Uptime Institute®

Disruptive Data Center Technologies

13 technologies driving a wave of change

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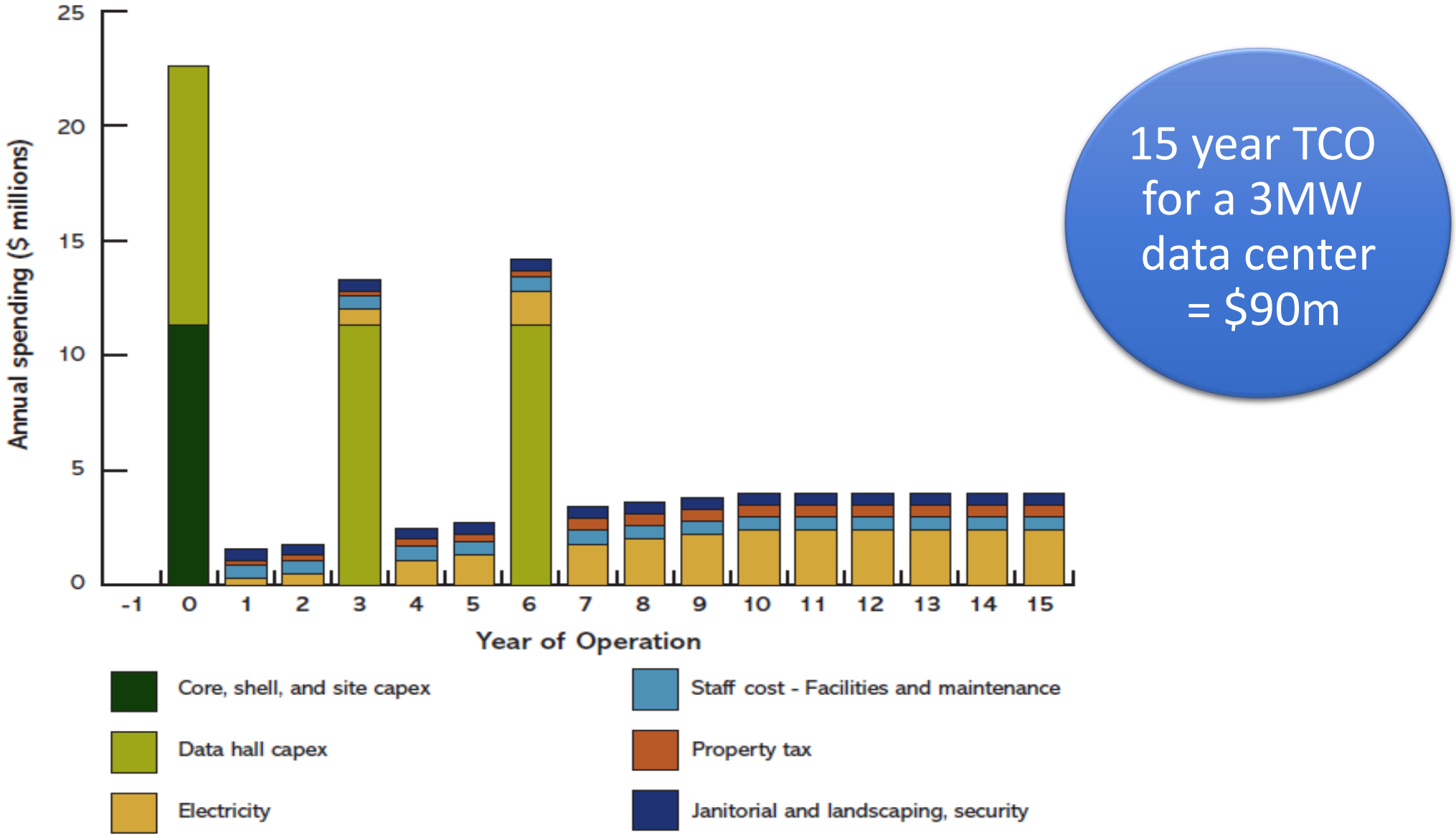
Disruptive process

Half of data center costs committed up front



15 year TCO for a 3MW data center = $90m

Building data centers ….

"Building semiconductors is like
playing Russian roulette.

You put a gun to your head, pull the trigger
& find out four years later if you blew your brains out."

- Robert Palmer, former CEO of Digital Equipment

Disruptive metrics

- How big the impact will be
- How fast it will happen
- How likely it is to happen

- Final metric made up of 12 sub-metrics
- Assessed by 27 experts from:
  - Uptime Institute
  - 451 Research
  - Handful of vendor execs
- Not a ranking – an informed view

What the ratings mean…

5	Prepare for competitive, disruptive change now
4	Assess how it will affect your business – some impact likely soon
3	Watch closely, but impact not immediate
2	Background development – no need to watch closely
1	Impact remote, minor or unrealistic

Disruptive assessment

- Technology has low or no adoption
- ***Could*** enjoy very high adoption if fulfills evangelists' promises
- ***Could*** upset the economics/technical design of existing/new DCs
- ***Could*** upset the roadmap, products, supply chain of product suppliers

Technologies *not* considered

COOLING	POWER DISTRIBUTION	CORE IT
• Ground source cooling • Refrigerant additives • Thermal energy storage	• Direct current • Medium voltage • Power over Ethernet	• Exascale server computing • Mixed-core servers • Quantum computing • Nano photonics
DATA STORAGE	**ENERGY STORAGE & RE-USE**	**DATA CENTER DESIGN & FORMAT**
• Advanced storage management • Tiered storage	• Combined heat & power (co-generation) • Flywheel UPS • Air compression energy storage	• Multi-tier data centers
POWER GENERATION	***And* virtualization, multicore processors, the cloud…**	
• Cogeneration		

1. Micro-modular embedded data centers

- Self-contained, hardened cabinets for use in non-data centers
- Highly integrated, indoor or outdoor, wide capacity range

PRO	CON
'Plug & play' installation	Costs more over low-spec closets
Rapid delivery	Different operational practices

DISRUPTOR DRIVER

Edge - growing demand for distributed IT closer to demand

2. Storage-class memory

- Holy Grail of computing - combines persistence of storage with the speed of operational memory
- In early production, others promise delivery soon

PRO	CON
Faster data access	Marginal gains in storage arrays
Instant hibernation/recovery	Unproven

DISRUPTOR DRIVER

Brings much more data ‘closer’ to processors
No need for 2N distribution/UPS for non-critical workloads

3. Silicon photonics

- Fiber optic links directly integrated in semiconductor chips, without the need for discrete electrical-optical conversion

PRO	CON
Cheaper yet faster than copper	Limited availability, risk of vendor lock-in Only makes $ sense at scale

DISRUPTOR DRIVER

IT subsystem disaggregation & pooling without loss of performance
Potential for much higher resource utilization

4. Data center microgrids

- Localized energy sources for increased energy security
- Often tied to utility but can disconnect (island mode operation)

PRO	CON
Energy assurance Energy security	Utility costs are often low Added capex, geo limits, expertise

DISRUPTOR DRIVER

Choice of energy sources, using renewables for cost optimization & carbon reduction

5. Software-defined power

- Power as a pooled resource, matched to IT load needs
- Automated capping, re-routing, storing & discharging energy

PRO	CON
Dynamic capacity management Higher utilization	Data integration Moves risks to software; complex ROI

DISRUPTOR DRIVER

Much leaner power capacity, lower redundancy & higher utilization → lower capex

6. Data center management as a service (DMaaS)

- Encrypted data in a vendor cloud for big data, AI analytics
- Enables predictive maintenance, higher efficiencies

PRO	CON
Lowered risk via additional scrutiny Best practices	Data security Reliance on third parties, latency issues

DISRUPTOR DRIVER

Insights that no single operator can produce
Asset as a service?

