Business case for loss reduction using Volt/VAR control in Indian grid

Loss Management with V-VAR controller

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V-Var-W Control Spans into the business of

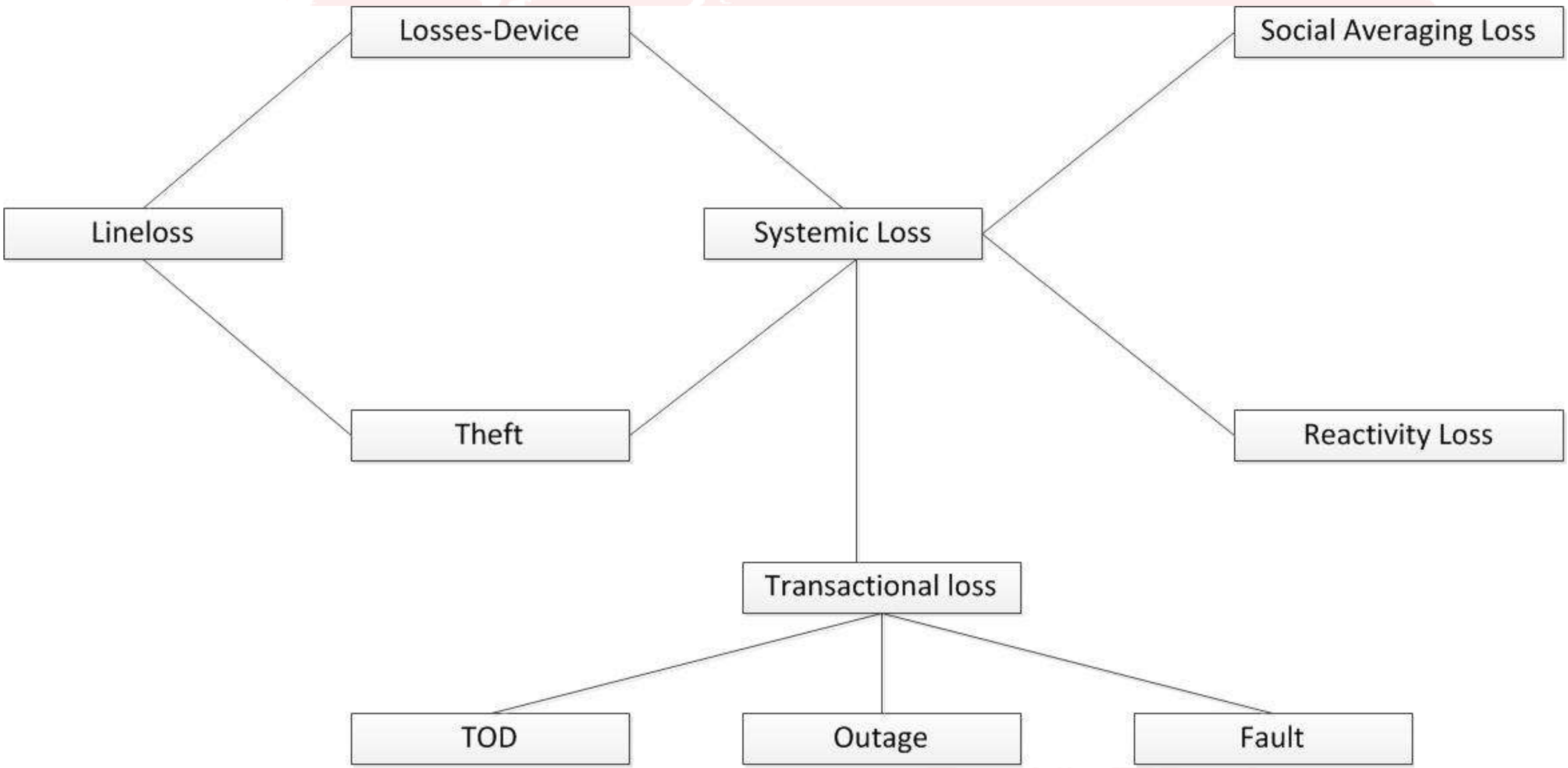
- Loss management
- Reactive power pricing
- Distributed Generation(DG)
- Protection System Management
- Reactive power dispatch business

What is Volt-VAR control?

