Power Virtualization in Multi-tenant Networks

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Consumption

| Computing	Networking
In datacenter, ~45%	In datacenter, ~15%
Billed by hourly rate of use	Flat-fee, or byte-based
Power aware	Power oblivious
More energy proportional; Idle power = ~30% peak	Least energy proportional; Idle power = ~80% peak;
Multiple power modes	2 power modes: on/off

ElasticTree

- Based on a given workload, pack flows into fewer devices and turn-off unused elements
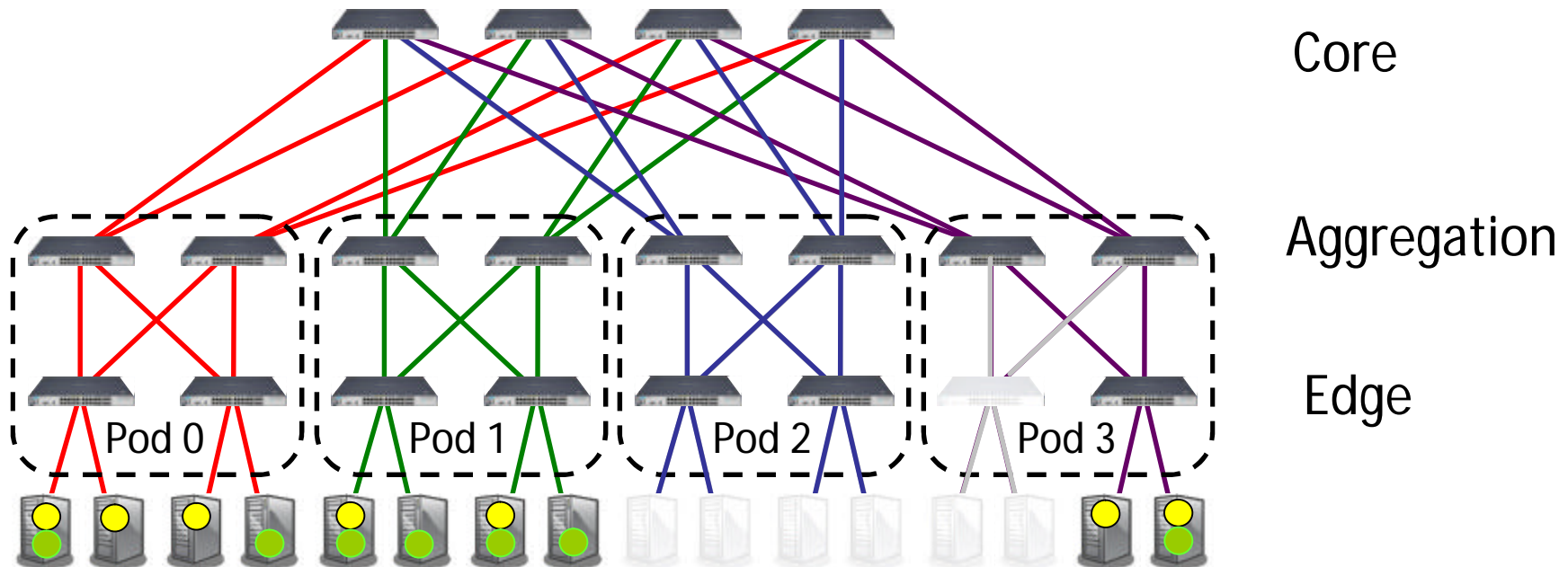
Workload
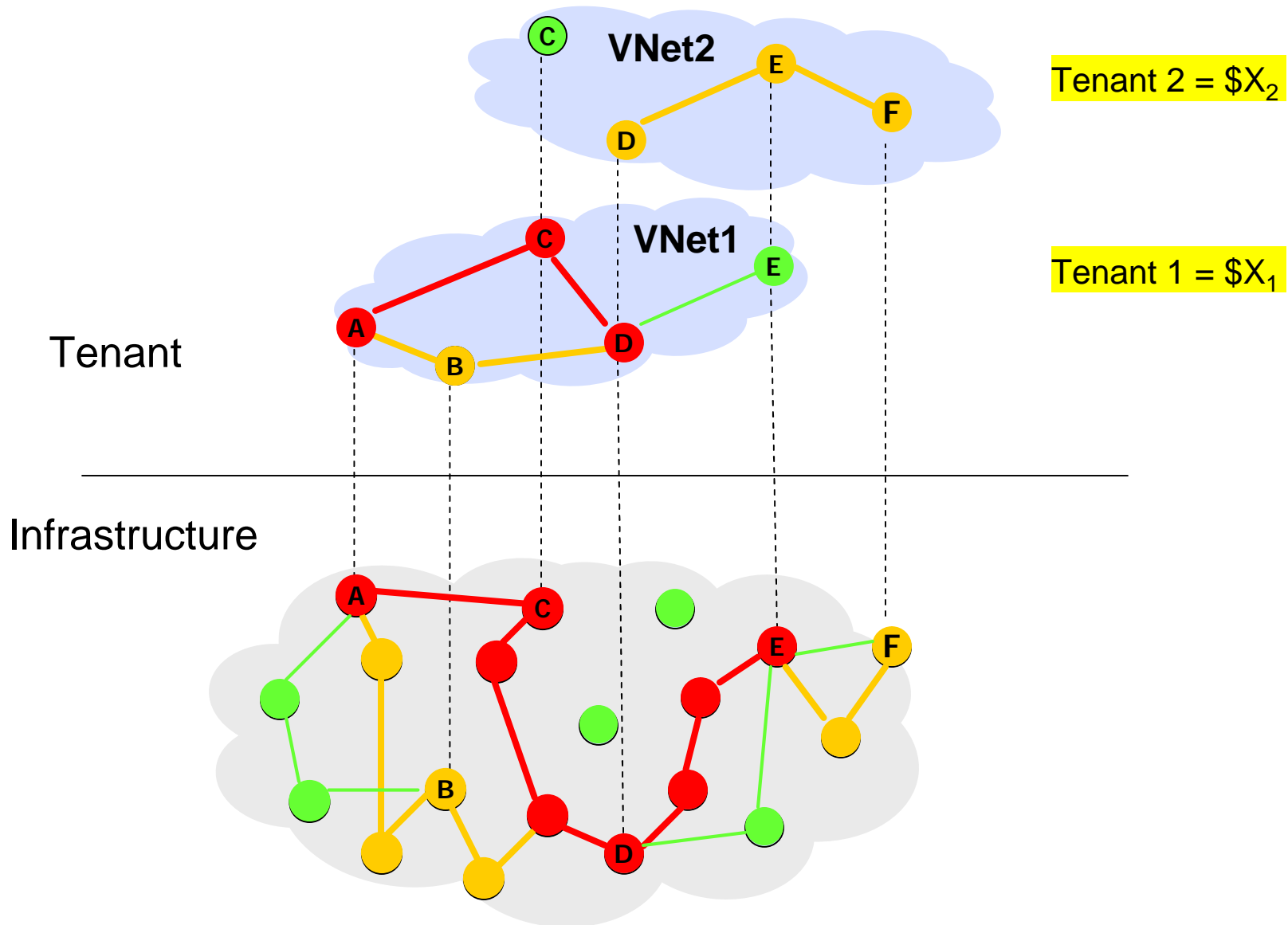
Proposal

