"How **LOW**
can you **GO**?"

CVR APPLIED AS DEMAND RESPONSE USING AMI METER DATA

2020

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Principal Technology Engineer

your most powerful membership

CONNEXUS® ENERGY
Your Community Energy Partner

130,000 member customers

1,000 square miles territory

44 substations

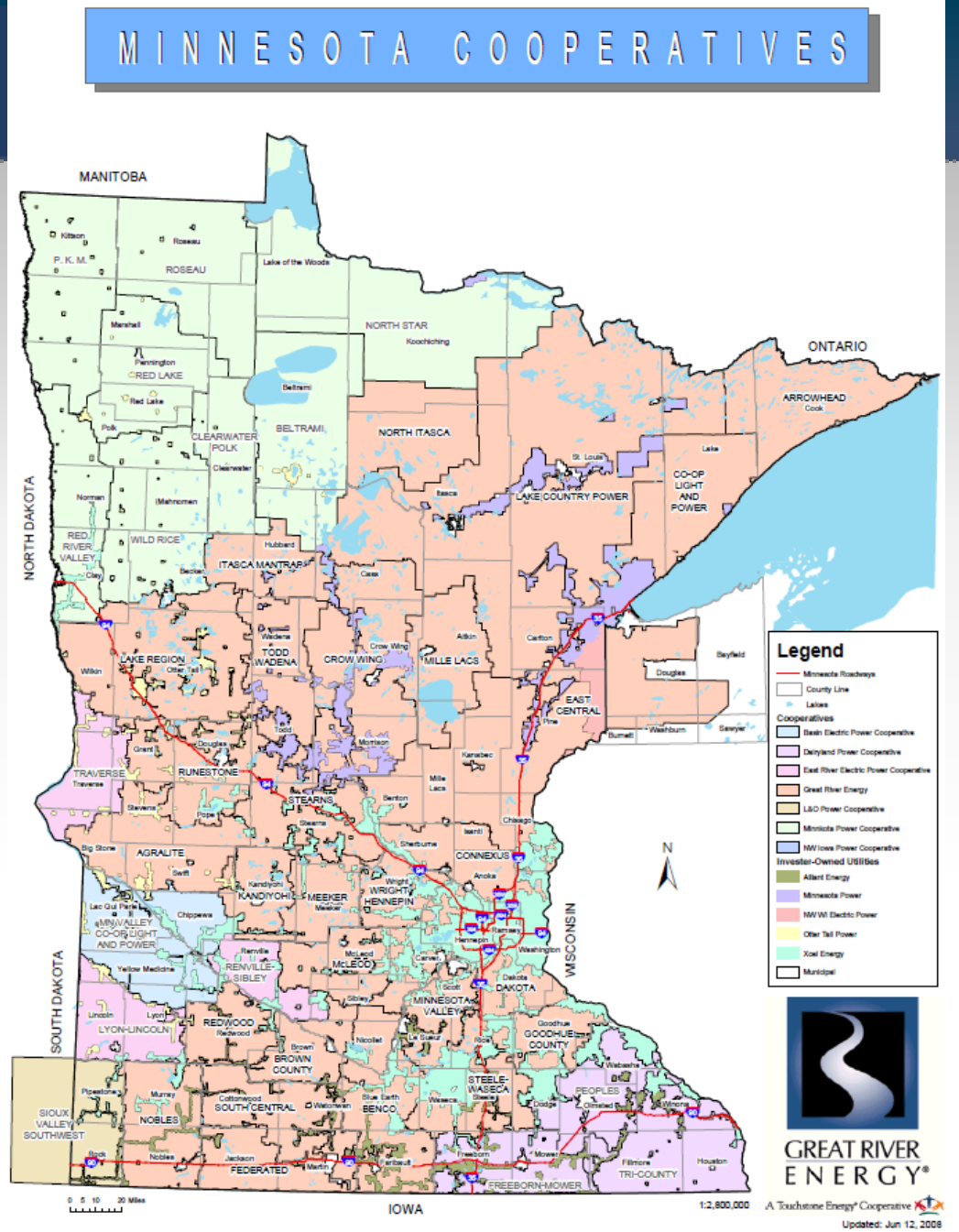
12.5 kV 9,000 miles of line

92% residential by customer

System peak demand 550 MW

Wholesale Power Supplier –

Great River Energy



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AGENDA

Conservation Voltage Reduction

- CVR for Demand Response - Basis of Operation
- History at Connexus
- AMI – Integration – “Dynamic Voltage Reduction”
- Results, Issues, Lessons Learned

VOLTAGE REDUCTION HISTORY

2000	Developed concept, initial field testing
2001 – 2002	Initial production trial – 10 substations
2003 – 2012	Annual production – summer months (June - August)
2013	Expanded – full 12 month operation
2014 – 2016	Launched centralized capacitor control (base for AMI integration)
2017 – 2018	AMI deployment
2018 – 2019	Integrated AMI for real time voltage operation
2020	Full operation of “Dynamic Voltage Reduction” (DVR)

