Datacenter Organization

Single server:
- 4-8 cores
- DRAM: 4-16GB @ 100ns
- Disk: 2 TB @10ms

Rack:
- 50 machines
- DRAM: 200-800GB @ 300 μs
- Disk: 100TB @ 10ms

Row/cluster:
- 30+ racks
- DRAM: 6-24TB @ 500 μs
- Disk: 3 PB @ 10ms
Sun Containers
Sun Containers, cont'd
Google Containers
Microsoft Containers

COOLING: High efficiency water-based cooling systems—less energy-intensive than traditional chillers—circulate cold water through the containers to remove heat, eliminating the need for air-conditioned rooms.

STRUCTURE: A 24,000-square-meter facility houses 4,000 containers. Delivered by trucks, the container stack in a spine in the structure that feeds network connectivity, power, and water. The data center has one conventional data floor.

POWER: Two power substations feed a total of 1,000 megawatts to the data center, with 300 MW used for computing equipment and 700 MW for cooling and electrical losses. Two towers and generators provide backup power.

CONTAINS: Each 65-square-meter container houses 2,500 servers, about 30 times as many as conventional data centers packed in the same space. Each container integrates computing, networking, power, and cooling systems.

The Million-Server Data Center

Today's most advanced data centers house tens of thousands of servers. What would it take to house 1 million?
Microsoft Containers, cont'd
Failures are Frequent

Typical first year for a new cluster (Jeff Dean, Google):

- ~0.5 overheating (power down most machines in <5 mins, ~1-2 days to recover)
- ~1 PDU failure (~500-1000 machines suddenly disappear, ~6 hours to come back)
- ~1 rack-move (plenty of warning, ~500-1000 machines powered down, ~6 hours)
- ~1 network rewiring (rolling ~5% of machines down over 2-day span)
- ~20 rack failures (40-80 machines instantly disappear, 1-6 hours to get back)
- ~5 racks go wonky (40-80 machines see 50% packet loss)
- ~8 network maintenances (4 might cause ~30-minute random connectivity losses)
- ~12 router reloads (takes out DNS and external vips for a couple minutes)
- ~3 router failures (have to immediately pull traffic for an hour)
- ~dozens of minor 30-second blips for DNS
- ~1000 individual machine failures
- ~thousands of hard drive failures
- Slow disks, bad memory, misconfigured machines, flaky machines, etc.

- Long distance links: wild dogs, sharks, dead horses, drunken hunters, etc.
How Many Datacenters?

- 1-10 datacenter servers/human?
- 100,000 servers/datacenter

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<thead>
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<th>U.S.</th>
<th>World</th>
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<tbody>
<tr>
<td>Servers</td>
<td>0.3-3B</td>
<td>7-70B</td>
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<tr>
<td>Datacenters</td>
<td>3000-30,000</td>
<td>70,000-700,000</td>
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- 80-90% of general-purpose computing in datacenters?