AIT
Asian Institute of Technology

Power System – SCADA

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Syllabus progress

Time/Date	Monday 11-Jun-2012	Tuesday 12-Jun-2012	Wednesday 13-Jun-2012
09:00-10:00	**Opening Ceremony & Break (09:30 - 11:00)**	**SCADA Functional Requirements and Components**	**Power Systems SCADA and SCADA in Power System Automation**
10:00 - 10:30			
10:30-12:00	**Introduction to Supervisory Control and Data Acquisition**		
12:00-13:30			***Lunch Break***
13:30-15:00	**Introduction to Supervisory Control and Data Acquisition** *(cont'd)* *Dr. Sreedharan*	**General features, Functions & Applications Benefits** *Dr. Sreedharan*	**Power Systems SCADA and SCADA in Power System Automation** *(cont'd)* *Dr. Sreedharan*
15:00 - 15:30			
15:30-16:30			

SCADA In Power Sector

It is used for Managing Power System Networks

Generation – Transmission – Distribution – Metering – Billing etc.

Monitoring & Managing the Power Network up to the Level of Transmission Network

Power Sector - Milestones….

- Evolution
  - Small islanded utilities
  - Vertically integrated utilities
- Bifurcation into Regions
- Opening up for competition
- Generation companies
- Distribution licensees
- Transmission Utilities and Licensees
- Independent System Operator

GDP and Per Capita Consumption

There is close correlation between GDP and per capita consumption

Growth of Economy – 7 to 8%
Power sector growth required – 10-12%
Per capita consumption 2012 – 900kWh

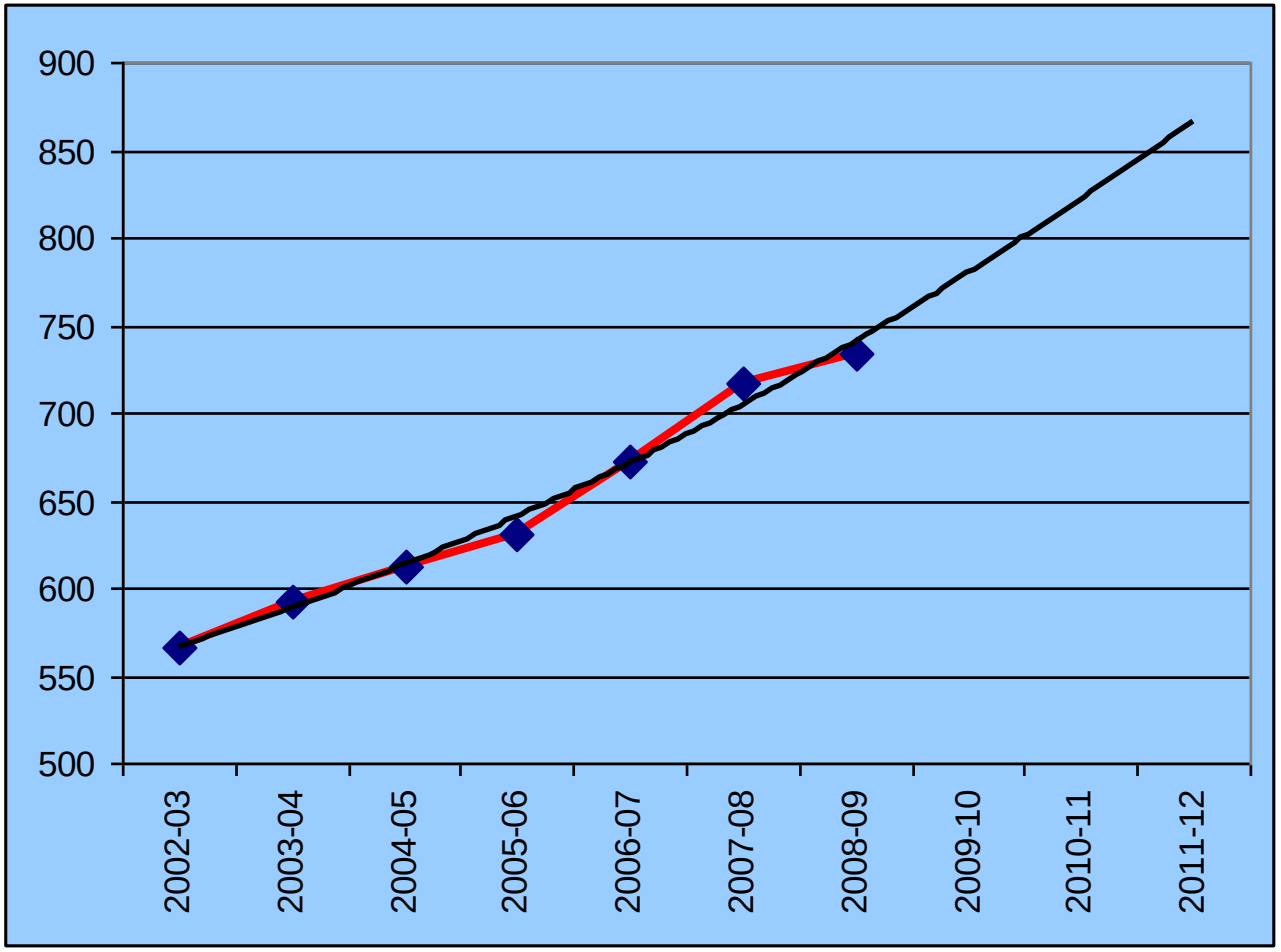
All India Annual per Capita consumption of Electricity

Year		Per Capita Consumption (kWh)		
		(As per U. N. methodology)		
2002-03			566.69	
2003-04			592.00	
2004-05			612.50	
2005-06			631.50	
2006-07			671.89	
2007-08			717.13	
2008-09			733.54	

Indian Case Study

Per capita Consumption

Trend analysis (Polynomial 2nd order)



Power sector in nutshell

- Per capita consumption is a Key index to economic growth
- **Growth can be correlated to growth of GDP**
- **Per capita consumption – much low**
- **Restructuring and New Business models – world wide**
- Vibrant field
- Changes by regulations and acts

Power Sector Future

- Decentralization of generation
- Micro grids, Smart grids
- Penetration of Non - conventional energy sources
- Probability of competition in wires – in distribution
- Need for competitiveness

AIM OF POWER SYSTEM ENGINEERS

- EARLIER STATEMENT
  - To provide **Reliable, Stable** and **Secured Power supply** to the end user with **Least possible cost**

- PRESENT STATEMENT
  - **To provide *Reliable, Stable* and *Secured* Power supply to the end user with *Least possible cost* WITH *Maximizing profit* to all stake holders**

How do we relate Internationally to the Other Grid Operators Worldwide ?

Associations Worldwide

- **Very Large Power Grid Operators (VLPGO)**
- TSO-Comparison Group
- CIGRE - C2 and C5 committees
- International Interconnections - SAARC

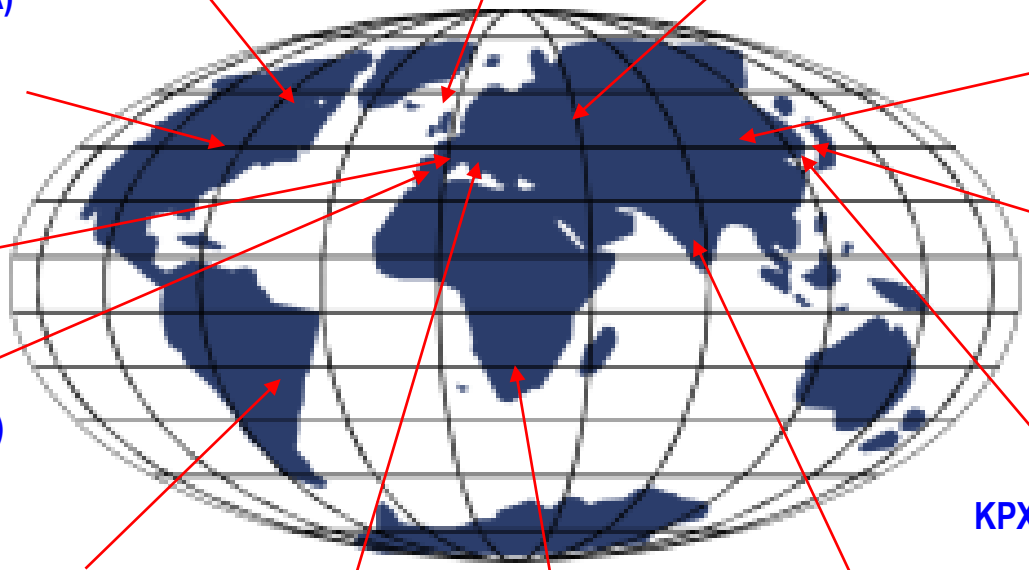
Formation of the VLPGO

- A voluntary initiative of the world's largest Power Grid Operators
- Representing together more than 60% of the electricity demand in the world.
- Created in 2004
  - Not-for-profit organization
  - Followed several blackouts across the world
  - To investigate fundamental issues of common interest to its members
  - To develop joint action plans addressing the improvement of power system security.
- Formalized in 2009
- Specific Focus
  - Issues related to Very Large Power Grids
- Membership
  - Size > 50 GW

VLPGO Aims and Objectives

- Work constantly to plan, monitor, supervise and control the energy delivered as a continuous process 24 hours a day
- Delivering the electricity that powers modern societies
- Critical role of Grid Operators includes
  - acting on behalf of Consumers, to **ensure quality** while **minimizing costs** and recognizing economic and societal dependence on electricity;
  - a **technical role** in planning, designing, and managing the Power Systems;
  - an **interface role** with generators, market participants and distributors, which are the most direct users of the transmission grid;
  - a **natural role** of interlocutors with power exchanges, regulators and governments.

Very Large Power Grid Operators (VLPGO)



National Grid (UK)
68GW
Capita: 65m

PJM (USA)
165GW
Capita: 51m

SO - UPS (Russia)
146 GW
Capita: 144m

MidWest ISO (USA)
159GW
Capita: 40m

SGCC (China)
900GW
Capita: 1000m

RTE (France)
93GW
Capita: 65m

Tepco (Japan)
64GW
Capita: 45m

Red Electrica (Spain)
93GW
Capita: 47m

KPX (South Korea)
70GW
Capita: 49m

ONS (Brazil)
100GW
Capita: 170m

Terna (Italy)
57GW
Capita: 60m

Eskom
(South Africa)
43.5GW
Capita: 49m

PGCIL (India)
163GW
Capita: 1200m

The largest close to us is India and hence we are analyzing the case of India

http://www.vlpgo.org

Source: VLPGO, 2010

Website of System Operators Worldwide

S.No.	Name of the TSO	Country	Web Presence
1	ESKOM	South Africa	www.eskom.co.za
2	Red Eléctrica de España*	Spain	www.ree.es
3	Landsnet	Iceland	www.landsnet.is
4	Fingrid*	Finland	www.fingrid.com
5	Amprion*	Germany	www.amprion.net
6	Transpower NZ	Newzealand	www.transpower.co.nz
7	Saudi Electricity Company	Saudi Arabia	www.se.com.sa
8	TenneT	Netherlands	www.tennet.org
9	Statnett SF	Norway	www.statnett.no
10	PJM Interconnection**	PA,USA	www.pjm.com
11	National Grid Electricity Transmission*	UK	www.nationalgrid.com
12	CLP Power	Hong Kong	www.clpgroup.com.hk
13	ESB NG	Ireland	www.eirgrid.com
14	Transpower	Germany	www.transpower.de
15	Swisssgrid	Switzerland	www.swissgrid.ch
16	Rede Eléctrica Nacional	Portugal	www.ren.pt
17	Hydro Québec	Canada	www.hydroquebec.com
18	Svenska Kraftnät	Sweden	www.svk.se
19	PSE	Poland	www.pse-operator.pl
20	EWA	Bahrain	www.mew.gov.bh
21	China Southern Power Grid	China	www.eng.csg.cn
22	Power Grid Corporation of India Ltd.	India	www.powergridindia.com / www.nldc.in

Common Challenges for VLPGO

- Providing power system reliability and security
- Smart Grid development
- Integration of Renewables
- Integration of Electric Vehicles
- Capacity development and optimization including system renovation and development, equipment upgrading.
- Reducing CO2 emissions
- Improve productivity and energy efficiency
- Power system visualization
- Demand Side Management
- Interconnections
  - Development of new technologies and HVDC
- Establishment and coordination of new control centers

VLPGO 2011 Joint Activities

Working Groups

- *WG #1 – Wide Area Monitoring Applications*
- *WG #2 – Enhanced Security*
  - *WG 2a – Security vs. Operation Costs*
  - *WG 2b – Enhanced Network Restoration*
  - *WG 2c – Equipment Overstressing*
  - WG 2d –Security of Supply to large metro areas
- *WG #3 – Integration of Renewables*
- *WG #4 – Load Forecasting*
- *WG #5 – HVDC*
- *WG #6 – Electric Vehicles*
- *WG #7 – Storage*

Joint Projects

- *Visualization*

Workshops

- *WS #1 – KPIs*
- *WS #2 – Smart Grid (KPX)*

VLPGO Work plan … Road Ahead

VLPGO Workplan									
Driver	No.	Activity	Owner	2010	2011	2012	2013	2014	Conclusion
Renewables	1	WG Integration of Renewables	NGC						
	2	JP HVDC (Technology)	NGC						
	3	**WG HVDC (Op Experience)**	ONS						
	4	WG Storage	N/A		4	4	5	5	
SMARTer	5	WS Smart Grids	KPX						
	6	WG Smart Grids	N/A						
	7	WG Electric Vehicles	PJM						
	8	WG Frequency Response	N/A		6	6	6	6	
	9	**WG Load Forecasting**	REE						
Security of Supply	10	WG Operational Cost vs Risk	Terna						
	11	JP Monitoring & Automation	Tepco		Combine				TofRef
	13	WG Cyber Security	N/A		1				
New Technologies	14	WG Wide Area Monitoring Applications	PJM						
	15	WG Enhancing Network Capacity	N/A		6	6	7	7	
Efficiency	16	WS Operational KPIs	UPS						
	17	WG Enhanced Network Restoration	Terna						
	18	WG Overstressing	ONS						
	19	JP Asset Management	Tepco						
	20	JP Visualisation	SGCC						
	21	WG EMS Architechture	Sec		Combine				TofRef
		No. of Activities		**12**	**12**	**10**	**8**	**8**	

VLPGO Current Activities - mapped

Principle Drivers

Renewable

- WG #3: Integration of Renewable Technologies
- JP #2: HVDC in Synchronous Power Systems