BASIS OF OPERATION

Reduce Voltage -> reduce demand

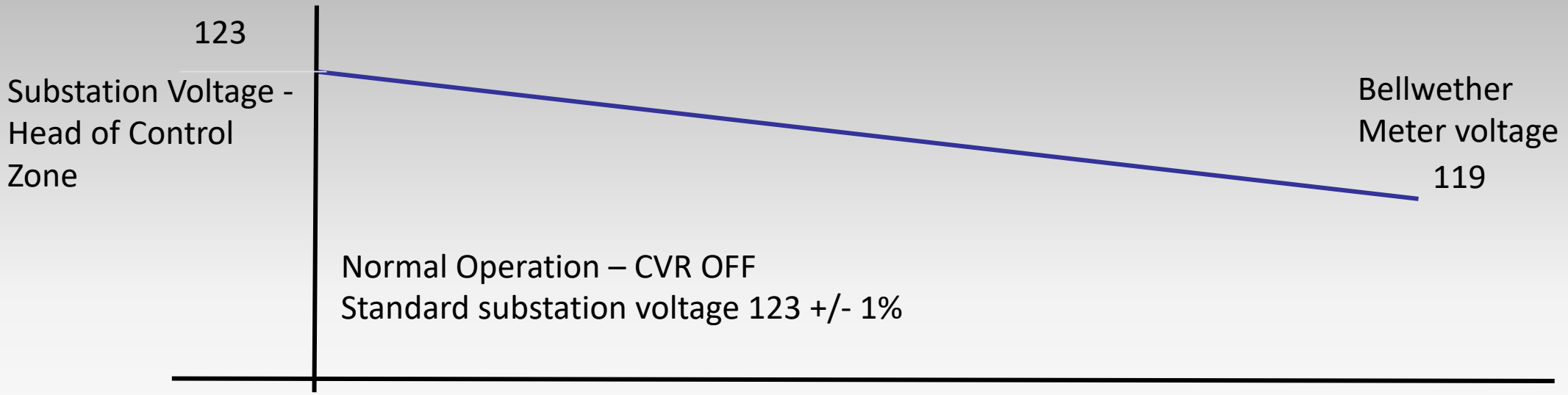
Terms:

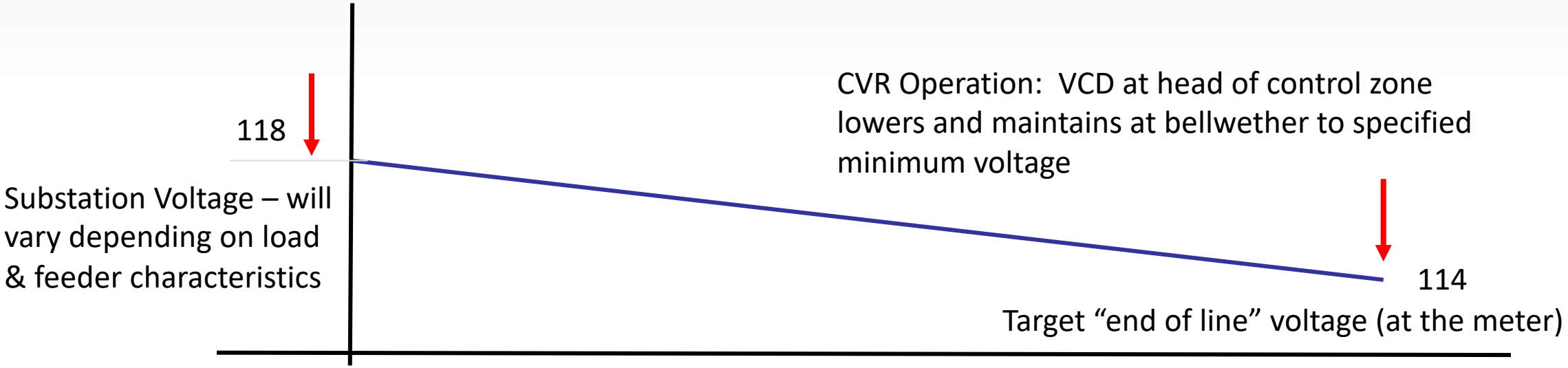
VR: CVR (Conservation) vs DVR (Demand)

"Static" VR – % reduction by modeling – applying static values to operations
"Dynamic" VR - % reduction automated using real time voltage values

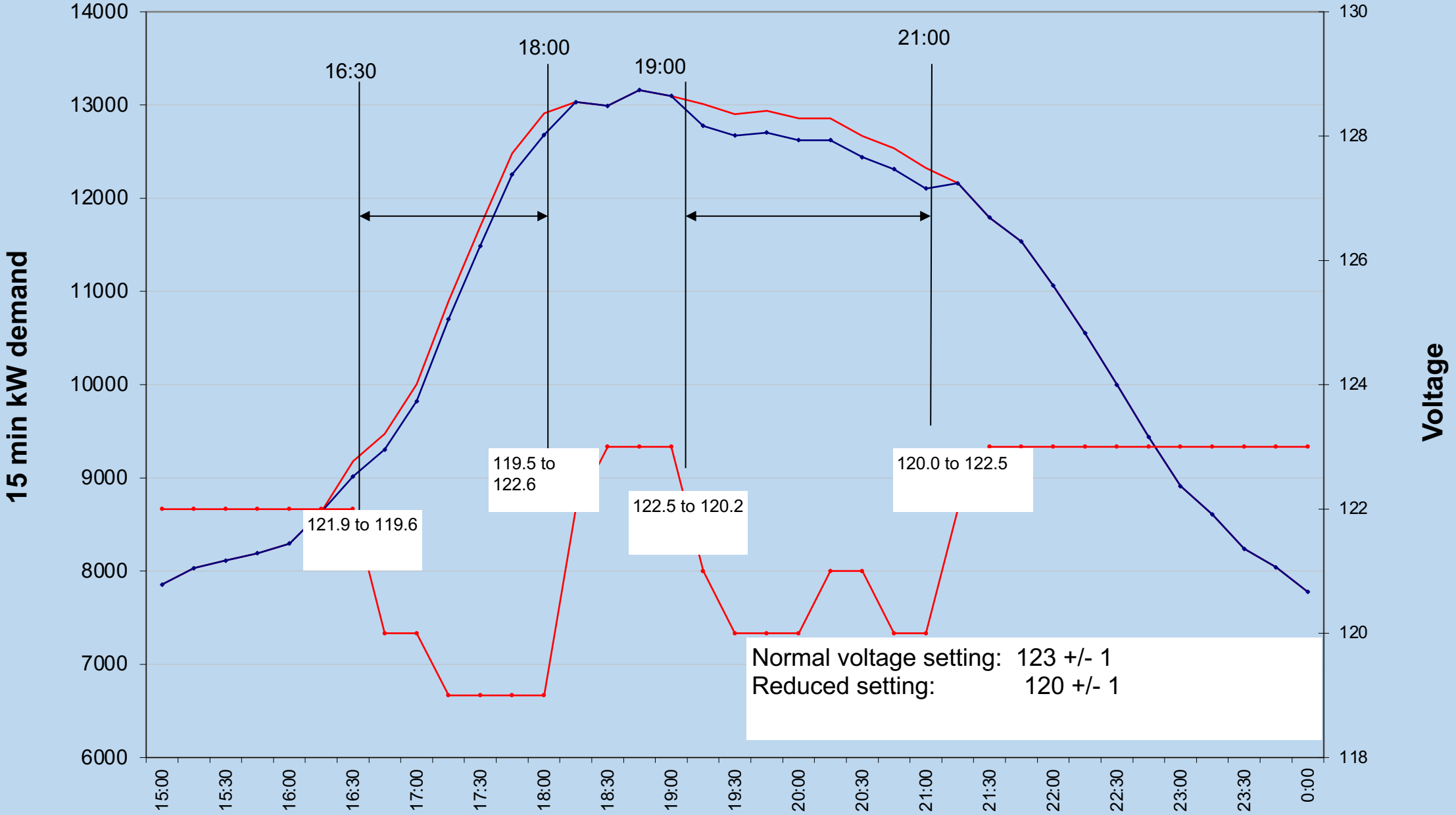
"CVR Ratio" - % demand reduced / % voltage reduced
Will vary depending on load (i.e., resistive heat vs motor)
Connexus measured (weighted average) 0.72
Typical across industry : 0.6 – 0.8

