NASPInet Modeling

An Exploration of Potential Realities

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NASPI Working Group Meeting

Feb 29 – March 1 2012

Orlando, FL

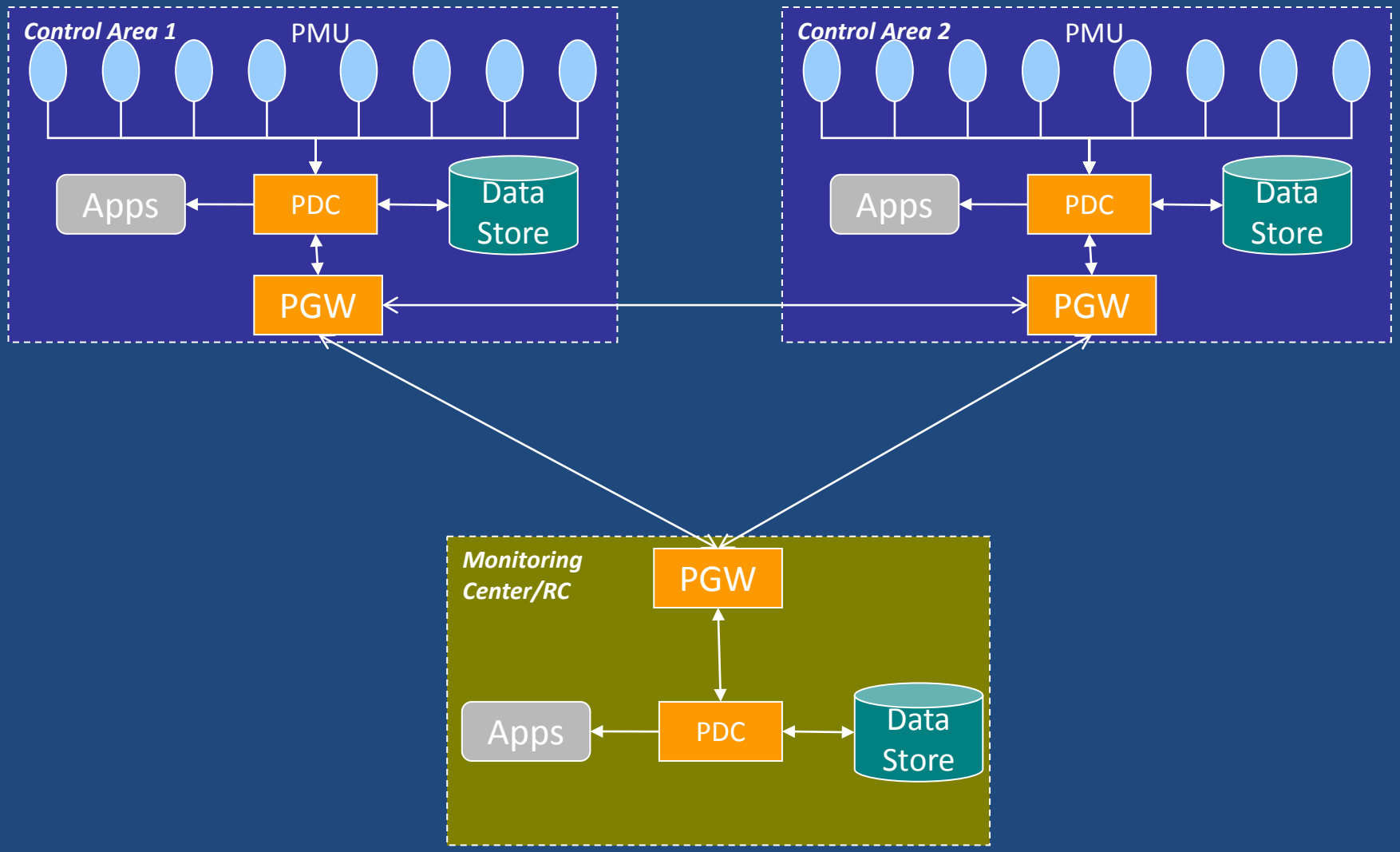
ILLINOIS DARTMOUTH UCDAVIS CORNELL UNIVERSITY WASHINGTON STATE UNIVERSITY