Smart

- WS #1: Smart Grids
- JP #3: Plug-in Hybrid Electric Vehicles

Security and Safety of Supply

- WG #2a: Enhanced Security - Vulnerability
- JP #4: Monitoring and Automation

Enduring Drivers

New Technology

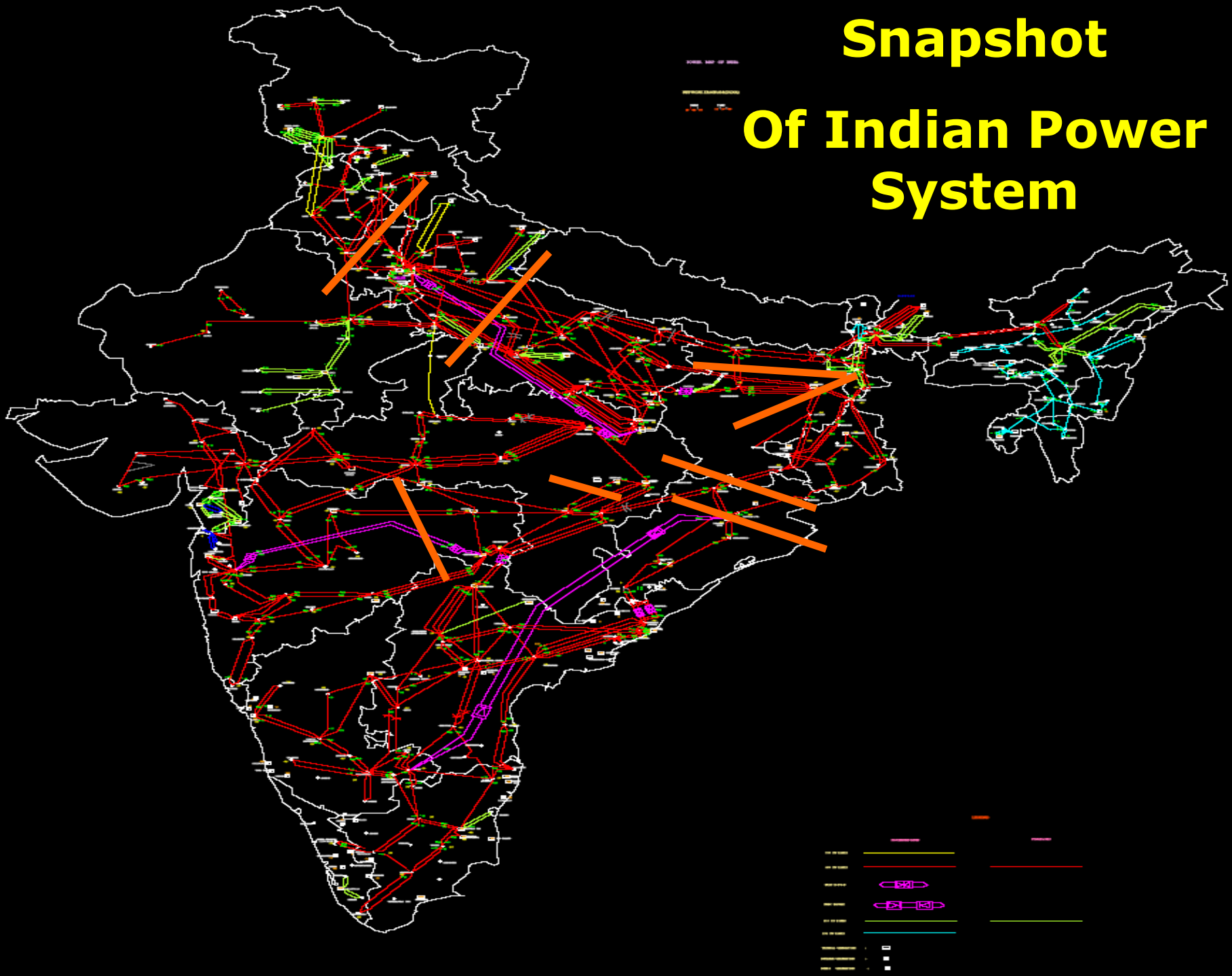
- WG #1: SynchroPhasors (Wide Area Monitoring)

Efficient Operation

- JP #1: Asset Management
- WG #2c: Equipment Overstresses
- WS #2 – Key Performance Indicators (KPIs)
- #5: Visualization
- WG #2b: Enhanced Security - Restoration

Snapshot

Of Indian Power System



1.Total Installed Capacity:

Sector	MW	%age
State Sector	85,918.65	42.61
Central Sector	60,182.63	29.84
Private Sector	55,535.75	27.54
Total	**2,01,637.03**	

Fuel		MW	%age
Total Thermal		**133363.18**	**66.14**
	Coal	113,782.38	56.42
	Gas	18,381.05	9.11
	Oil	1,199.75	0.59
Hydro (Renewable)		38,990.40	19.33
Nuclear		4,780.00	2.37
RES** (MNRE)		24,503.45	12.15
Total		**2,01,637.03**	**100.00**

Renewable Energy Sources(RES) include SHP, BG, BP, U&I and Wind Energy

SHP= Small Hydro Project ,BG= Biomass Gasifier ,BP= Biomass Power,

U & I=Urban & Industrial Waste Power, RES=Renewable Energy Sources

Peculiarities of Indian Power System

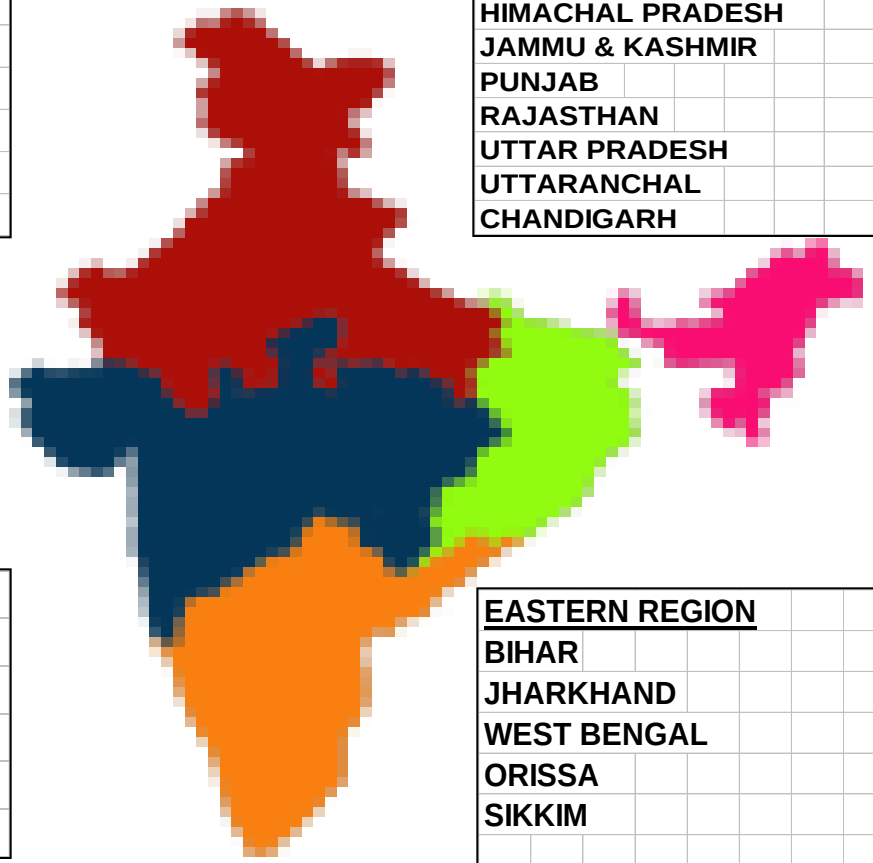
- High Growth Rate
- Shortage – both (MW & MU)
- Federal Structure
- Decentralized Scheduling & Despatch
- Diversity
- Unique Holding pattern
- Floating Frequency
- Large Hydro Variation
- Large Demand Variation

Electricity Regions in India

WESTERN REGION
GOA
DAMAN & DIU
GUJARATH
MADHYA PRADESH
CHATTISGARH
MAHARASHTRA
DADRA & NAGARHAVELI

NORTHERN REGION
DELHI
HARYANA
HIMACHAL PRADESH
JAMMU & KASHMIR
PUNJAB
RAJASTHAN
UTTAR PRADESH
UTTARANCHAL
CHANDIGARH

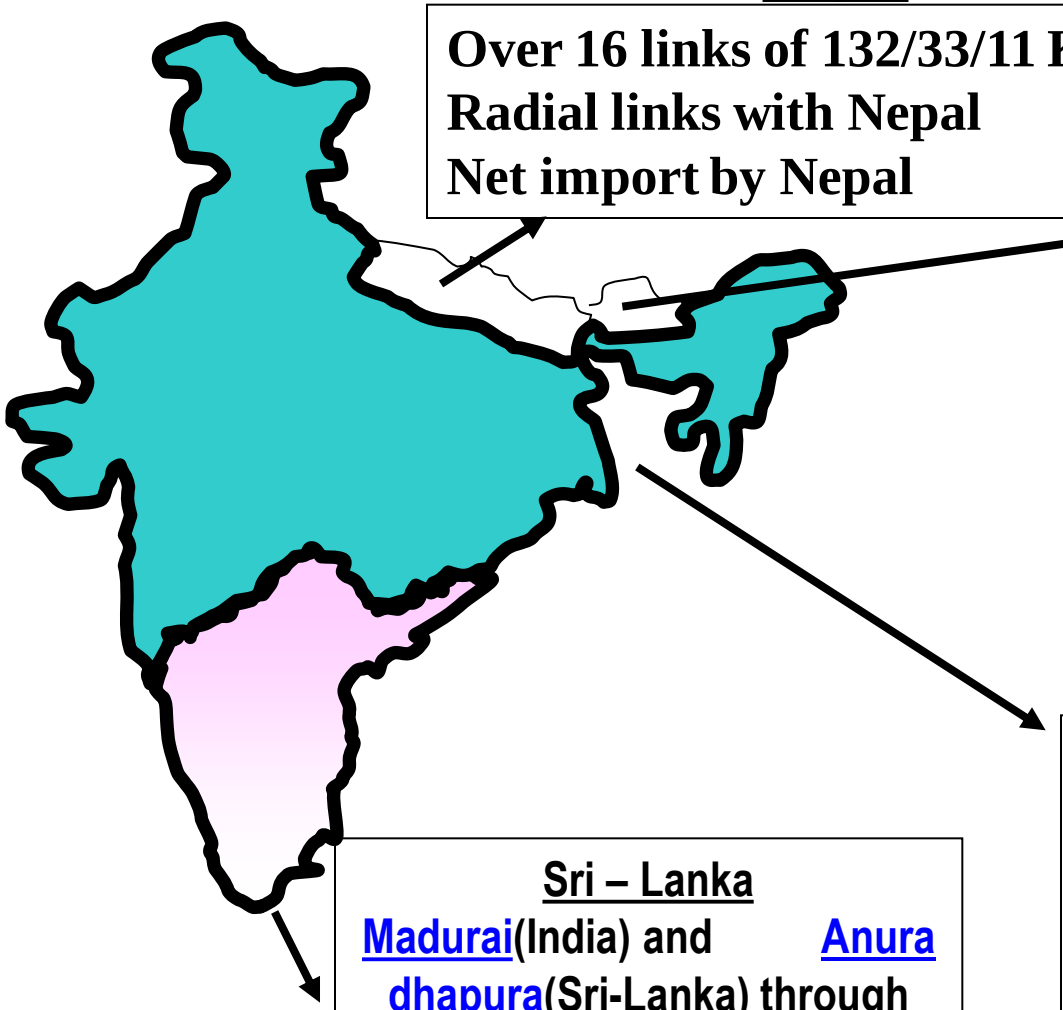
NORTH EASTERN REGION
ASSAM
ARUNACHAL PRADESH
MEGHALAYA
TRIPURA
MANIPUR
NAGALAND
MIZORAM



SOUTHERN REGION
ANDHRA PRADESH
KARNATAKA
KERALA
TAMIL NADU
PONDICHERRY

EASTERN REGION
BIHAR
JHARKHAND
WEST BENGAL
ORISSA
SIKKIM

International Interconnections (Future Plans)



Nepal

Over 16 links of 132/33/11 KV
Radial links with Nepal
Net import by Nepal

Bhutan

Tala: 1020 MW
Chukha: 336 MW
Kurichu: 60 MW
Net import by India

India- Bhutan synchronous links

400 kV Tala-Binaguri D/C
400 kV Tala-Malbase-Binaguri
220 kV Chukha-Birpara D/C
220 kV Chukha-Malbase-Birpara
132 kV Kurichu-Bongaigaon

Bangladesh

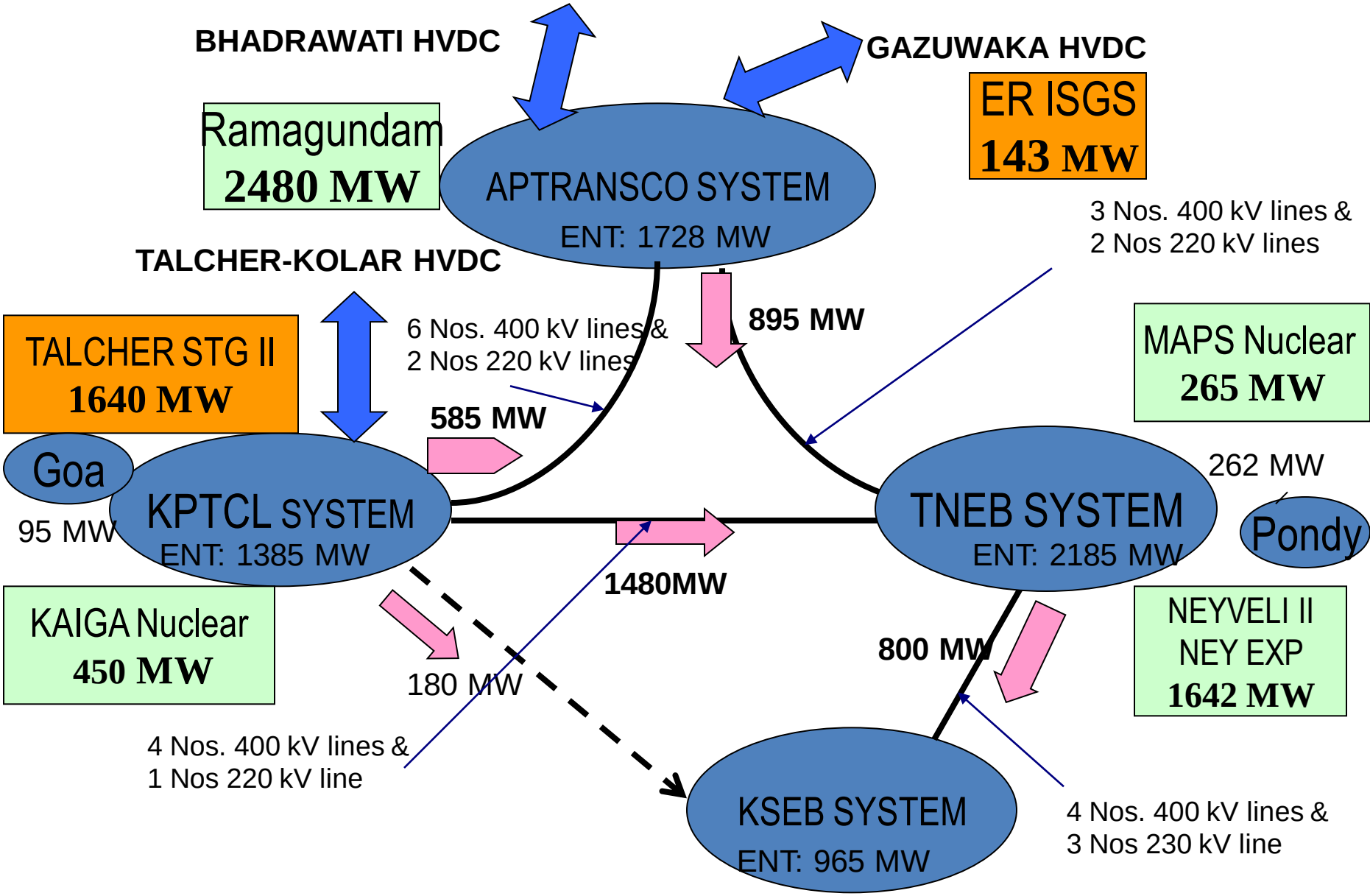
400 KV AC line between Baharampur(India) and Bheramara(Bangladesh) with 500 MW HVDC sub-station at Bheramara