VOLTAGE REDUCTION CONCEPT





Blue – Metered demand
Red - Simulated demand - no control
CVR ratio .75



PLANNING / ENGINEERING PROCESS (Static)

Base Requirement:

- **Maintain voltage at meter > 114 volts (ANSI Range A)**
- **Connexus – model primary voltage – minimum 118 volts**

Project system peak load

↓

Run load flow for each substation

↓

Identify lowest voltage constraint across all feeders per sub

↓

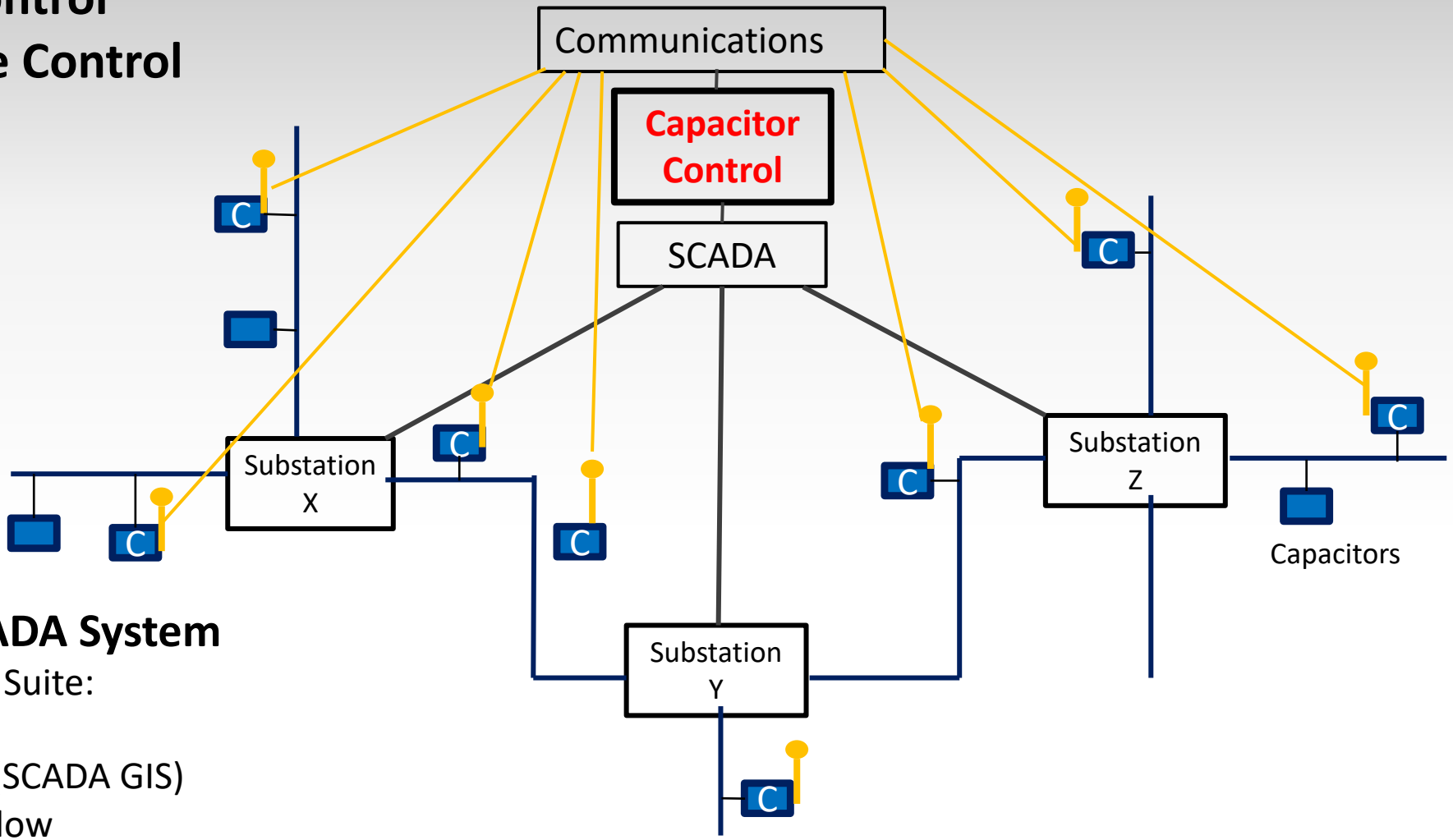
VR “bandwidth” :
lowest modeled voltage – minimum allowed