NASPInet

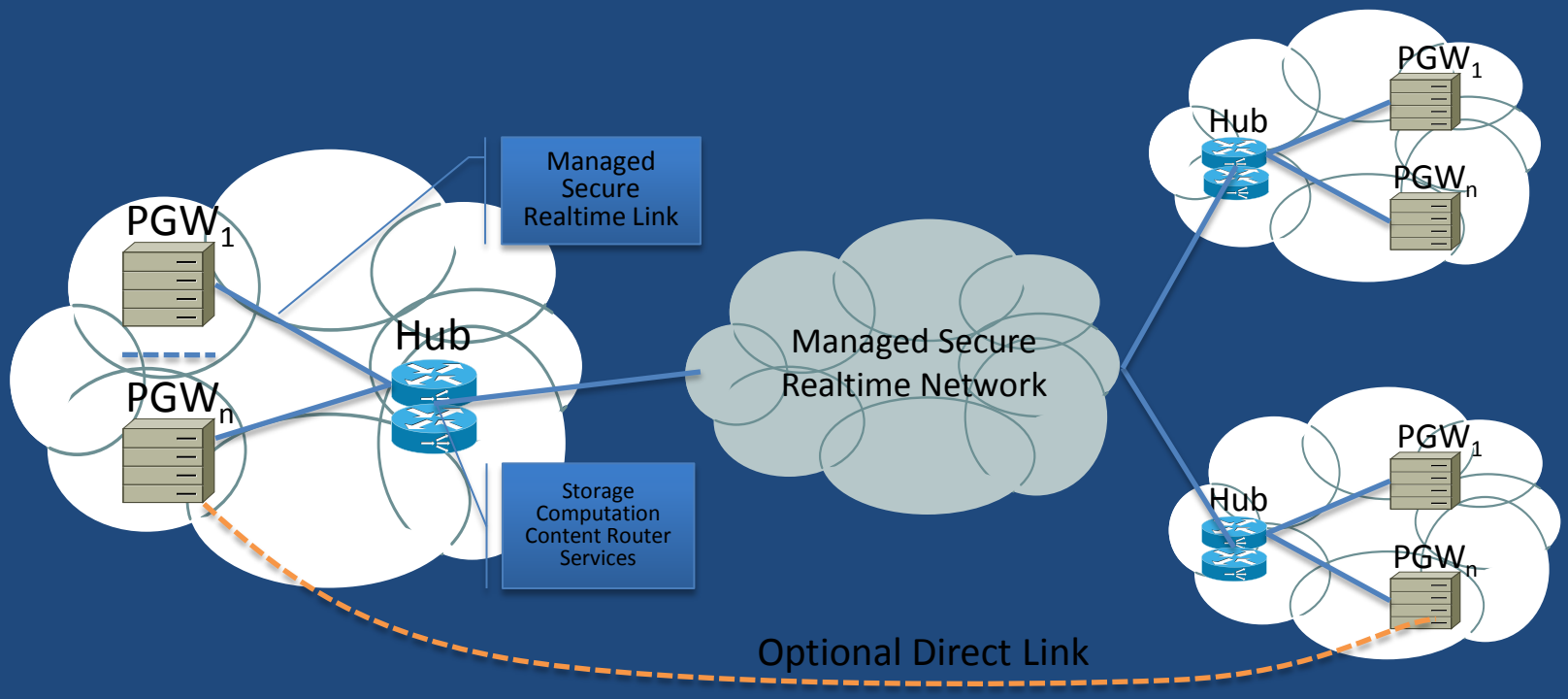
- A robust, widely available and secure synchronized data measurement infrastructure.
- Leverages PMUs, GPS, and network infrastructure.
- Contains at least a network, a phasor gateway, and data

WHAT IS IT GOING TO LOOK LIKE WHEN IT EXISTS?

