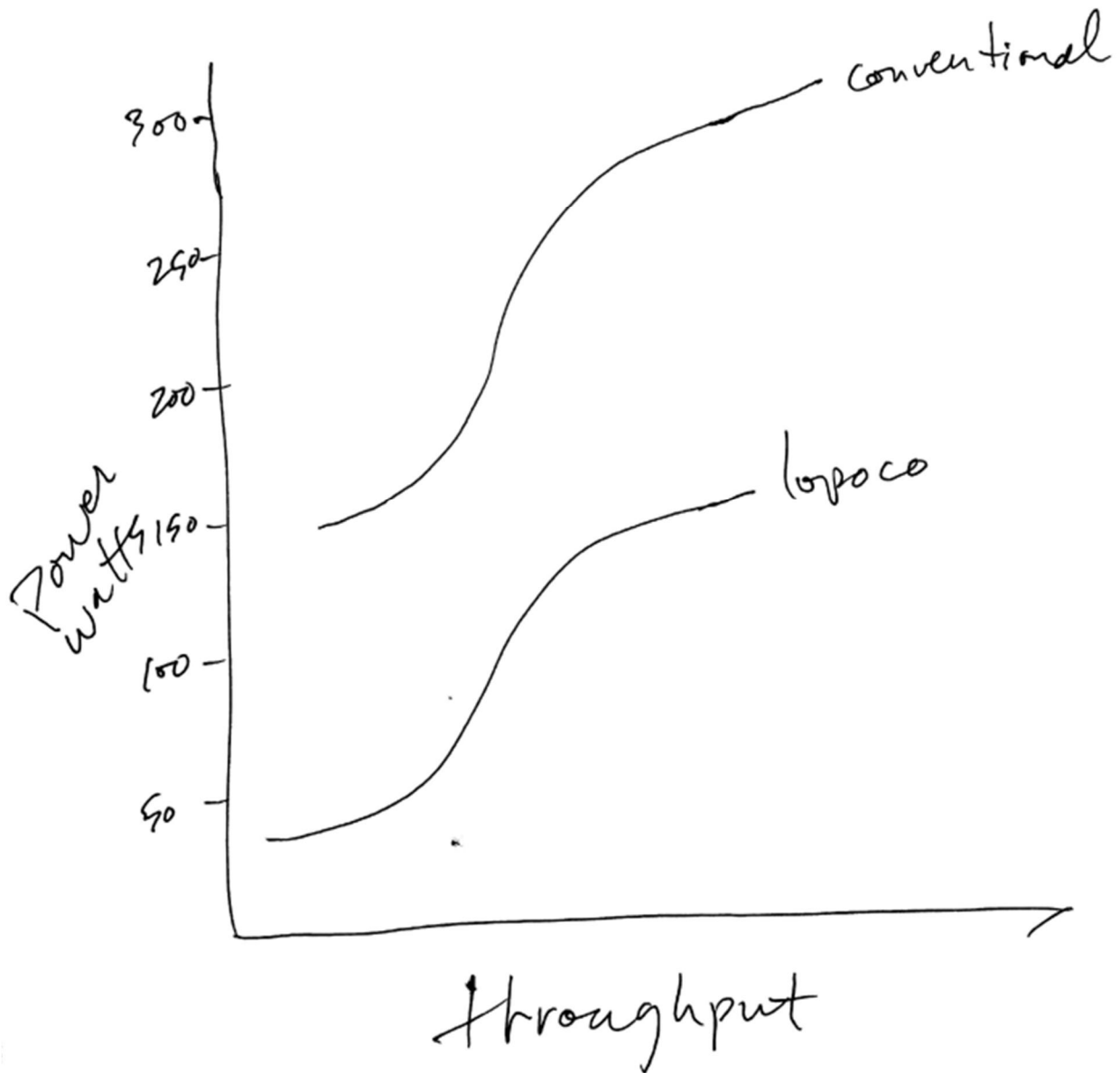Figure 1

Notice how the curves don't align vertically. That's because we're willing to give up a small percentage of