↓

Load fixed % drop setting into LTC / Regulator controls

REVIEW - VOLT/VAR CONTROL (VVC)

Phase 1: VAR Control
Phase 2: Voltage Control

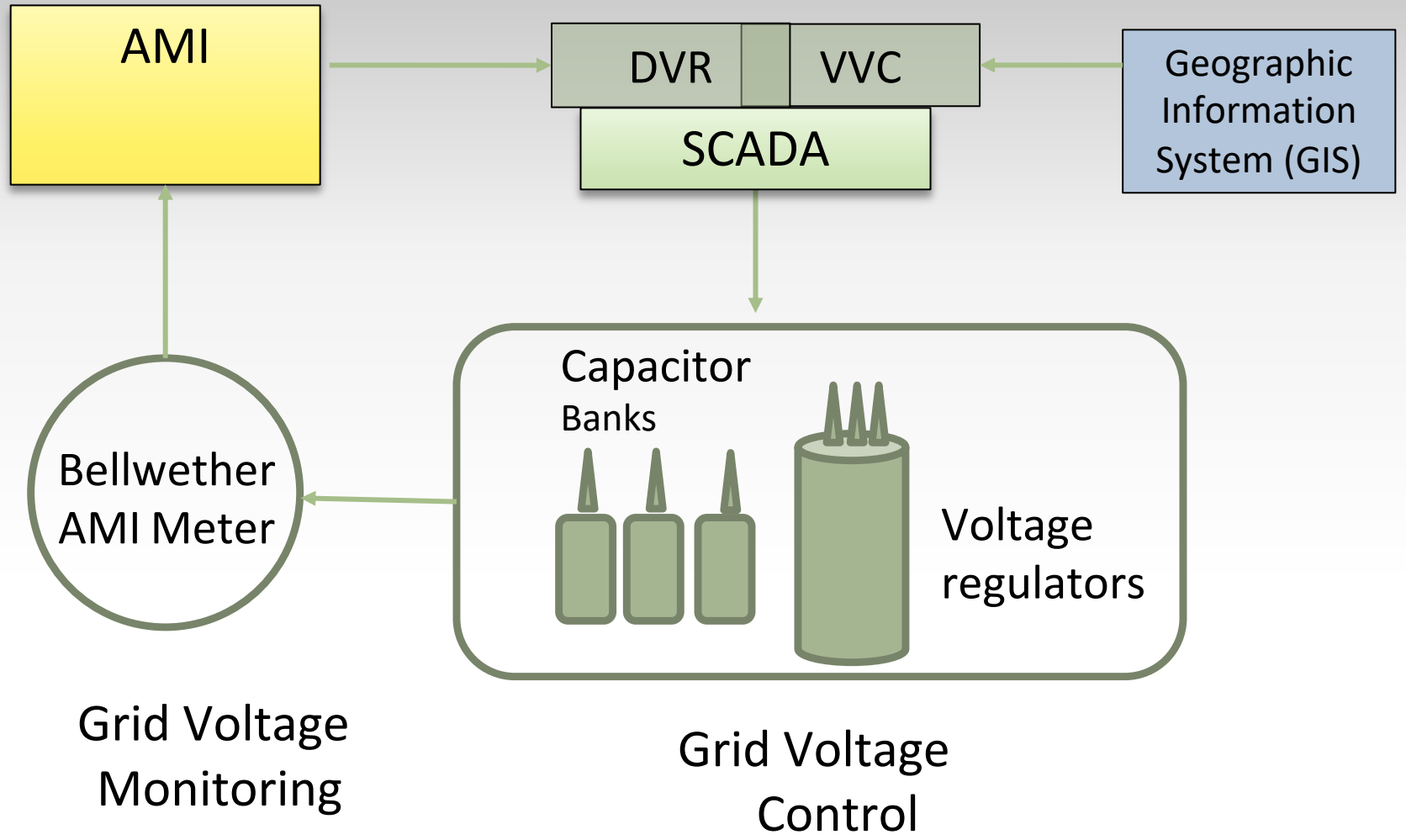


OSI SCADA System

"Spectra" Suite:

- VVC
- Emap (SCADA GIS)
- Load Flow

NEW - "DYNAMIC VR" INTEGRATED WITH AMI

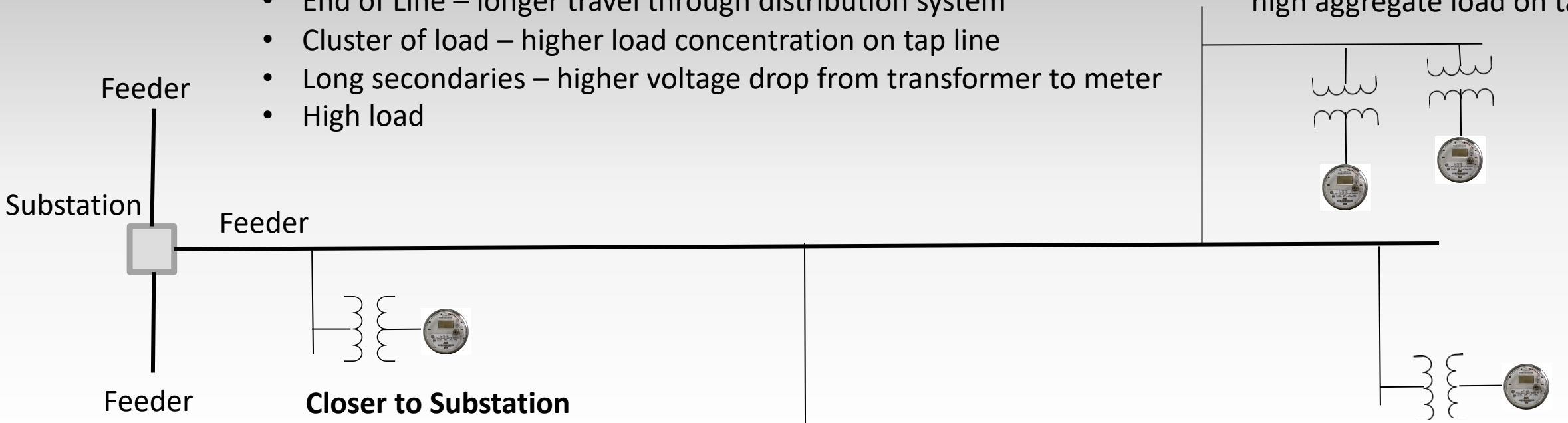


BELLWETHER LOCATION STRATEGY

Lower Voltage at Meter – Drivers:

- End of Line – longer travel through distribution system
- Cluster of load – higher load concentration on tap line
- Long secondaries – higher voltage drop from transformer to meter
- High load

Cluster – neighborhood high aggregate load on tap



Closer to Substation

- Small transformer
- Long secondary
- Cluster
- High load

Voltage variance – same transformer

typical load, good voltage

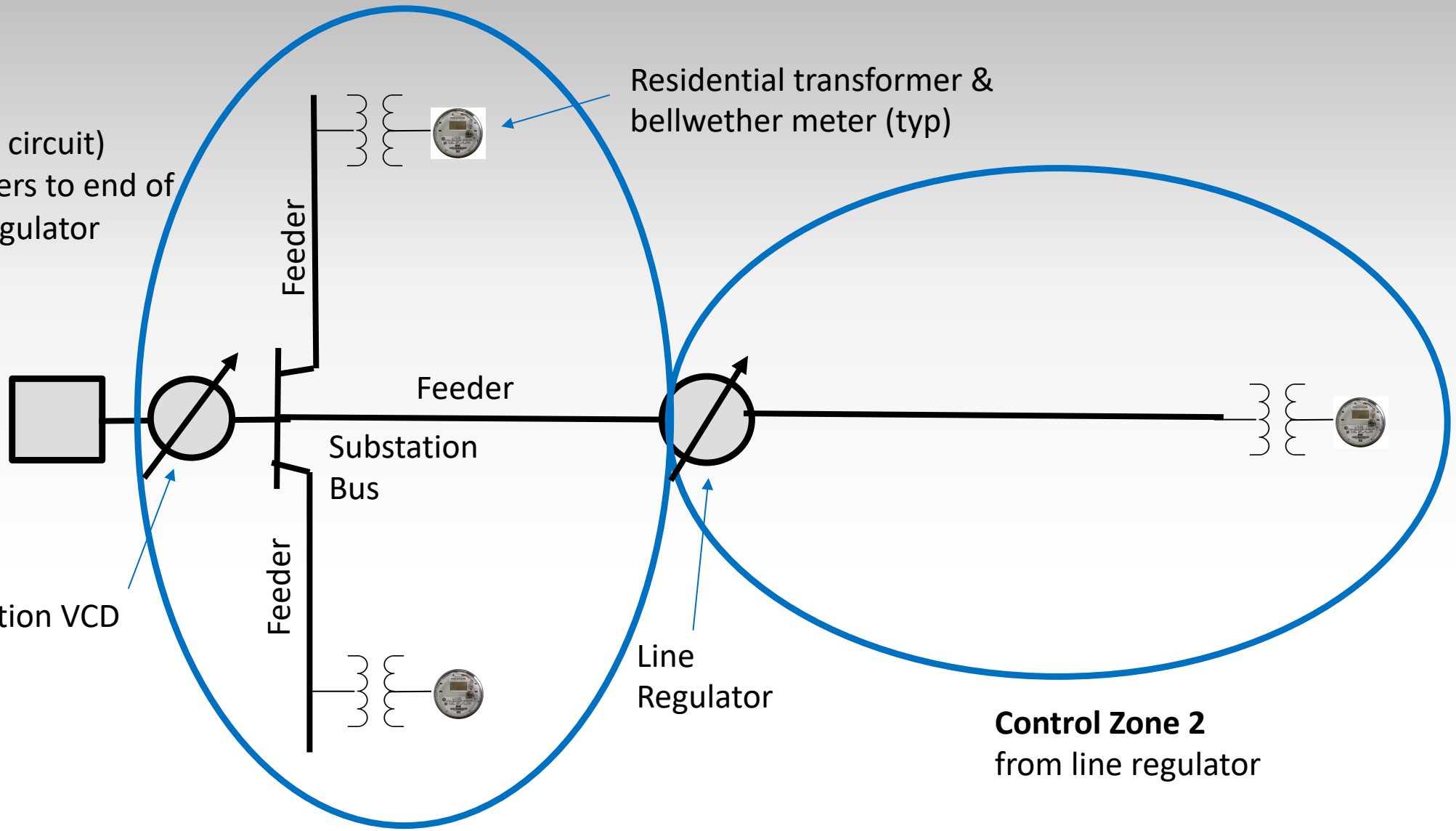
Low voltage:

- High load
- Long secondary

“**End of Line**”