- The use of capacitor banks, voltage regulators, distributed generating units, static VAR compensator, and other devices …:To maintain acceptable voltages at all points along the feeder under all loading conditions
- To operate the distribution system as efficiently as possible without violating any load and voltage constraints
- To support the reactive power needs of the bulk power system during system emergencies

APQI ASIA POWER QUALITY INITIATIVE

What are losses in distribution system?



What losses we are addressing and how?

- Systemic losses

I. by way of using V-VAR compensation.

How Is Volt-VAR Control Accomplished?

- Traditional Devices for Volt-VAR Control Fixed and switched capacitor banks (in substation and out on the feeder)
- Substation transformers with Load Tap Changers (LTCs)
- Voltage regulators (in substation and/or out on the feeder)
- “Future” Devices for Volt-VAR Control-Distributed generating resources
- Static VAR compensators

Approaches to Volt VAR

- Traditional Approach
- SCADA Volt VAR
- Integrated V-VAR controller

Requirements for the "Ideal" Volt-VAR System

- Maintain **Acceptable Voltage Profile**at all points along the distribution feeder under all loading conditions
- Maintain **Acceptable Power Factor**under all loading conditions
- Provide **Self Monitoring**–alert dispatcher when a volt-VAR device fails
- Allow **Operator Override**during system emergencies
- Work correctly following **Feeder Reconfiguration**
- Take advantage of **SmartGrid Devices**(StatCOM, DG, etc.)
- Provide **Optimal Coordinated Control**of all Volt VAR devices
- Allow **Selectable Operating Objectives**as different needs arise

Limitations of Traditional Volt-VAR Control

- *The system is not continuously monitored*
- *The system lacks flexibility to respond to changing conditions out on the distribution feeders –can mis-operate following automatic reconfiguration*
- *System operation may not be "optimal" under all conditions*
- *Cannot override traditional operation during power system emergencies*
- *System may mis operate when modern grid devices (e.g., distributed generators) are present –reverse power flow from DG can "trick" standalone controller tobelieve feeder has been reconfigured*

“Scorecard” for Traditional Volt VAR

- *Volt VAR Requirements Traditional*
- *Acceptable voltage profile at the location*
- *Acceptable power factor*

