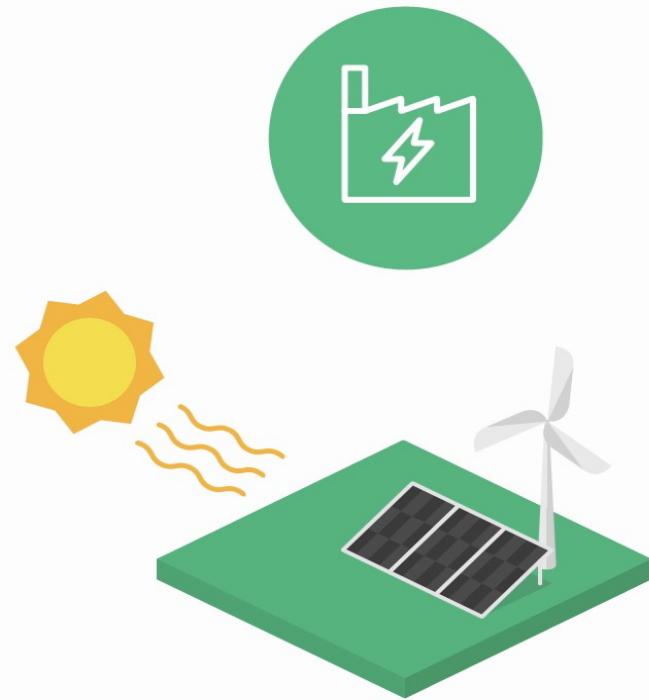


Fortum SPRING

Virtual Battery for the Power Grid

Mungai Evans / Software Lead

Distributed Systems Meetup 27.02.2019

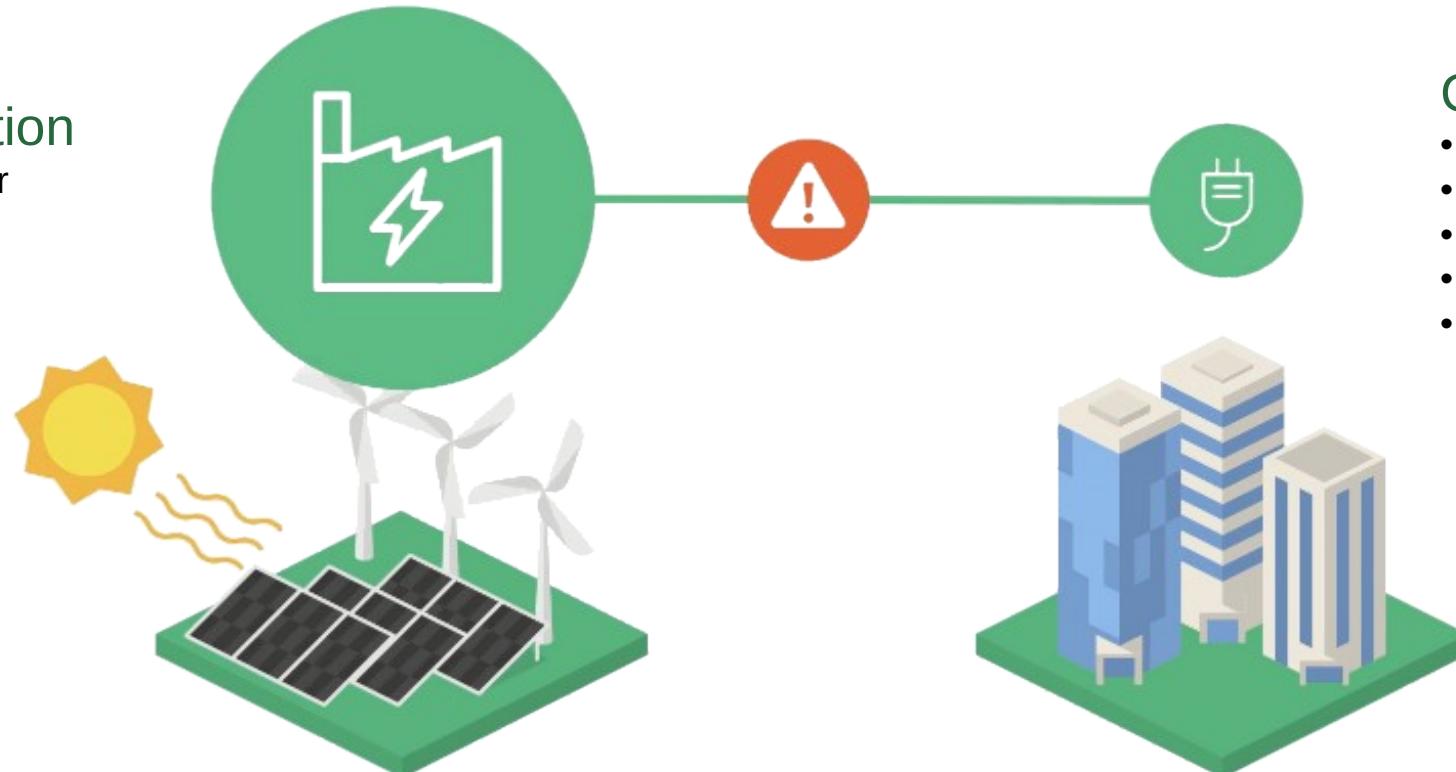


**Enable the grid to support
renewable energy sources**

Power systems

Production

- Nuclear
- Solar
- Hydro
- ...



Power Grid

- Transmit electricity in AC
- Operated by TSO (FinGrid)