unneeded performance for large increases in efficiency. I tried to draw the curves to indicate less than 10% performance difference. For many applications that are not CPU bound, the actual throughput difference will be neglibilble.
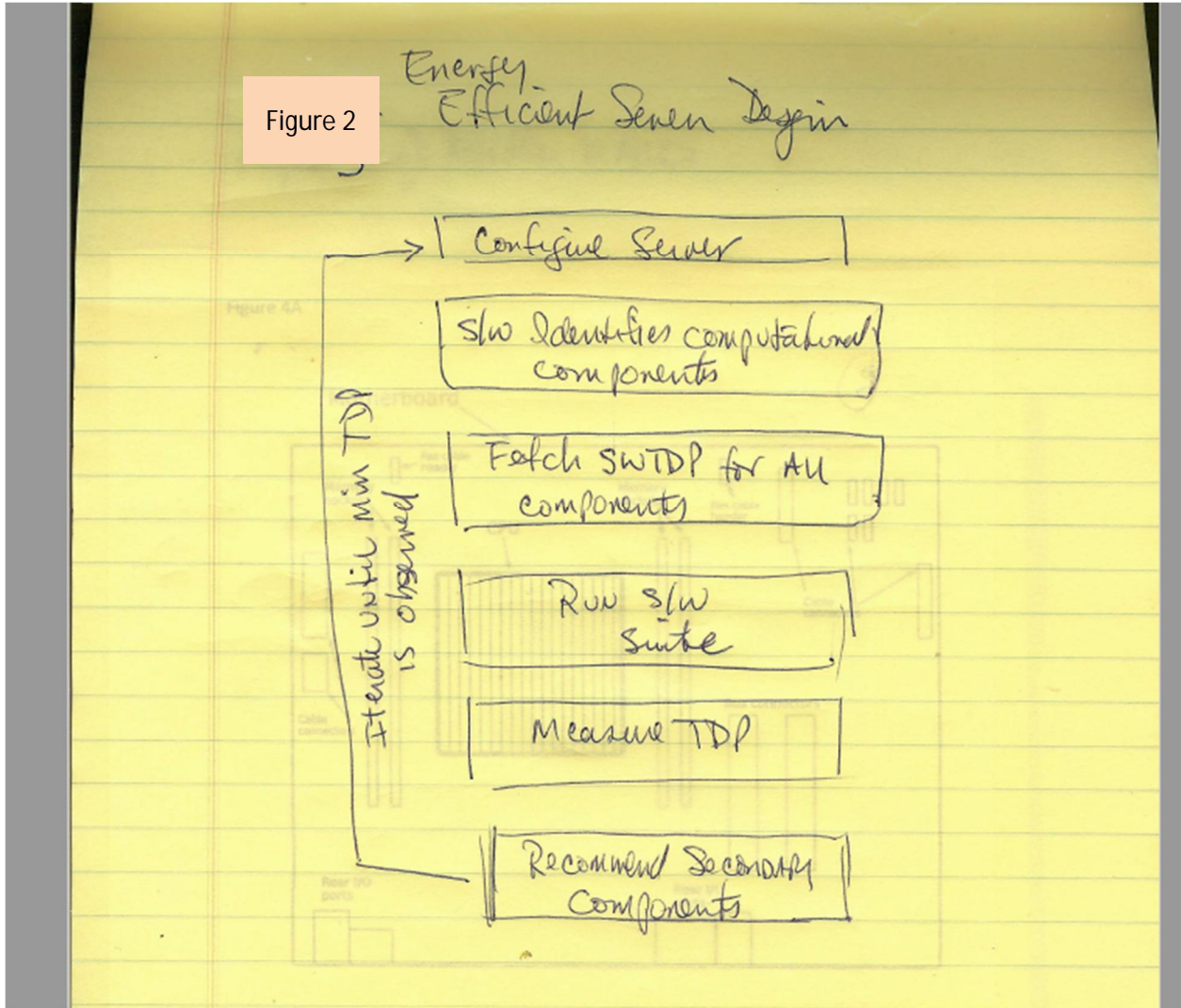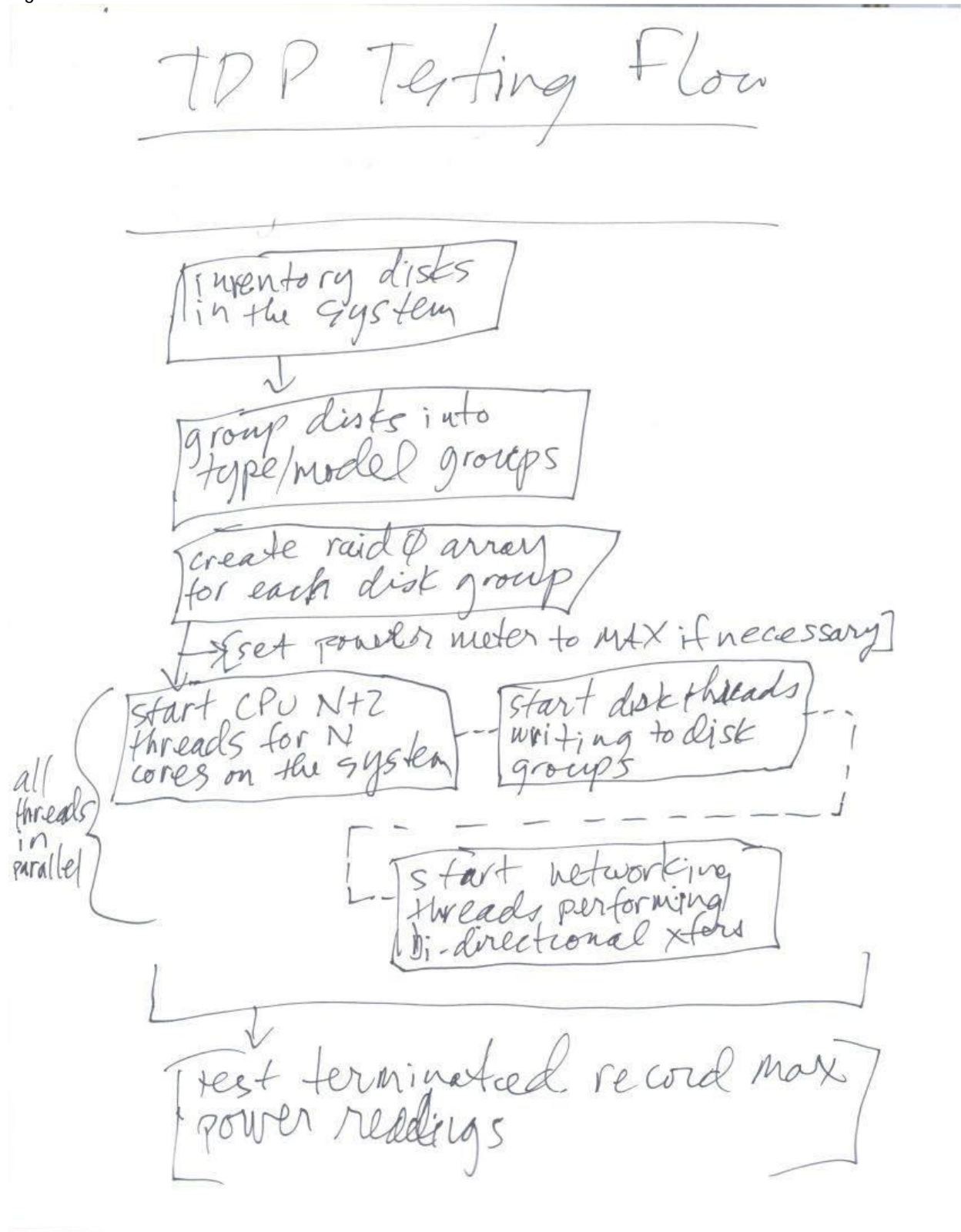
Figure 2

