Delivering Renewable Energy with Kubernetes

Deploying Kubernetes with multi-region, edge computing, and AI

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Sheng Liang, CEO, Rancher Labs
A Global Wind Turbine Technology and Clean Energy Solutions Provider

- 20 Years
- 44 GW
- 28 Units
- 3rd in the World
- 1st in China

Annual Reduction of CO2 Emission: 90.40 Megatons
Equivalent of Planting Trees: 49.40 Million Square Meters
Goldwind Smart Energy Business Overview

A leading renewable energy provider in China

- 30,000 Power Generation Devices
- 300+ Sensors per Device
- 300 TB Operations Data
- 300+ TB/year Operations Data Growth
- 300+ TB 30 Year Weather Simulation Data
- 100+ Big Data Device Forecast Model
- 700+ Edge Locations Providing Weather Forecast Service
- 30,000+ Turbines
- 50 TB/year Simulation Data Growth
- Data Assets
- Data Services
Renewable Energy Weather Forecast Platform
Challenges Facing Energy Industry

How the electric grid handles distributed energy

- Low carbon macro trend dictated by the Paris Agreement
- Fluctuation of wind and solar output
- Rapid increase of wind and solar power generation
- Disruptions to electric grid stability

Demands of electric energy trading

- Free market pricing of energy
- Real-time trading of electric energy
Cloud Native Architecture for Power Forecasting

Apps
- Business Operations: Client-side App for Power Forecast
  - Basic Info
  - Power Forecast
- Weather for Energy: Weather for Energy
  - Weather Forecast
  - Sensor Devices
- Forecasting Logic: Cloud Ops for Power Forecast
  - Near Term Offline Forecast
  - Super Near Term Online Forecast

API
- Analysis Service
- Reporting Service

ETL
- MongoDB
- Hadoop
- GlusterFS
- S3

Storage
- Sampling Gateway
- Protocol Translation
- Kafka
- Logstash
- SFTP

Data Intake

PaaS
- Kubernetes

Edge

AI

HPC
Challenges of multi-level edge deployment

30GW+ Capacity
5 Operator
30+ Region
700+ Total Plant
400+ Wind Plant
200+ Solar plant
100+ Distributed Solar
Business operations architecture for power forecasting

- **Power Company**: Public or private cloud
  - 5+ utility companies

- **Region**: 5+ regions per company
  - 30+ regions and provinces

- **Edge Location**: 5+ edge locations per region
  - 600+ wind and solar stations

- **Power Generator**: 30+ generators per edge location
  - 30K+ wind turbines and solar arrays
## Deployment architecture tradeoff

<table>
<thead>
<tr>
<th></th>
<th>Option 1: One big cluster for all regions and edge locations</th>
<th>Options 2: Independent cluster for each region and edge location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simplicity</strong></td>
<td>• Simple deployment</td>
<td>• Complex deployment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rancher 2.0 supports centralized management of many Kubernetes clusters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• RKE simplifies cluster deployment</td>
</tr>
<tr>
<td><strong>2MB network bandwidth</strong></td>
<td>• Majority of network bandwidth must be used for transmitting sensor data</td>
<td>• Independent clusters greatly reduce bandwidth consumption</td>
</tr>
<tr>
<td></td>
<td>• Infra-cluster communication consumes too much bandwidth</td>
<td>• Independent clusters greatly improve system reliability</td>
</tr>
<tr>
<td><strong>Fixed public IP</strong></td>
<td>• Requires fixed public IP</td>
<td>• Does not require fixed public IP</td>
</tr>
<tr>
<td><strong>Resource consumed on edge nodes (4 core 8GB)</strong></td>
<td>• No need to install Kubernetes master and etcd at the edge</td>
<td>• Must install Kubernetes master and etcd at each edge location</td>
</tr>
<tr>
<td></td>
<td>• Low compute resource consumption</td>
<td>• High compute resource consumption</td>
</tr>
</tbody>
</table>
Every company has one Rancher 2.0 Server instance, used to manage Kubernetes clusters across all regions and edge locations.

Every region has one Kubernetes cluster, 30 clusters total.

Every edge location has one Kubernetes cluster, 600 clusters total.
<table>
<thead>
<tr>
<th>状态</th>
<th>集群名称</th>
<th>供应商</th>
<th>主机数</th>
<th>处理器</th>
<th>内存</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>group-tianrun</td>
<td>自定义</td>
<td>2</td>
<td>0.8/1 秒</td>
<td>0.17/2 GB</td>
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<tr>
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<td>jiangsu-punan-solar</td>
<td>自定义</td>
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<td>n/a</td>
<td>n/a</td>
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<tr>
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<td>jiangsu-nudong</td>
<td>自定义</td>
<td>1</td>
<td>0.5/1 秒</td>
<td>0.17/19 GB</td>
</tr>
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### Value and Challenges of Cloud Native Architecture

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<thead>
<tr>
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<th>Value</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DevOps</strong></td>
<td>• Software iteration cycle improved from once every 2 weeks to once a day</td>
<td>• Steep learning curve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Experienced operations engineers faced huge challenges</td>
</tr>
<tr>
<td><strong>Microservices</strong></td>
<td>• Good adaptability</td>
<td>• Wrong granularity in partitioning services</td>
</tr>
<tr>
<td></td>
<td>• From loosely coupled technologies to loosely coupled teams</td>
<td>• Business growth led to too many services</td>
</tr>
<tr>
<td></td>
<td>• Flexibility in service partitioning</td>
<td>• As edge locations grow in number, maintaining and upgrading them became too expensive</td>
</tr>
<tr>
<td><strong>AI</strong></td>
<td>• Highly efficient when deploying across multiple platforms</td>
<td>• Algorithm engineers don’t like the complex low-level architecture</td>
</tr>
<tr>
<td></td>
<td>• Able to iterate algorithms quickly</td>
<td>• Slow to adopt new cloud native technologies</td>
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