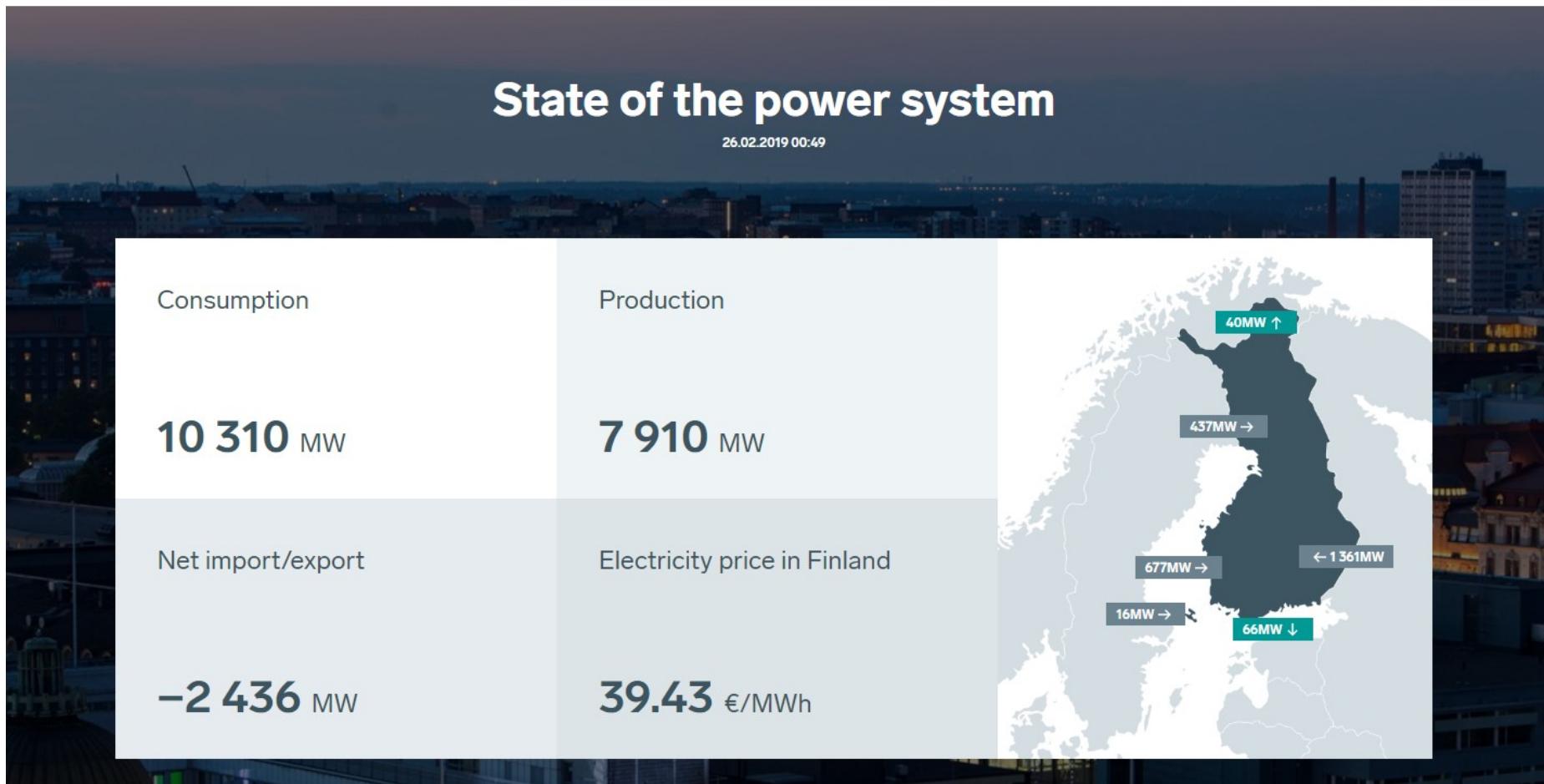
Consumption

- Homes
- Factories
- Data centers
- Electric vehicles
- ...

Production-consumption equilibrium

FINGRID

Services ▾ Electricity market ▾ Grid ▾

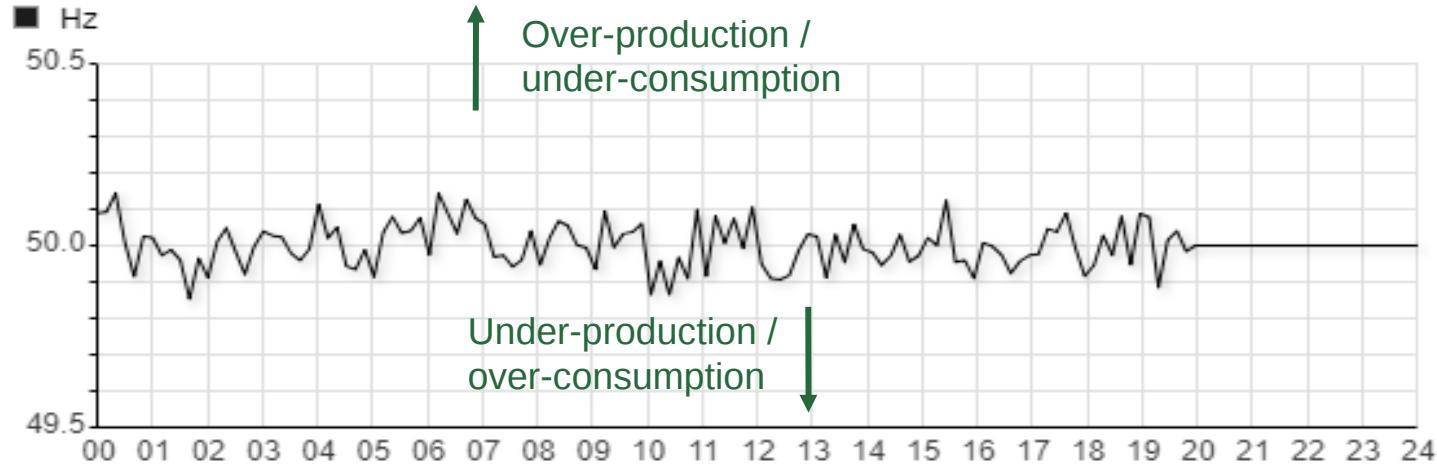


Electricity & balancing markets

- The "stock exchange" of buying and selling electricity
- Power plant operators sell, electricity suppliers buy on behalf of consumers
- Market places
 - Future-based markets (Yearly, monthly day-ahead)
 - Realtime-based markets (intra-day, intra-hour)
 - Balancing markets (daily reserve bids, TSO activated via Hz or manual)