Sri – Lanka

Madurai(India) and Anuradhapura(Sri-Lanka) through ±500 KV HVDC under sea cable

Maps not to scale

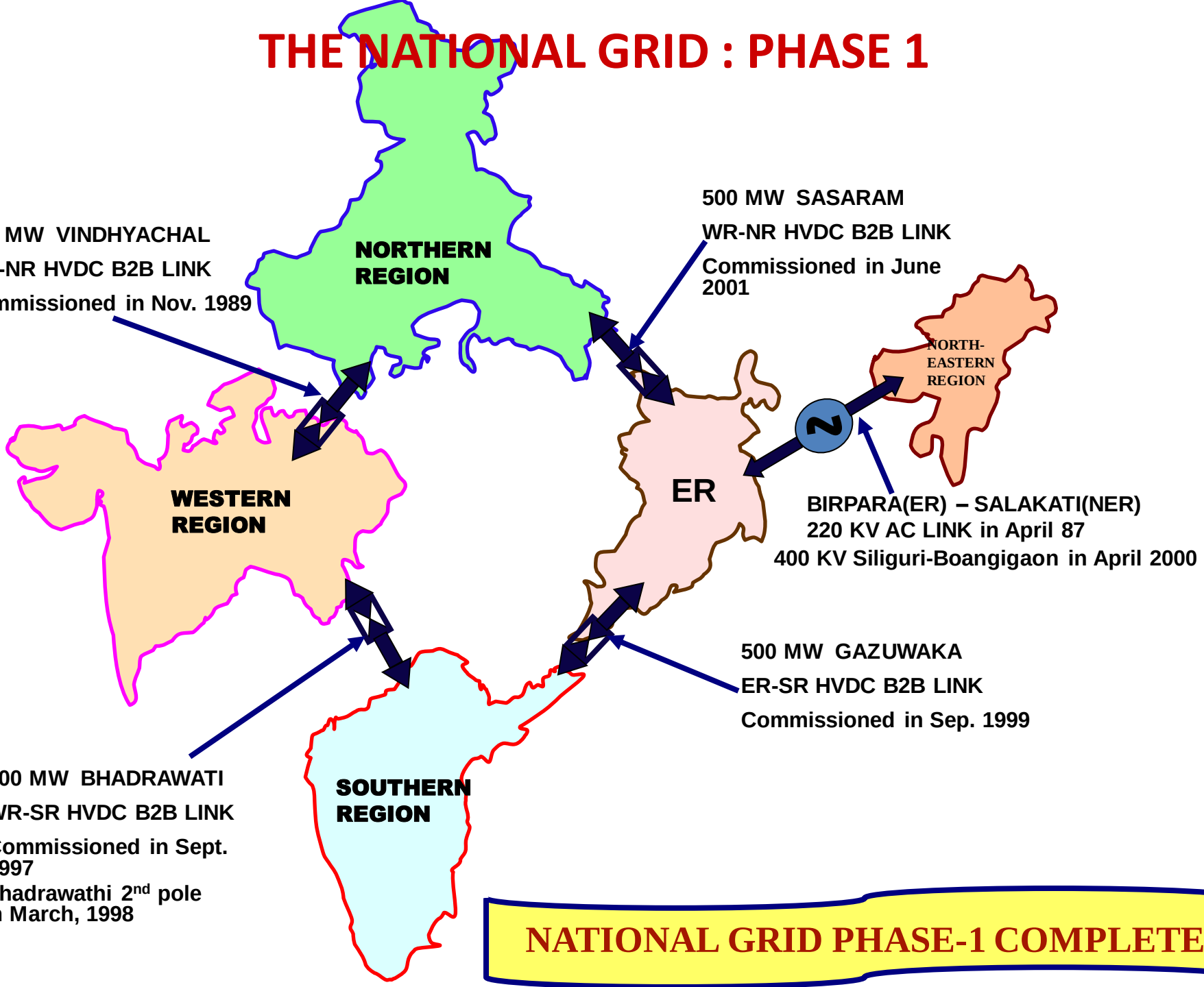
TYPICAL INTER STATE FLOWS DURING A SAMPLE PEAK HOUR



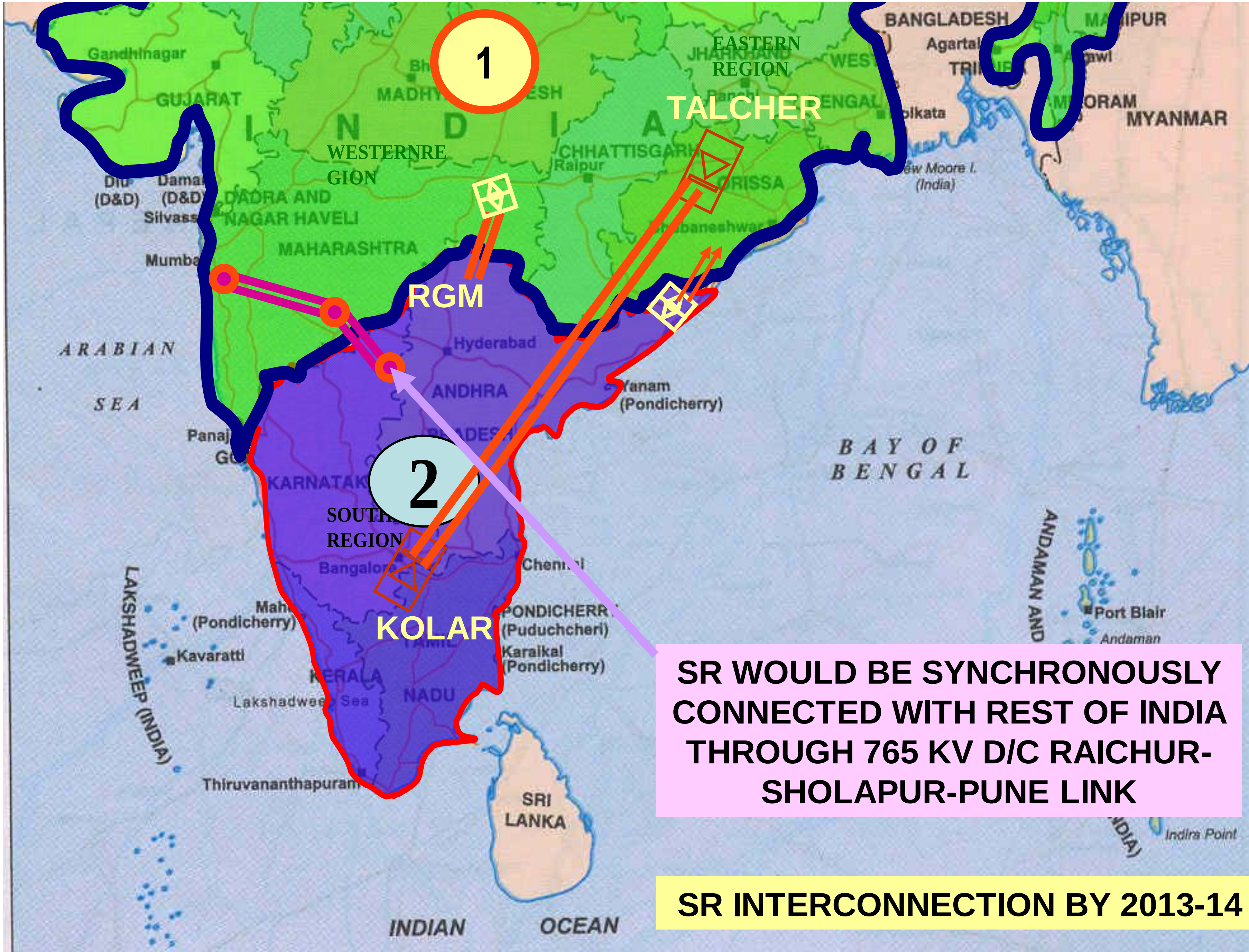
Transmission System

- Inter state Transmission system (ISTS)
  - Lines by Central Transmission Utility (CTU) , State Transmission Utility (STU) , Licensees
  - 400V & Above – ISTS
  - **Next level – 1200kV**
- Regional network transforming to National network
- FACTS, SVC, HVDC – already in use

