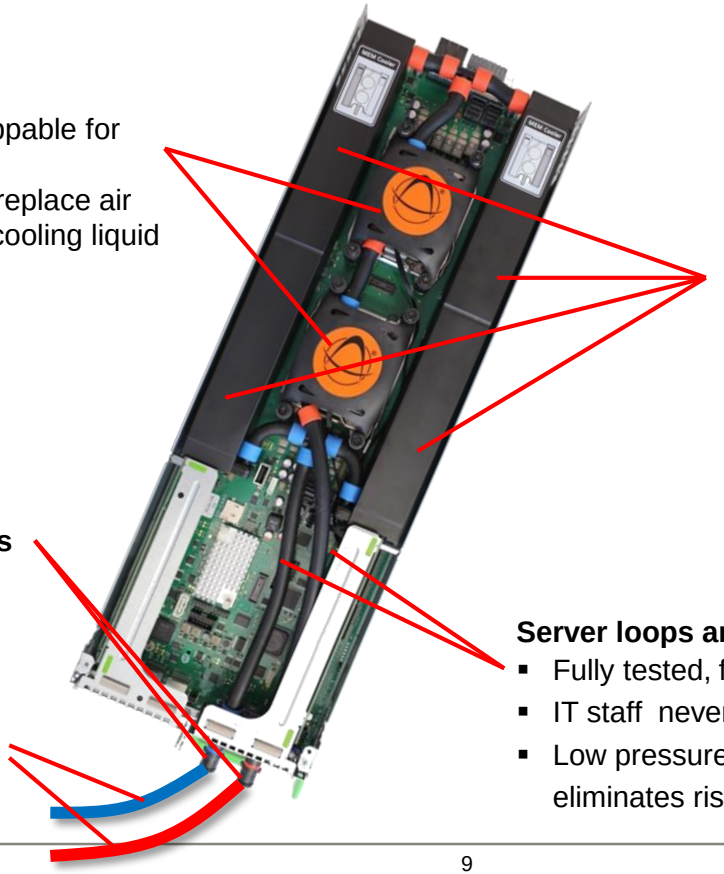
Pump/cold plate units
atop CPUs, GPUs and RAM circulate liquid through server and RackCDU, collecting heat and returning to RackCDU for exchange with facilities liquid

Facility water requirement

- Maximum water temperature
  - Facility supply: 40 °C
  - Facility Return: 59 °C
- Water pressure
  - Max: 100 PSI
  - Min: 10 PSI

Cool-Central® LCT: How it Works

Dual in-series pumps
- Provide redundancy
- Pumps / motors hot swappable for serviceability
- Pumps / cold plate units replace air heat sinks and circulate cooling liquid



Memory Coolers

Wide range of compatible components
- Intel Xeon and Xeon Phi
- Nvidia Tesla, Grid
- Memory modules

Quick Connectors

From / to RackCDU

Server loops and tubes
- Fully tested, filled and ready to install
- IT staff never has to handle liquids
- Low pressure, factory sealed design eliminates risk of leaks