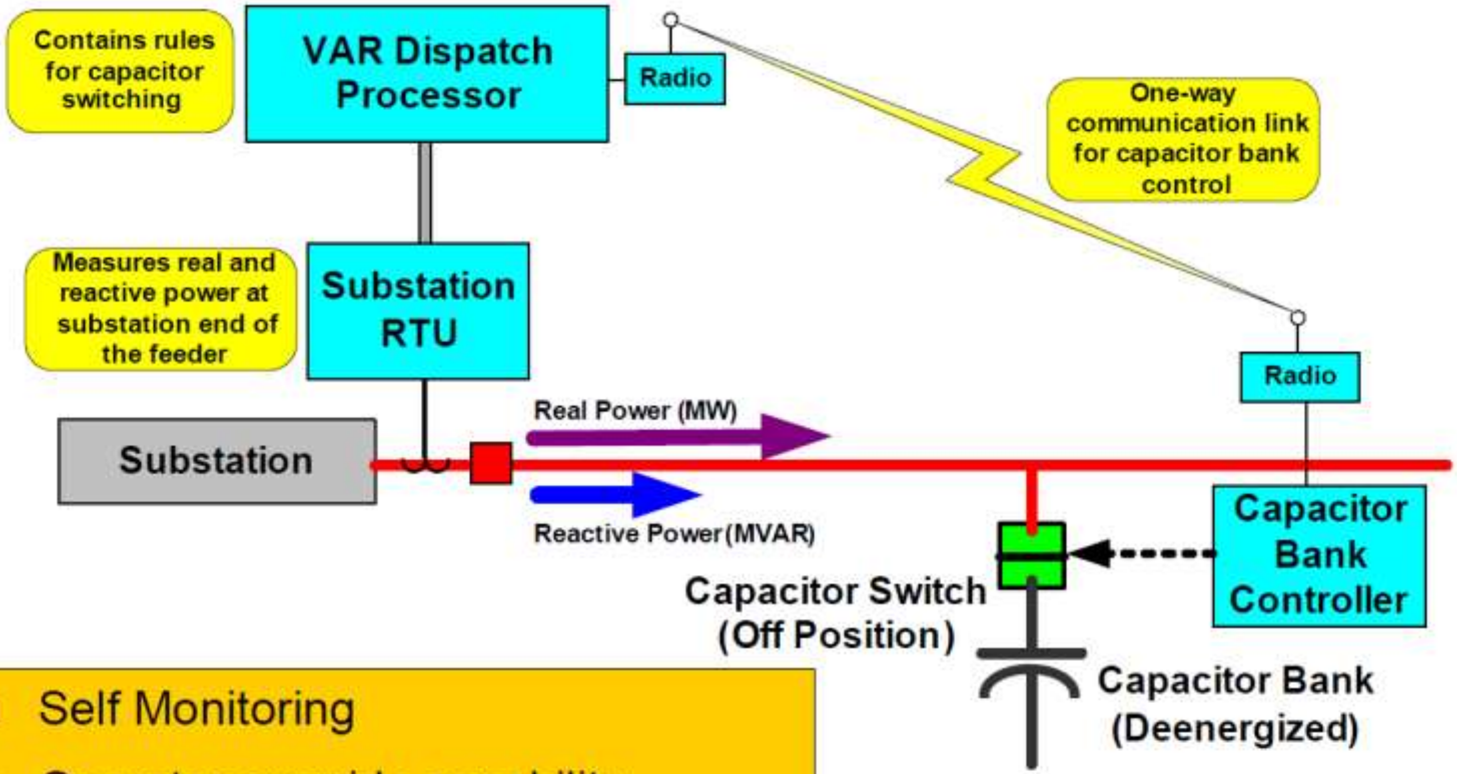
"SCADA" Controlled Volt-VAR

- Volt-VAR power apparatus monitored and controlled by Supervisory Control and Data Acquisition (SCADA)
- Volt-VAR Control typically handled by two separate (independent) systems: **VAR Dispatch**–controls capacitor banks to improve power factor, reduce electrical losses, etc
- **Voltage Control**–controls LTCs and/or voltage regulators to reduce demand and/or energy consumption (aka, **Conservation Voltage Reduction**)
- <u>Operation of these systems is primarily based on a **stored set of predetermined rules**(e.g., *"if power factor is less than 0.95, then switch capacitor bank #1 off")*</u>