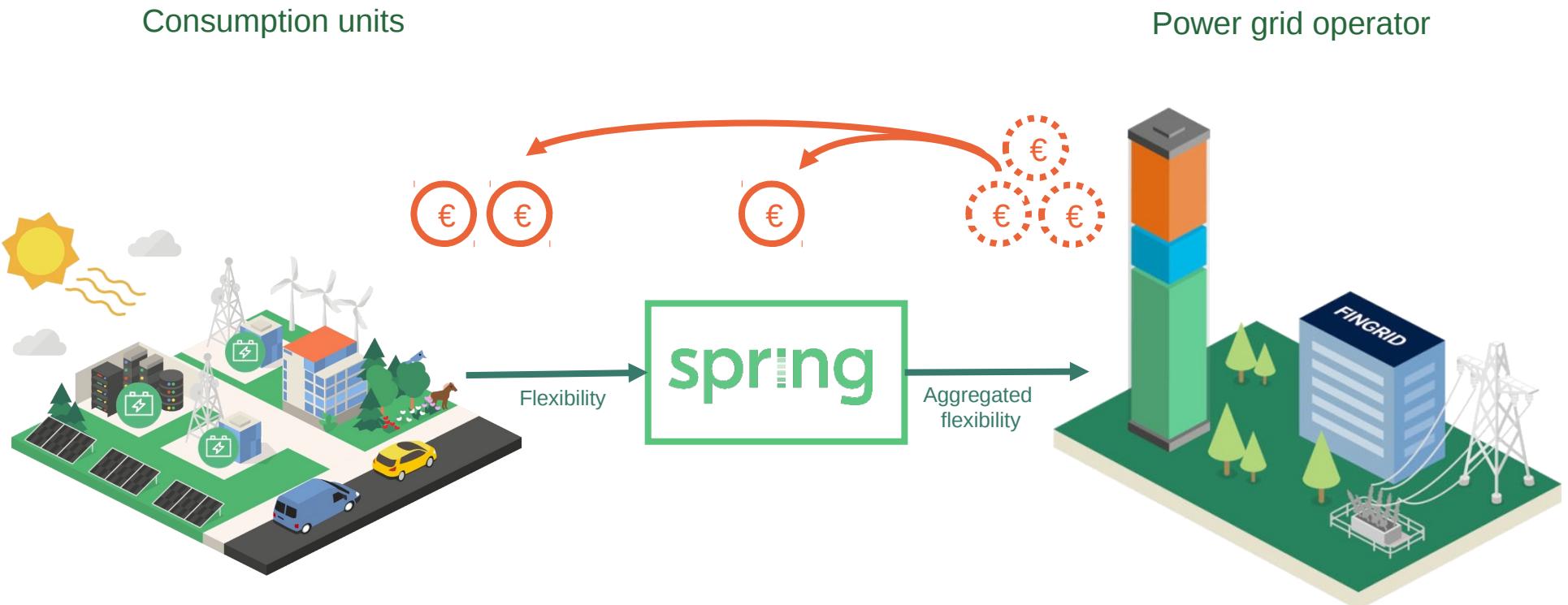


Production-consumption imbalance challenges

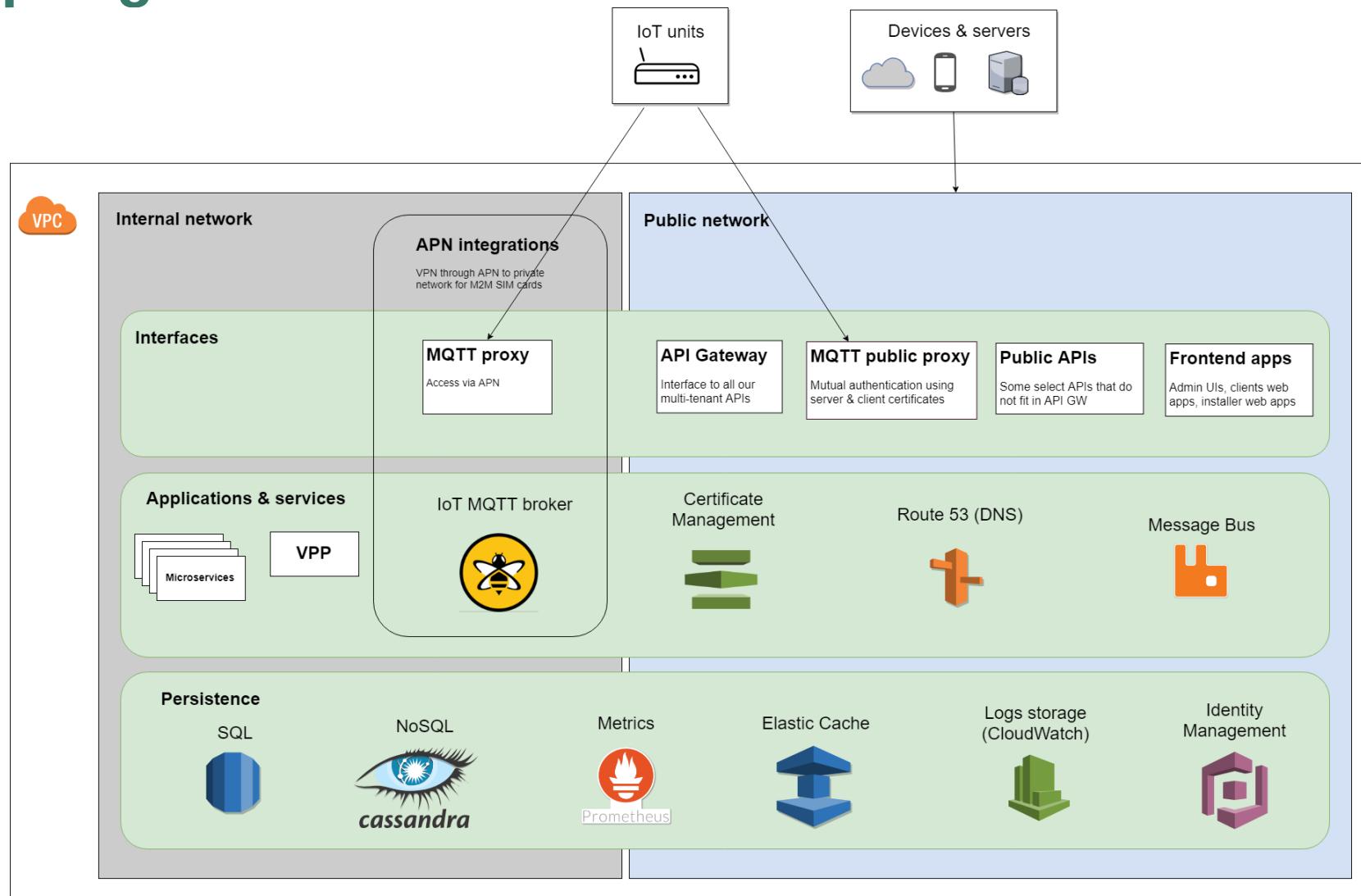


- Grid operator's mandate to maintain frequency levels
- Switch on/off stand-by power plants (diesel generators, gas, hydro)
- Reduce/increase consumption – Demand Response
- Participation incentivised by earning from the balancing market place