7. Distributed resiliency

- Spreading workloads across sites using networks, data replication, load balancing & traffic switching
- Resiliency migrates up to the IT level

PRO	CON
Higher availability of business services Lower need for gensets	Costs are unclear (incl. networking) Legacy applications

DISRUPTOR DRIVER

Improves business survivability without expensive single-site facility infrastructure

8. Direct liquid cooling

- Delivering liquid, directly or indirectly, to chips
- 2 major types: cold plates (liquid in a heat sink) on chips & full immersion

PRO	CON
Lower power via elimination of fans	Added complexity, operational changes
Higher reliability	Added cost in air-cooled facilities

DISRUPTOR DRIVER

Higher sustained processing speeds & more IT capacity in a power envelope

9. Chiller-free data centers

- Trend: lower mechanical refrigeration, however, most retain for backup
- Next step: complete elimination for financial prudence

PRO	CON
Lower capex & simpler maintenance	IT managers are against wide temp bands
More power available to IT load	Split budgets mean no gain for IT people

DISRUPTOR DRIVER

Fears over IT failure rates will likely diminish while pressures to reduce excess capital spend on cooling will grow

10. Open source infrastructure

- Open Compute Project & Open19 – next stage of IT commoditization
- More rack-integration of power, relaxed climatic specs

PRO	CON
Eliminates 15%-30% costs (IT & facility)	Immature supply chain May require organizational change

DISRUPTOR DRIVER

Cuts costs, operational complexity, improves efficiency

11. Post-silicon computing

- New semiconductor compounds, such as gallium
- Spintronic devices
- Mott transition devices

PRO	CON
Ultra-low-power logic & memory Denser integration = chip-design agility	Unlikely to be available until 2025 onward Software dev & instruction set complexity

DISRUPTOR DRIVER

A dramatic drop in IT systems' power & footprints could potentially change data center facility demand

12. Application-optimized data center

- Data center designs for specific capacity, density, reliability, climatic & security requirements of major IT & business use cases
- Application-optimized environments

PRO	CON
Right-sized infrastructure	Organization & procurement disruption
Higher efficiency, lower costs per app	Aesthetics of small, app-specific sections

DISRUPTOR DRIVER

Greater alignment between infrastructure design & use cases will drive down costs

13. Data center as a machine

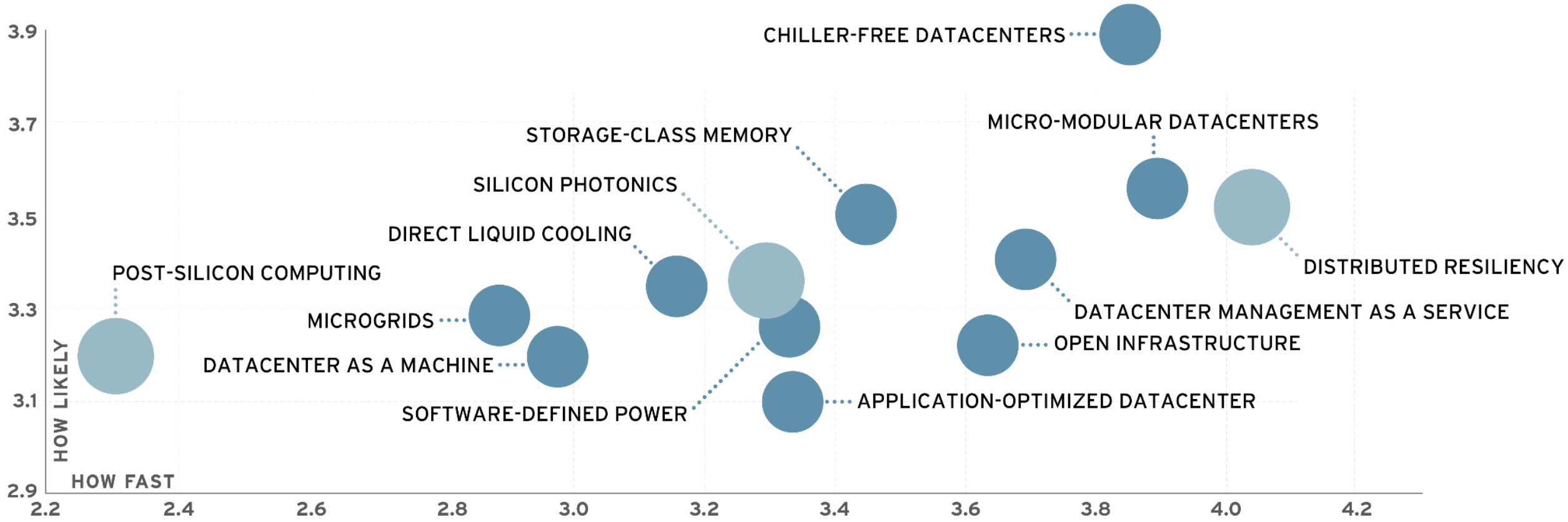
- Self-regulating data centers, unstaffed by design
- Software-controlled component integration, remote AI-driven management

PRO	CON
High temps & density, space efficient Low TCO (high capex, low opex)	Unproven tech (robots, distr. resiliency, etc.) Health & safety, & other regulatory issues

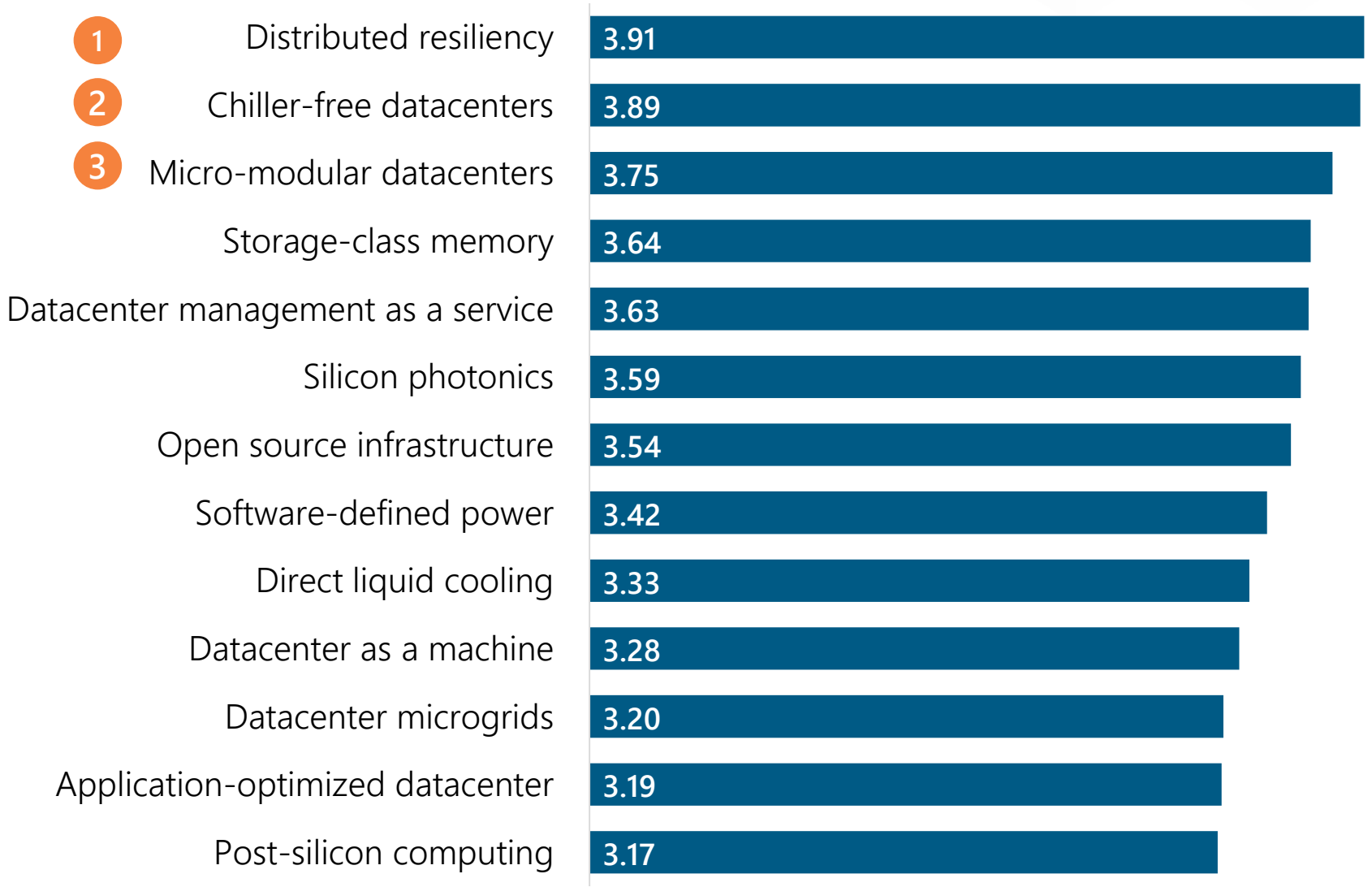
DISRUPTOR DRIVER

Data centers can operate with higher efficiency, availability & security, incl. in urban & industrial environments

How the technologies map out…



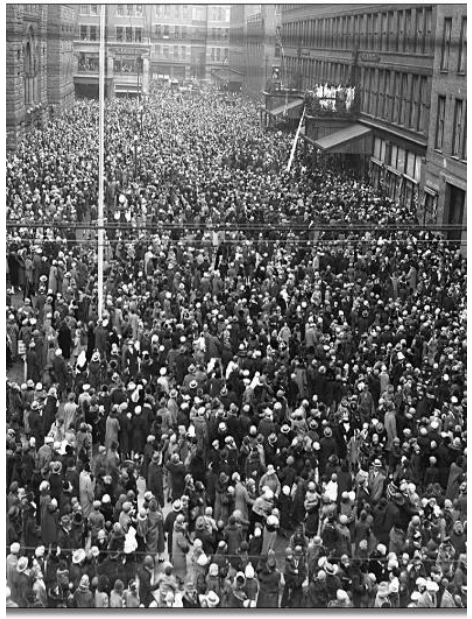
Disruptive Score



Expert panel vs user pool?