Overview of VAR dispatch

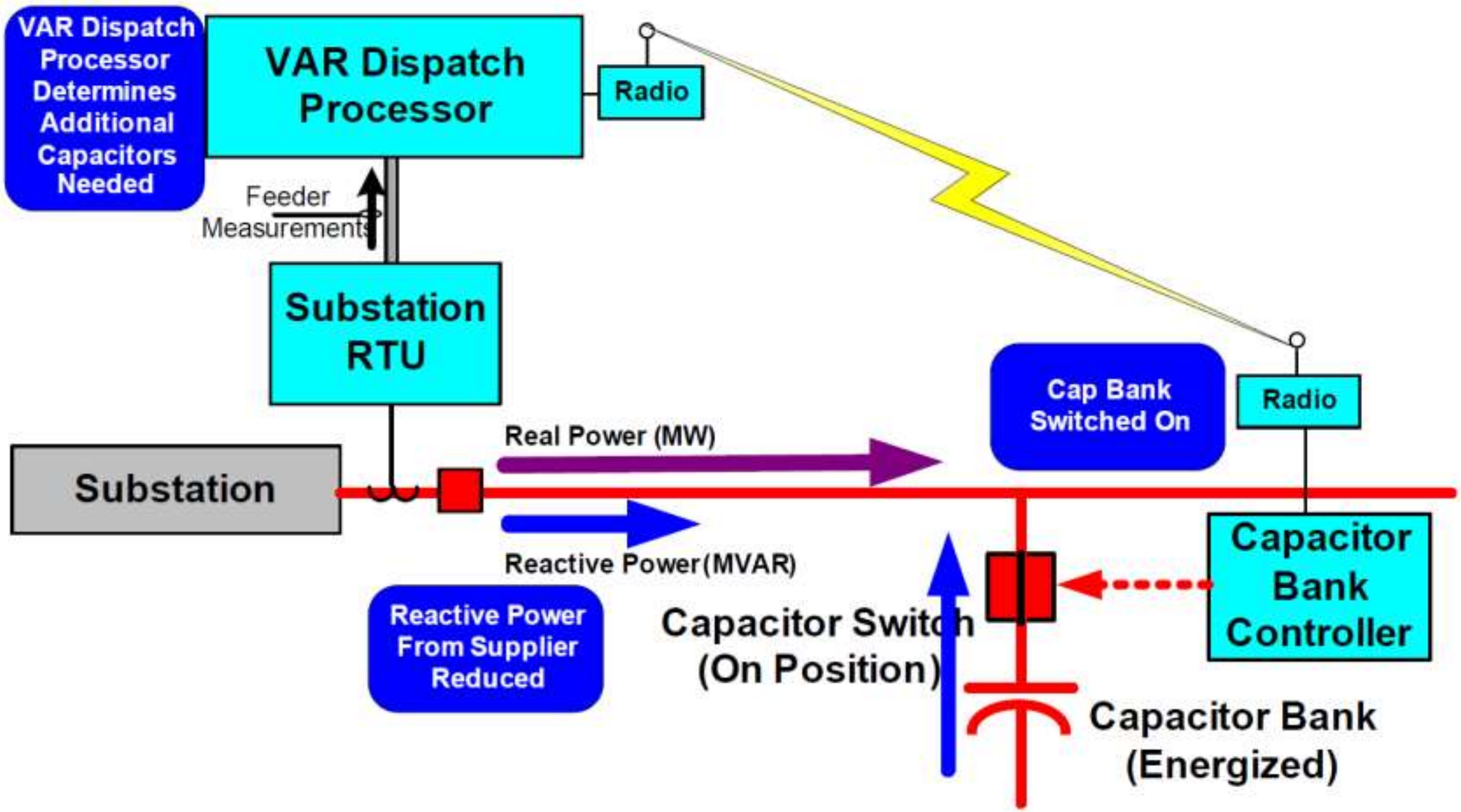
- General objective is to maintain power factor as close to unity at the head end of the feeder without causing leading power factor
- Simplified formula for loss reduction due to average power factor improvement:
  - % Loss Reduction = (1 – $AVGPF_2$ / TPF_2) x 100
  - Example: (1 - .942 / .992) = 9.84%
- Simplified formula for demand reduction due to power factor improvement at peak load:
  - Demand Reduction = (1 / PKPF – 1 / TPF) x 100
  - Example: (1 / .97 – 1 / .99) = 2.08%