Original Vision



Hierarchical Vision



Organic Realization

- Various DOE awards are materializing “NASPInet”-like architectures – e.g., SGIG awards
- No one “NASPInet”-like architecture is identical.

IS THIS A PROBLEM?

THE WORK

Prior Work

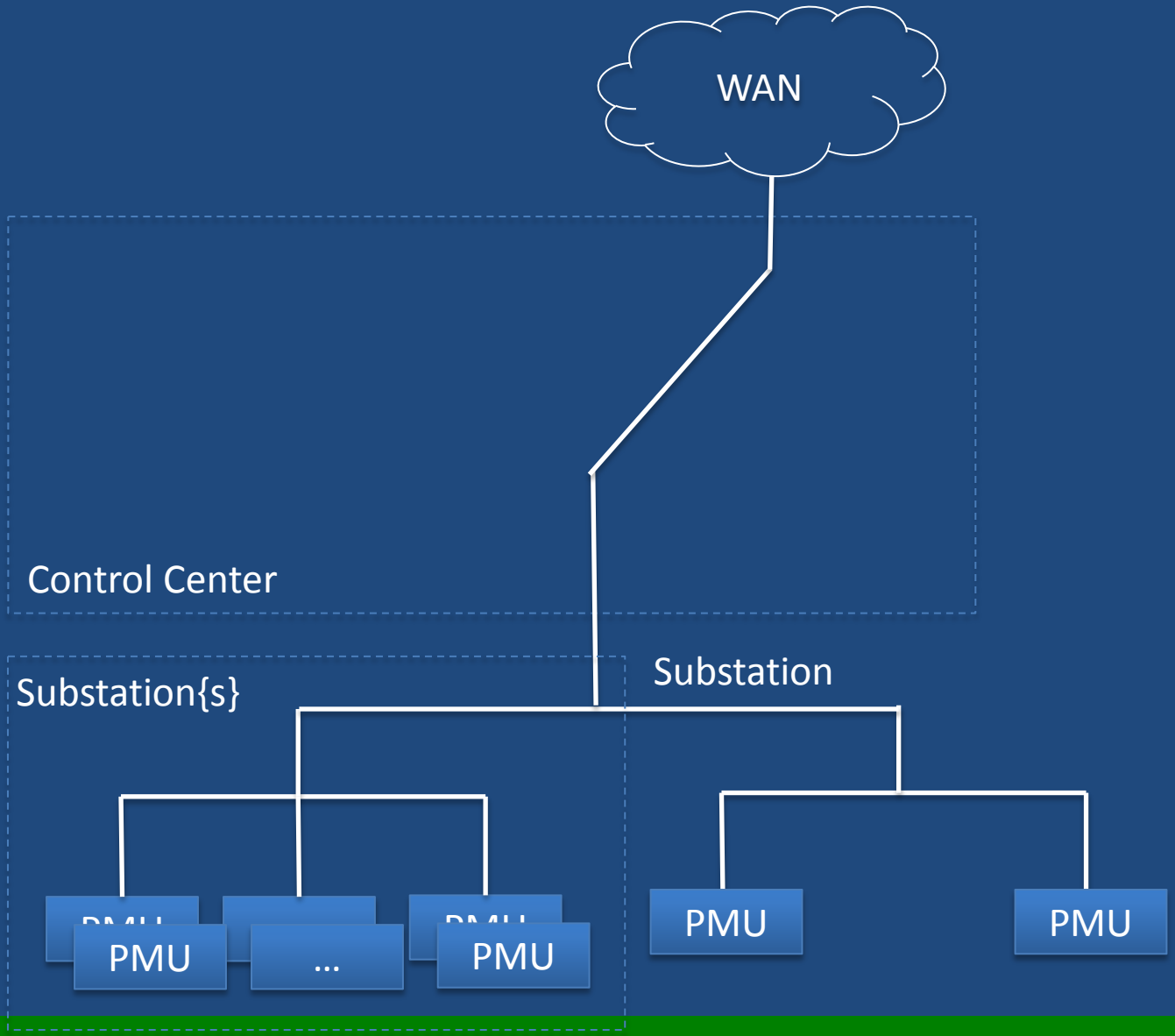
- NASPInet DNMTT work
- Analyzing NASPInet Data Flows. Hasan, R.; Bobba, R.; Khurana, H. Proceedings of the IEEE PES Power Systems Conference & Exposition (PSCE), Seattle, Washington, March 15-18, 2009.
- SGIG project implementation documents
- “Pen and Paper” planning

