GridCloud Core Technologies

Highly Assured Cloud Computing Technology

sponsored by the Department of Energy ARPA-E program

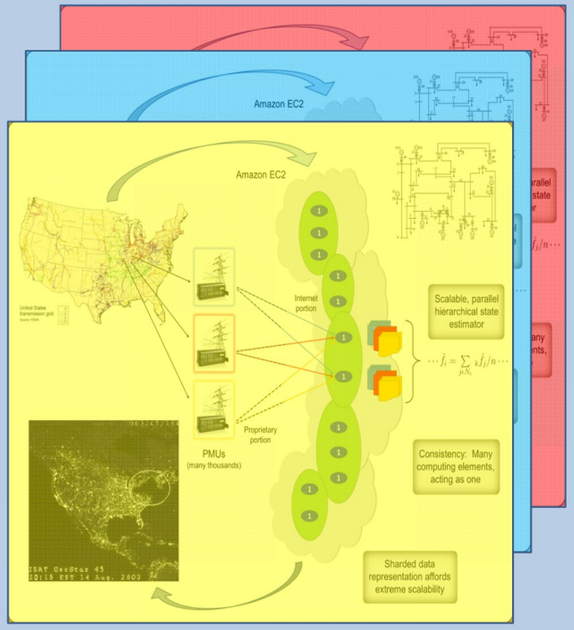
Cornell University

Why Clouds?

- Cost effective: pay only for resources you are using, amortize infrastructure over many users
- Geographic scale: multiple data centers at widely separated locations gives physical reliability
- Scalable capacity: potential to do real-time tracking of PMU data at national scale

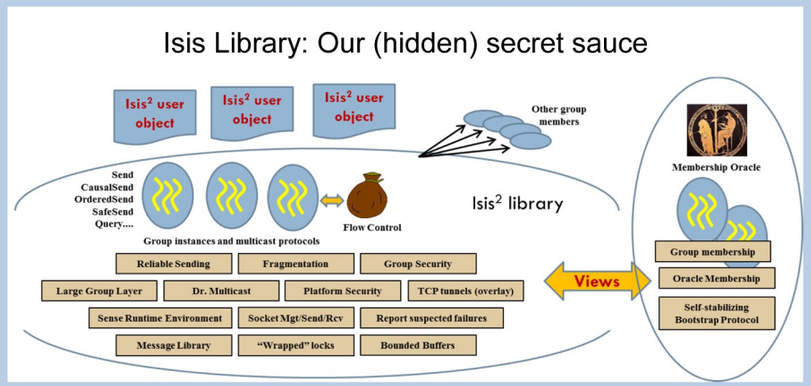
What Makes it Hard?

- Today's cloud is inadequately secure and has poor real-time guarantees
- At scale with many moving parts, transient and permanent faults are common, and rare events occur surprisingly often
- We need a computing model that matches the reality: multiple operators
- We need to find scalable ways to compute state estimates rapidly and robustly
- Even if power industry runs the cloud, demands new trust and auditing approaches



Application Layer

Real-Time State Estimation enabling a wide range of new operator-oriented functionality and the potential for direct control of sensitive tasks

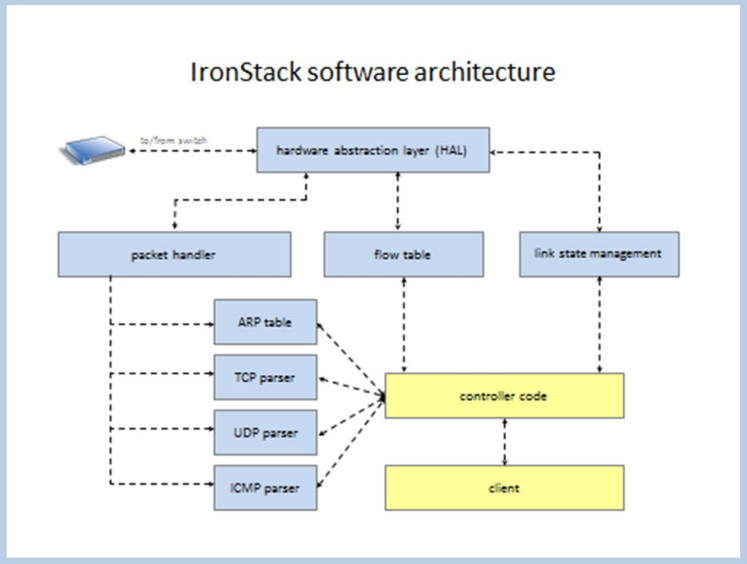


Performance targets?

- **15,000 or more PMUs or other sensor devices monitored at 30Hz**
- **Nationwide physical scale**
- **30 State estimates per second with 250ms delay**
- **Delays 10x smaller in smaller regional setups**
- **Instant and automated recovery from faults. Geographic replication to handle major outages.**

Status?

- **GridCloud is working! Demos at steadily increasing scale (but using simulated data, and Amazon EC2).**



Three key techniques

- Redundancy / Replication
- Consistent monitoring and management
- Software defined network with real-time guarantees

Tools

- **Isis2:** A DARPA funded Cornell-developed toolkit for building highly assured cloud computing solutions. Aims at programmers.
- **DMake:** Based on Isis2, monitors and manages a large, complex system. Aims at a higher level system operator.
- **IronStack:** A new networking package that transforms private networks into highly secure, highly assured real-time network solutions

Future:

- **Powerful operator-oriented visualization and collaboration tools**
- Think of a table-sized tablet with a wide range of "smart" computational elements you can touch/drag/drop