THE NATIONAL GRID : PHASE 1



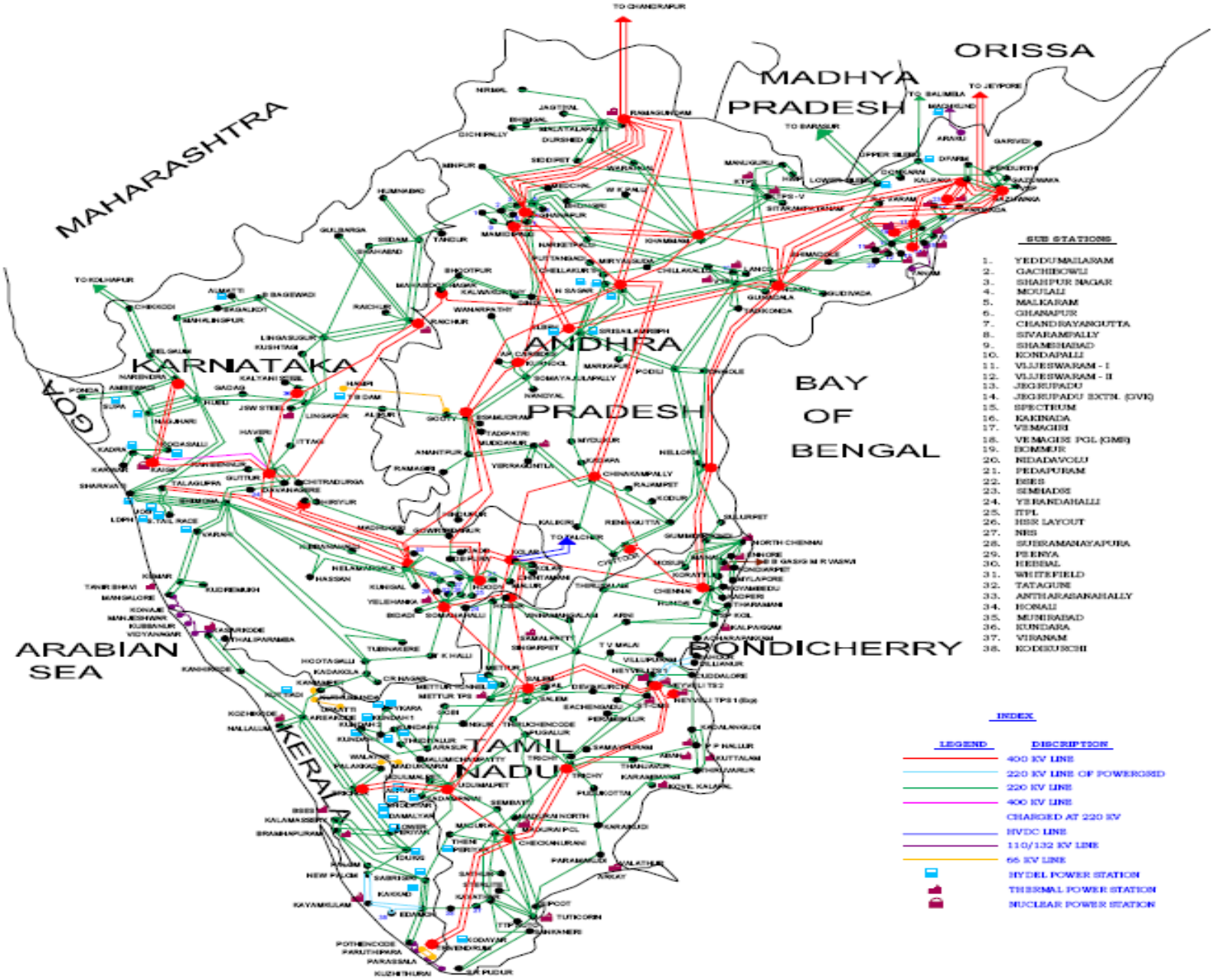
NATIONAL GRID PHASE-1 COMPLETE

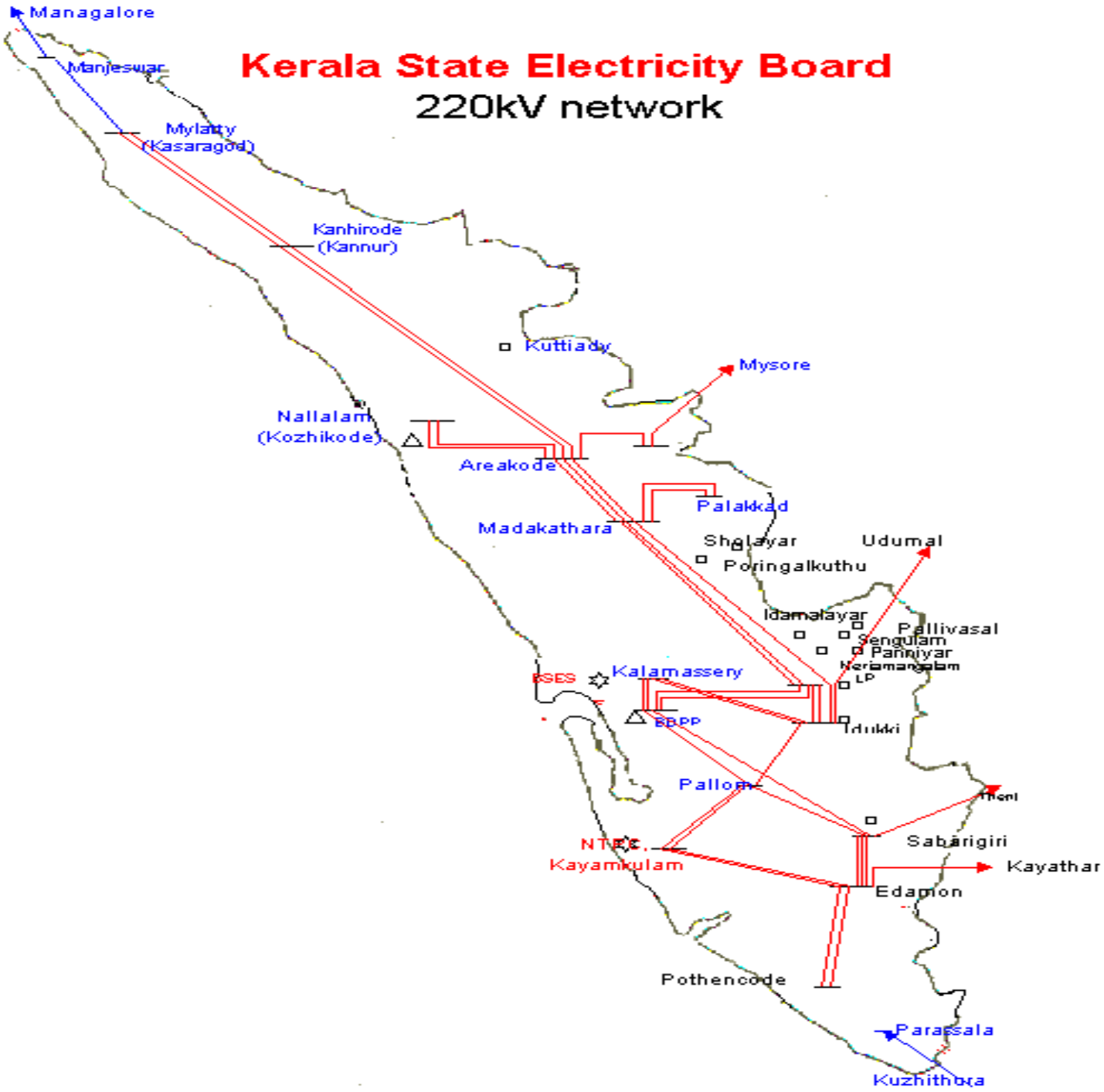


SR WOULD BE SYNCHRONOUSLY CONNECTED WITH REST OF INDIA THROUGH 765 KV D/C RAICHUR-SHOLAPUR-PUNE LINK

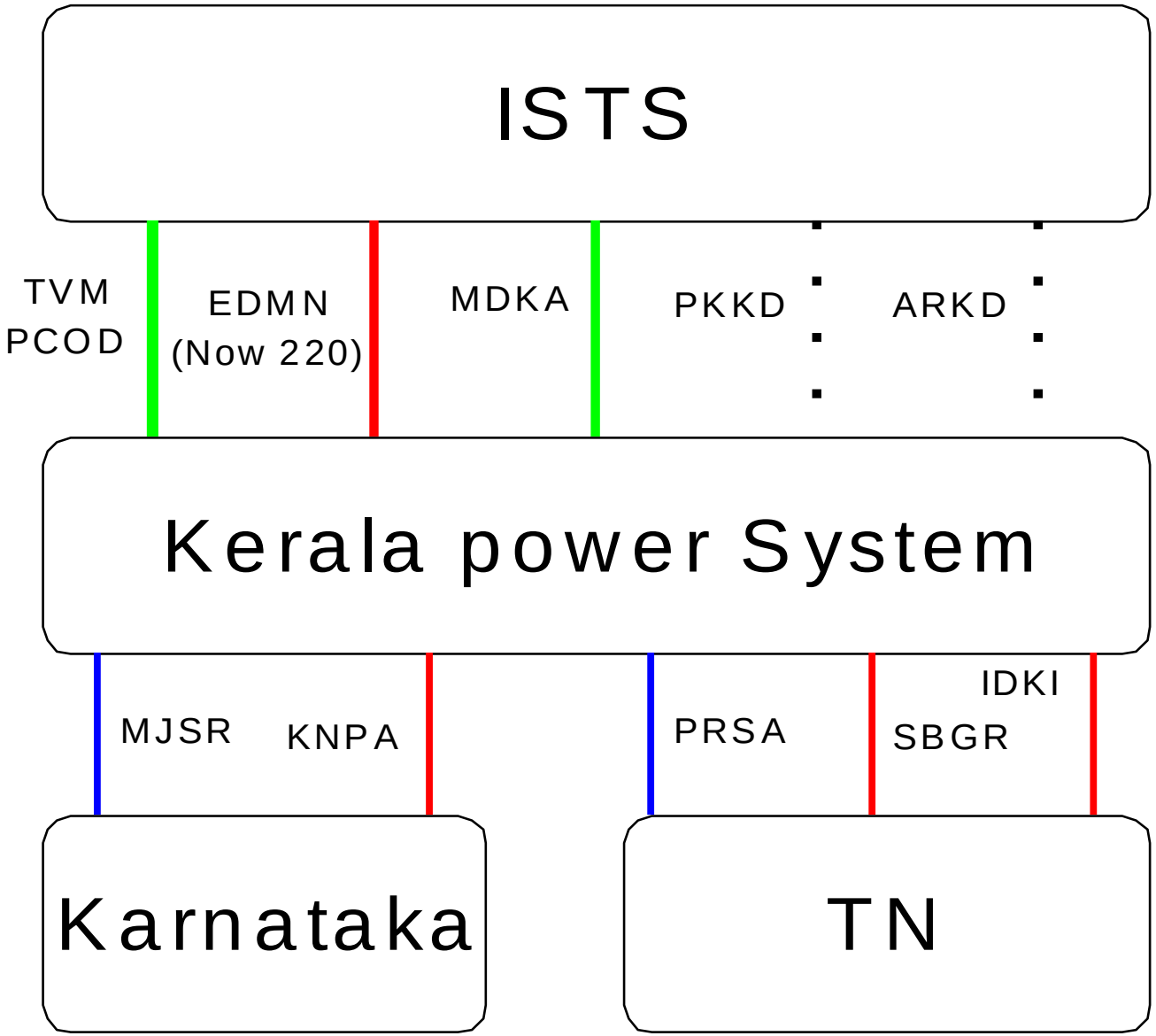
SR INTERCONNECTION BY 2013-14

POWER MAP OF SOUTHERN REGION




Kerala State Electricity Board
220kV network
Managalore
Manjeswar
Mylatty
(Kasaragod)
Kanhirode
(Kannur)
Kuttiady
Mysore
Nallalam
(Kozhikode)
Areakode
Palakkad
Madakathara
Sholayar
Udumal
Poringalkuthu
Idamalayar
Pallivasal
Sengulam
Panniyar
Kalamassery
BSES
BBPP
LP
Idukki
Pallom
Theni
Sabarigiri
NTPC
Kayamkulam
Kayathar
Edamon
Pothencode
Parassala
Kuzhithura

Kerala grid - Interstate lines



Peak Analysis

	Installed capacity (MW)	Availability (Peak) (MW)
Hydel	1920	1600
Thermal	234	160
IPP/ co gen	378	340
Wind	29	
Central sector	1012	800
Total	3573	2800

Evening Peak Availability

Hydro	1780 MW
Thermal	82 MW
IPPs	163 MW
CGS	925 MW
Total Availability	2950 MW
Expected Demand	3100 MW
Power Shortage	**150 MW**

Kerala Grid – Generating Stations

Hydel Stations		Small Hydels	
Kuttiady	125	Madupetty	2
Poringal	48	Peppara	3
Sholayar	54	Kallada	15
Idamalayar	75	Chembukadavu, Urmi	12.6
Pallivasal	37.5	Lower Meenmutty, KTR	6
Sengulam	48	Malampuzha	2.5
Neriamangalam	77.5	Malankara	10.5
Panniar	30	**Thermal**	
Lower Periyar	180	BDPP	106.6
Idukki	780	KDPP	128
Sabarigiri	330	**IPP**	
Kakkad	50	BSES	157
Captives	33	NTPC	180
Co Gen	10	KPCL	22
Wind	29	Ullumkal	10
	Total	**2562MW**	

Central Sector

	% allocation	MW available
Ramagundam I &II	11.7%	245
Ramagundam III	12.2%	61
MAPS	5.23%	23
KAPS I &II	8.64%	38
KAPS III	7.95%	17.5
Neyveli St I	10%	63
Neyveli St II	10.7%	90
Neyveli Exp	14%	58.8
Talcher II	20.8%	415.8

RESERVOIR PARTICULARS

RESERVOIR	Minimum Draw Down Level (m)	Full Reservoir	
		Level(m)	Storage(mcm)
IDUKKI	694.94	732.43	1460.00
PAMBA	963.17	986.33	31.00
KAKKI	908.30	981.46	446.54
SHOLAYAR	779.37	811.68	149.23
IDAMALAYAR	115.00	169.00	1017.80
KUNDALA	1735.84	1758.70	7.79
MADUPPATTY	1554.48	1599.59	55.22
KUTTIADI	737.62	758.04	33.99
ANAYIRANKAL	1188.00	1207.01	48.97
PONMUDI	678.80	707.75	47.40
NERIAMANGALAM	445.00	456.59	5.56
PORINGAL	405.69	423.98	30.36
SENGULAM (SBR)	844.86	847.60	1.61
LOWER PERIYAR	237.74	253.00	4.55
KAKKAD	181.36	192.63	1.16

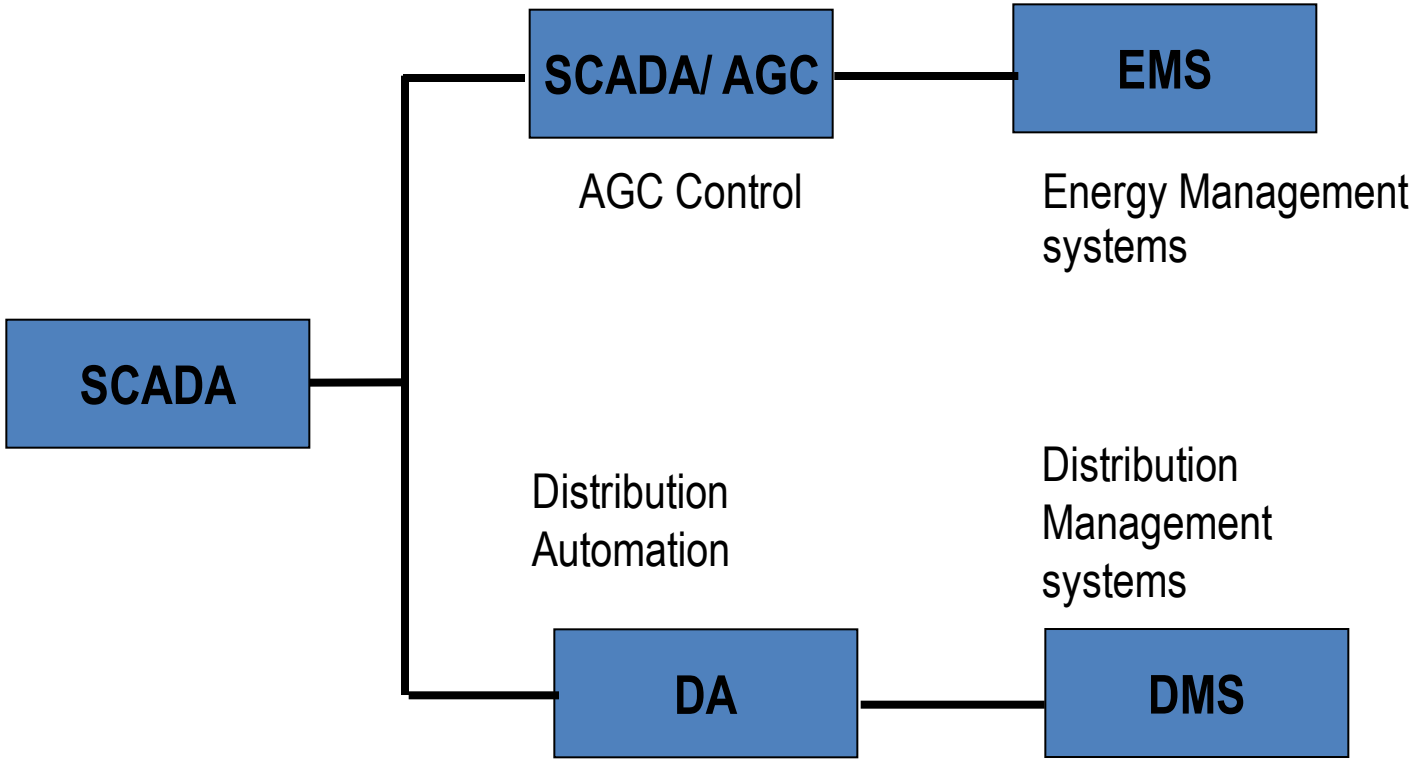
Evening Peak Availability

Hydro	1780 MW
Thermal	82 MW
IPPs	163 MW
CGS	925 MW
Total Availability	2950 MW
Expected Demand	3100 MW
Power Shortage	**150 MW**

SCADA

- Data Acquisition
- Remote Control
- User Interface
- Areas of Responsibility
- Historical Data Analysis
- Report Writer

Power System SCADA - Components



SCADA / AGC

- Automatic Generation Control
- Economic Dispatch Calculation/Hydro Allocator.
- Interchange Transaction Scheduling
- Transaction Evaluation (Area A and Area B)
- Unit Commitment
- Short-Term Load Forecasting

EMS

- Network Configuration/Topology Processor
- State Estimation
- Contingency Analysis
- Three Phase Balanced Operator Power Flow
- Optimal Power Flow
- Dispatcher Training Simulator

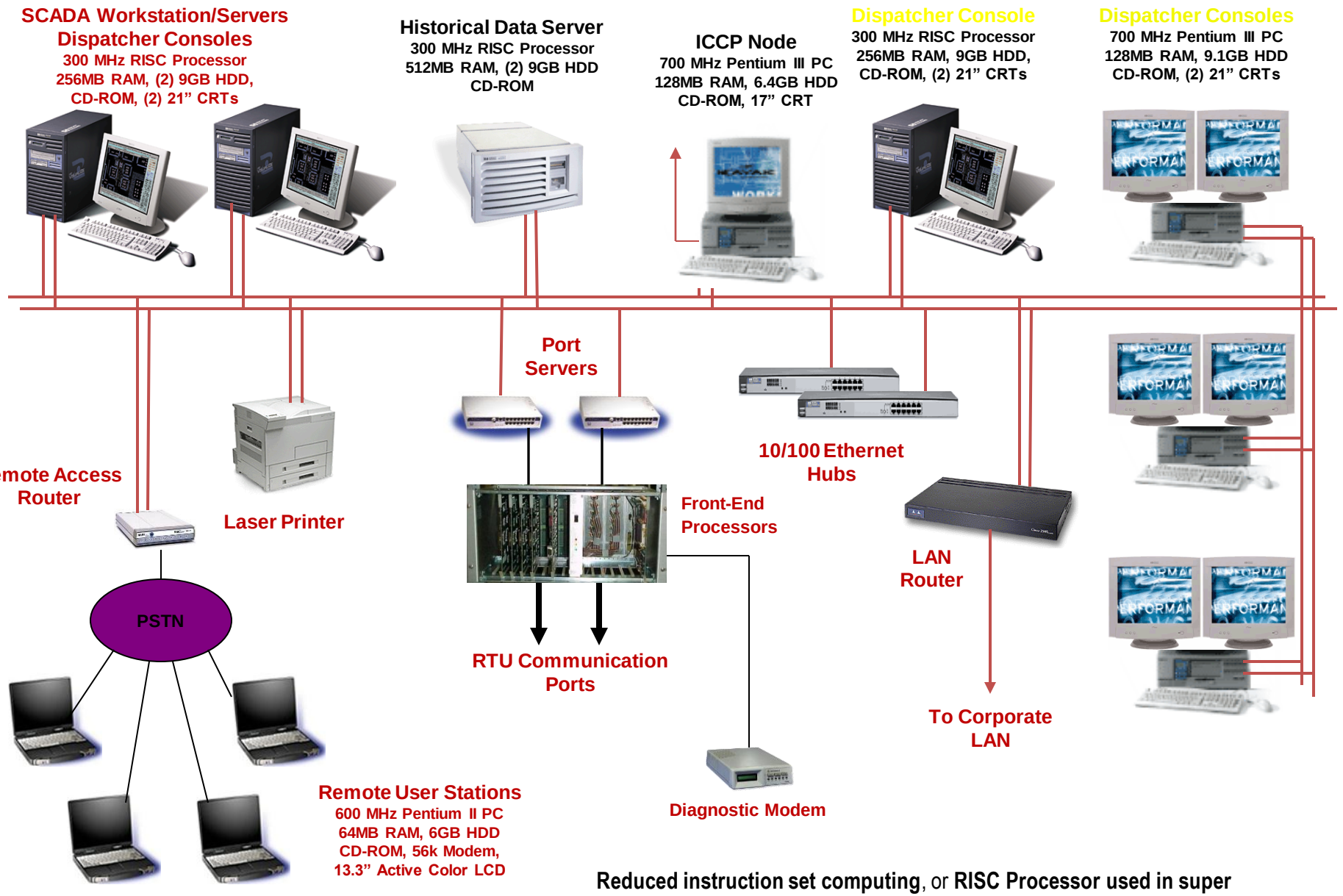
DA

- Voltage Reduction
- Load Management
- Power Factor Control
- Two-Way Distribution Communications
- Short-Term Load Forecasting
- Fault ID/Fault Isolation/Service Restoration
- Interface to Intelligent Electronic Devices (IEDs)