NASPInet Models

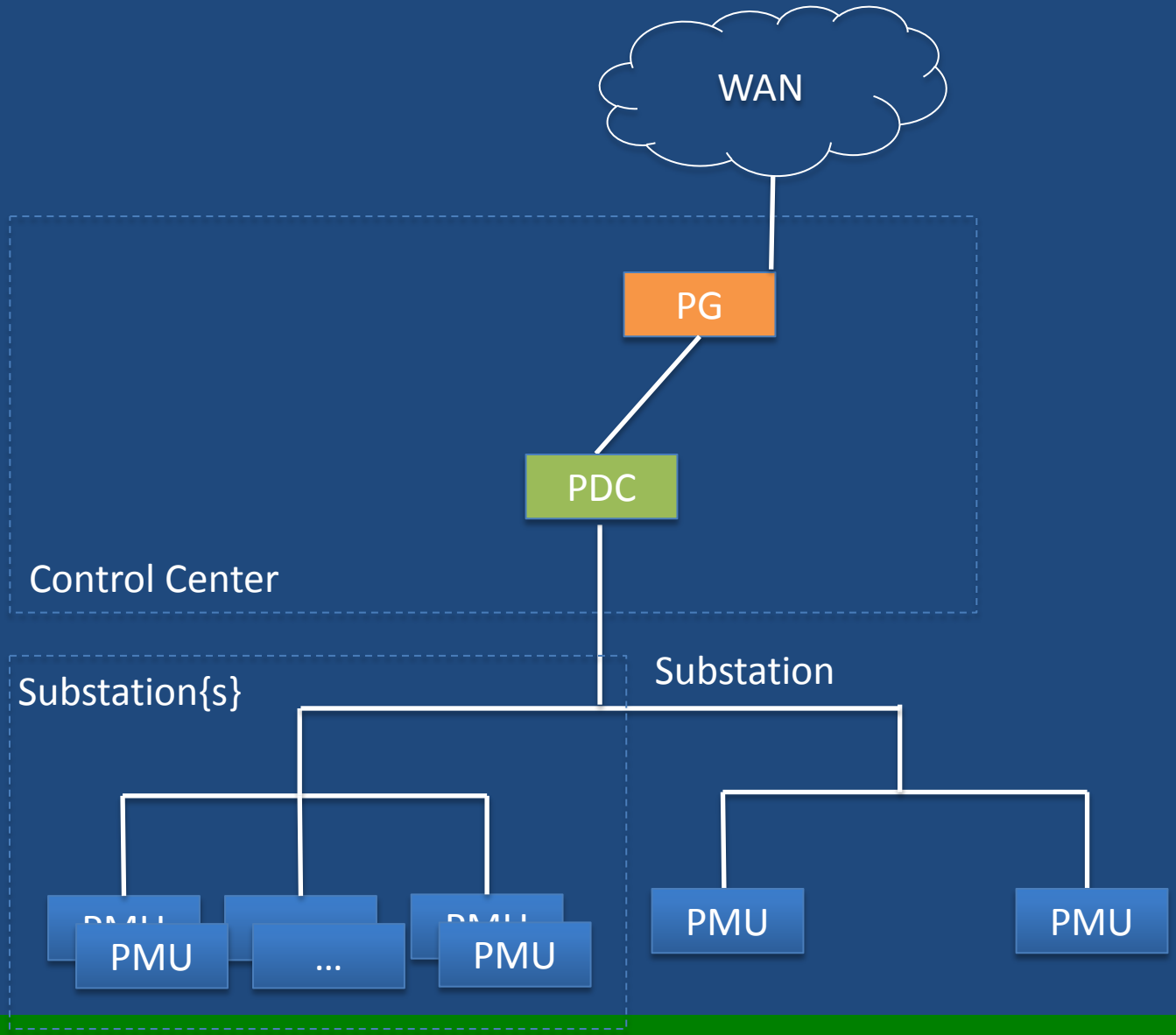
- PMU home-run architecture
  - Design in which the PMU's send data all the way to the entity interested in the data.
- Centralized PDC architecture
  - Design in which the PMU's send data to a centralized PDC which aggregates and sends on to other entities.
- PDC stacked architecture
  - Design in which the PMU's send data to a PDC (perhaps in a substation) which aggregates and sends data to another PDC (centralized).
- Hybrid architecture
  - Both home-run and PDC stacked (or centralized)