Benefits of VAR Dispatch vs Traditional

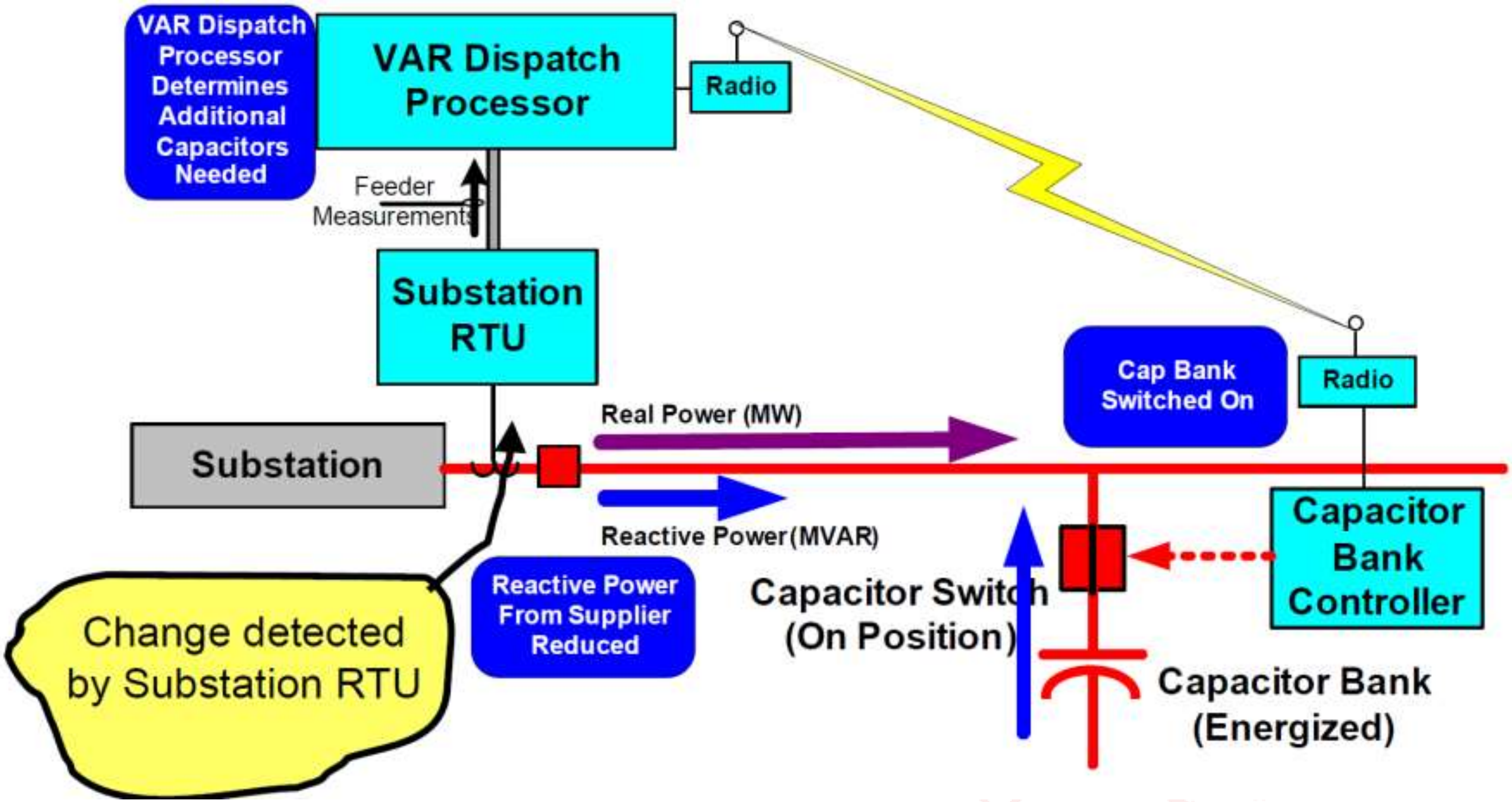


- Self Monitoring
- Operator override capability
- Some improvement in efficiency

