Intelligent Software Defined Networks for Resilient Smart Grid Communications

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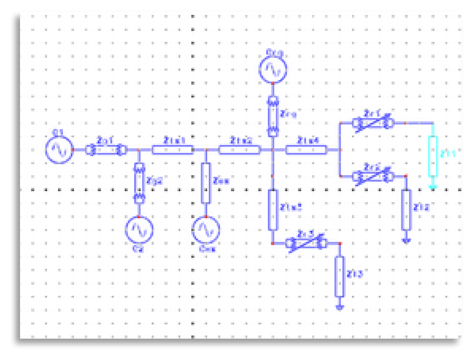
Introduction

- Smart grids are highly complex systems: large number of intelligent devices
- Exchange and process huge amounts of data in real time
- Need reliable, adaptable and resilient communication network
- Existing infrastructure: no dedicated bandwidth or priority based communications
- Guaranteed bandwidth and security requirements not fulfilled
- Presented SDN based virtualized services/applications can alleviate these problems

Why SDN?

- Dynamic control of network:
  - Bandwidth allocation
  - Priorities
- Resilience / Fault tolerance:
  - Decoupled control plane
  - Easy reprograming

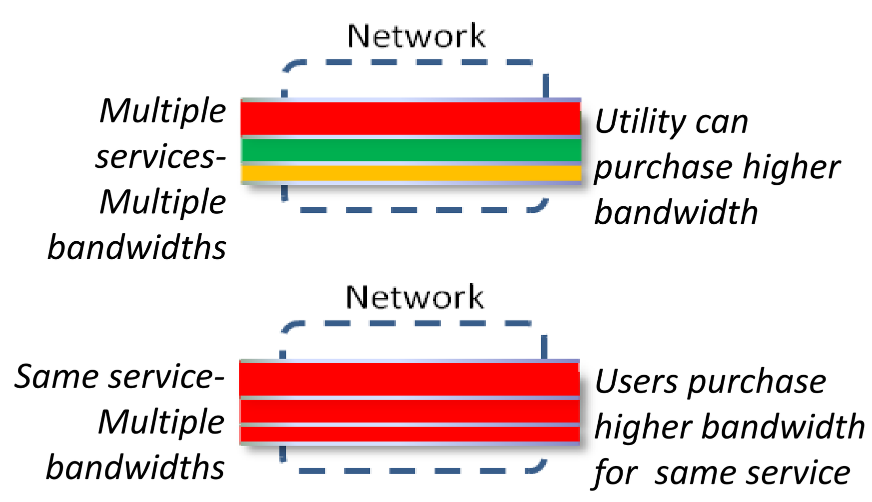
SDN for Smart Grids



- Smart grid communication require adaptable control
- SDN based control for communication between modules
- Individual virtual channel for each module (user)
- Communication routed through a central controller(s) (providers)
- If a channel fault happens, dynamic rerouting
- Channel Bandwidth dynamically adaptable

Adaptive Communication

- Users can request for higher bandwidth/priorities
- Dynamic pricing based on dynamic bandwidths