Figure 2

Figure 4

TDP Testing Flow

- Inventory disks in the system
- group disks into type/model groups
- create raid 0 array for each disk group
- [set power meter to MAX if necessary]
- start CPU N+2 threads for N cores on the system
- start disk threads writing to disk groups
- start networking threads performing bi-directional xfers

all threads in parallel

- [test terminated record max power readings]

Figure 5A

Efficient Server Motherboard
(top view)

Fans (grey = possible optional fans)

Motherboard

Airflow

Fan cable header

Memory sockets

Memory sockets

Fan cable header

CPU heatsink

Cable connectors

Cable connectors

Bus connectors

Rear I/O ports

Rear I/O ports

CPU heatsink fins, motherboards sockets of all types, cable connectors are all placed and situated to be parallel in length in order to optimize and smooth airflow.

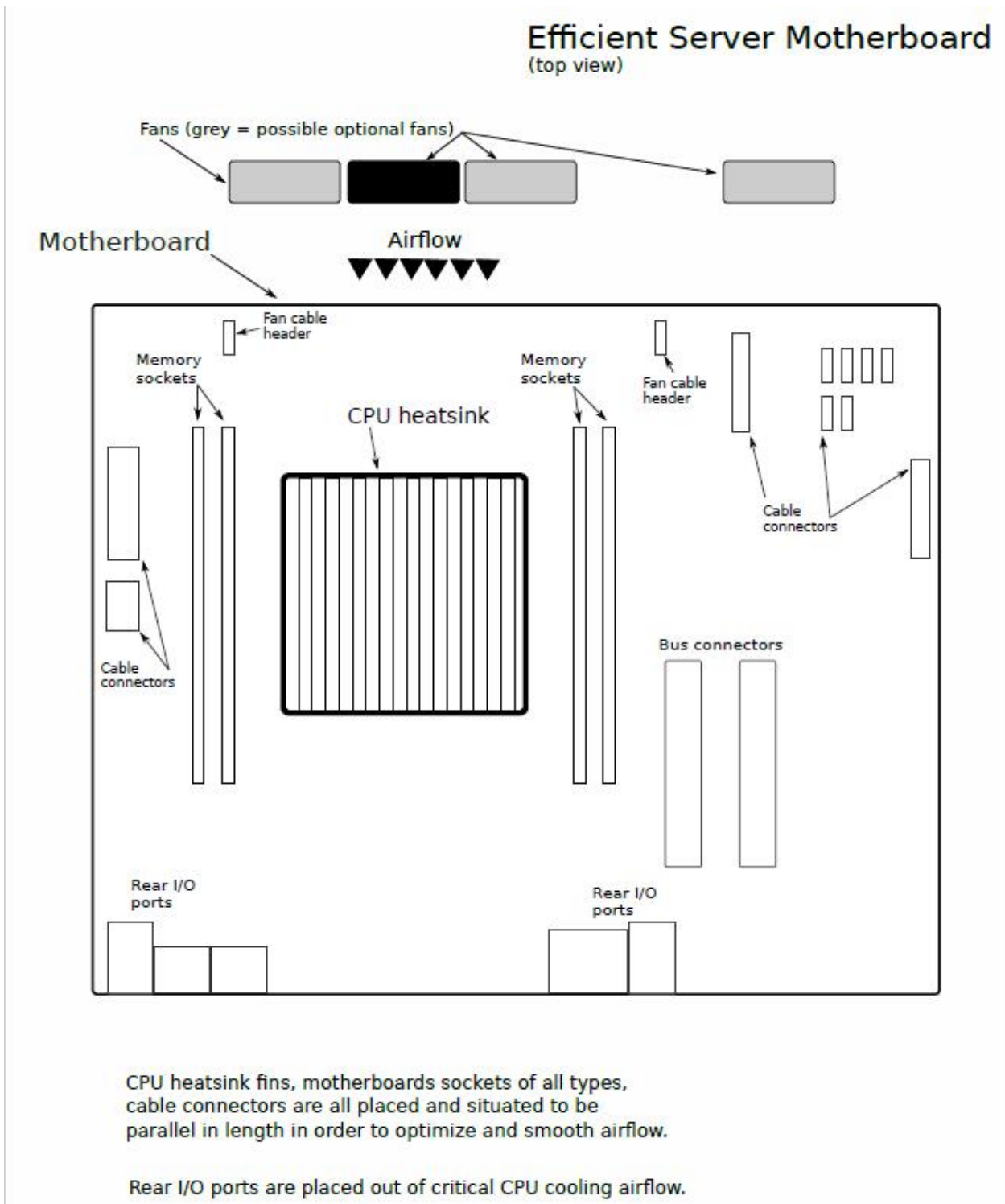Rear I/O ports are placed out of critical CPU cooling airflow.