27 experts

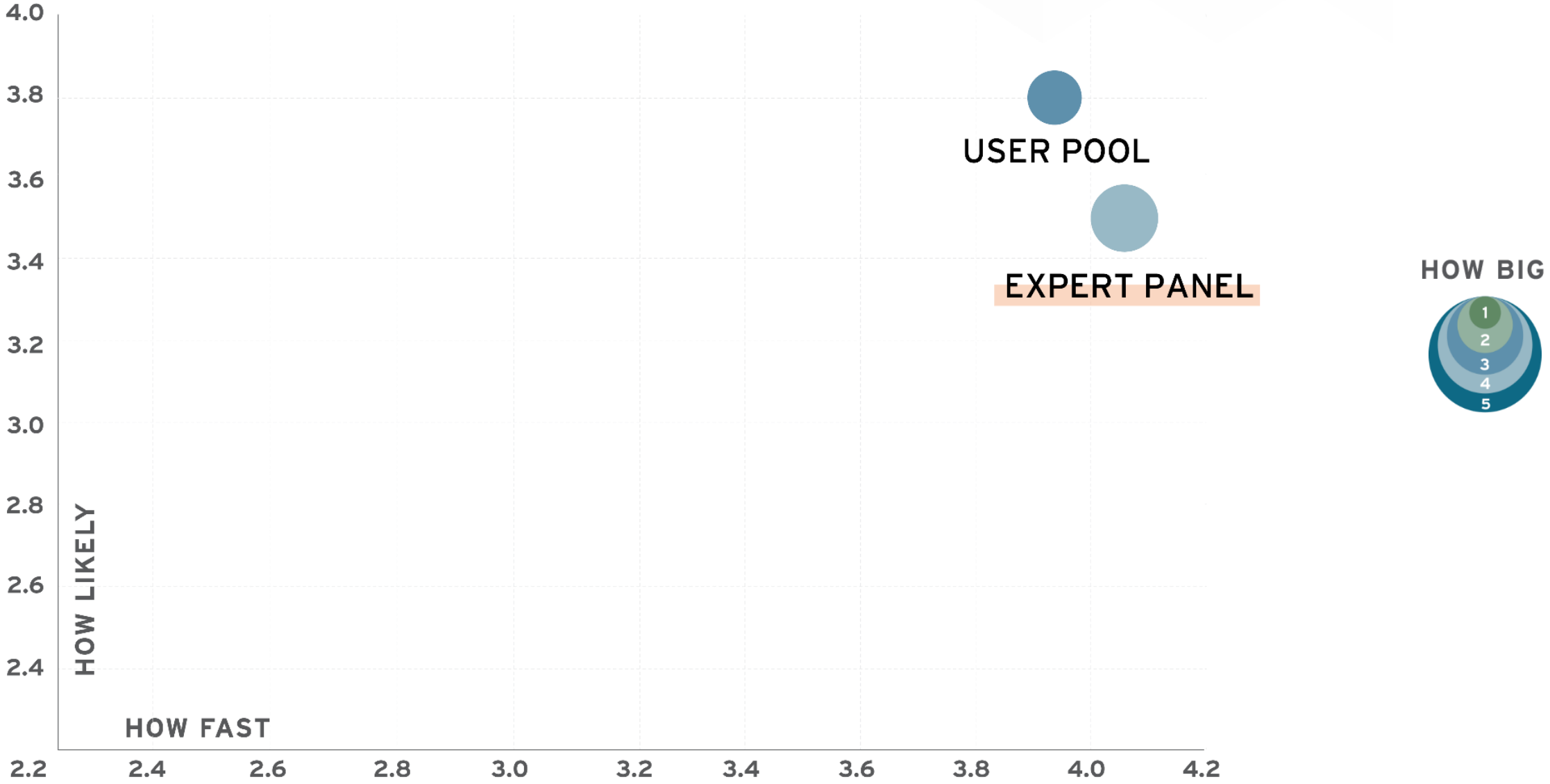
- Uptime Institute
- 451 Research
- Handful of vendor execs