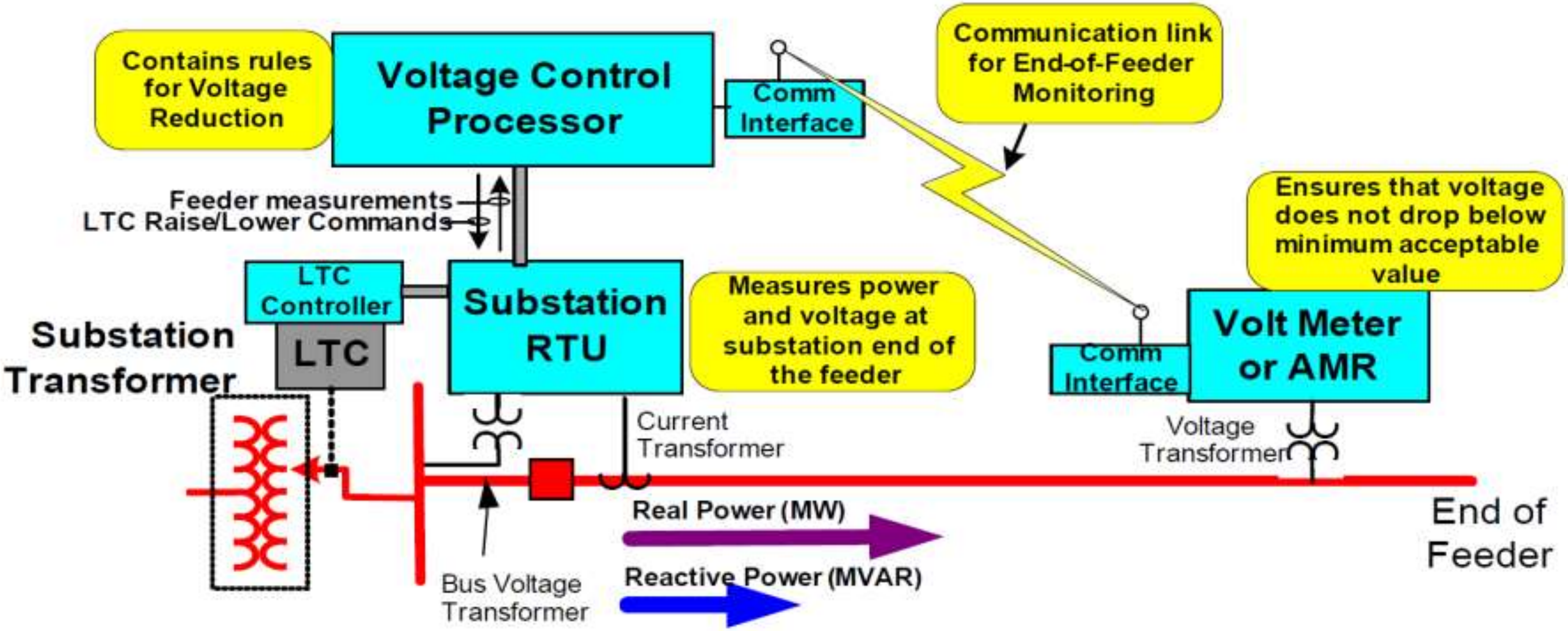
Change in Reactive Power Detected



Change in Reactive Power Detected



Voltage Control Components



Integrated Volt-VAR Control (IVVC)

- Develops and executes a coordinated "optimal" switching plan forallvoltage and VAR control devices -uses optimal power flow program as its "engine"
- Achieves utility-specified objective functions:Minimize distribution system power loss
  - Minimize power demand (sum of distribution power loss and customer demand)
  - Maximize revenue (the difference between energy sales and energyprime cost)
  - Combination of the above
- Can bias the results to minimize tap changer movement and other equipment control actions that put additional "wear and tear"on the physical equipment