DMS

- Three Phase Unbalanced Operator Power Flow
- Interface To/Integration With Automated Mapping/Facilities Management (AM/FM)
- Interface To Customer Information System (CIS)
- Map Series Graphics
- Trouble Call/Outage Management

SCADA System – Configuration overview



Reduced instruction set computing, or **RISC Processor used in super computers**

Operator Consoles

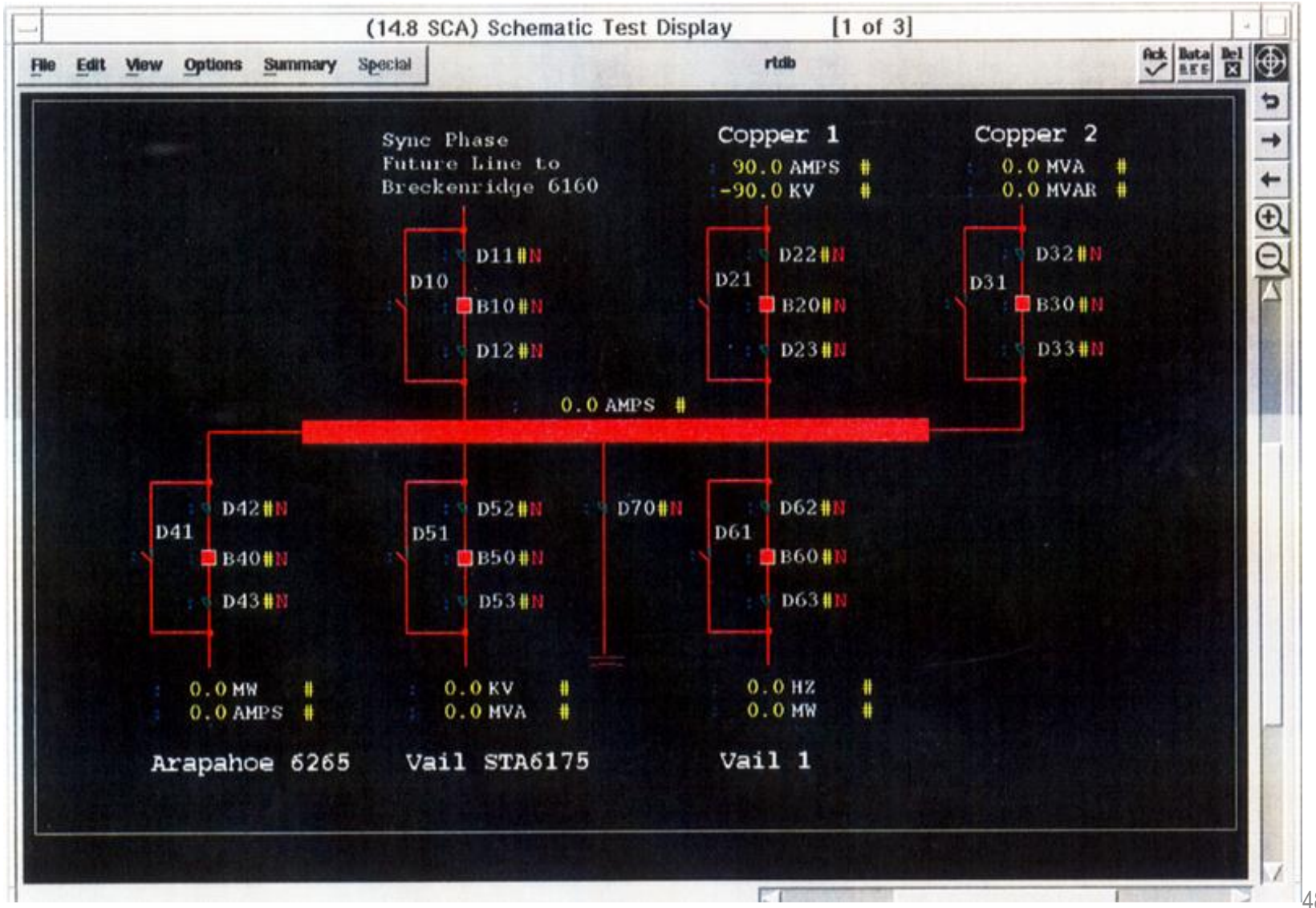
- User Interface (UI) devices
  - *Color CRT monitors*
  - *Alphanumeric (PC) keyboard*
  - *Cursor control device (mouse, trackball)*
  - *Audible alarm*

- Monitors
  - *Minimum 21 inch diagonal*
  - *Glare reduction features (anti-glare screen coatings)*
  - *Provide display of multiple viewports (windows)*

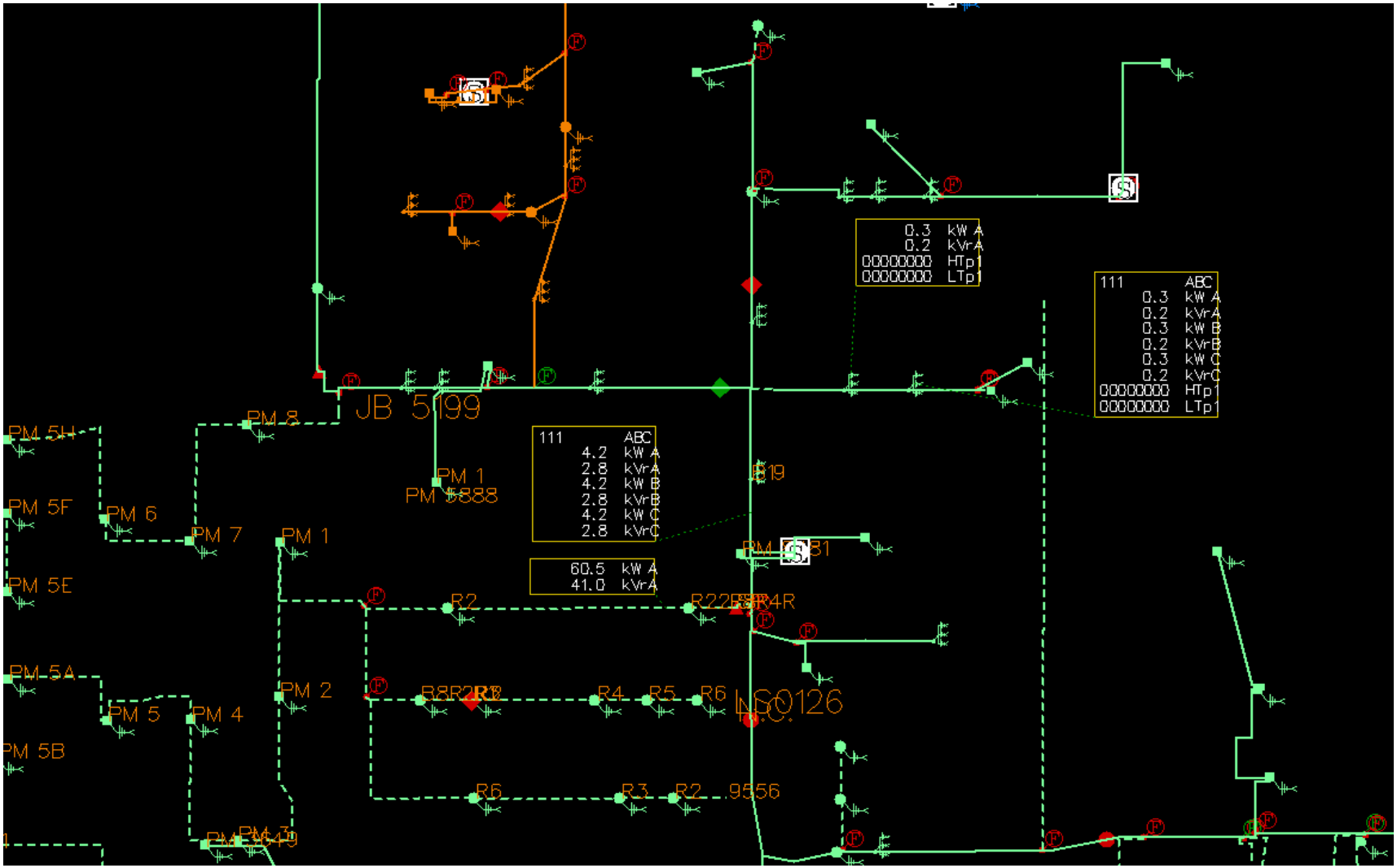
User Interface Devices

- Full graphics capabilities
  - *World coordinate space*
  - *Zoom with decluttering*
  - *Translation (Panning)*
- Keyboard and cursor pointing device shared among all monitors at each console
  - *Cursor moves across all screens without switching by user*
- Printers
  - *Dot matrix Alarm/Event printer*
  - *Color report printer*
  - *B&W laser report printer*

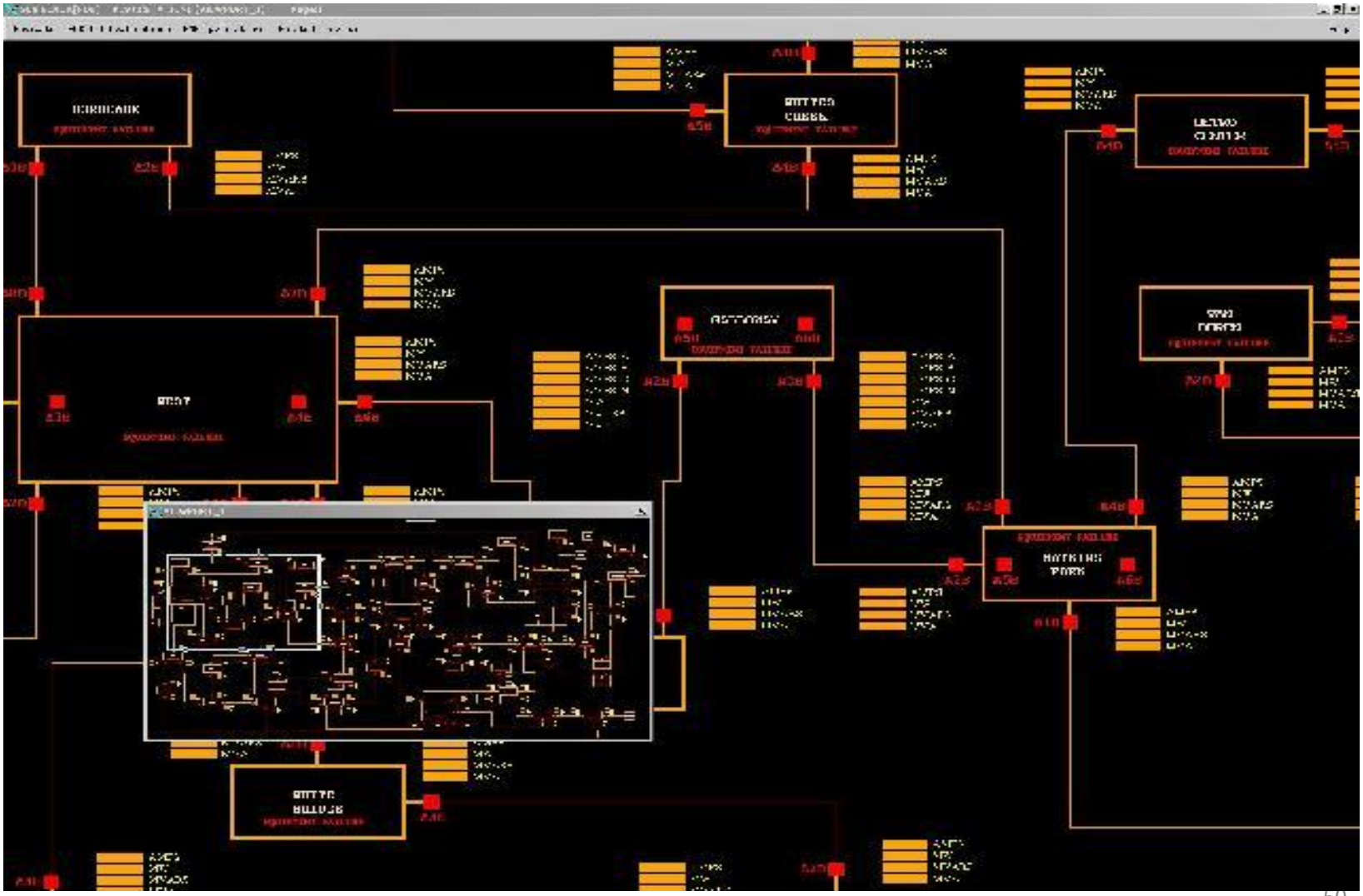
One Line Display



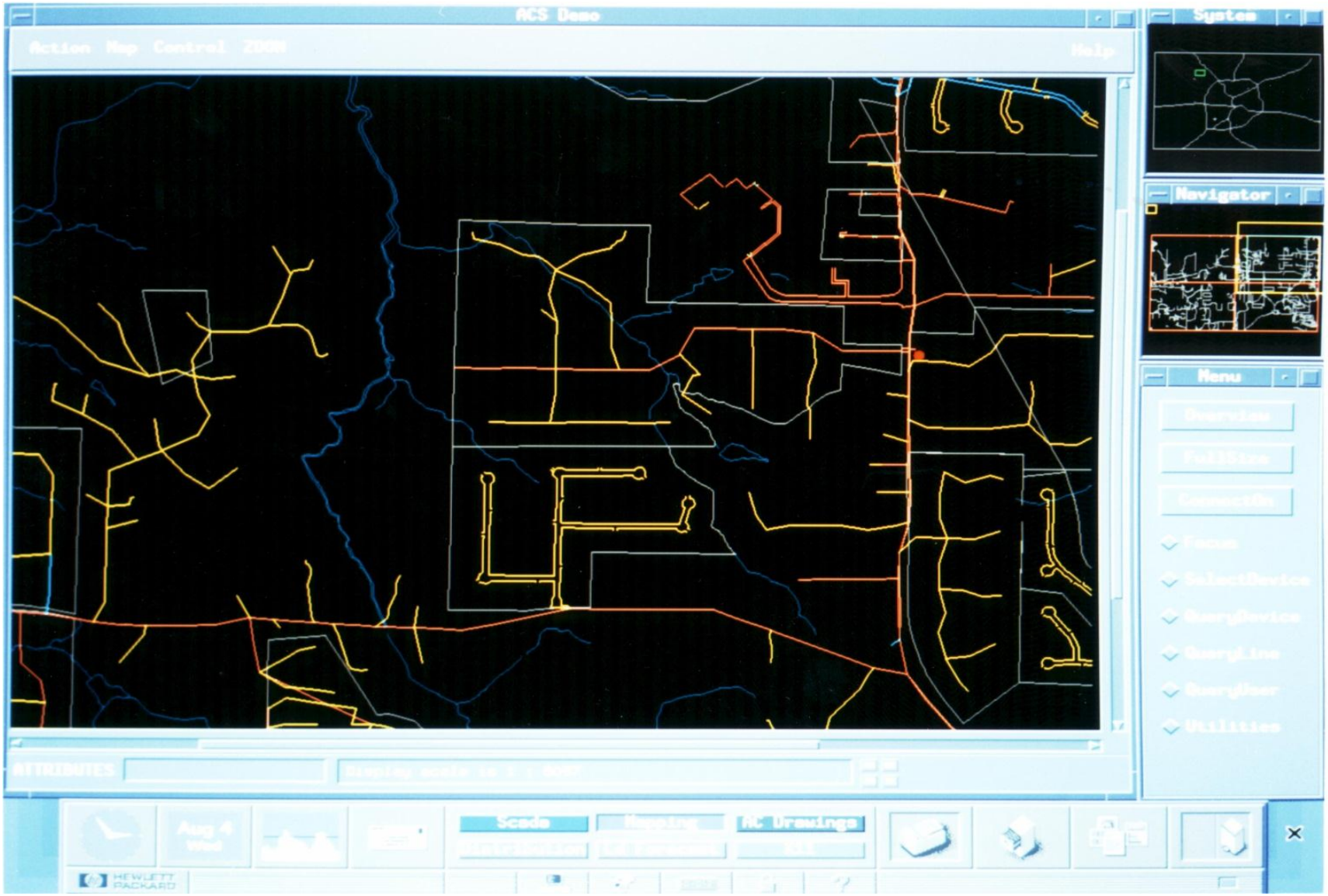
Feeder Map Display



World Coordinate Display Schematic Diagram



Full Graphics (Feeder map)



