# Unlocking the full value of DERs

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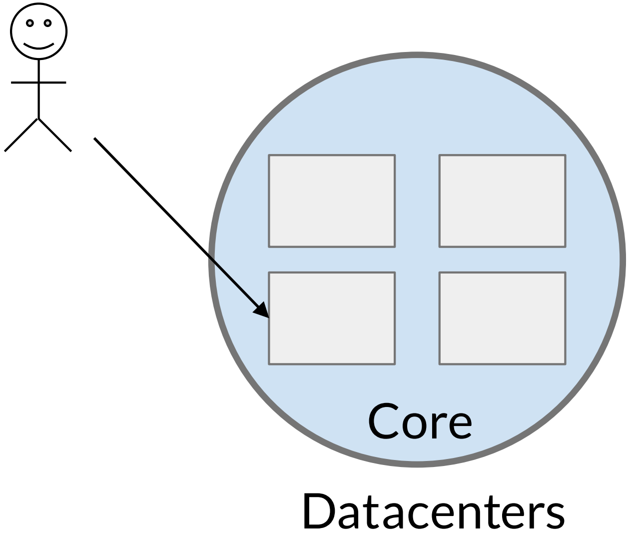
- System design: What does it take to incorporate distributed resources effectively?
- Value structure: Who pays, and how much?

# Lessons from edge computing

# Internet-scale serving at 99.999% reliability

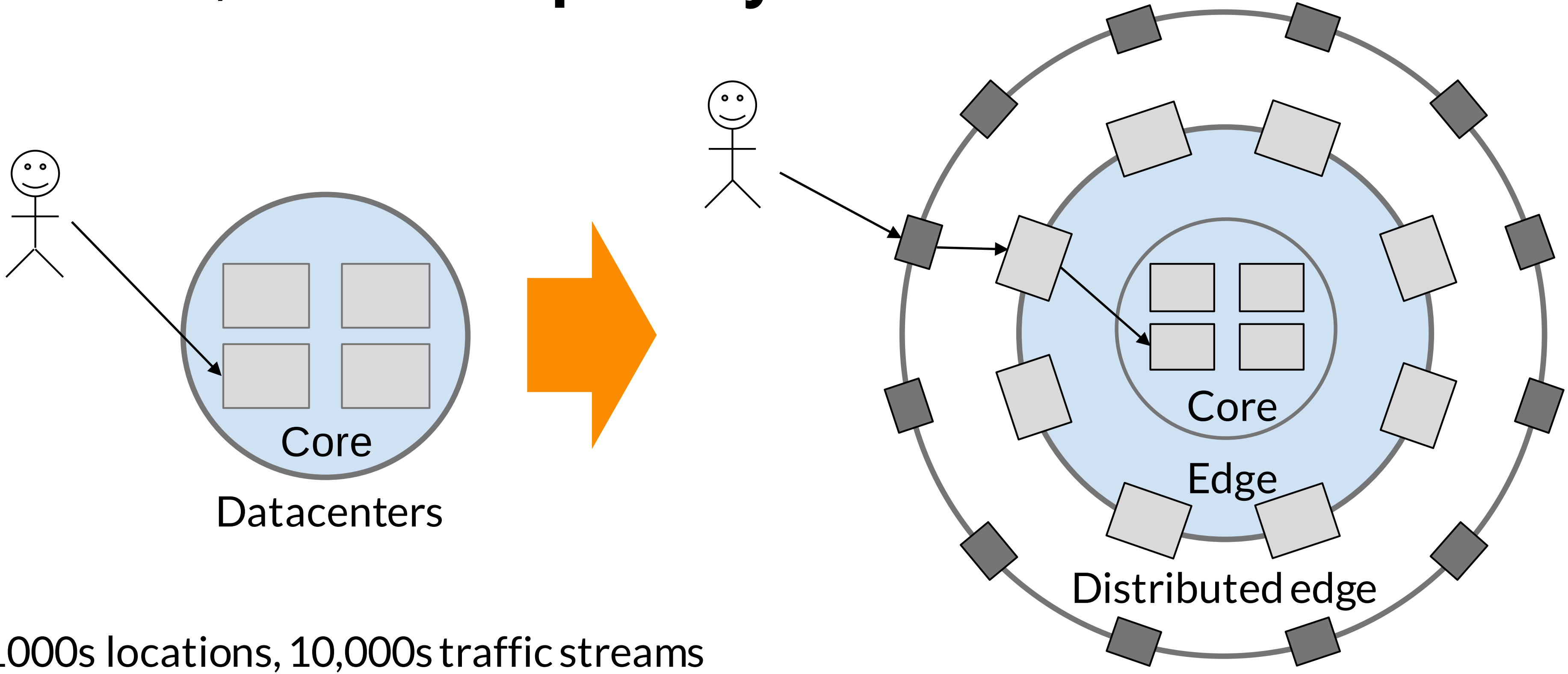



Demand = user traffic
Supply = computing resources

Network-constrained real-time capacity dispatch:

- Multiple physically redundant locations
- N+2 capacity
- Real-time load balancing

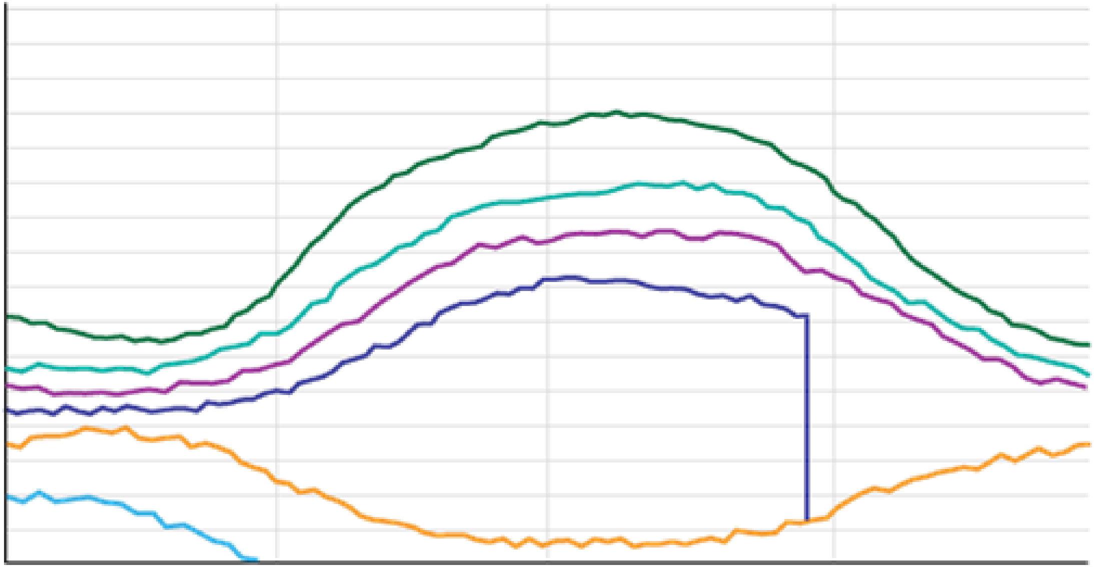
# ...at 10,000x complexity




1000s locations, 10,000s traffic streams
hundreds of millions of participants

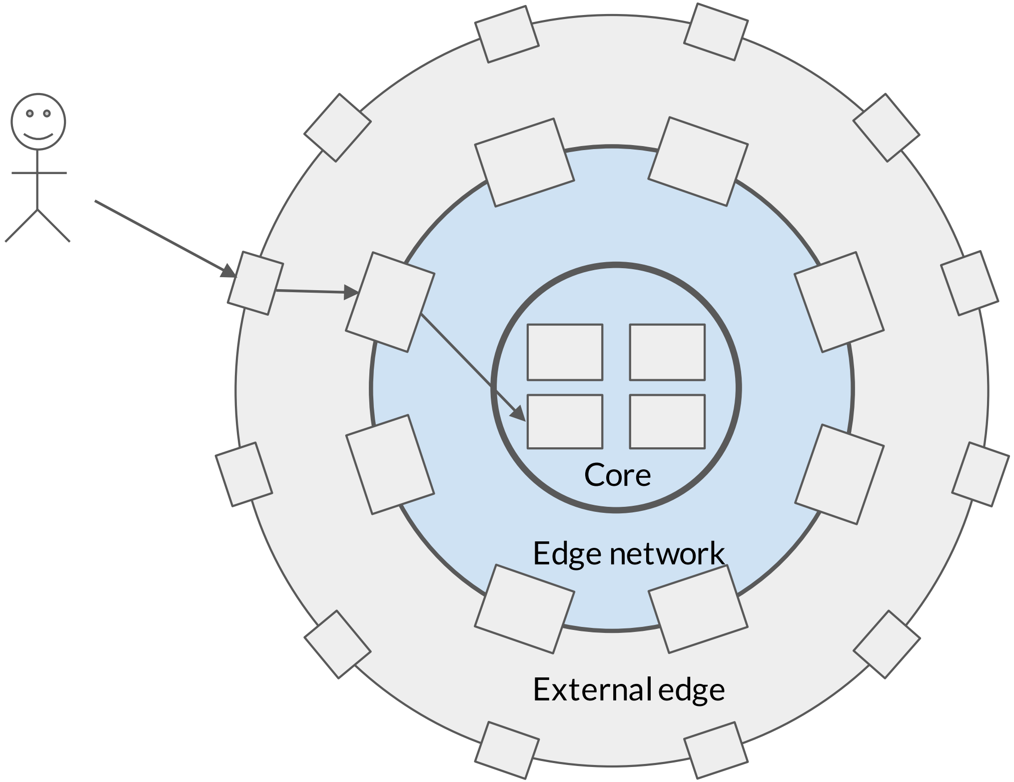
# Software loadbalancing: supply and demand