BELLWETHER CONTROL ZONES

Control Zone 1
(from substation circuit)
Includes all feeders to end of line, or to line regulator

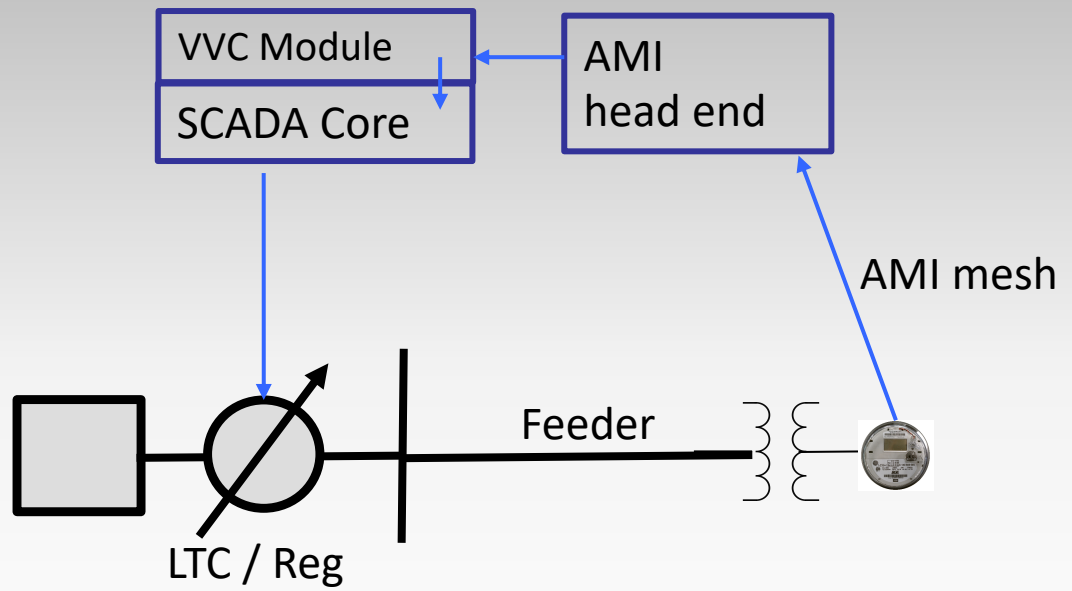


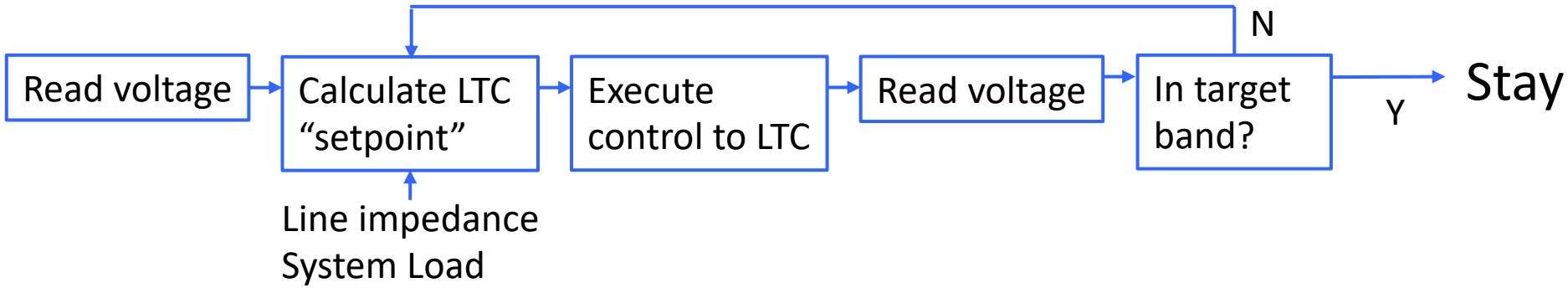