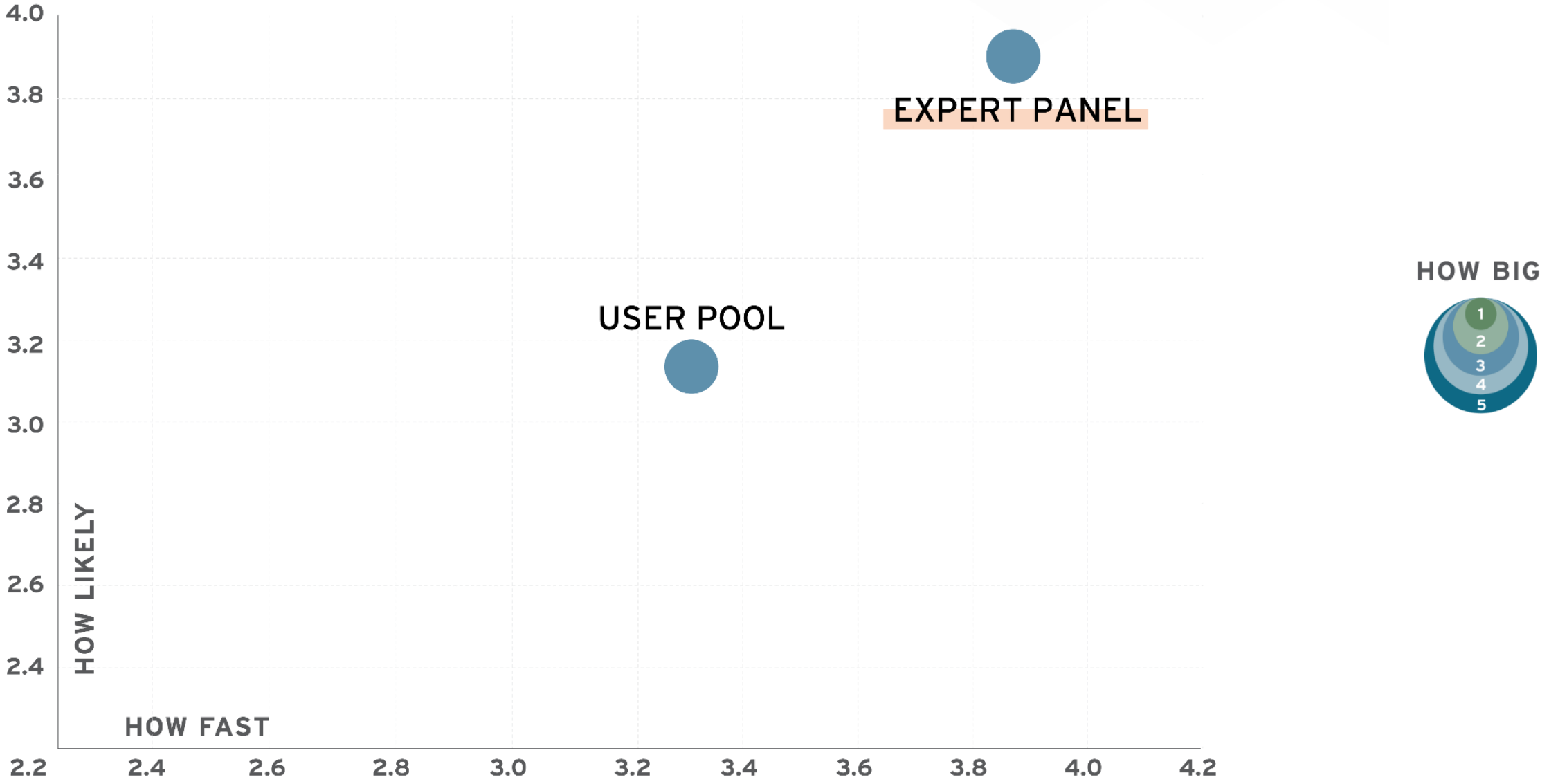
600 users

- VPs, C-level execs
- IT & facilities managers
- Data center design engineers

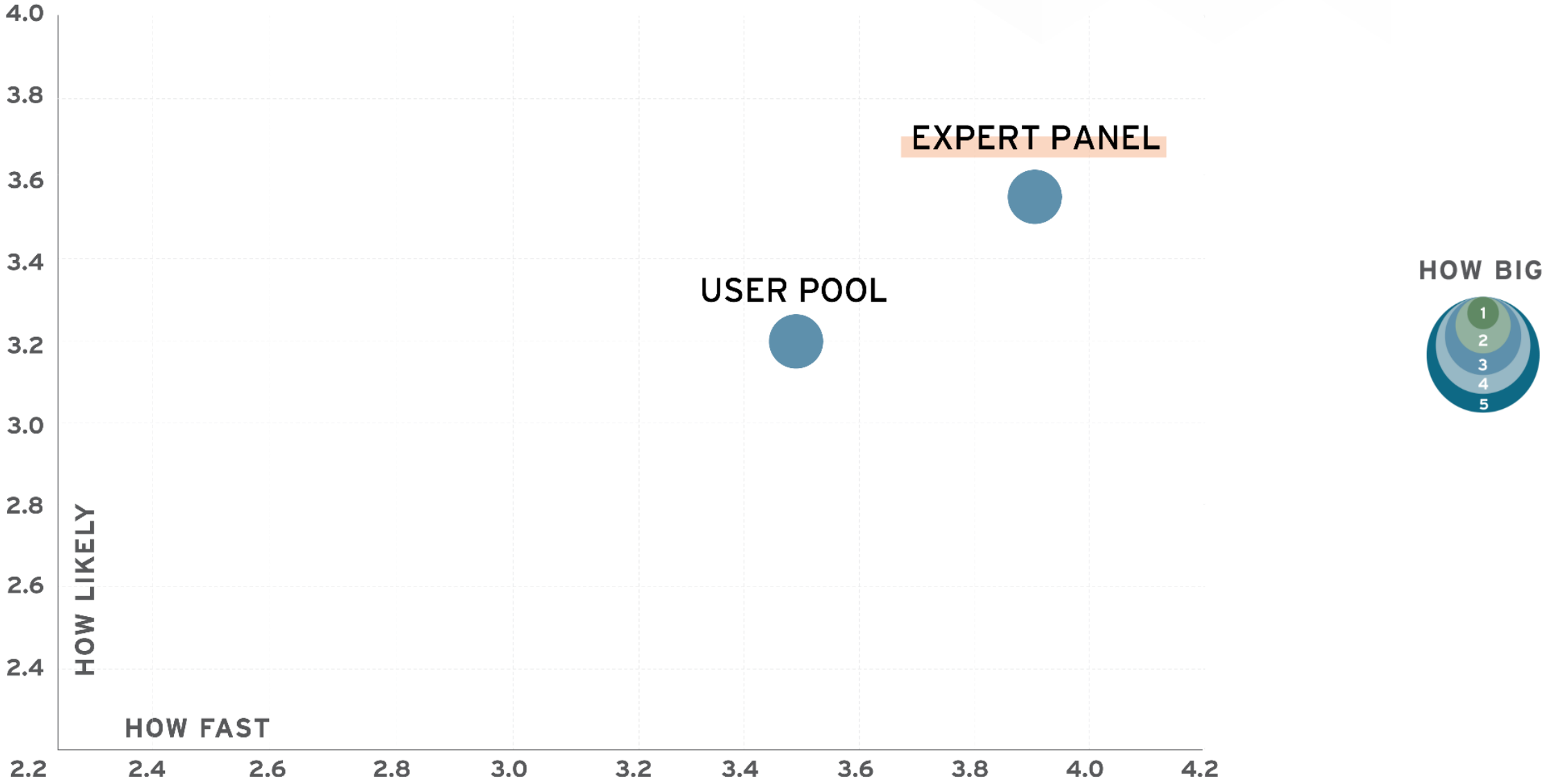
#1 Distributed resiliency



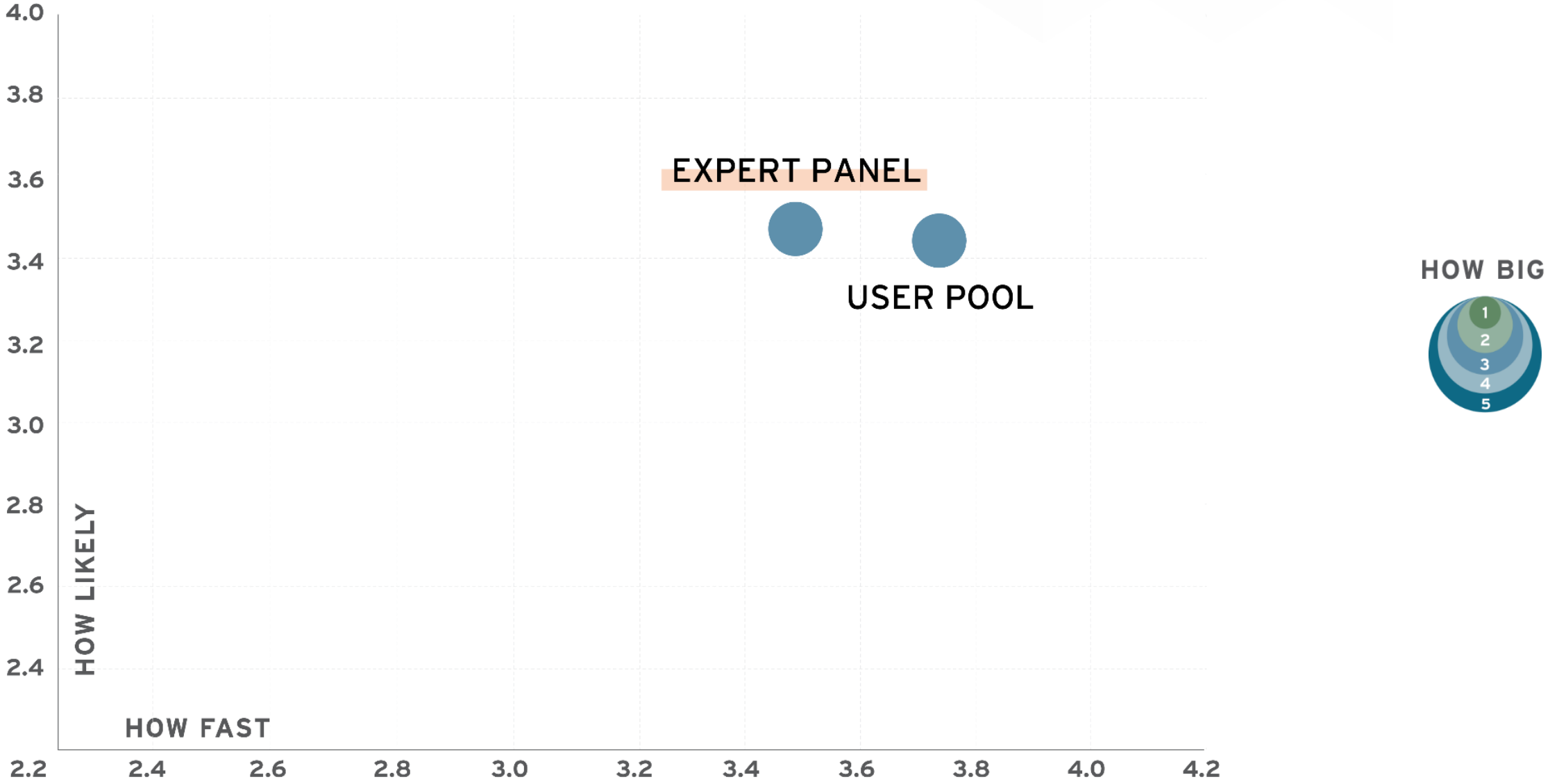
#2 Chiller-free data centers



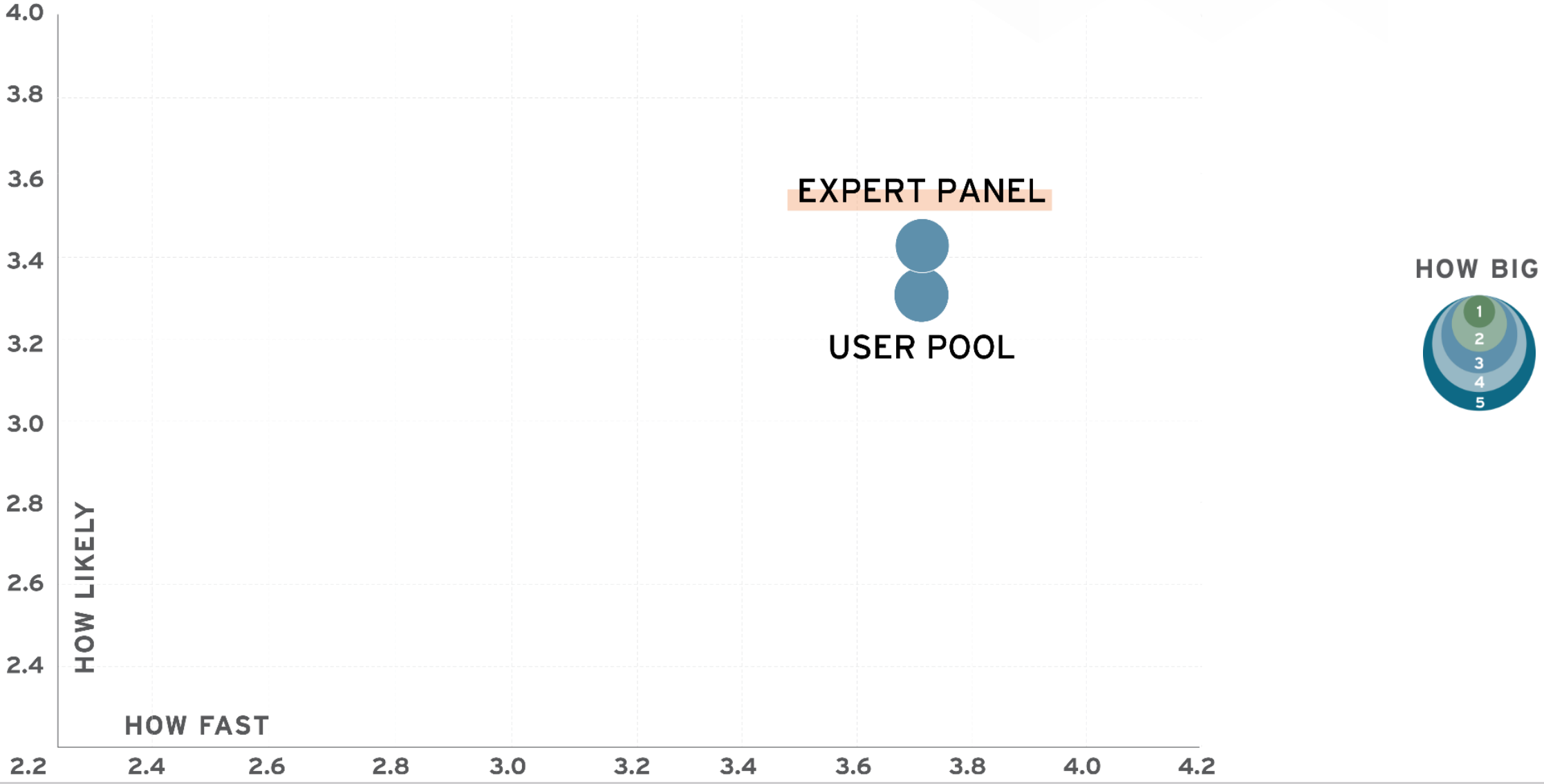
#3 Micro modular data centers