- We've made models of all of these.

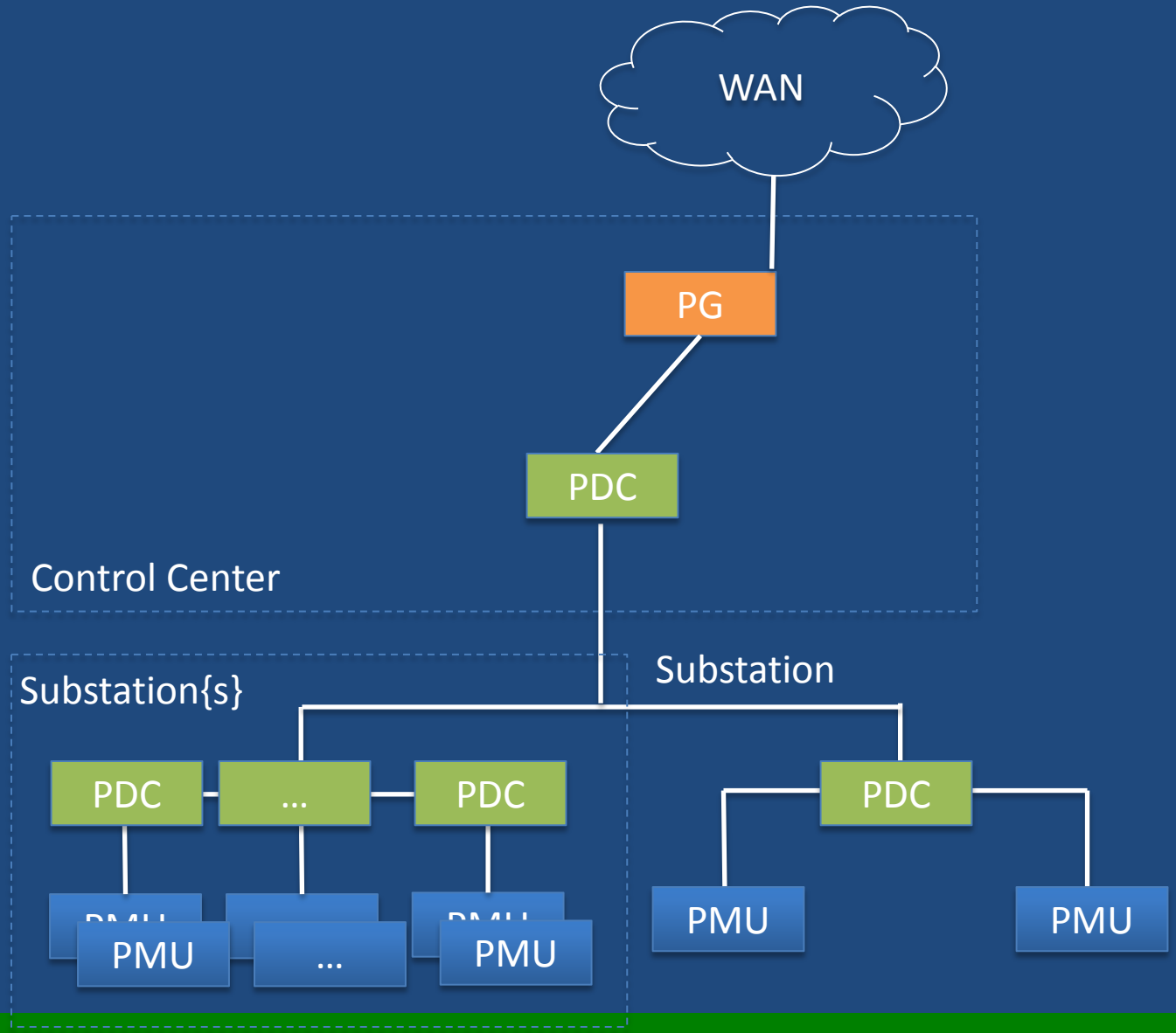
Home-Run Architecture



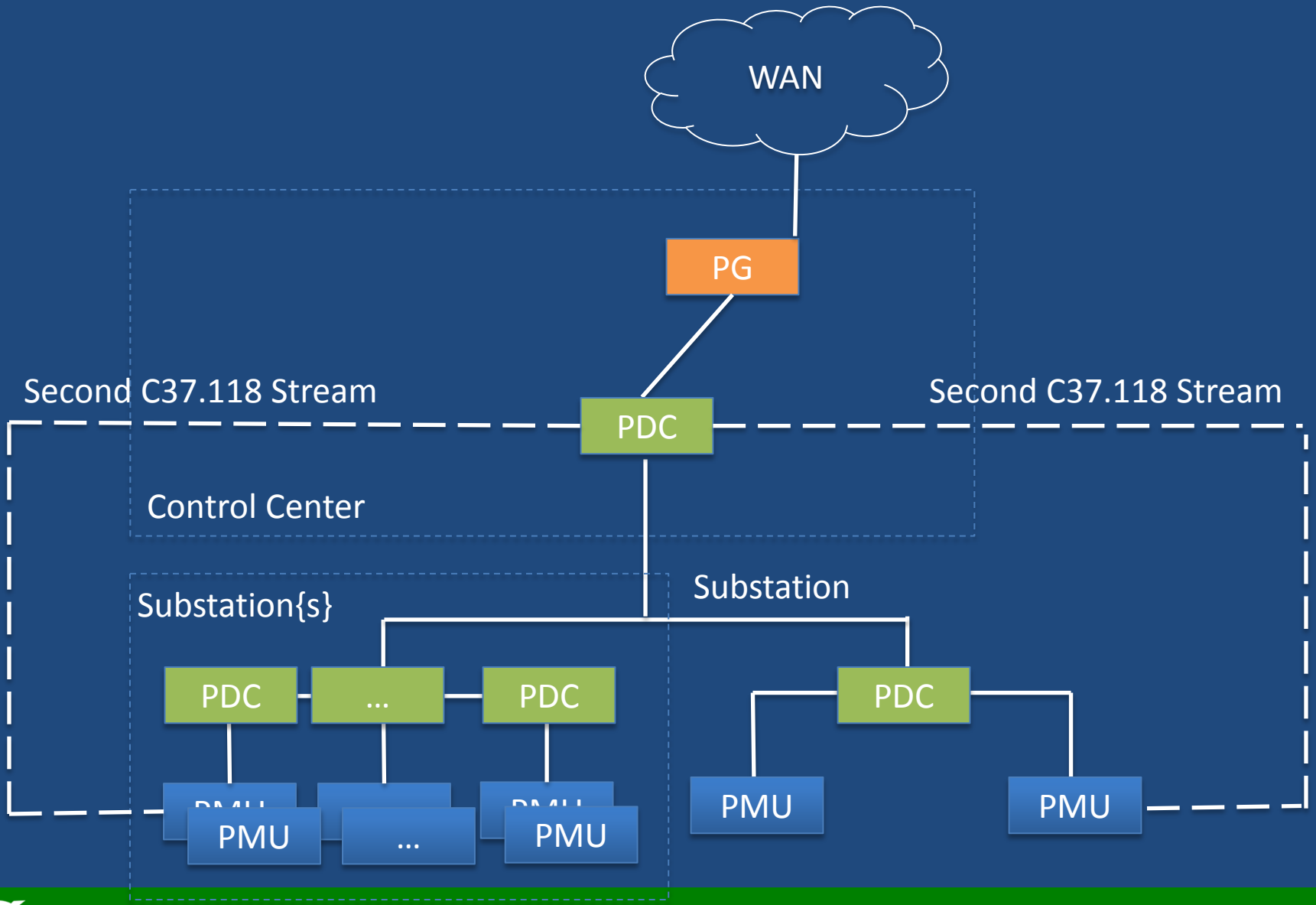
Centralized Architecture



Stacked PDC Architecture