Figure 5B Mother Board Side View Airflow

Side view
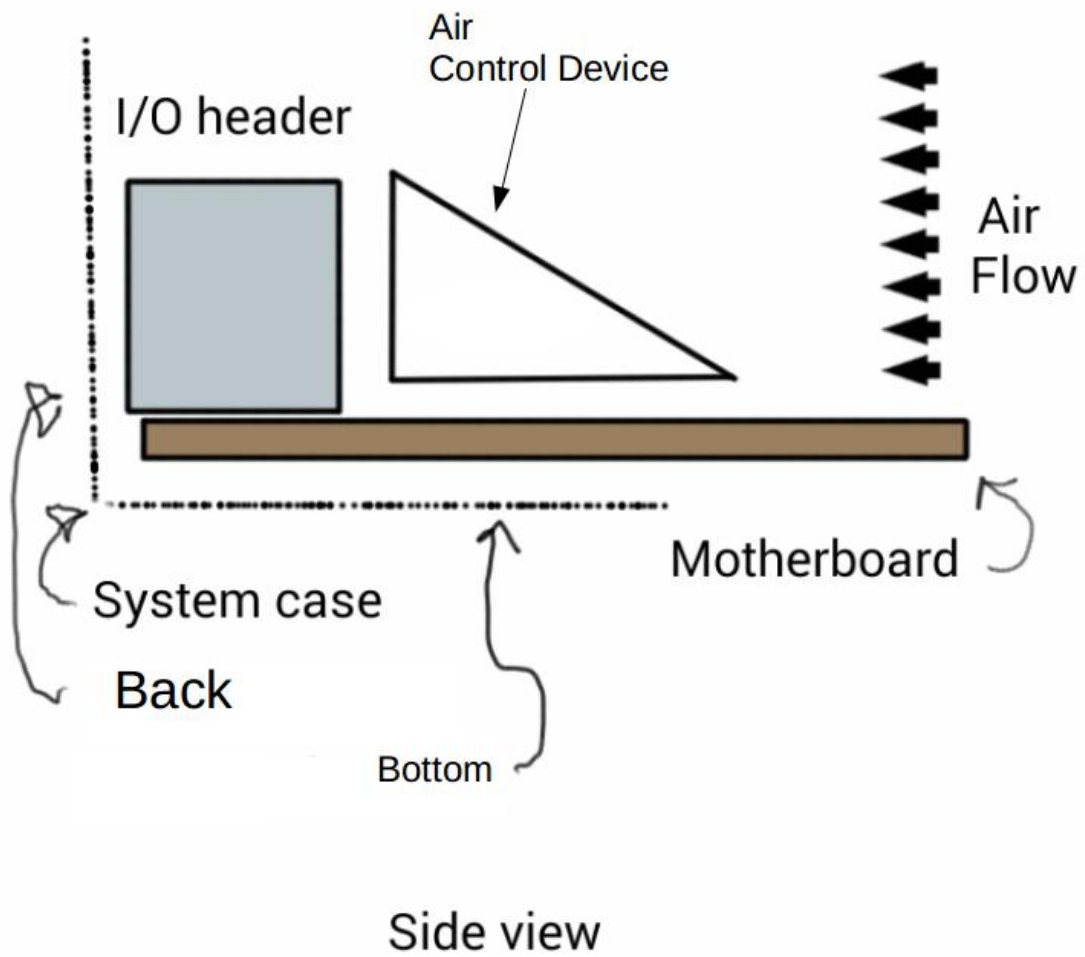
FIG 6

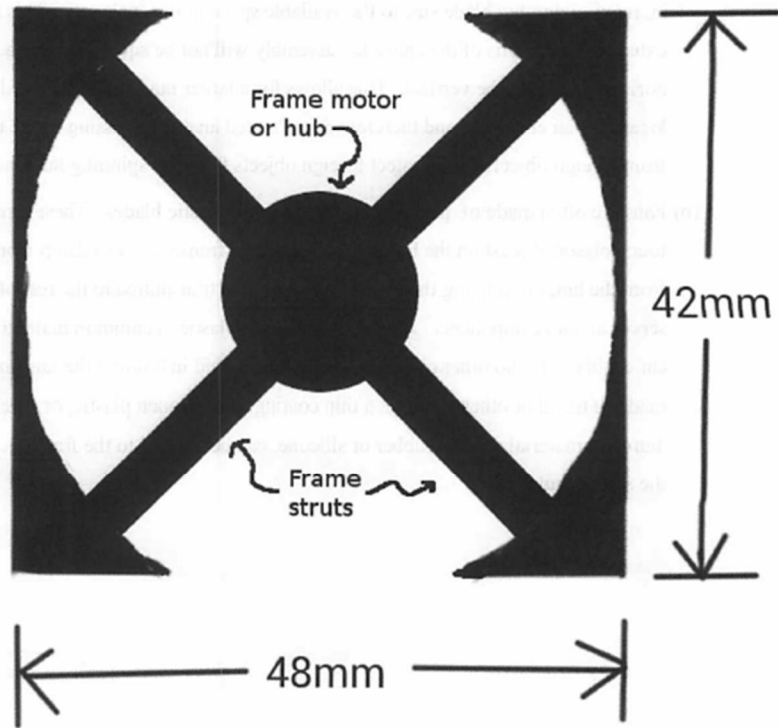Example drawing of fan with disappearing top and bottom frame segments. Fan blades not shown (frame only).