Highlights and examples

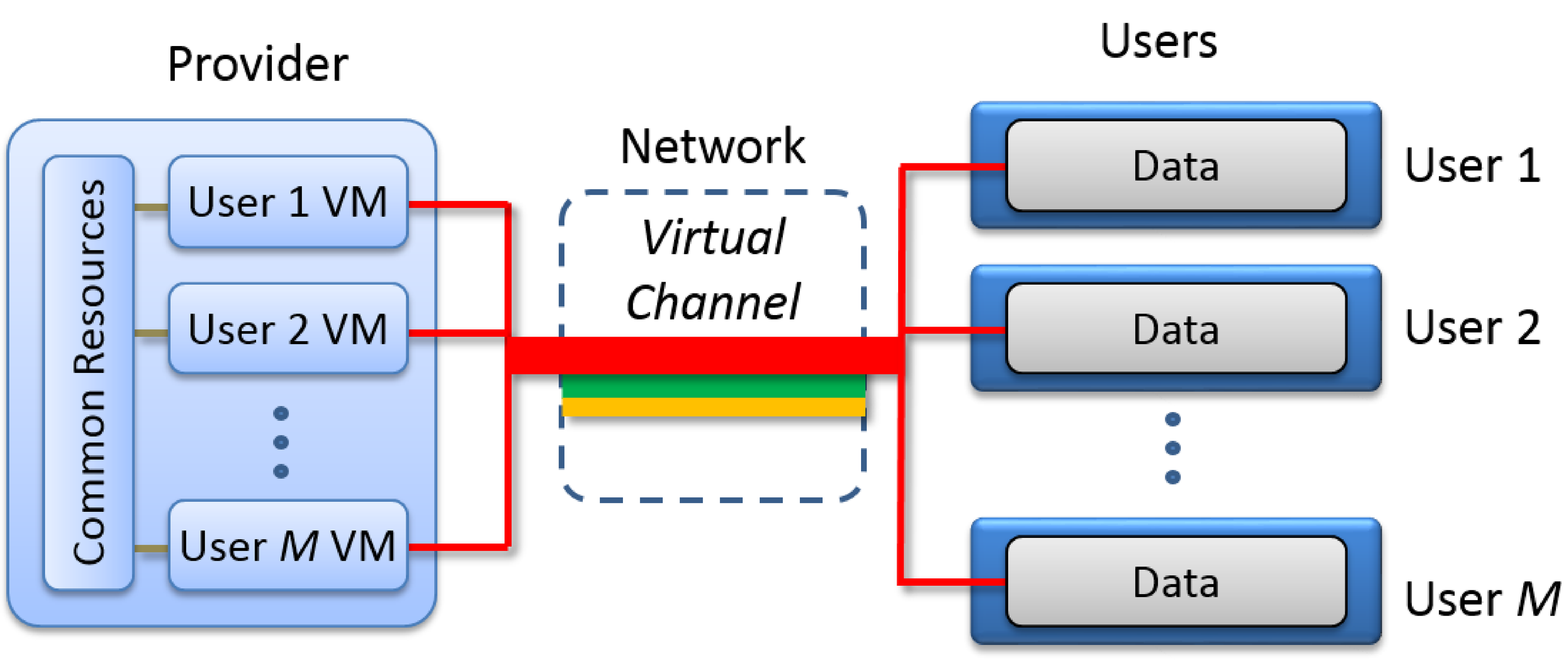
- Fully thin client on user end
- client hardware specification independent
- Isolation of communication channels
- Dynamic bandwidth control
- Scalability and resilience/fault tolerance
- High priority to critical communication:
  - *Critical infrastructure Emergencies*
- Dynamic bandwidth control:
  - *Time based (night time setbacks)*
  - *Usage based*
  - *Situation based (disaster situation)*
- Easy network reprogramming:
  - *Reduced down times*
  - *Easy updating*

Architecture

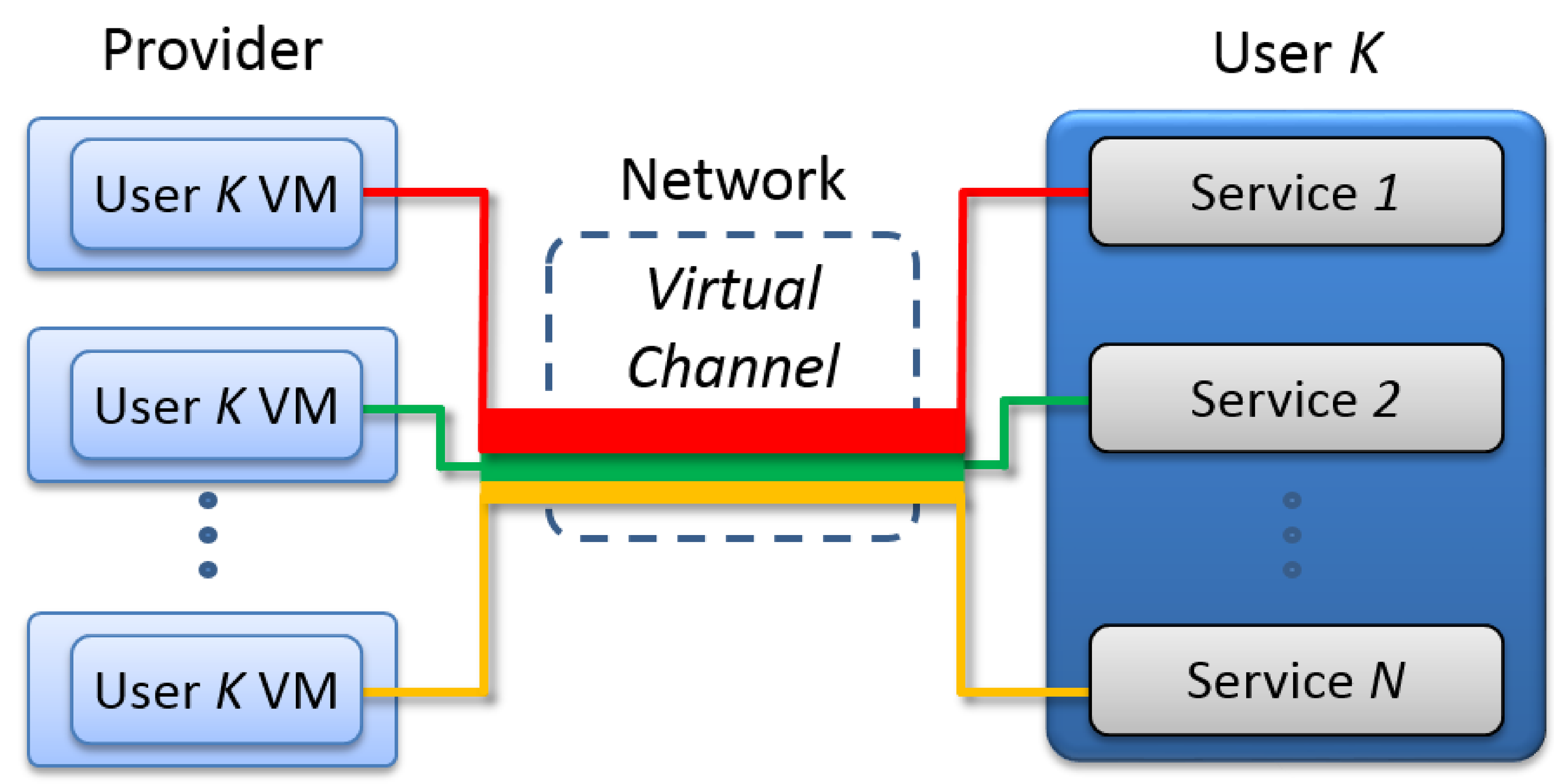
Each provider has a virtual *channel*":
- Encapsulates service end-to-end
- Completely virtualized
- Through-network isolation