Demand response using a Virtual Battery



Spring IoT Platform



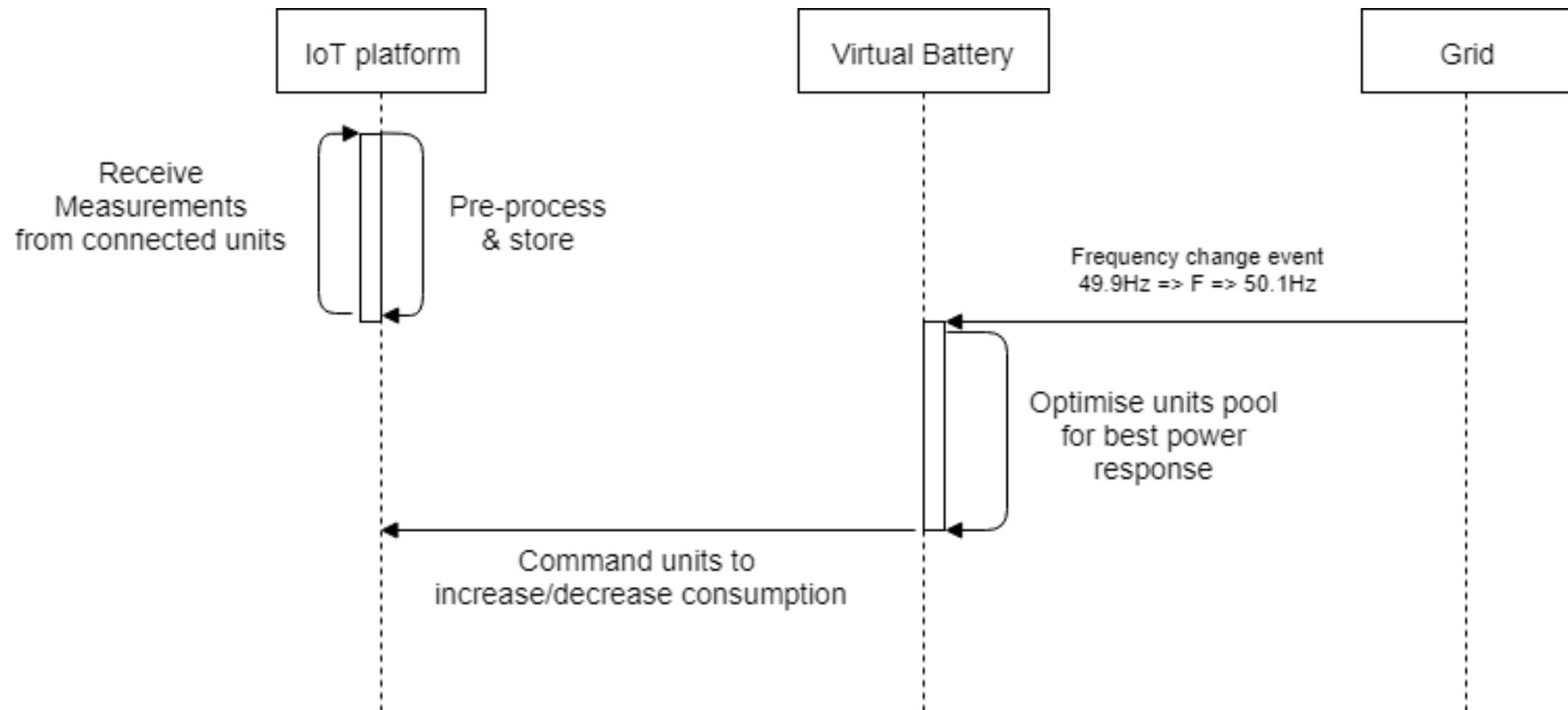
Spring's IoT platform

- Collects measurements from units (MQTT protocol)
- Commands, configures and upgrades (retro-fit gateway devices) units
- Hosts an event pipeline (AMQP)
 - Various measurement calculations and enrichments
 - Data driven monitoring
- Expose public and internal REST APIs
- Microservices architecture
 - Stateless & stateful services
 - Docker + ECS
 - Synchronous (HTTP) & asynchronous (AMQP) communication protocols

What is Spring's Virtual Battery

- Part of the national power grid
- The intelligence that provides Demand Response i.e balance grid frequency by reducing/increasing consumption
- Units that can participate in balancing
 - Water boilers
 - Heaters
 - Batteries
 - Electric Vehicles
 - Freezers etc
- Either smart units or retro-fitted units using gateway devices

Virtual Battery balancing logic (simplified)



Technology stack

- Data analytics and algorithm development
 - Python, SciPy stack, PuLP
- IoT Platform
 - AWS (ECS, Route 53, ACM, Elastic Cache, VPC)
 - Spring Boot framework
 - Docker
 - React & Angular (web apps)
 - HiveMQ (MQTT protocol for IoT devices)
 - RabbitMQ (AMQP)
 - SQL (MariaDB, MySQL) & NoSQL (Cassandra) databases
 - Grafana + prometheus

Platform Security

- Machine to machine SIM cards (APN)
- TLS + client-server certificates
 - mutual authentication
 - Private Certificate Authority
- VPNs
 - cloud to cloud integrations



QUESTIONS?

감사합니다
Grazie VINAKA
TERIMA KASIH
THANK YOU TAKK
謝謝
ありがとう
merci