Picture does not show Fujitsu node

Cool-Central® LCT: Monitoring and DC Integration

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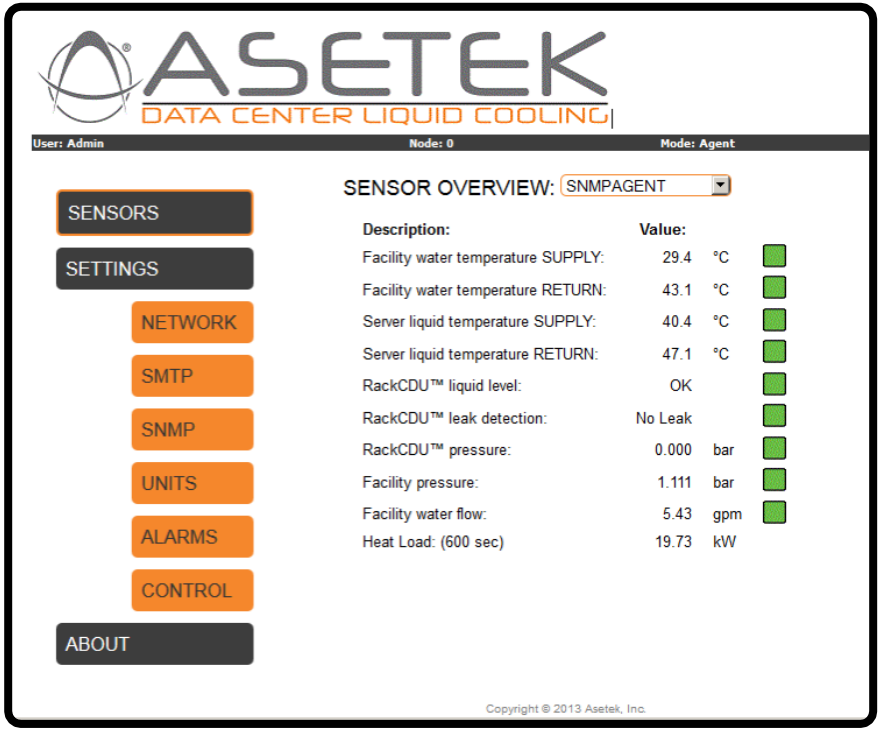
- Monitoring, readouts and user controlled alarming for items such as temperatures, flow, pressures and leak detection
- Surveillance/alarm system is web accessible by operations management
- System supports integration into data center management suites/DCIM via SNMP



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Customer Pain Points, Usage Scenarios

Data Center Cooling: Customer Pain Points

Higher density in existing DC required

Equipping an existing data center with additional servers leads to cooling and density challenges.

Challenge:

- Air cooling capability: traditional air cooled data centers support max 15 kW per rack
- 15 kW per rack means that a fully equipped 42 U rack just supports servers with max wattage of 350 W
- Alternatively a rack can be populated with just 30x 500 W servers

Advantages of Liquid Cooling Technology:

- No real max wattage limit per rack as up to 80 % of heat is dissipated through water
- Racks can be fully equipped with servers
- Furthermore: the Liquid Cooling Technology does not occupy height units in the rack or precious floor space in the data center

Data Center Cooling: Customer Pain Points

To high cooling costs in existing data center

Operating costs for the traditional air cooled data center are too high.

Challenge:

- Air cooling has a low efficiency due to losses in exchanging the heat from air to water and back to air (CRAH / chiller) or with cooling compressors (CRAC)
- CRAH units require water cooled down to ~10 °C by chillers which is energy and cost intensive
- Hotspots in the rack / data center are hard to cool as the stream of cold air is tricky to route to the needed place

Advantages of Liquid Cooling Technology:

- Liquid cooling allows to collect the waste heat directly at its source
- Exchanging the heat with water is highly efficient
- Hot water based cooling simply relies on dry coolers which have high efficiencies and low operating costs
- Water just has to be cooled down to 40 °C, which maximizes the number of hours in which “free cooling” is possible

Data Center Cooling: Customer Pain Points

Save money when building a new data center

The cooling equipment of a newly built data center can easily amount for 20 % of the total investment.

Challenge:

- Air cooling equipment like computer room air handlers (CRAH) + chillers or computer room air conditioners (CRAC) are expensive and take up lots of floor space

Advantages of Liquid Cooling Technology:

- A hot water based liquid cooling infrastructure requires a way lower investment than traditional air cooled infrastructure
- Dry coolers have a by factors higher cooling capacity and can thus replace several CRAC+chiller / CRAH units
- As dry coolers for the liquid cooling infrastructure are placed outside the data center precious floor space can be saved

Data Center Cooling: Customer Pain Points

Lower the overall energy consumption of the company

Why is energy and money spend on the cooling of the data center and on heating the offices at the same time?

Challenge:

- Especially in the temperate zones offices have to be heated for a large part of the year, while at the same time a lot of effort is put into the removal of the heat produced in the data center. Is there a way to use this waste heat?