BELLWETHER DATA

5 minute “average” voltage readings

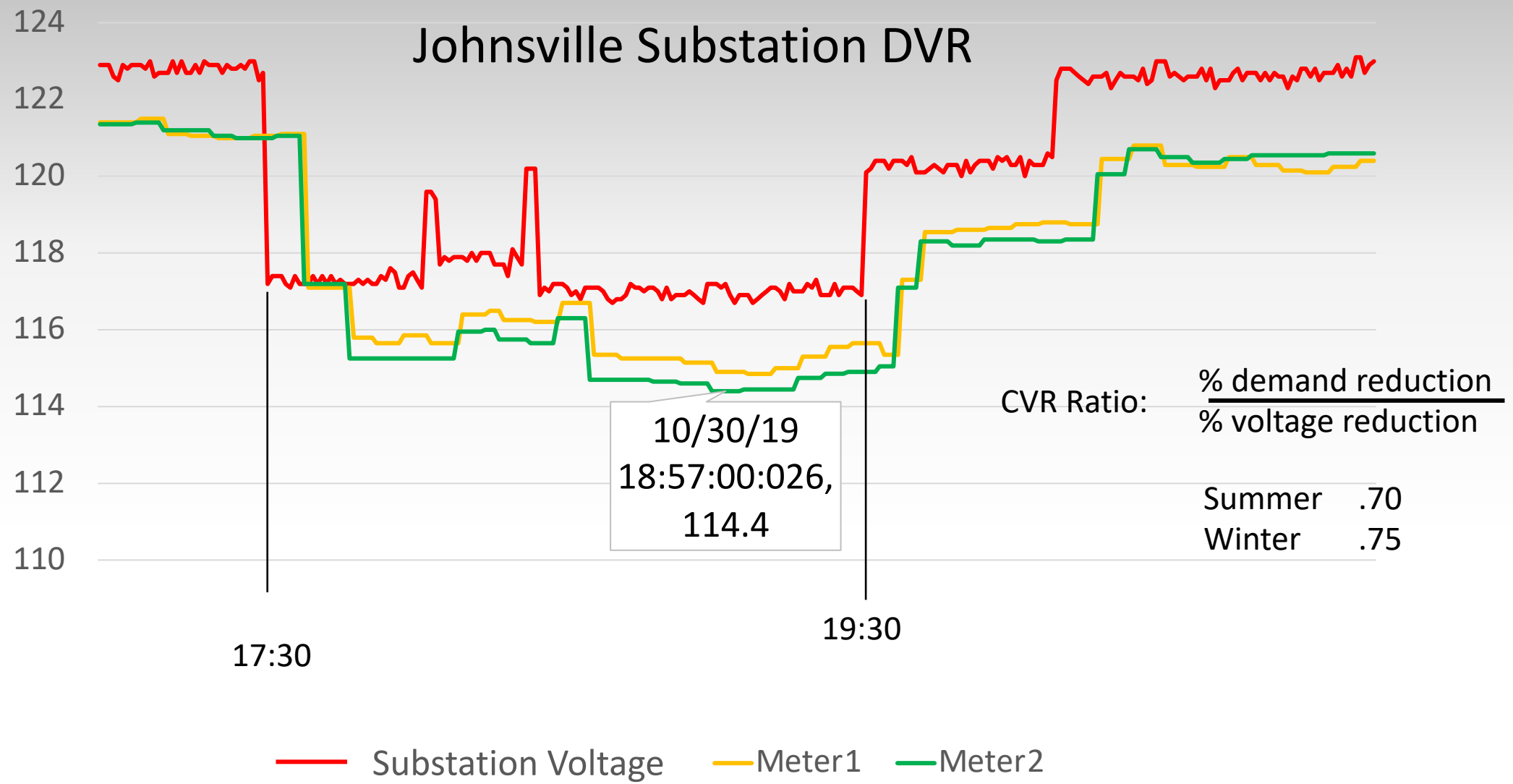
Transferred every 5 minutes

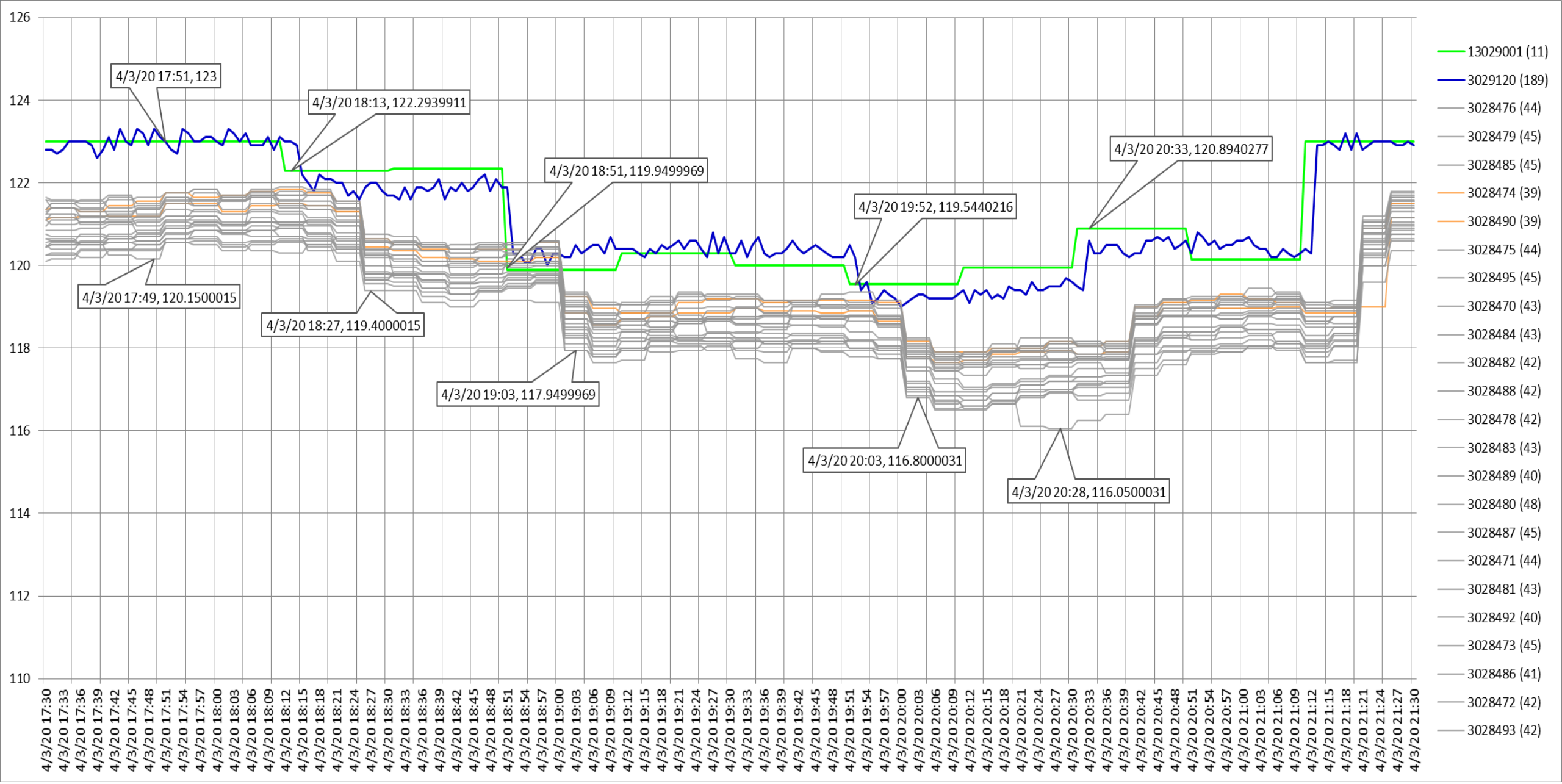
SCADA “refresh” read and operate – 20 minutes