#4 Storage class memory



#5 DMaaS


4.0
3.8
3.6
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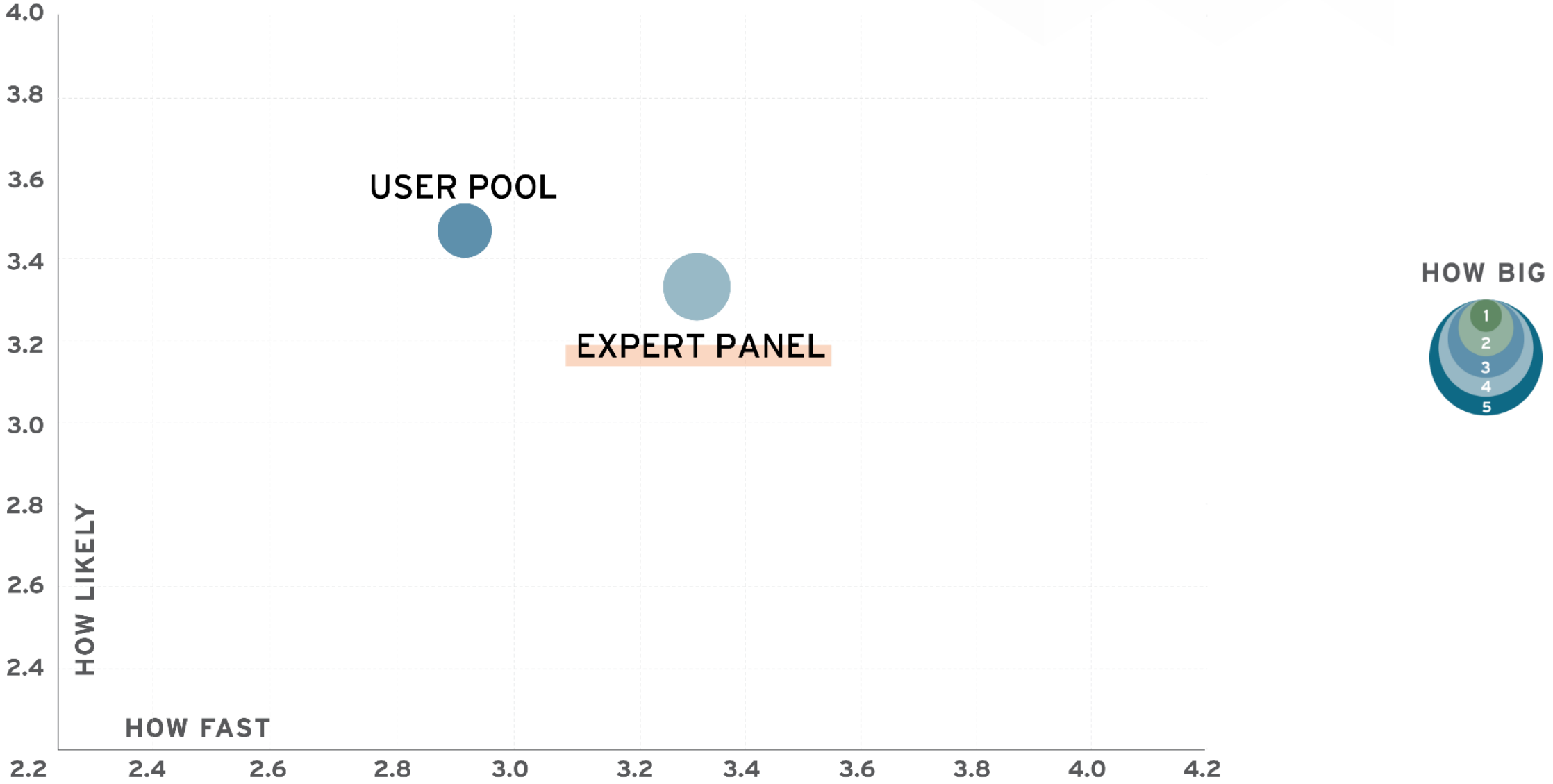
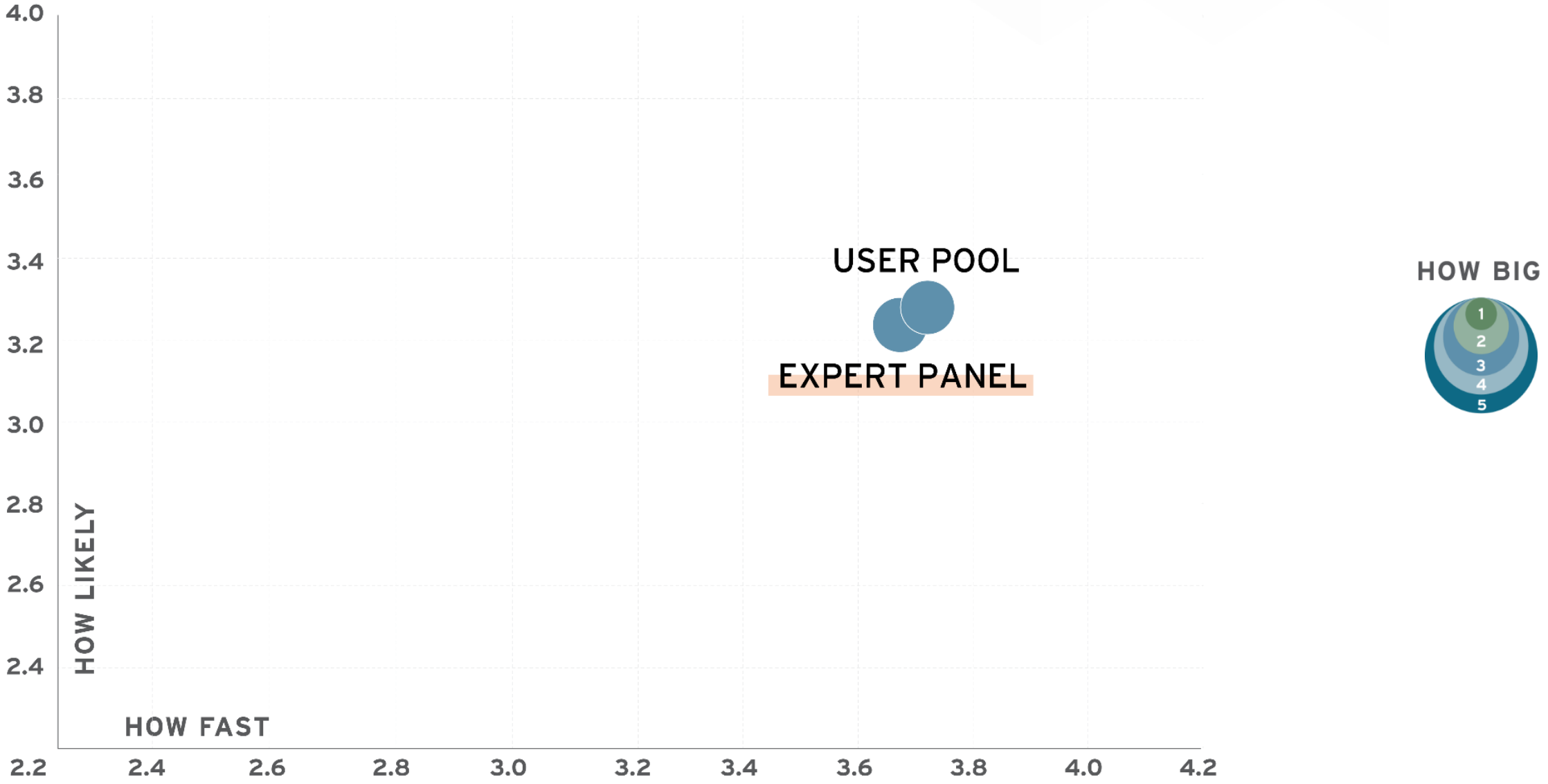
3.2
3.0
2.8
2.6
2.4
HOW LIKELY
HOW FAST
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
EXPERT PANEL
USER POOL
HOW BIG
1
2
3
4
5