Frame motor or hub

Frame struts

42mm

48mm

FIG 7

I   **Example drawing of fan with disappearing top and bottom frame segments.**

42mm

48mm

Figure 9

Ultra Efficient Data Center Design

Set of test suites

Set of server configurations

test results per application

efficient server class data center subsections

Figure 8

side view

alt. 1

blockage device

alt. 2

Figure 10

top view

alt. 1

blockage device

alt. 2
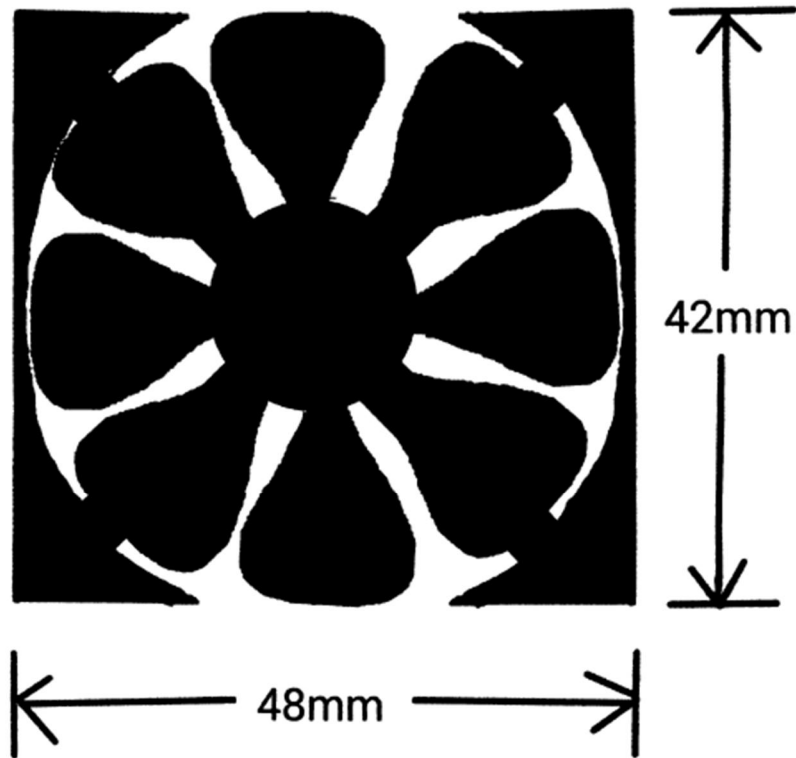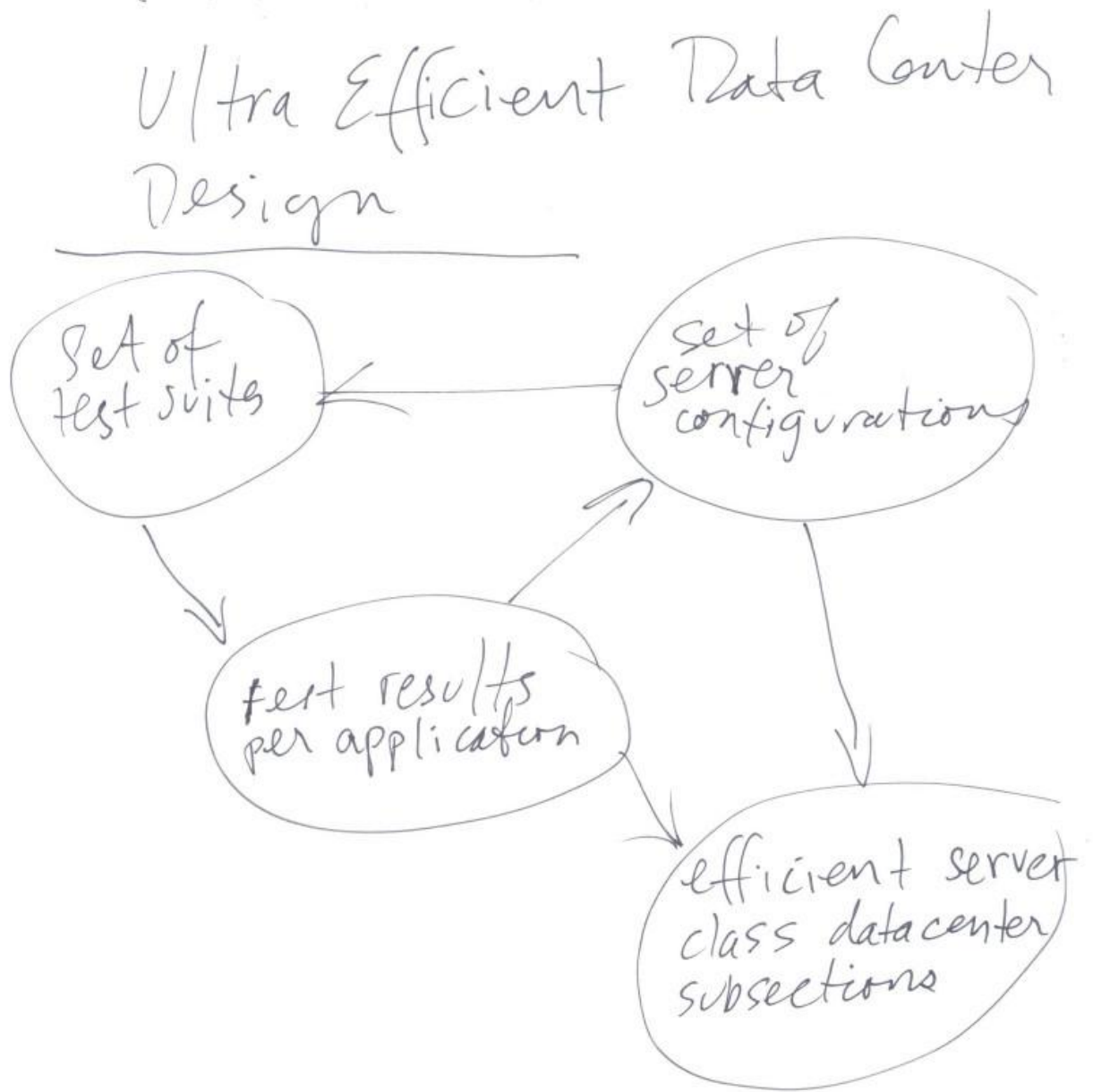
Ultra-Efficient Data Center