Hybrid PDC Architecture



ACTUAL MODELING

DETER

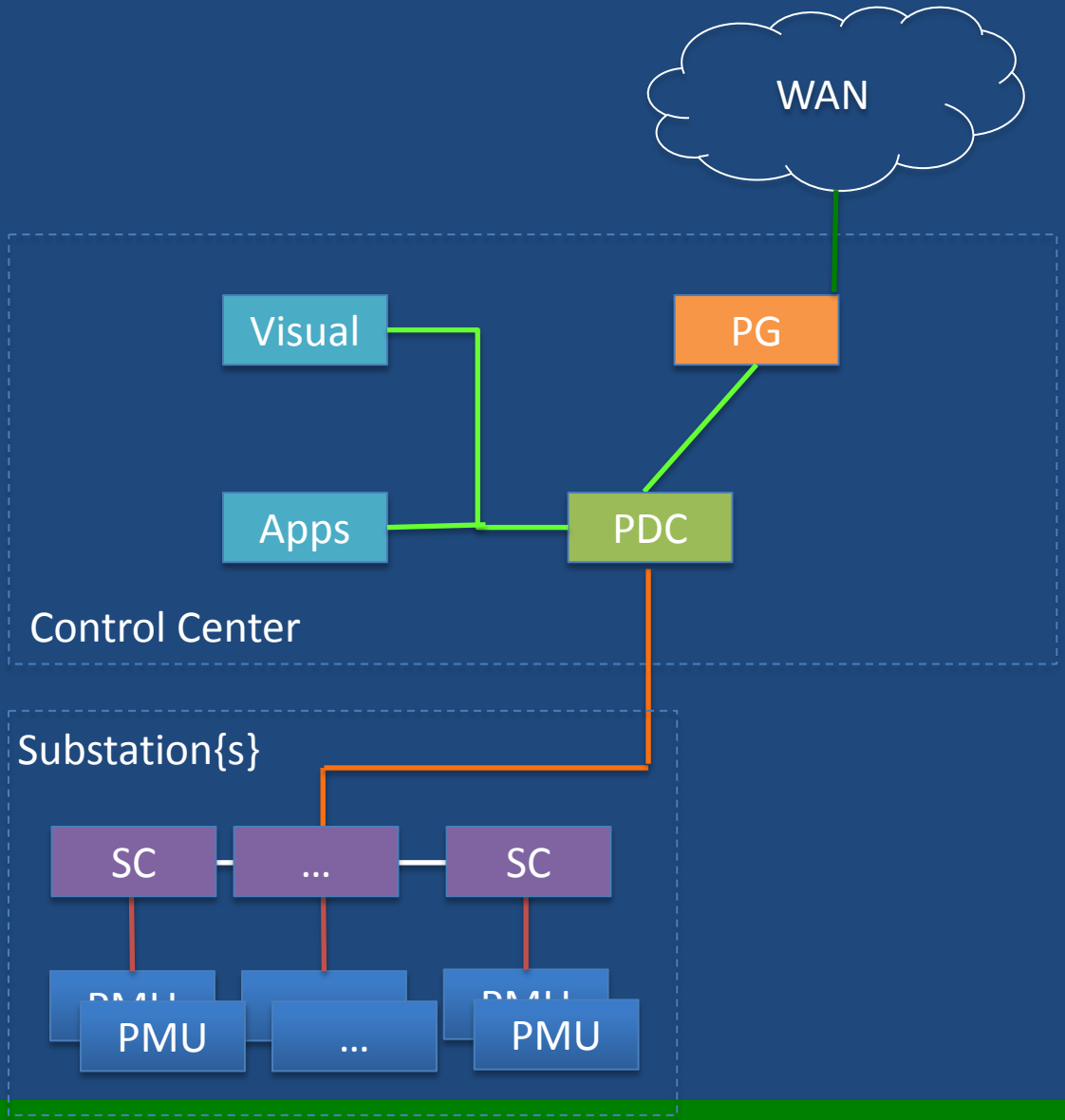
- An experimentation framework that allows you to easily
  - Configure hosts with custom software and built-in instrumentation
  - Configure network topology
  - Configure network parameters like delay, bandwidth, etc
  - Change provisioning mechanisms to emulate or provision real links leveraging external projects like GENIE