The loadbalancer acts as a central co-ordinator, which can allocate the optimal set of capacity resources in real time, based on **reliability**, **cost**, **performance**, and **constraints**.



It automatically adjusts for changes in resource mix. Operators handle exceptions.

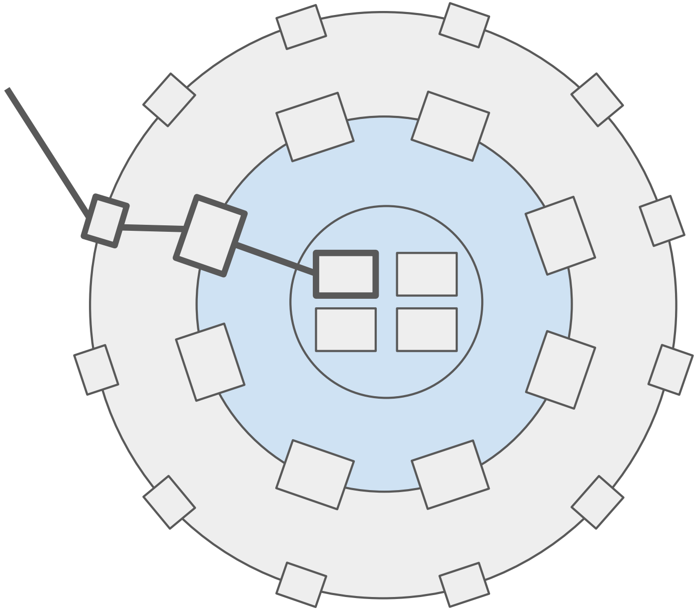
# Local decision-making, globally optimized




- Decision making happens at each node
- Directed by policy updates from the loadbalancer
- Each node has enough information to make local decisions indefinitely
- The loadbalancer knows who has what state and what will happen as a result

The **state** of the system is nondeterministic, but its behavior is **predictable**.

# … but what's the value model?



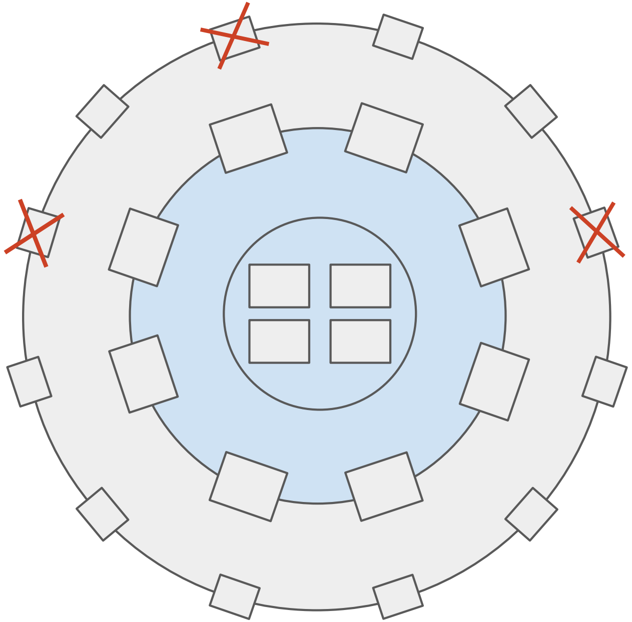
Two drivers of cost:

- Compute work (capacity cost)
- Network traffic (network cost)

Change became cost effective when network cost exceeded capacity cost.

Side benefit: **vastly increased reliability and resilience**.

# Driving down the cost of change



Edge resources can reduce both costs… but only with a **differential reliability model**.