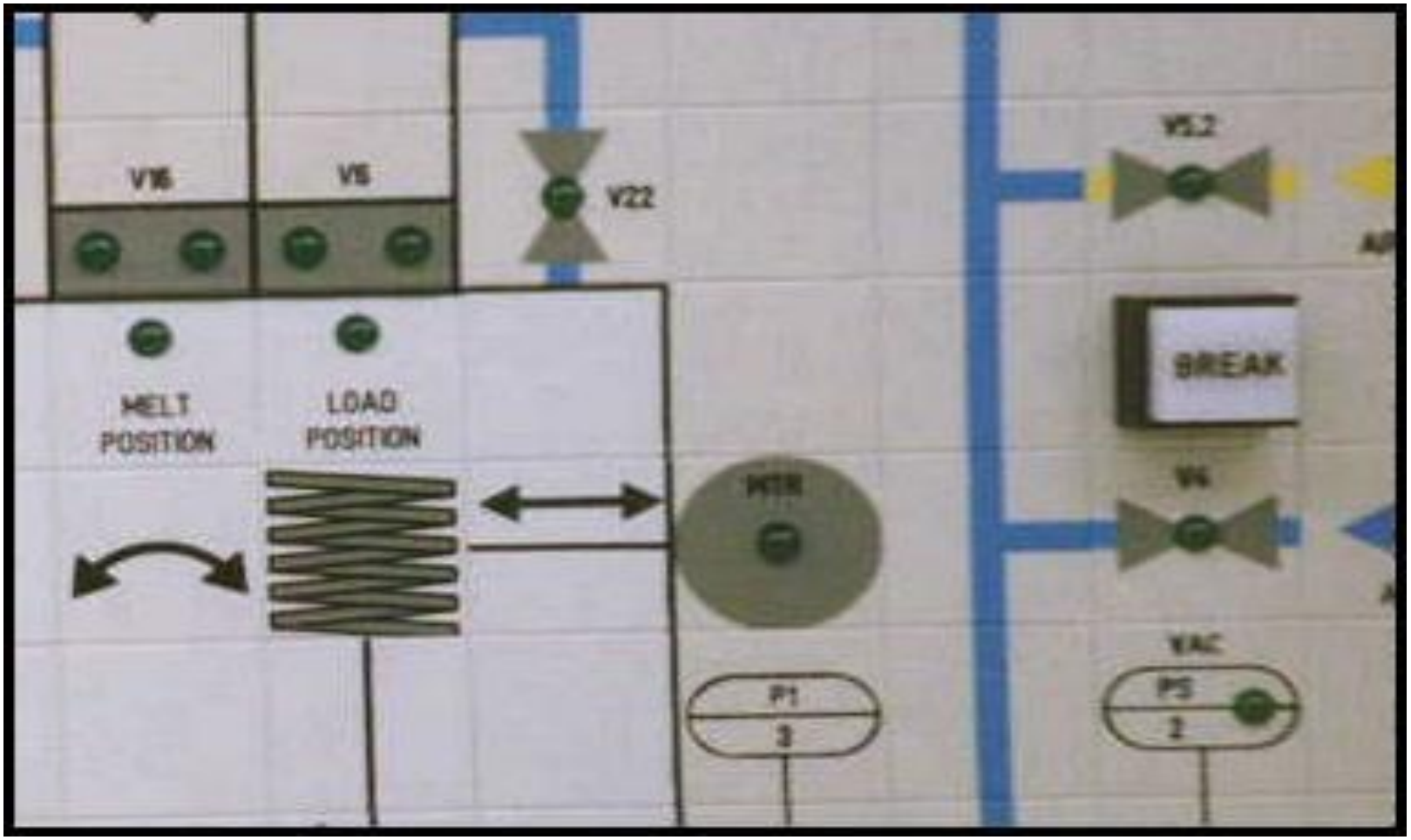
User Interface Devices

- Video Wall Board
  - *Large screen display with full SCADA operability*
  - *Multiple screens*
- Mosaic Mapboard
  - *Dynamic or static tile mapboard*
  - *Dynamic mapboard lamps updated by SCADA*
- Magnetic Mapboard
  - *Static magnetic 'tiles'*

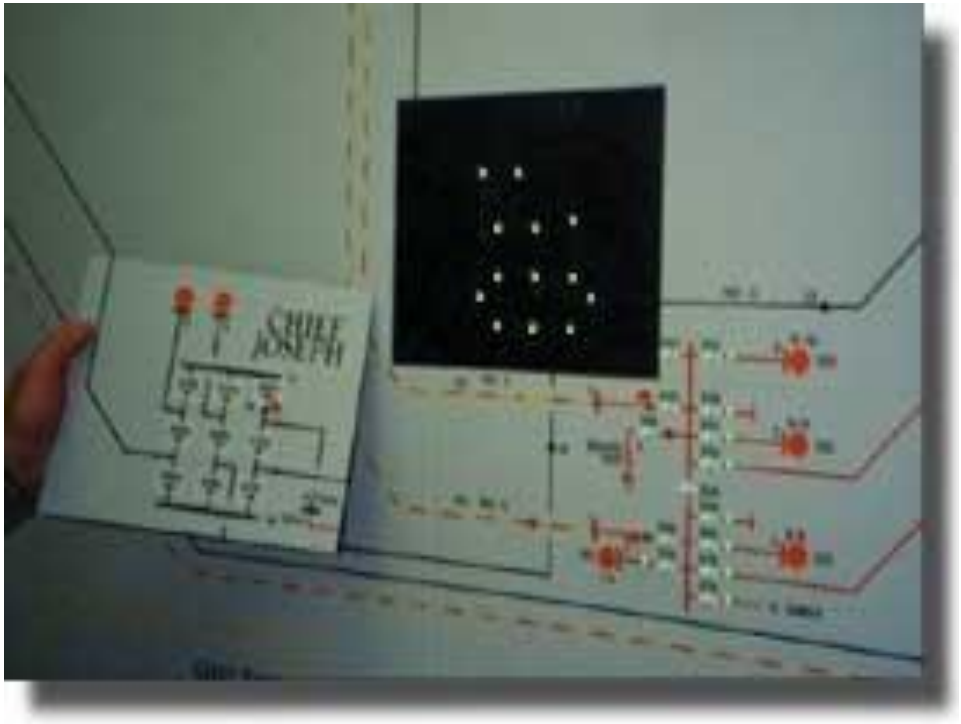
Map board/Projection Screens

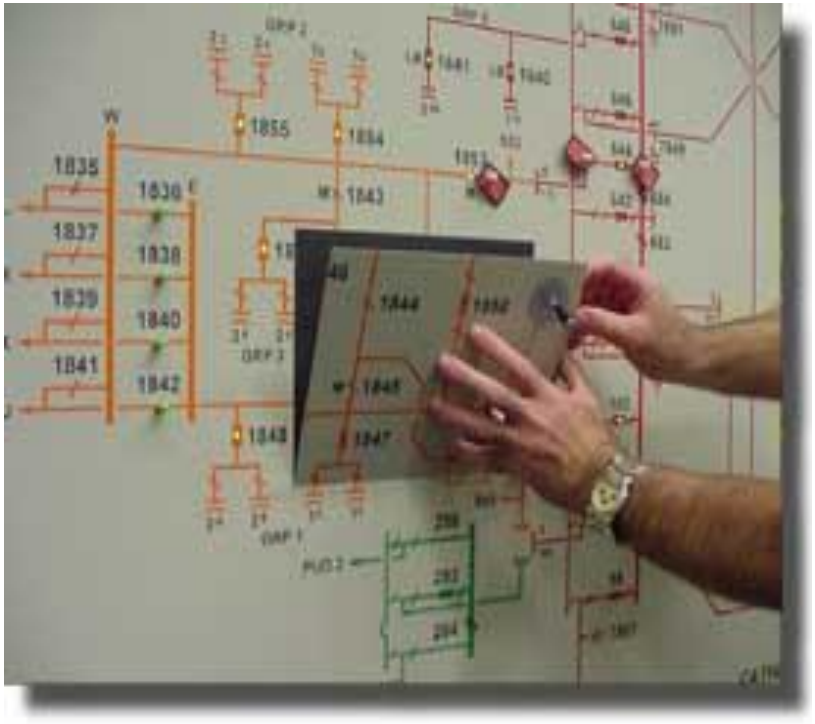
Mapboard/Projection Screens

- Mosaic:



Magnetic Map board





Processors and Auxiliary Memory

- Should be able to **upgrade or replace** without changing software
- Include facilities for **orderly shutdown** & **resumption of operation** on loss & restoration of power
- User **Interface processors** tend to be Pentium class machines
- Servers tend to be **UNIX Workstations**

Archive Storage

- Uses:
  - *Backup of SCADA system data and software*
  - *Archive storage for Information Storage and Retrieval function*

- Devices Used:
  - *Rewriteable single platter Digital Video Disk (DVD)*
  - *Rewriteable Compact Disk (CD-ROM)*
  - *Digital Linear Tape (DLT)*

Local Area Networks

- SCADA System Network
  - *Connects the SCADA master station components*
  - *Typically based on Ethernet (IEEE 802 series)*
  - *Typically implemented using intelligent switches*
  - *Category 5 UTP (STP) cabling / FOC preferred*
  - *LAN components can be redundant*

Local Area Networks

- Interface to Corporate IT Network
  - *Provides support for*
    - **Corporate Data Repository**
    - Interfaces to external systems (**GIS, Outage management, etc.)**
  - *Firewall required for security purposes*
    - Allows access from **SCADA to IT systems**
    - Provides limited access form **IT LAN to SCADA**
    - Provides limited access to **SCADA user interface functions**

Interface to Field Devices

- Provides interface between **SCADA system LAN and communication circuits to substation devices**
- **Modems** required for **analog communication circuits**
- Functions performed:
  - ***Manage communications*** *over the channel*
  - *Check for and report protocol and communication errors*
  - *Convert RTU protocol to a common internal format compatible with SCADA Data Processing functions*
  - *Process the retrieved data*
  - *Pass data on to other SCADA resources for further processing and storage*

Time/Date Reference

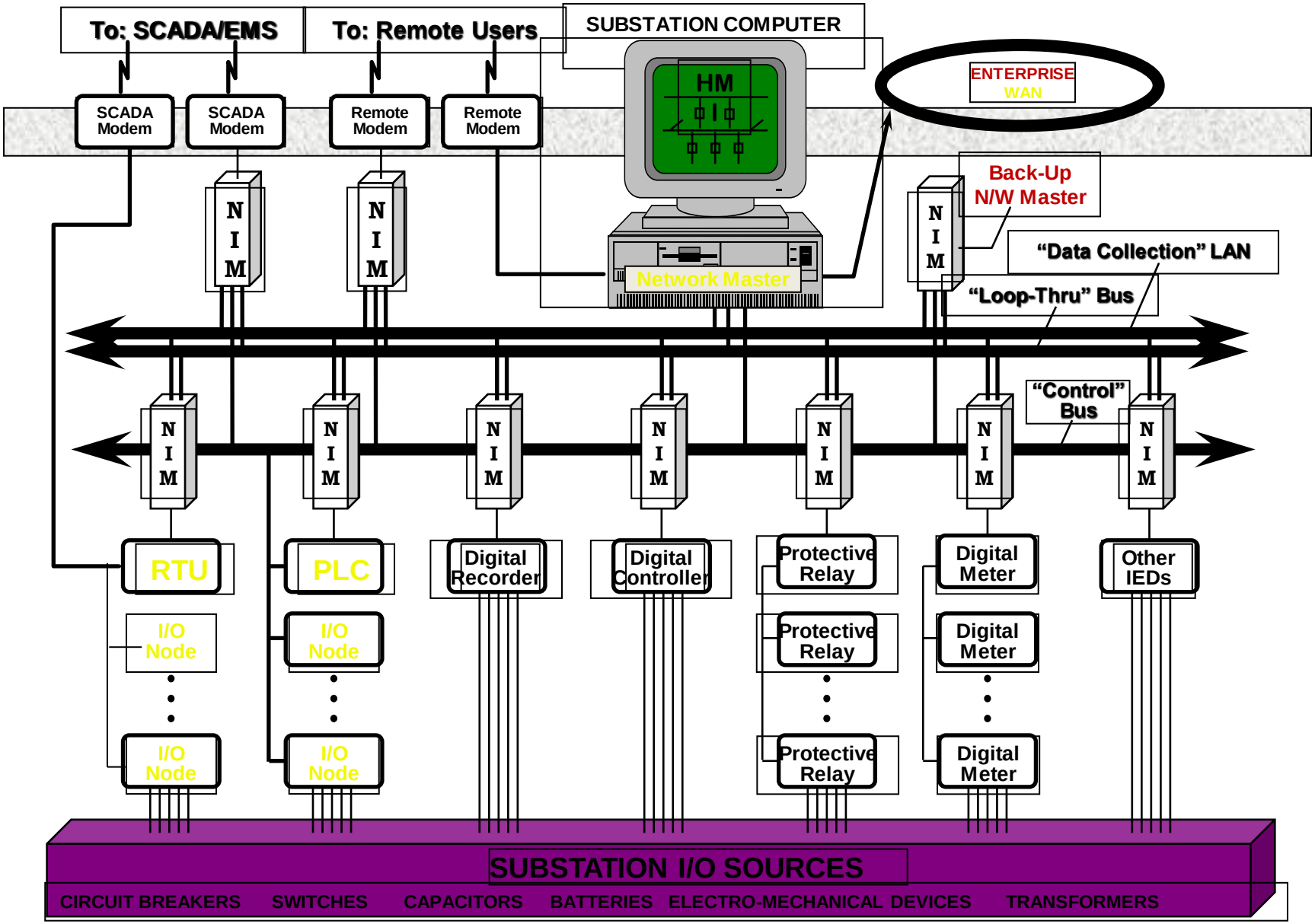
- Facility obtains time and date from the **Global Positioning System (GPS) satellite constellation**
- Overall accuracy **± 1.5ms** ideal (5 msec)
- Installed at **substations** (many options)
- Useful for **time stamping data** acquired at remote locations to a consistent time base.