DVR OPERATION




4/3/20 17:51, 123
4/3/20 18:13, 122.2939911
4/3/20 18:51, 119.9499969
4/3/20 19:52, 119.5440216
4/3/20 20:33, 120.8940277
4/3/20 17:49, 120.1500015
4/3/20 18:27, 119.4000015
4/3/20 19:03, 117.9499969
4/3/20 20:03, 116.8000031
4/3/20 20:28, 116.0500031
13029001 (11)
3029120 (189)
3028476 (44)
3028479 (45)
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3028474 (39)
3028490 (39)
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3028495 (45)
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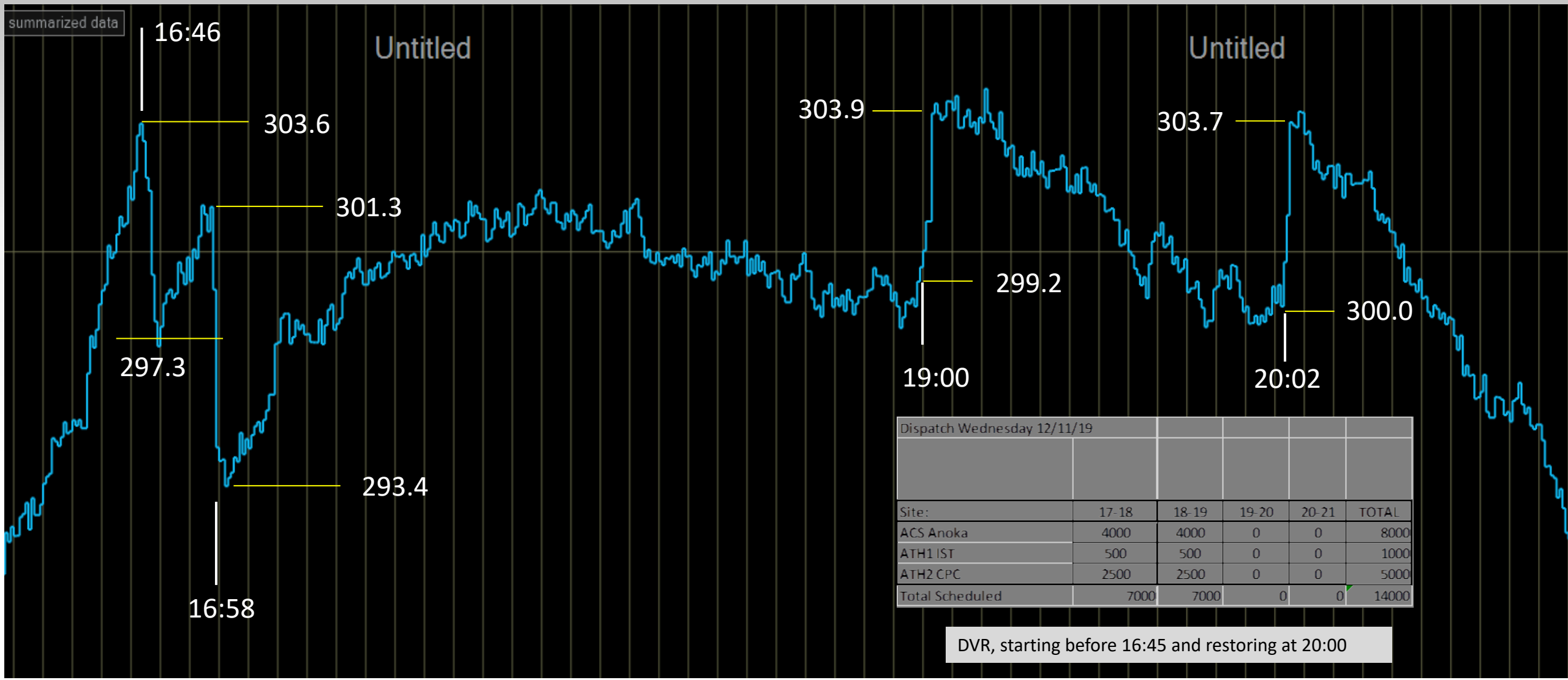
3028486 (41)
3028472 (42)
3028493 (42)

CONNEXUS TOTAL DEMAND



Dispatch Wednesday 12/11/19					
Site:	17-18	18-19	19-20	20-21	TOTAL
ACS Anoka	4000	4000	0	0	8000
ATH1 IST	500	500	0	0	1000
ATH2 CPC	2500	2500	0	0	5000
Total Scheduled	7000	7000	0	0	14000

DVR, starting before 16:45 and restoring at 20:00

PERFORMANCE

48 Substation Transformer Base

STATS:	SUMMER	NON-SUMMER
VR range achieved (%)	0 – 4.0%	0 – 4.3%
VR system wide weighted average (%)	1.6 - 2.0%	2.0 – 3.0 %
Total System Demand Reduced (%)	1.2 – 1.4%	1.4 – 2.4%

WHAT HAPPENS IF… ??

Bellwether meters stop reporting…

Data link from AMI to SCADA breaks…

One meter stops reporting, value goes to zero…

Communications go down??

Receive voltage complaint…

DISTRIBUTION UPGRADES / TECHNOLOGY

Distribution System Improvements to Enhance VR Ability

- Regulators
- Capacitor banks

IT Network

- Alarming Enhancements – Bellwether data link, data quality

DVR Operations – Technical Support

Post Operation Analytics

WRAP UP

Questions

Discussion