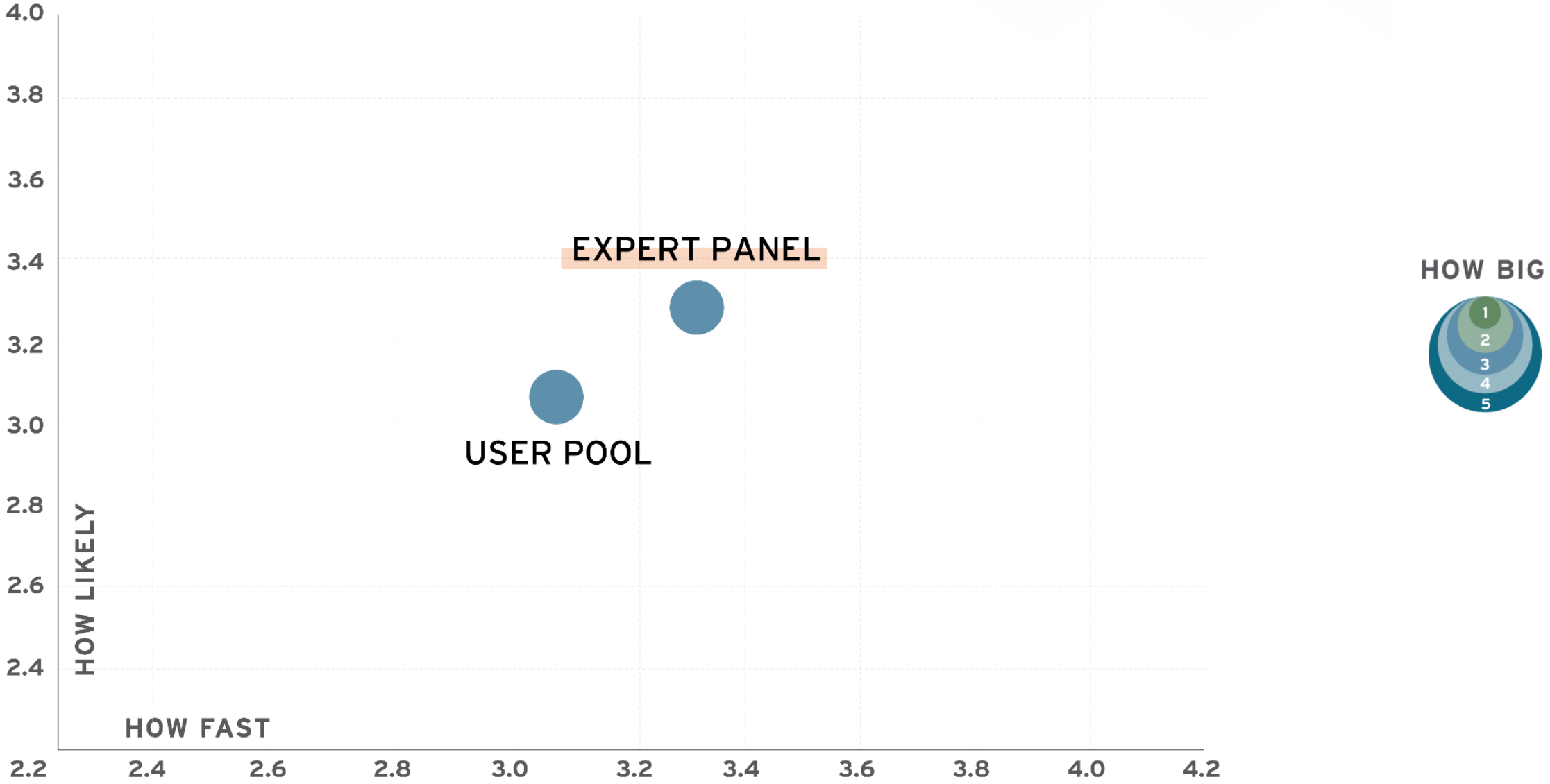
#6 Silicon photonics



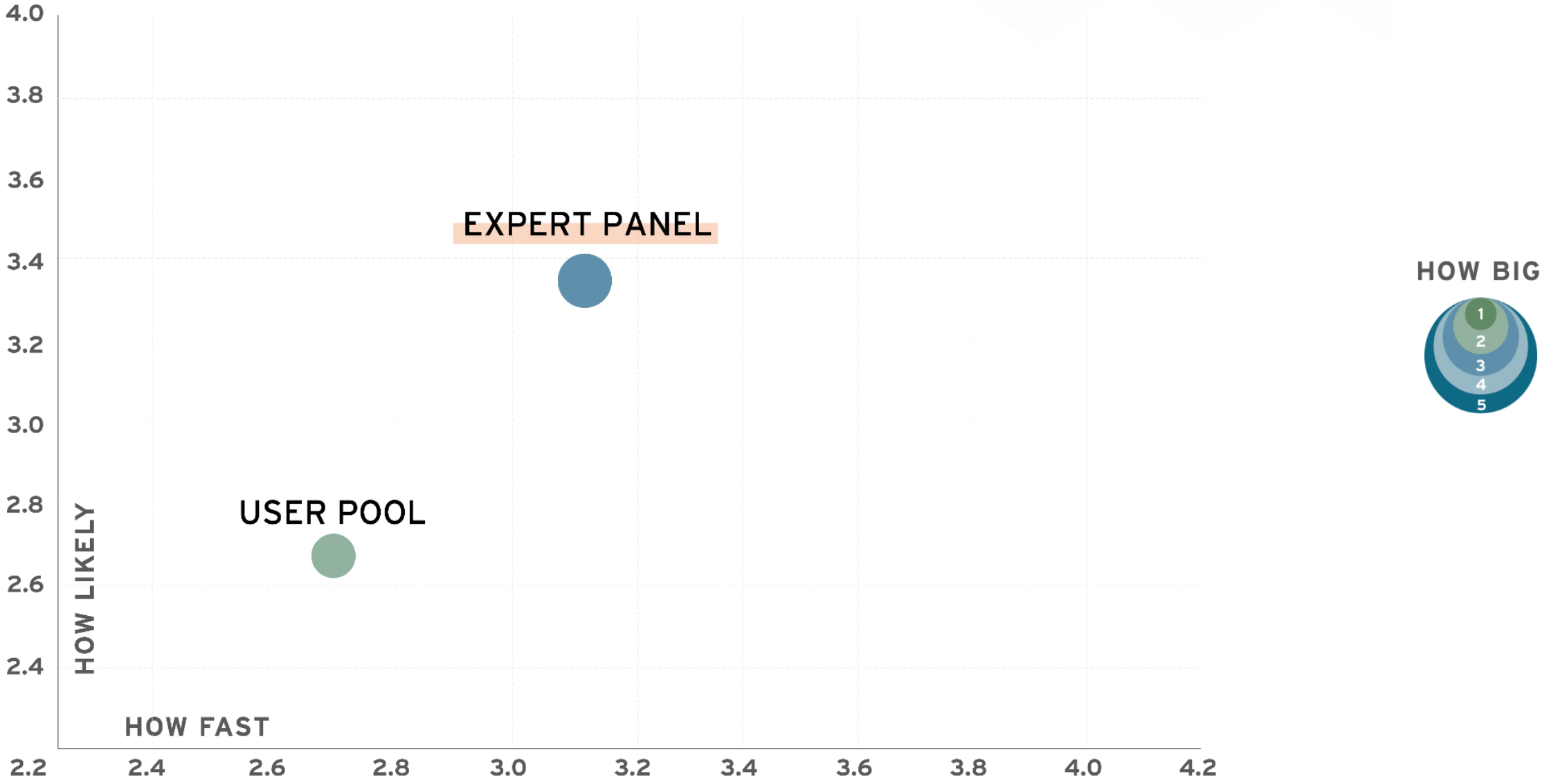
#7 Open source infrastructure



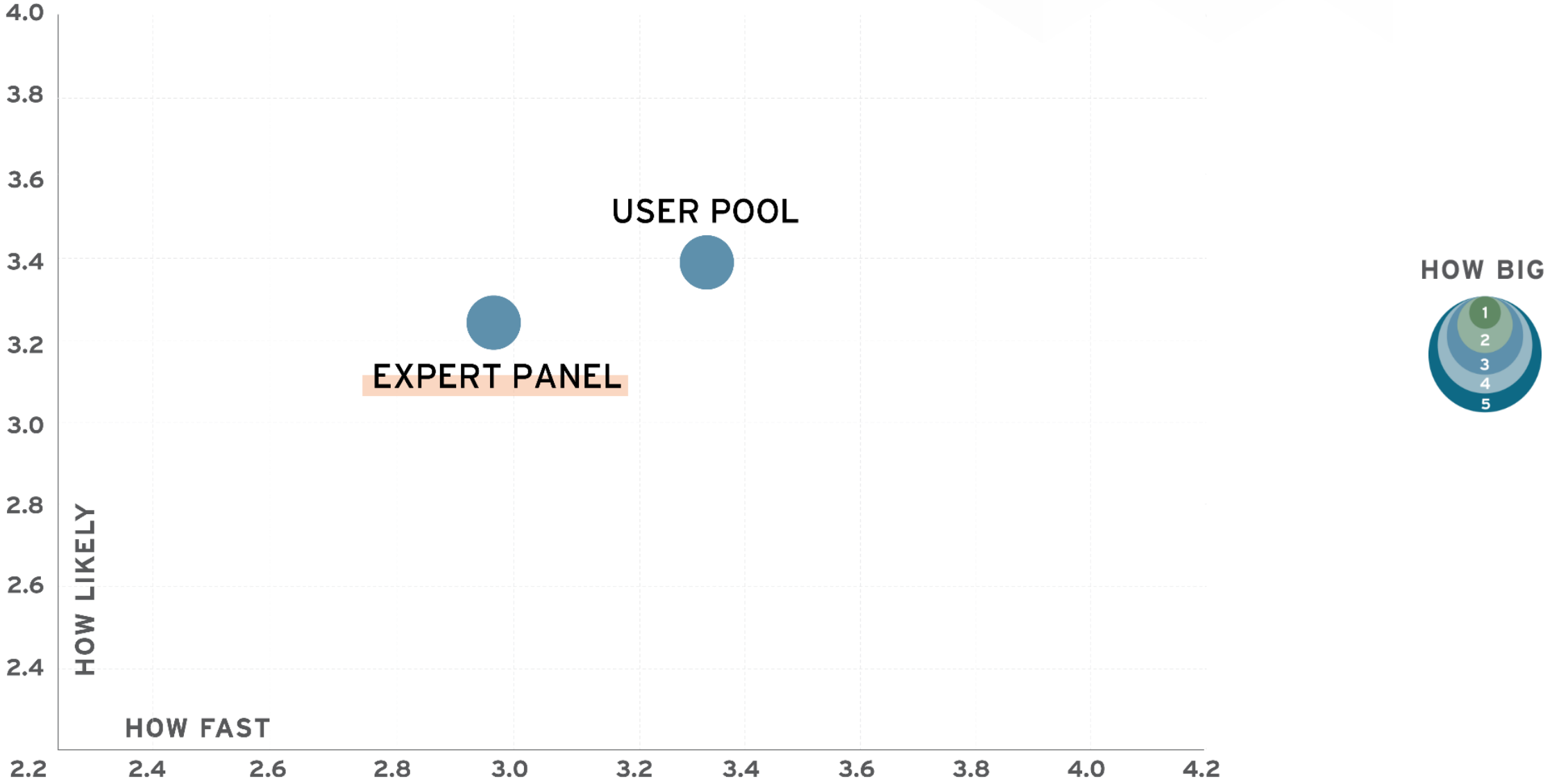
#8 Software-defined power



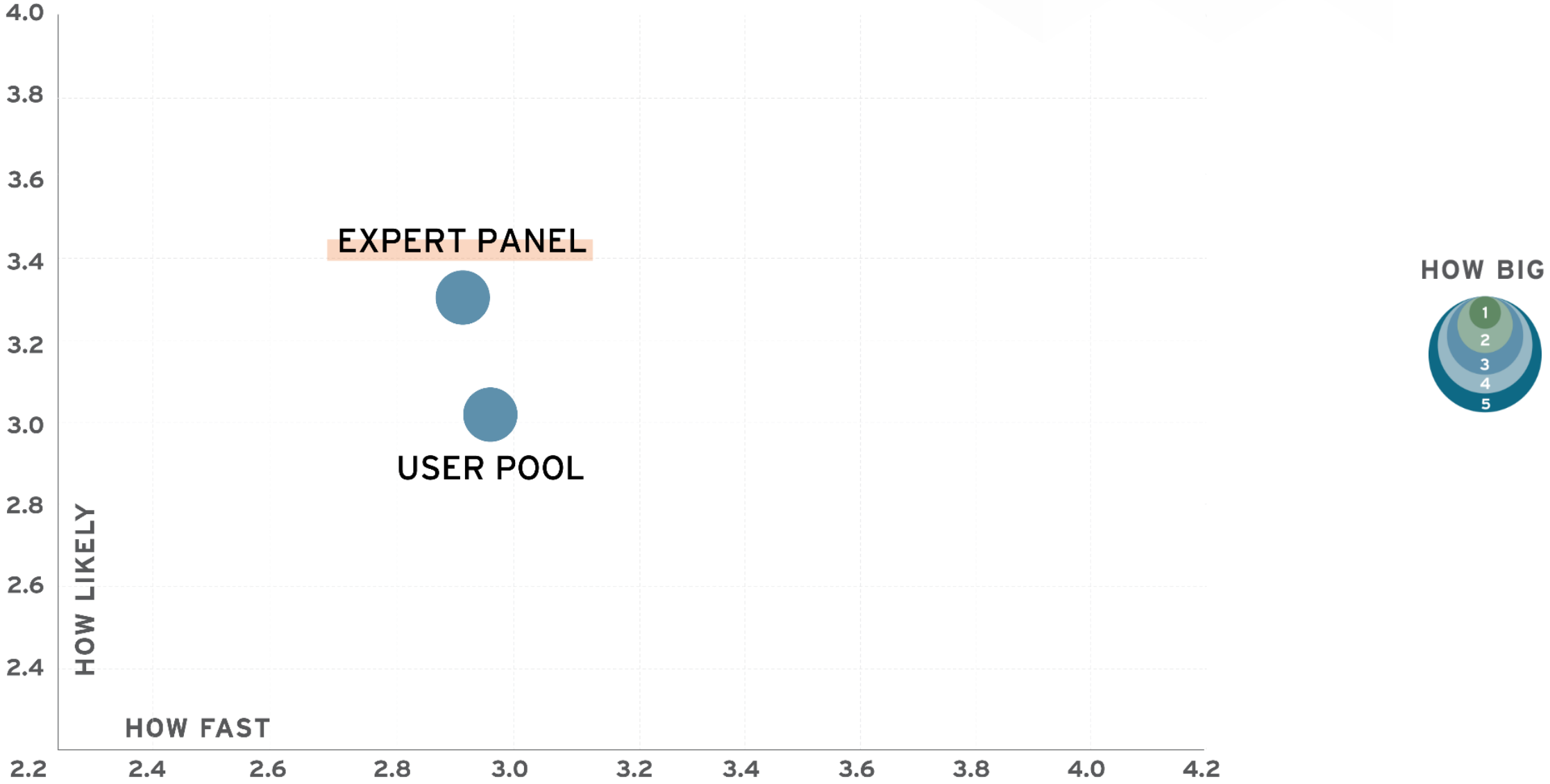
#9 Direct liquid cooling



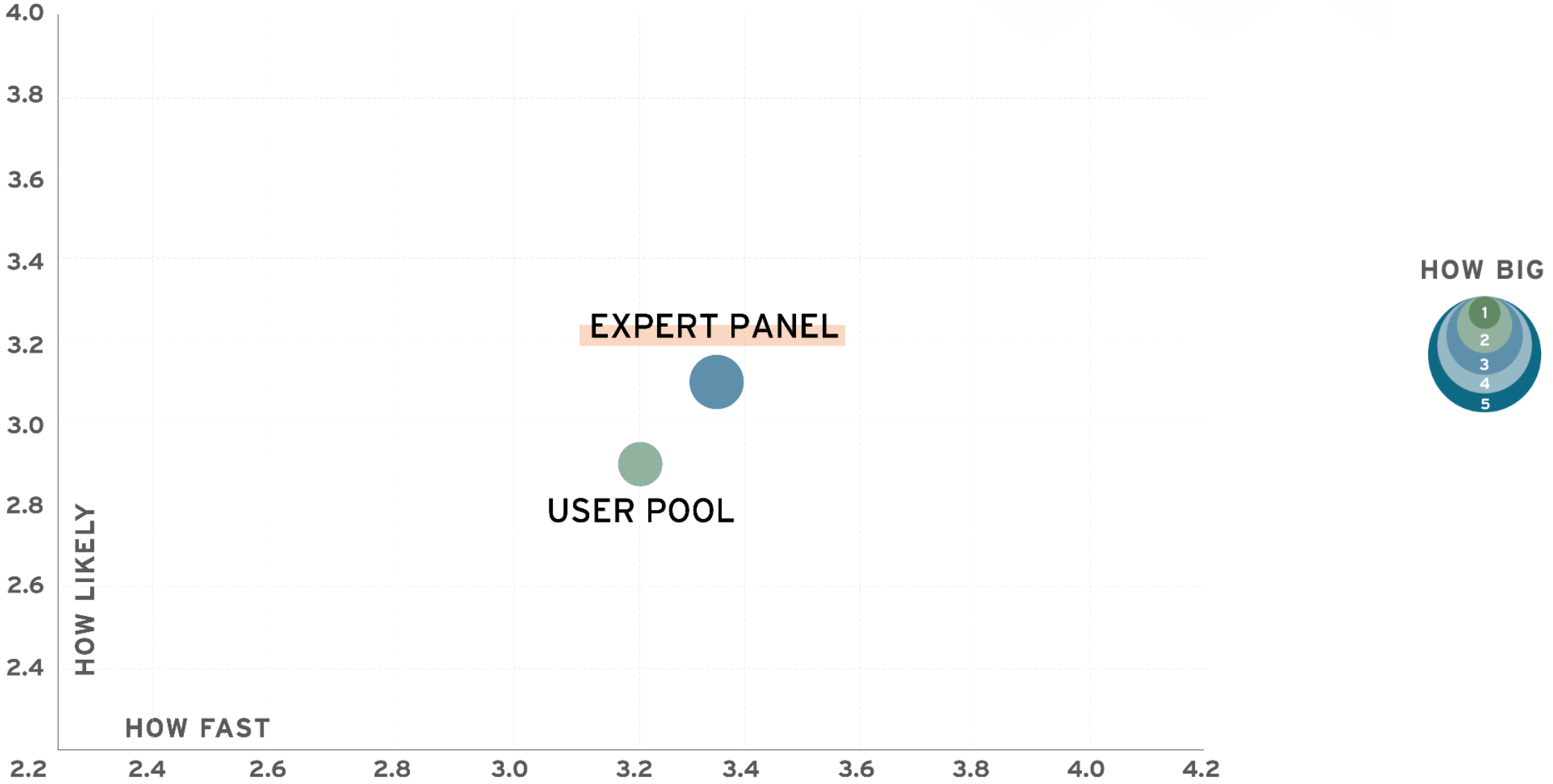
#10 Data center as a machine