GPS Time Reference Unit

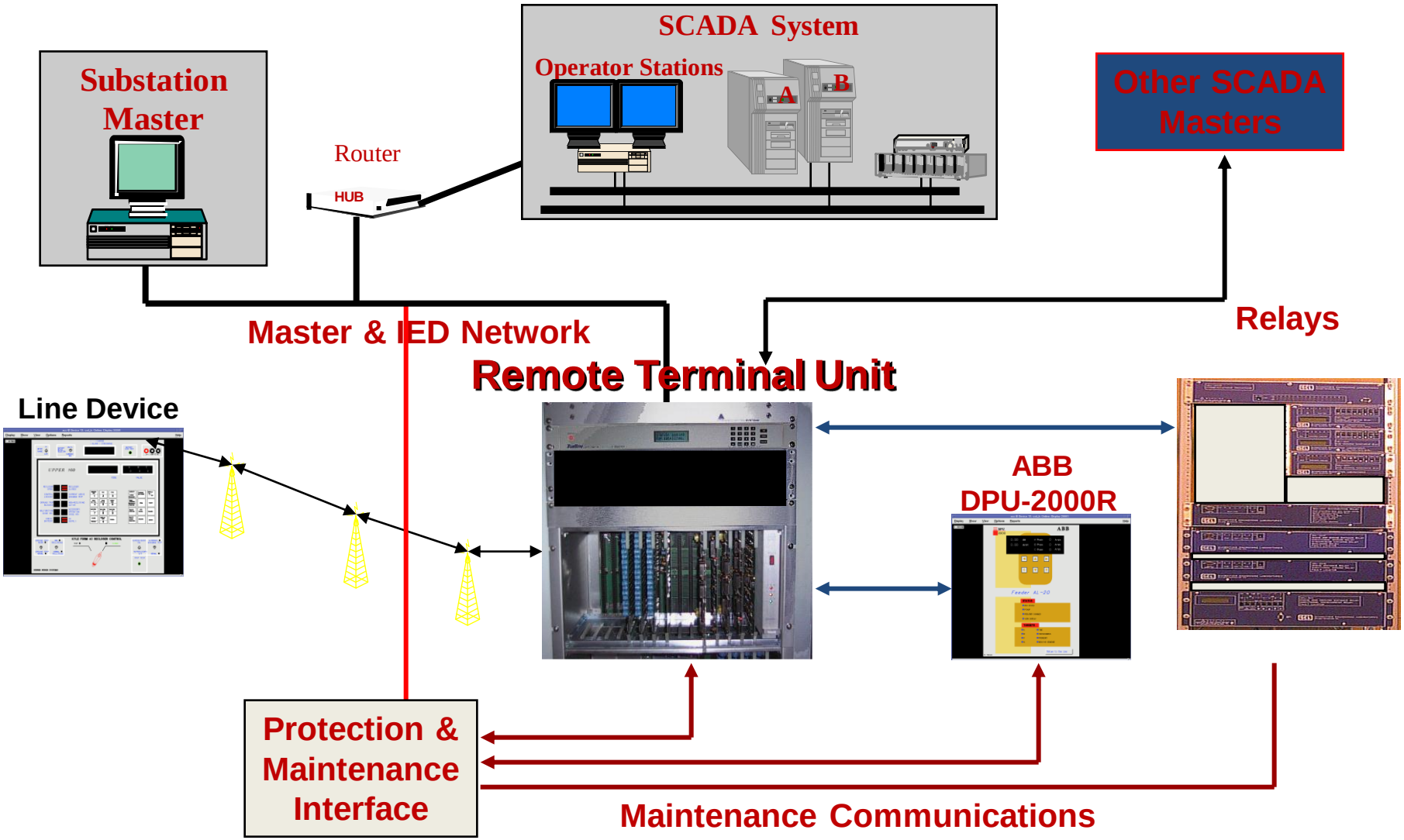
Substation Local Area Network (LAN)

- The S/S LAN provides the means connecting components of the system architecture:
  - *IEDs (Intelligent Electronic devices)*
  - *Substation Host Processor*
  - *Interface to Wide Area Network*

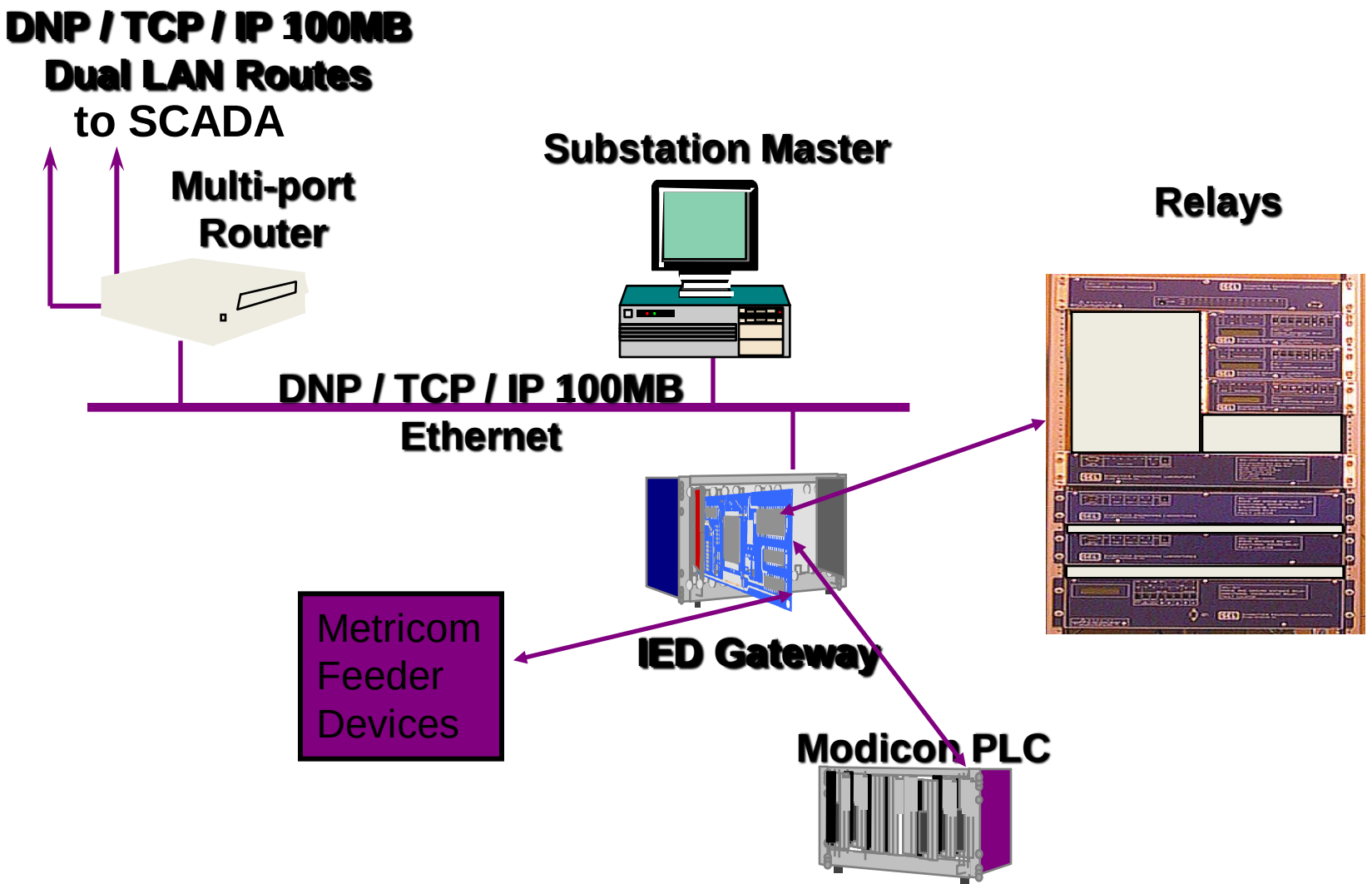
Substation Distributed LAN Architecture



Substation RTU-Centric Architecture



SA System for a Typical City



Local User Interface

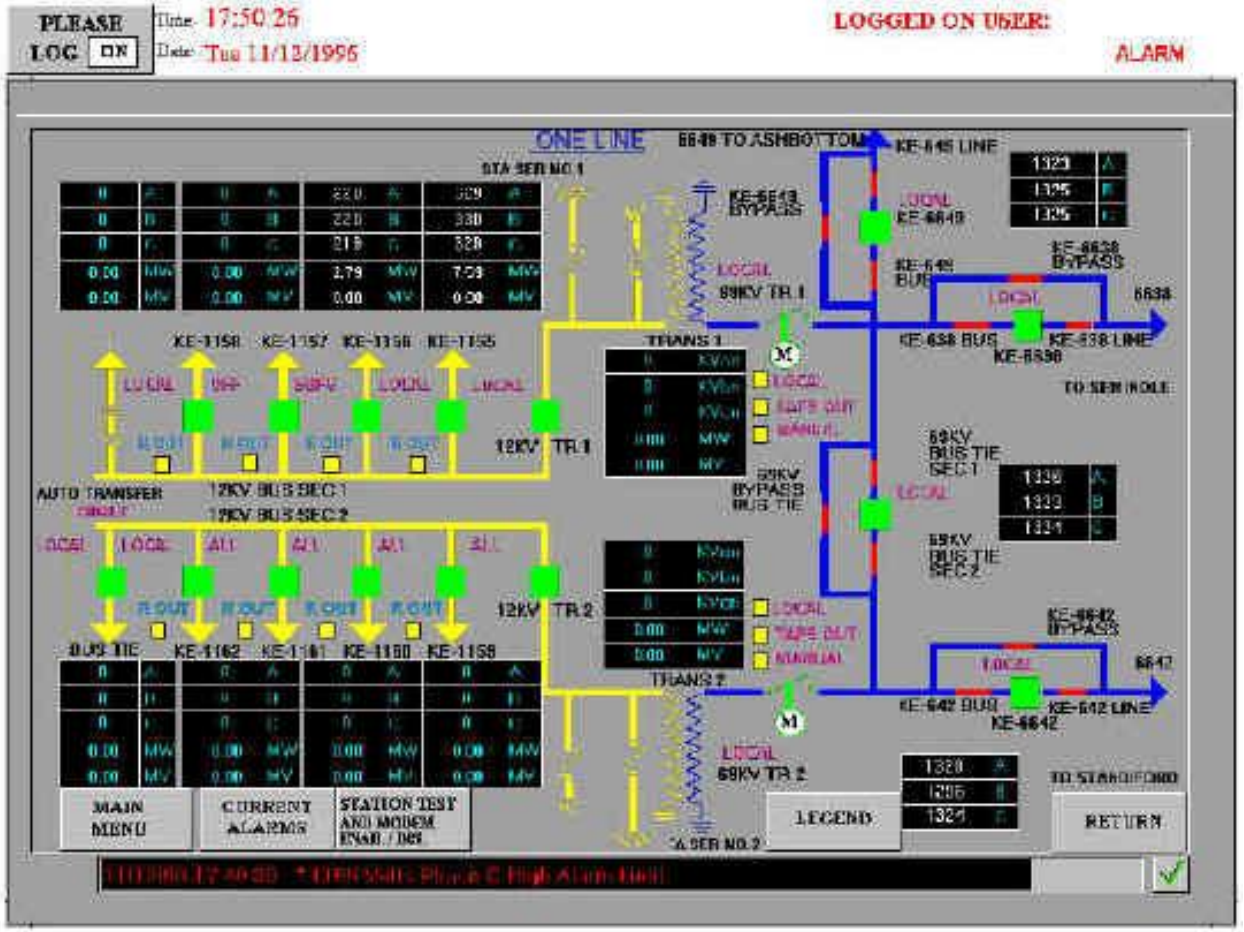
- Provides mechanism for:
  - Viewing data
    - meter readings
    - load tap changer position
    - relay targets
    - alarms
    - equipment status
    - oscillographic (waveform) data
    - power quality information

Control Devices/User Interface

- Provides mechanism for:
  - Controlling substation equipment
    - circuit breakers
    - motorized disconnect switches
    - substation capacitor banks
    - load tap changer
  - Viewing/Changing settings
    - Protective relays
    - Programmable controllers

Control Panel Mounted Interface

Substation One-Line Display



Control Devices/User Interface

- Other Displays
  - Control panel mimic
    - resembles conventional control panel
  - Alarm Annunciator mimic
    - resembles conventional alarm annunciator
  - Log sheet display
  - Operations summary

Alarm/Event Processing

- Knowledge-Based Alarm Suppression
  - Direct Linkages (can use pseudo status points)
  - Indirect Linkages

- Area of Responsibility
  - Use for each alarm window and each printer
  - Use to route alarms to proper windows/dispatchers and/or printers

Intelligent Electronic Devices (IED)

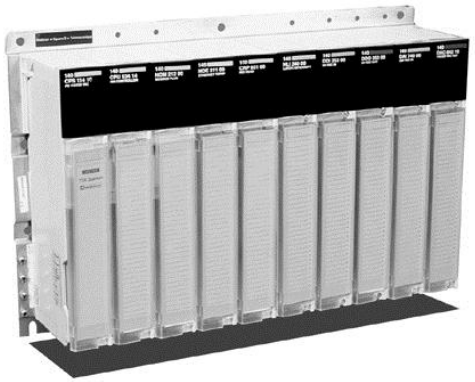
- ABB 2000R
  - *Protective Relays*

Intelligent Electronic Devices

- Bitronics Meter

Intelligent Electronic Devices

- Programmable Logic Controller
  - *Acquires status inputs from devices that don't have IED interfaces (motor operated disconnects)*
  - *Performs control actions for devices that don't have IEDs*
  - *Performs sequenced control actions using ladder logic*



Modicon PLC

Open System Architecture

- Essence of the problem:
  - *Communications among devices is key to successful SCADA implementation in modern system.*
  - *Traditionally most vendors established their own unique ("proprietary") way to communicate.*
  - *Getting two Vendor's proprietary devices to communicate properly is a complex and expensive task*

Possible Solutions to the Problem

Two basic approaches:

- Buy everything from one vendor
- Get vendor's to agree on a standard communication interface

The latter approach is the fundamental objective of the "Open Systems" movement

Open Systems

- An evolutionary means to allow a control system to be upgraded in the future with components available from multiple vendors at lowered or competitive costs that will allow **Integration** with **Relative Ease** and **Low Risk**

- Based on the use of Non-Proprietary and standard software and hardware interfaces

Open Systems Benefits

- Interoperability
- Avoid reliance on a single vendor
- Upgradable/expandable
- Longer expected system life
- Readily available third party components

Standard Protocols

- Open Protocols (Legacy):
  - Harris 5000
  - L&G 8979
  - L&N 2020
- “De Facto” (Widely Used) Protocols:
  - DNP 3.0
  - Modbus & Modbus+
  - IEC 60870 series
- Utility Communications Architecture (UCA 2.0)/ IEC 61850 (Only world wide STD)
  - Evolving worldwide standard
  - Manufacturing Message System (MMS)
  - Ethernet (10 or 100Mbps)
  - Growing number of commercially available products

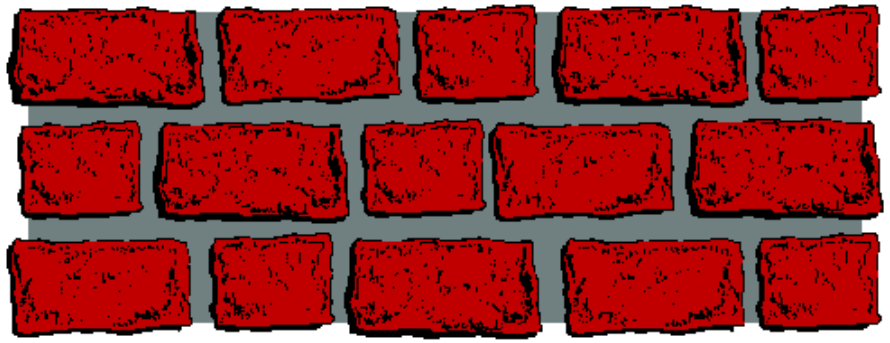
Integration with Corporate IT Systems

- Utilities spending considerable effort in integrating corporate computer systems:
  - SCADA
  - Geographic Information System (GIS)
  - Trouble Call/Outage Management/Mobile Dispatch
  - Work Management System
  - Customer Information System