- Can we provide incentive to align workload in a power-aware manner?
  - By making usage charge of tenant proportional to its energy consumed
    - Virtual power
    - How to determine virtual power in a non-proportional network?

Heuristics

Virtual_power $_{\text{tenant } i}$

$$= \Sigma \text{ Virtual\_power }_{\text{element } j}$$

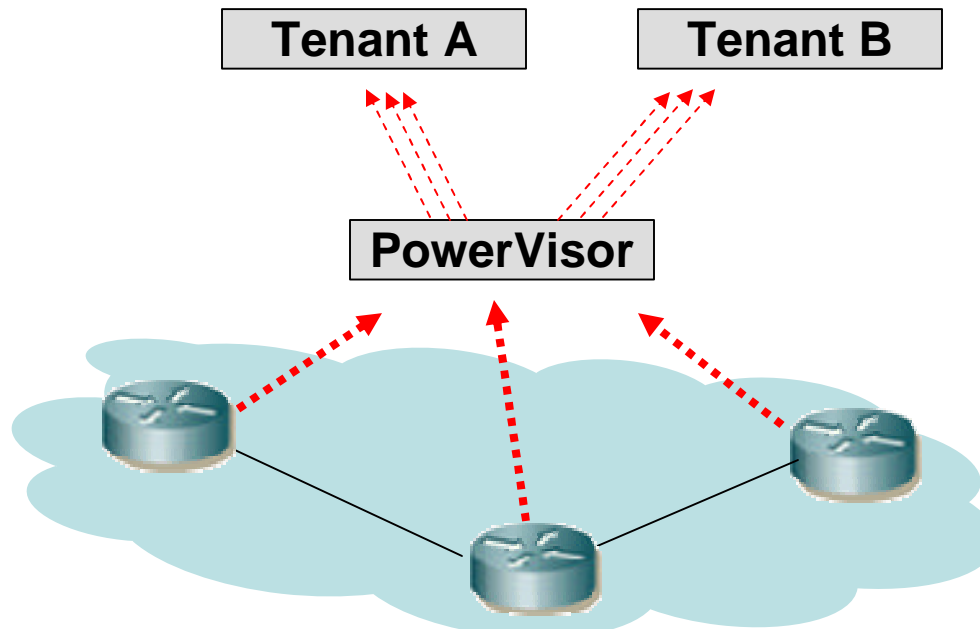$$= \Sigma \quad \frac{\text{Power}_{\text{element } j}}{\text{\# sharing tenants}}$$

Consequences

- Tenant penalized for being only occupant
- Encourages reuse of pre-paid / pre-powered-on elements
- One tenant unaware of other tenants
- One step closer to virtualizing networks

Implementation

- PowerVisor acts as a metering proxy between switches and tenants
  - Translates true power to virtual power

Billing

Multiple ways of monetizing the energy consumed:

- Directly proportional to the energy footprint

- Auction resources to tenants for flow usage

- Finite energy allocated that depletes in a capacitor model

Fineprint

- **Infrastructure**
  - Conserve by powering down devices
    (or choosing other available low energy states)
  - Fair across tenants; No cheating

- **Tenant**
  - Nothing blocks a tenant with infinite finances
  - Can possibly do the following:
    - Load-based conflict
    - Collusion among tenants
    - Masquerading as multiple tenants
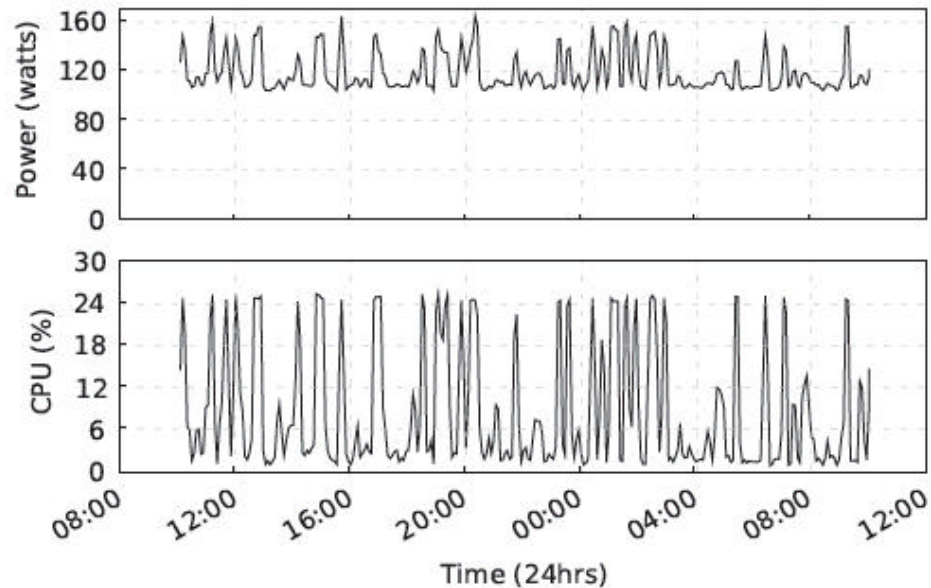   - Energy trading

Future

- Build emulation prototype over mininet and then extend to an actual cluster
  - To understand the dynamics and interactions