Each user has a VM on the provider server:
- Thin client implementation
- Virtualization through hardware

Dynamic control of the network:
- SDN enables dynamic control
- Dynamic priorities
- Dynamic bandwidth allocation



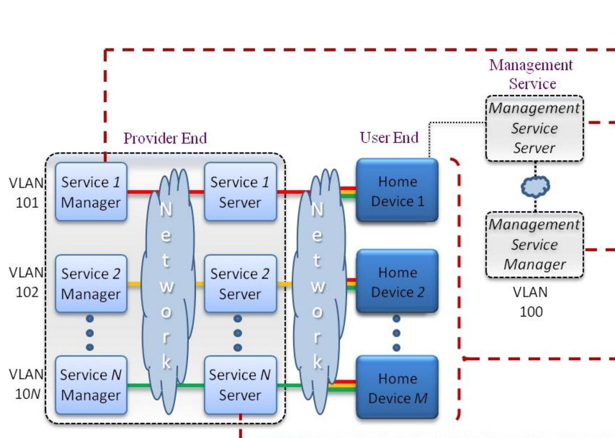
Provider End View

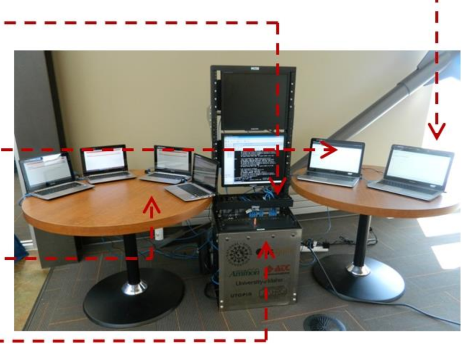


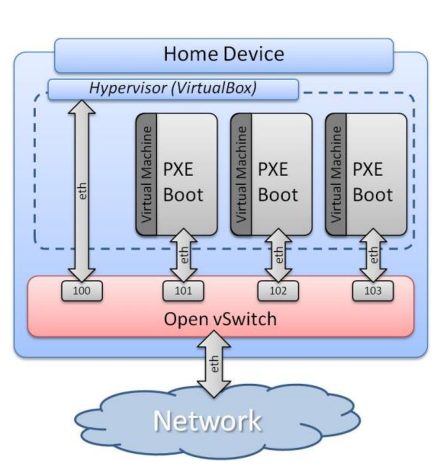
User End View

Implementation

- Implemented for Emergency Communications *(NSF Award ID: 1258486)*







Provider End:
- Server for each provider
- VLAN for application

User End:
- VMs pushed to user end
- Each VM - unique VLAN

Future Work

- Dynamic control of communication via OpenFlow
- Implementation testing/performance analysis on a smart grid testbed
- Implementation for communication with Mobile devices
- Implementation of intelligent control
- Testing for resilience and fault tolerance in adverse conditions

M. Manic, D. Wijayasekara, K. Amarasinghe, J. Hewlett, K. Handy, C. Becker, B. Patterson, R. Peterson, "Next Generation Emergency Communication Systems via Software Defined Networks," in Proc. GENI Research and Educational Experiment Workshop (GREE 2014) - Jointly with the 19th GENI Engineering Conference (GEC 19), Atlanta Georgia, Mar. 19-20 2014.
M. Manic, D. Wijayasekara, K. Amarasinghe, K. handy, "Universal Application Delivery via SDN Based Architecture," Poster presentation, US Ignite Application Summit, Sunnyvale, CA, June 24-27, 2014.