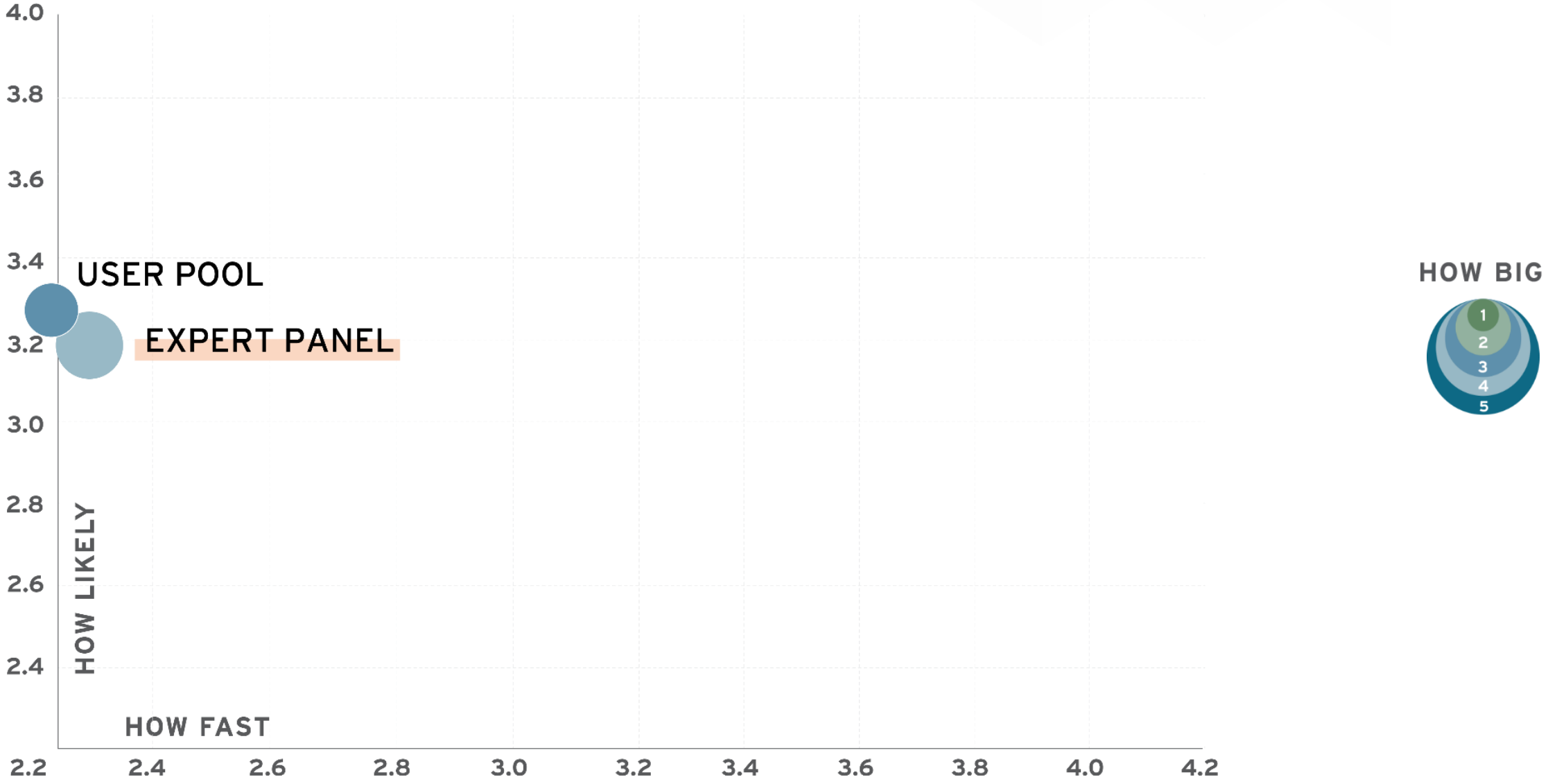
#11 Data center microgrids



#12 Application-optimized data center

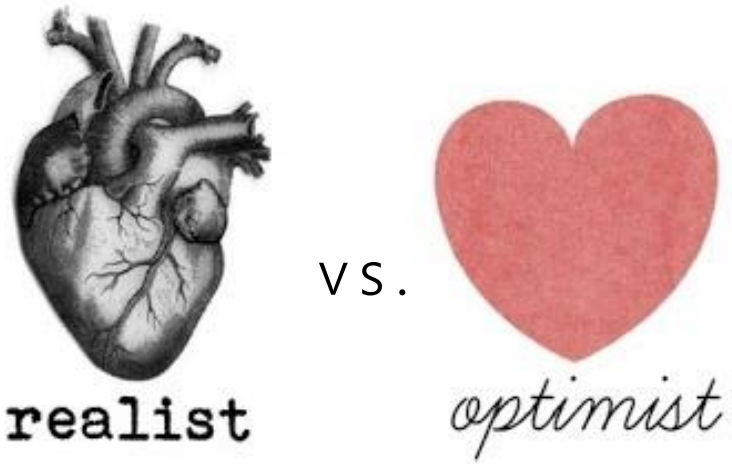


#13 Post-silicon computing



Expert panel vs user pool

- **Experts bullish on:**
  - Chiller-free data centers
  - Direct liquid cooling
  - Silicon photonics
  - Micro-modular data centers
- **Users more bullish on:**
  - Storage-class memory
  - Open-source infrastructure
  - Data center as a machine



Discussion

- Capacity planning is critical
- The data center is already being disrupted
- Data centers will become far more efficient
- Assess the top technologies now

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