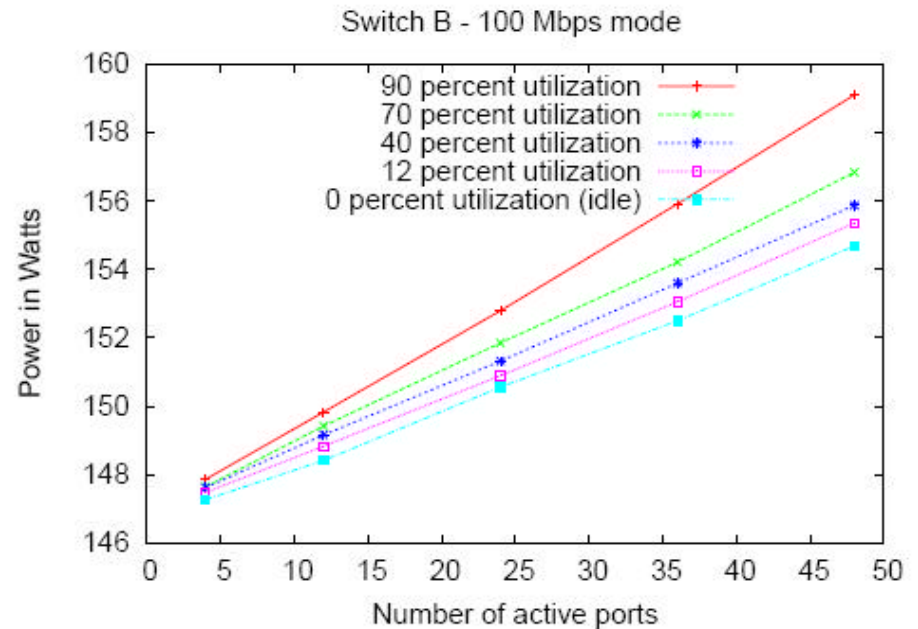- How can we achieve good network performance, while conserving power?
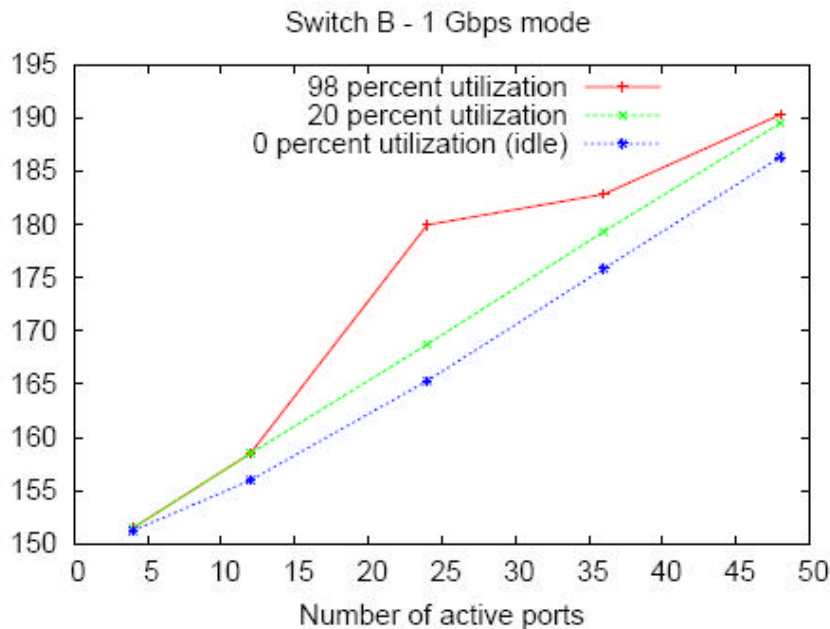
Backup

Previous analysis

- **Energy Dumpster Diving**

Previous analysis (contd.)

- Power Benchmarking Framework for Network Devices

Previous analysis (contd.)

- The cost of a cloud: Research problems in data center networks

Amortized Cost	Component	Sub-Components
~45%	Servers	CPU, memory, storage systems
~25%	Infrastructure	Power distribution and cooling
~15%	Power draw	Electrical utility costs
~15%	Network	Links, transit, equipment