FIGURE 11

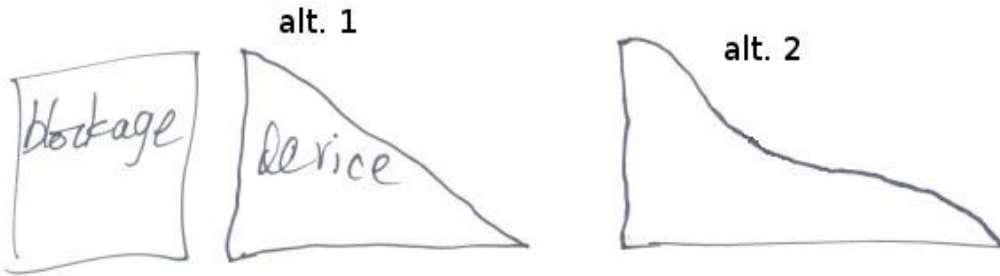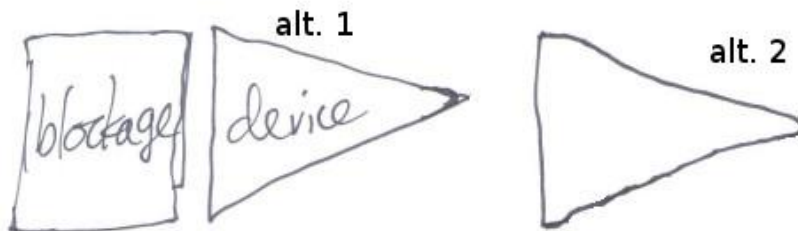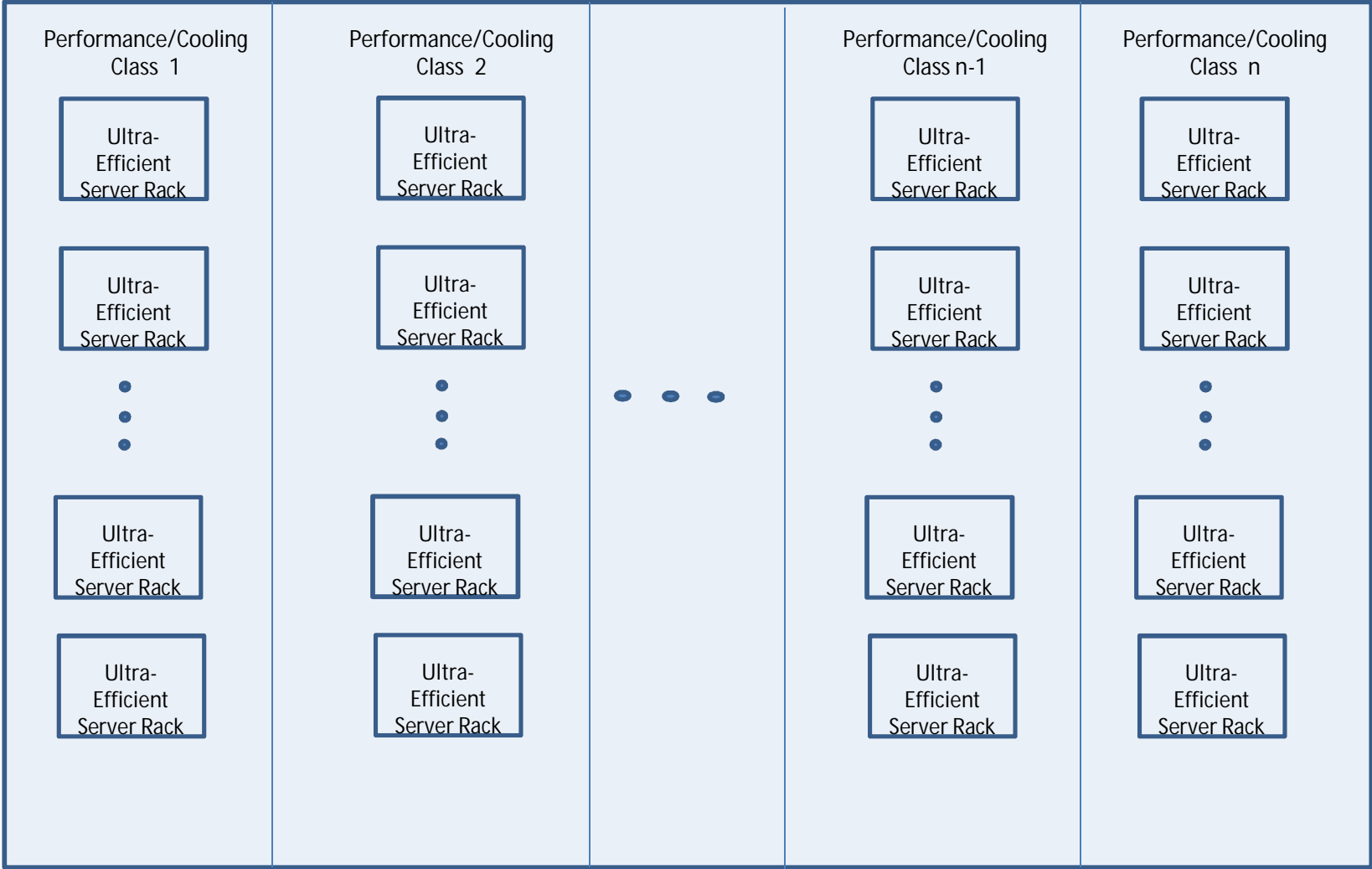| Performance/Cooling Class 1	Performance/Cooling Class 2		Performance/Cooling Class n-1	Performance/Cooling Class n
Ultra-Efficient Server Rack	Ultra-Efficient Server Rack		Ultra-Efficient Server Rack	Ultra-Efficient Server Rack
Ultra-Efficient Server Rack	Ultra-Efficient Server Rack		Ultra-Efficient Server Rack	Ultra-Efficient Server Rack
• • •	• • •	• • •	• • •	• • •
Ultra-Efficient Server Rack	Ultra-Efficient Server Rack		Ultra-Efficient Server Rack	Ultra-Efficient Server Rack
Ultra-Efficient Server Rack	Ultra-Efficient Server Rack		Ultra-Efficient Server Rack	Ultra-Efficient Server Rack

Diagram of Ultra-Efficient Data Center layout showing multiple racks of servers of different performance and cooling classes allowing highly efficient cooling provisioning and application migration based on application computational requirement. Highest performance is Class-1; lowest performance is Class-n.

FIGURE 11