- Edge nodes are far less reliable than core
- We needed to be able to count on the **overall** capacity benefit of the edge, but not any specific node

# Applications to the grid

# Valuing resources at the edge

1. Distributed resources are more valuable locally
    - Network value is locational
    - Capacity/energy value is system-wide
2. They're only valuable if you can use them effectively
    - Incorporating resources into distribution & ISO operational models
    - Extending current value models and creating new ones
3. They're *most* valuable if you can harness their unique characteristics
    - Improving resilience, providing flexibility

# Mapping to the gaps in the value stack

## Value sources:

Bulk market:
- Capacity, energy, services
- Demand response & flexibility

Distribution level:
- Network deferral
- Energy cost offset
- Reliability / resilience

Customer / microgrid:
- Local energy cost offset
- Resilience value

## Requirements:

Bulk market:
- Including DERs in system model
- New demand & storage products

Distribution level:
- Understanding network impact
- Incorporating DERs into IRPs / RA
- Localized system management

Customer / microgrid:
- Paying for services to the dist. grid
- Proactive resilience planning

# Role of a DSO

Bulk market:
- Including DERs in system model
- New demand & storage products

Distribution level:
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- Localized system management

Customer / microgrid:
- Paying for services to the dist. grid
- Proactive resilience planning

**TSO**

Extending the TSO model:
- Rules & pricing for aggregations
- First-class support for demand

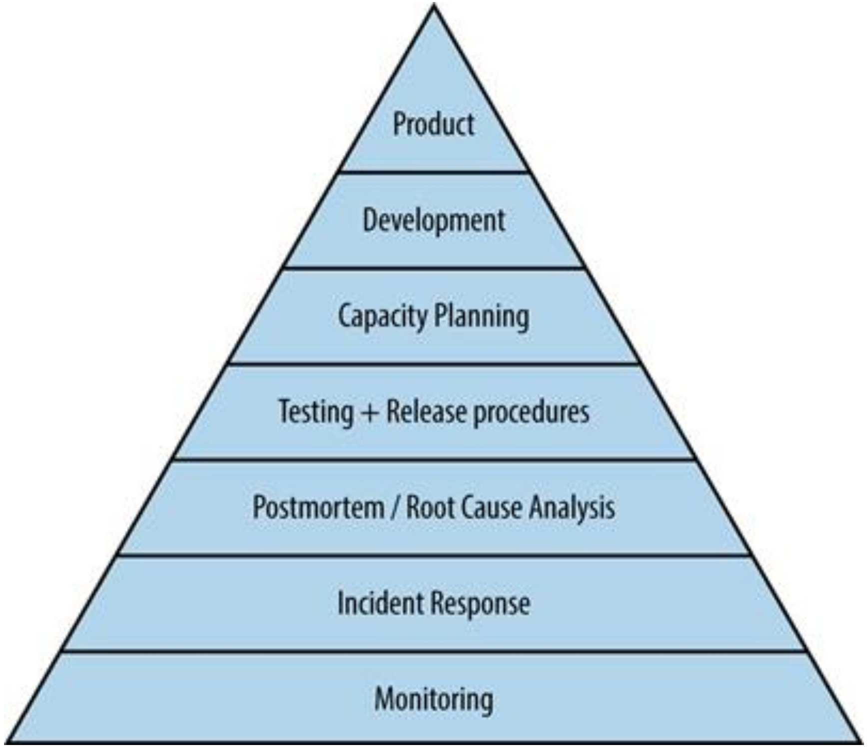
Bulk market interface

Local system operation

Distribution markets / price incentives

**DSO**

# Visibility: Enabling change across the stack




Mikey's hierarchy of reliability - from the Google SRE Book

You can't change (or value) what you can't see.

1. Improved visibility into distribution conditions
2. Manage increased operational complexity
3. Understand current role & value of DERs

# Adding DSO capabilities to current systems

1. Improved visibility and management for the current distribution grid
2. System management which can effectively incorporate DERs in balancing and operations
3. Adding market and pricing mechanisms:
   - Defining the DSO -> TSO interface
   - Providing local markets/pricing

# Case study: A co-op in transition

Kit Carson Electric Co-op serves the area around Taos, NM.

- Aiming to achieve 100% of daytime power usage supplied by local solar by 2022
- Needs to manage the grid in the presence of up to 100% power from local DERs
- Wants to provide a forward path for residential solar development

# Incremental path to transition

1. Visibility
    - What's the current behavior of the system, and how is it changing?
    - What distributed resources are present?
    - What is their contribution to the system?
2. Control
    - Operational tools for managing grid & utility DERs
    - Managing capacity locally and preventing backflow on transmission
3. Value
    - Mechanisms for paying for use of third-party resources, particularly batteries

# Thank you!