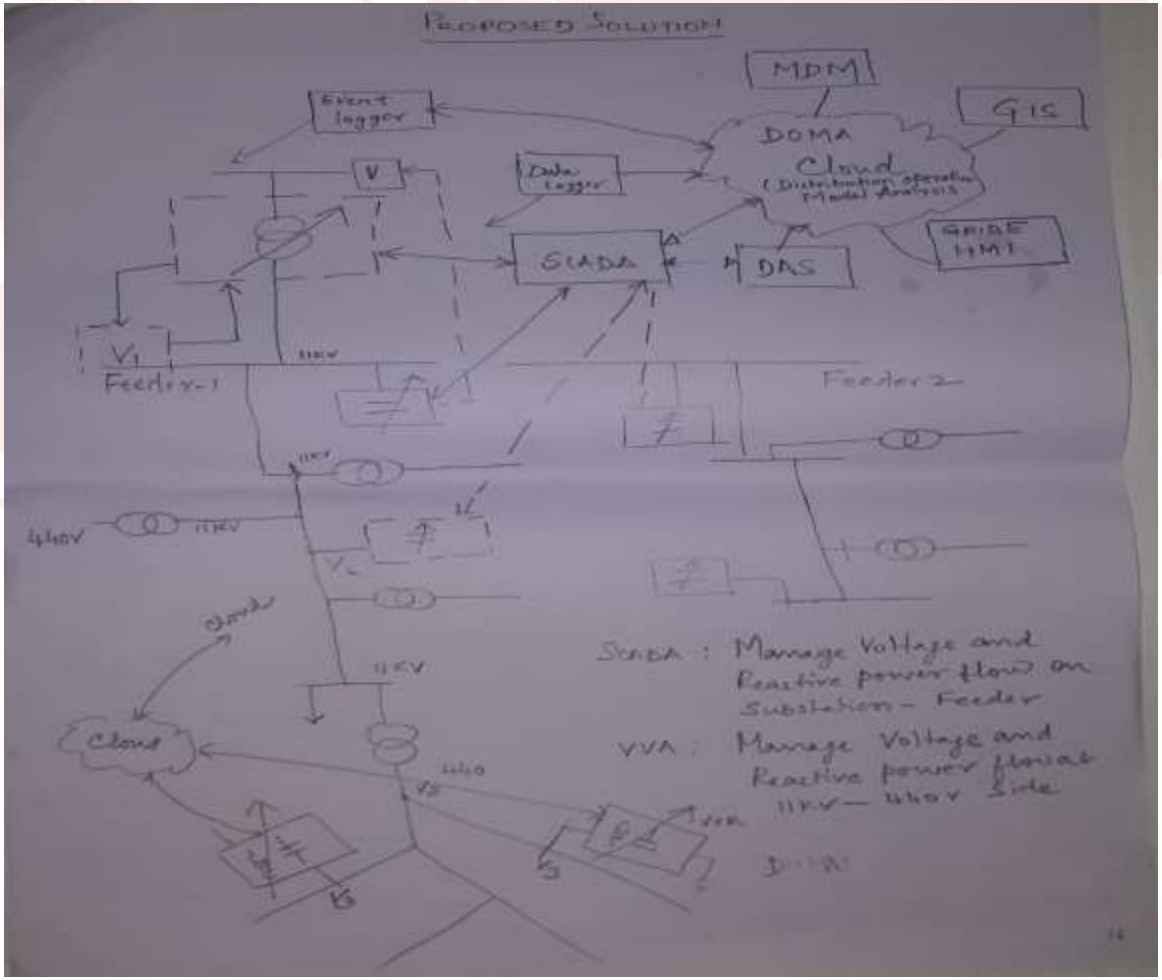
IVVC Benefits

- Dynamic model updates automatically when reconfiguration occurs
- Volt –VAR control actions are coordinated
- System can model the effects of Distributed Generation and other modern grid elements
- Produces “optimal” results
- Accommodates varying operating objectives depending on current need

Final Volt-VAR "Scorecard"

Volt Var requirements				
	Traditional V-VAR	SCADA V-VAR	Integrated V-VAR	
Acceptable Voltage Profile	√	√	√	
Acceptable power factor	√	√	√	
Self Monitoring		√	√	
Operator Override		√	√	
Feeder reconfiguration			√	
Smart Grid Devices			√	
Optimal Coordinated Control			√	
Selectable Operating Objectives			√	

Proposed Solution



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Results in

- Loss reduction in Distribution System(DS)
- Effective contingency management
- Congestion Management
- Effective augmentation of DG
- Better utilization of subsidies in DS
- Coordination with LDC – PTC resulting in traditional practices of reactive power as auxillary trades.
- SLA in protection system management.

THANK YOU