- Makes “building” networked systems easier, in the prototype phase.

DETER NASPInet Modeling

```
for {set n 0} {$n < $NASPINODES} {incr n}
   # PG node
   # PDC node
   # link PG to PDC
   set controllink($n) [$ns duplex-link $pg($n) $pdc($n) 100Mb 1ms DropTail]
   # Historian node
   # Visualization node
   # Application node
   # control center LAN
   set cclan($n) [$ns make-lan "$ccstr" 100Mb 1ms]
   # substation fans
   for {set i 0} {$i < $SUBSTATIONS} {incr i}
      # substation computer
      for {set j 0} {$j < $PMUS} {incr j}
         # PMU
      set pmulan${n}($lan) [$ns make-lan "$pmustr" 100Mb 1ms]
   # link substations to pdc
   set sublan${n} [$ns make-lan "$substr" 6Mb 15ms]
set naspiwan [$ns make-lan "$naspistr" 100Mb 20ms]
```

DETER NASPInet Model (representative)



Tools

- Trafficgen
  - Tool for generating PMU-like traffic at specified sampling rates and number of signals
  - Simple aggregation model, more complexity to follow
  - Originally built for CONES, a DOE project, and continued under TCIPG
  - All existing tools failed to produce streams matching the characteristics of PMUs (periodicity instead of constant bit rate)
- NASPInet Models
  - All 4 mentioned before
- Integration with DETER (finalizing soon)
  - This is what makes it easy for you!

SO WHAT?

Case Study: TVA

- Footprint
  - ~700 substations with voltage greater than 69 kV
  - Average 2 PMUs per substation (future)
  - ~1400 PMUs (future)
  - ~18 entities sharing information

- Centralized PDC architecture

Case Study: Entergy

- Footprint
  - ~1500 substations with voltage greater than 69 kV
  - Average 2 PMUs per substation (future)
  - ~3000 PMUs (future)
  - ~2 entities sharing information

- Hybrid Architecture

Case Study: WECC

- Footprint
  - ~35 entities in footprint
  - ~200 PMUs per entity (future)
  - ~7000 PMUs (future)
  - ~40 entities sharing information

- Centralized PDC architecture, many PGs

Questions

- Which architecture is best?
- How do you link them together?
- What bandwidth is needed?
- How do latency constraints affect provisioning and security?
- Will it scale from today to tomorrow?

Answers

- No one quite knows the answers yet, but tools like this framework leveraging DETER help answer that

- Available for release soon!
  - All 4 composible models, easily configured to represent your topology
  - Trafficgen (PMU traffic generation and aggregation)

- Future… stay tuned.
  - Run real PMU simulations (C37.118 streams)
  - Run OpenPDC, OpenPG, and more
  - Provision with both computers and real power equipment

See http://tcipg.org for more

YOUR QUESTIONS!