Advantages of Liquid Cooling Technology:

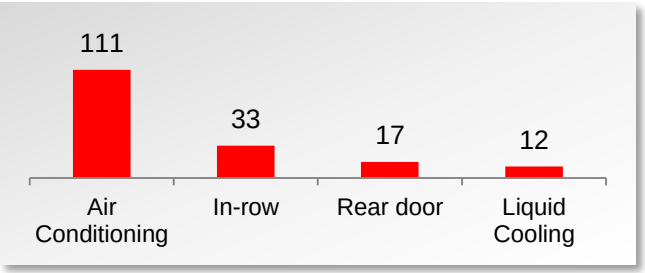
- The Cool-Central Liquid Cooling Technology just needs cool water of around 40 °C. The returning water is around 60 °C.
- The excess heat can be used to heat offices, homes, green houses, or swimming pools

Maximum achievable data center density

Data center density

- Maximum servers per rack
  - The max number of servers per rack is determined through the maximum heat dissipation rate
  - Only with direct to chip liquid cooling the heat dissipation is high enough to support a rack full of high performance servers
- Available floor space
  - In-row cooling in traditional air cooled data centers takes up a lot of floor space which could be used for further racks
  - A data center cooled partly with liquid cooling needs less than half the in-row CRACs offering more available floor space

Number of racks required for 1000x PRIMERGY CX2550 M1 LCT nodes



Liquid Cooling: Possible TCO Savings

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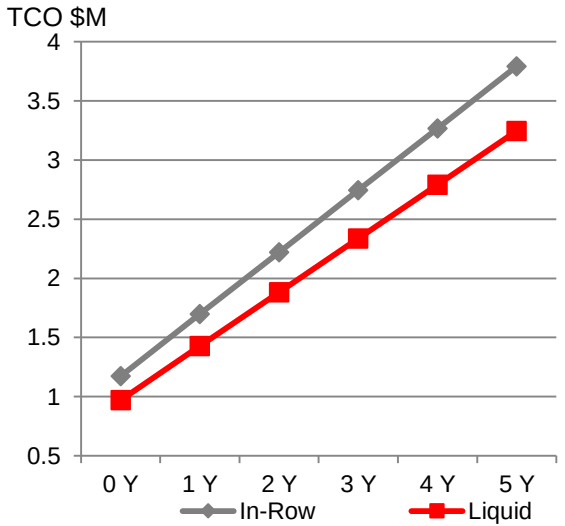
Power consumption and costs of 1,000x PRIMERGY CX2550 M1 (dual socket server)

	Air Cooling			Liquid Cooling
	Air conditioner	In-row	Rear door	LC + in-row cooling
Power consumption (Cooling infrastructure + servers)	956.3kW	796.7kW	763.4kW	696.4kW
Initial cost for cooling infrastructure	$2,186.4k	$1,174.4k	$934.4k	$972.0k
	Not realistic because 21x air conditioner required	Realistic	Cooling capability is too low (max 30 kW per rack)	Realistic

Total cost of ownership



TCO = initial cost + electricity cost ($0.15/kWh)
Electricity cost is calculated as 50% power load

In 5 years Cool-Central LCT can save up to $0.55M!

Savings through a slim cooling infrastructure

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Calculating the cooling infrastructure

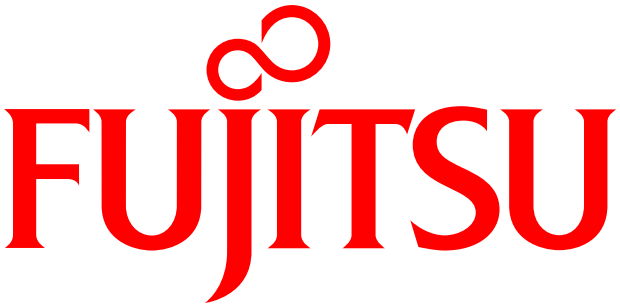
		Air (In-row)	Liquid + Air
Server heat dissipation		566 kW (Air) ⟷	216 kW (Air) 358 kW (Liquid)
Cooling infrastructure for **air** cooled parts	#In-row	14x 41 kW	6x 41 kW
	#Chiller	5x 118 kW	2x 118 kW
Cooling infra for **liquid** cooled parts	#Dry cooler	-	1x 422 kW

The heat dissipation of the servers is separated by components cooled by air (HDDs, mainboard) and by liquid (CPU, memory). The resulting kW have to be removed by the corresponding cooling infrastructure.

In-row cooler remove the heat of the data center and need additional chiller plants outside the building.

The dry cooler removing the heat from the liquid cooled parts features a high capacity.

With additional liquid cooling the cooling infrastructure of the data center can be designed way slimmer or with the same energy level a higher server density. The needed dry cooler has a high cooling capacity and at the same time a very low energy consumption.



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