- Examples of Shared Data:
  - Feeder switch positions (SCADA Outage Management)
  - Feeder map and facility data (GIS SCADA)
  - Equipment duty (SCADA Work Mgmt)

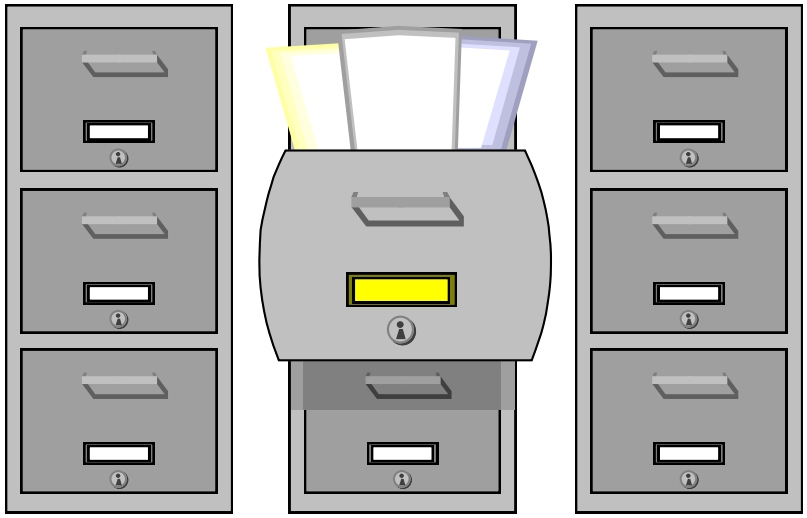
Corporate Data Repository

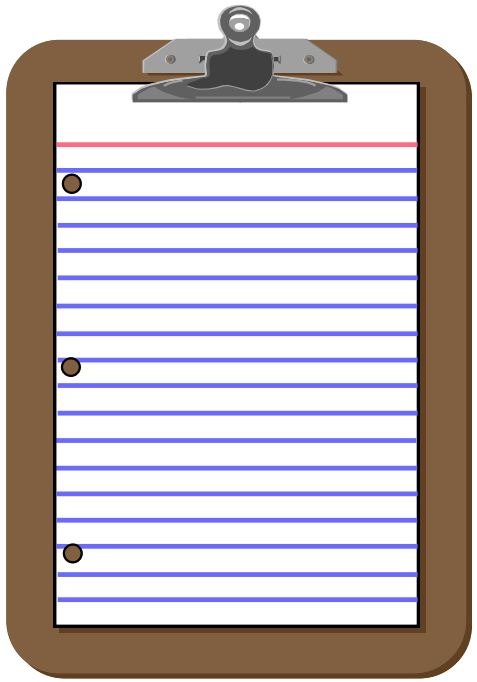
- Enables Users to Access Substation Data While Maintaining a Firewall to Substation Control and Operation Functions



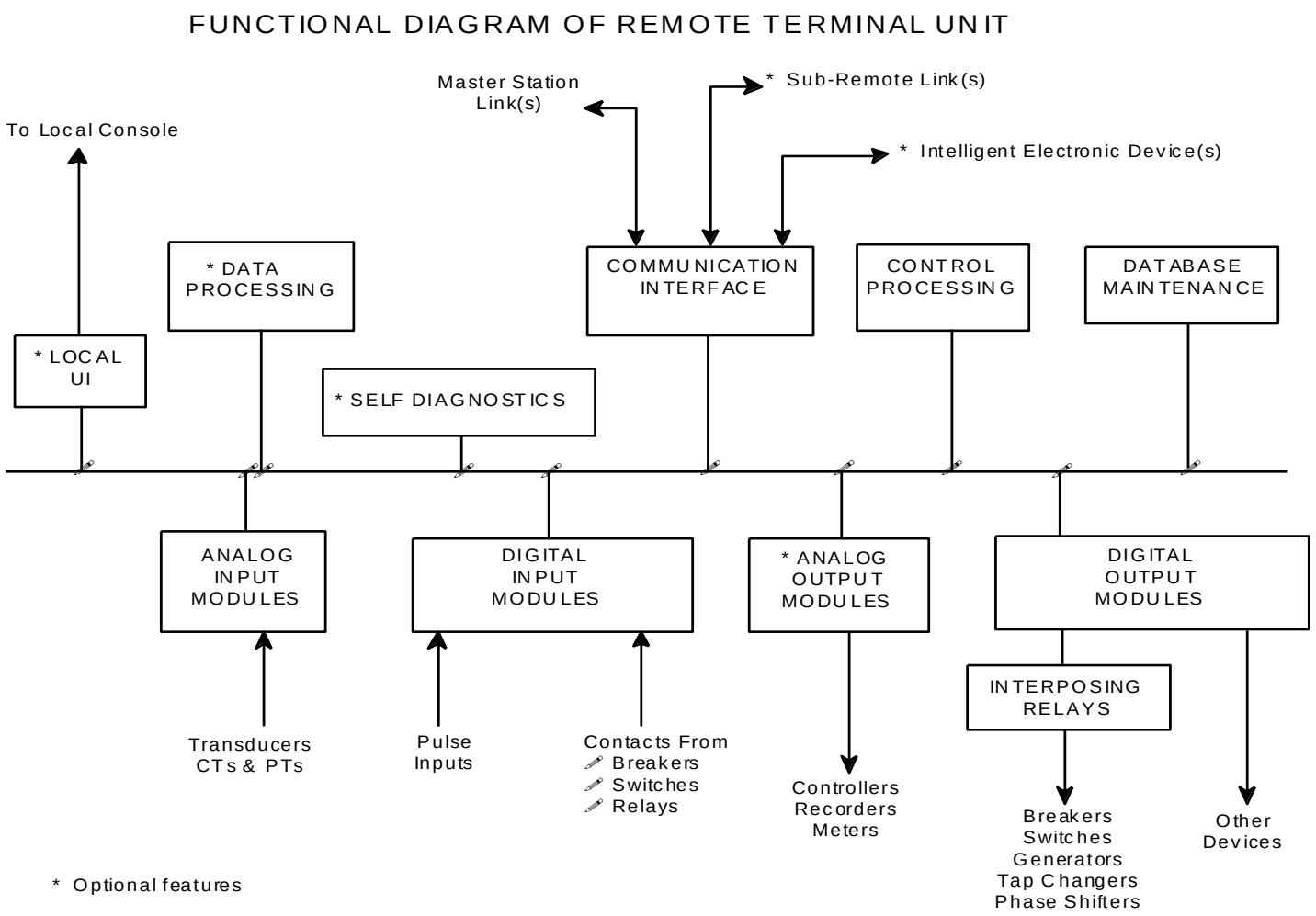
Corporate Data Repository

- Operational and Non-Operational Data storage:
  - Applications include: Load Forecasting, Engineering Studies, Outage Investigations





Conventional Remote Terminal Unit (RTU)



MAIN COMPONENTS OF SCADA

** Data Conversion Devices :- Transducers

** Field Data Collection Devices :- R T U

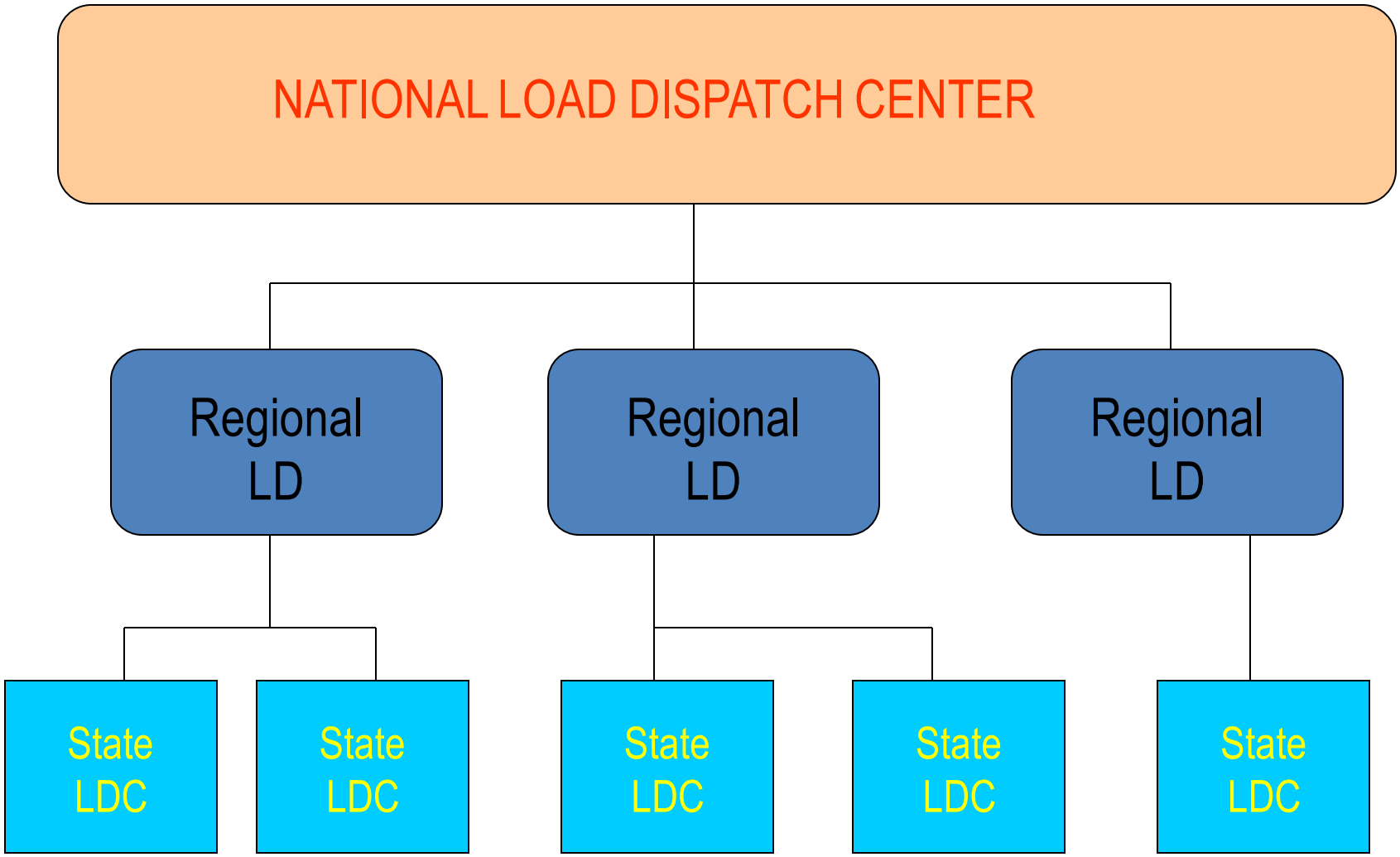
** Interfacing Devices :- MODEM

** Communication Media :- Different Modes

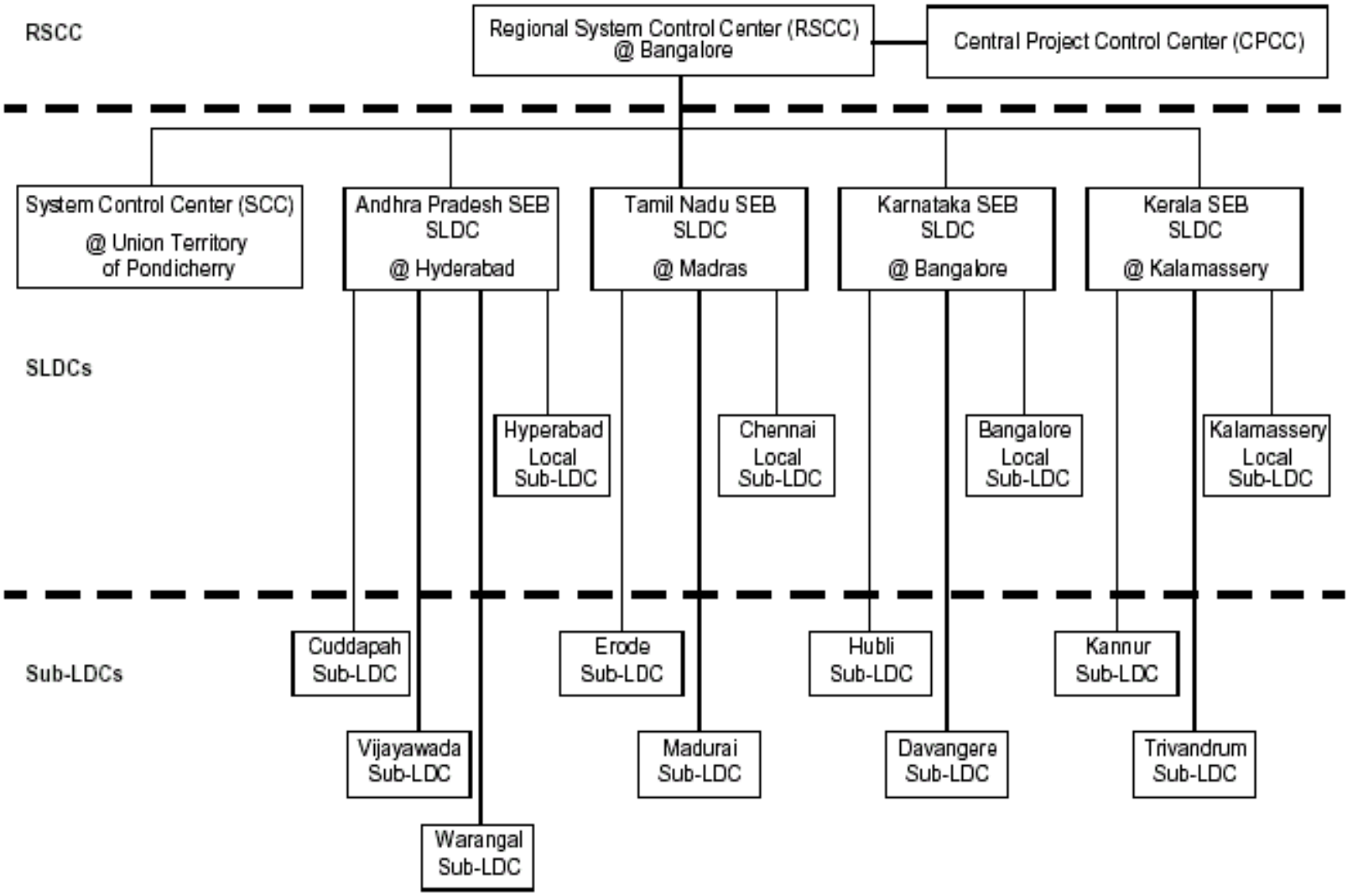
** Data Receiving Equipment :- FEP

** Processing and Distributing :- Computers, LAN etc

** Display Devices :- PC, Screen etc


NATIONAL LOAD DISPATCH CENTER
Regional LD
Regional LD
Regional LD
State LDC
State LDC
State LDC
State LDC
State LDC

Regional Level SCADA Overview



Southern Region DATA flow Hierarchical Overview

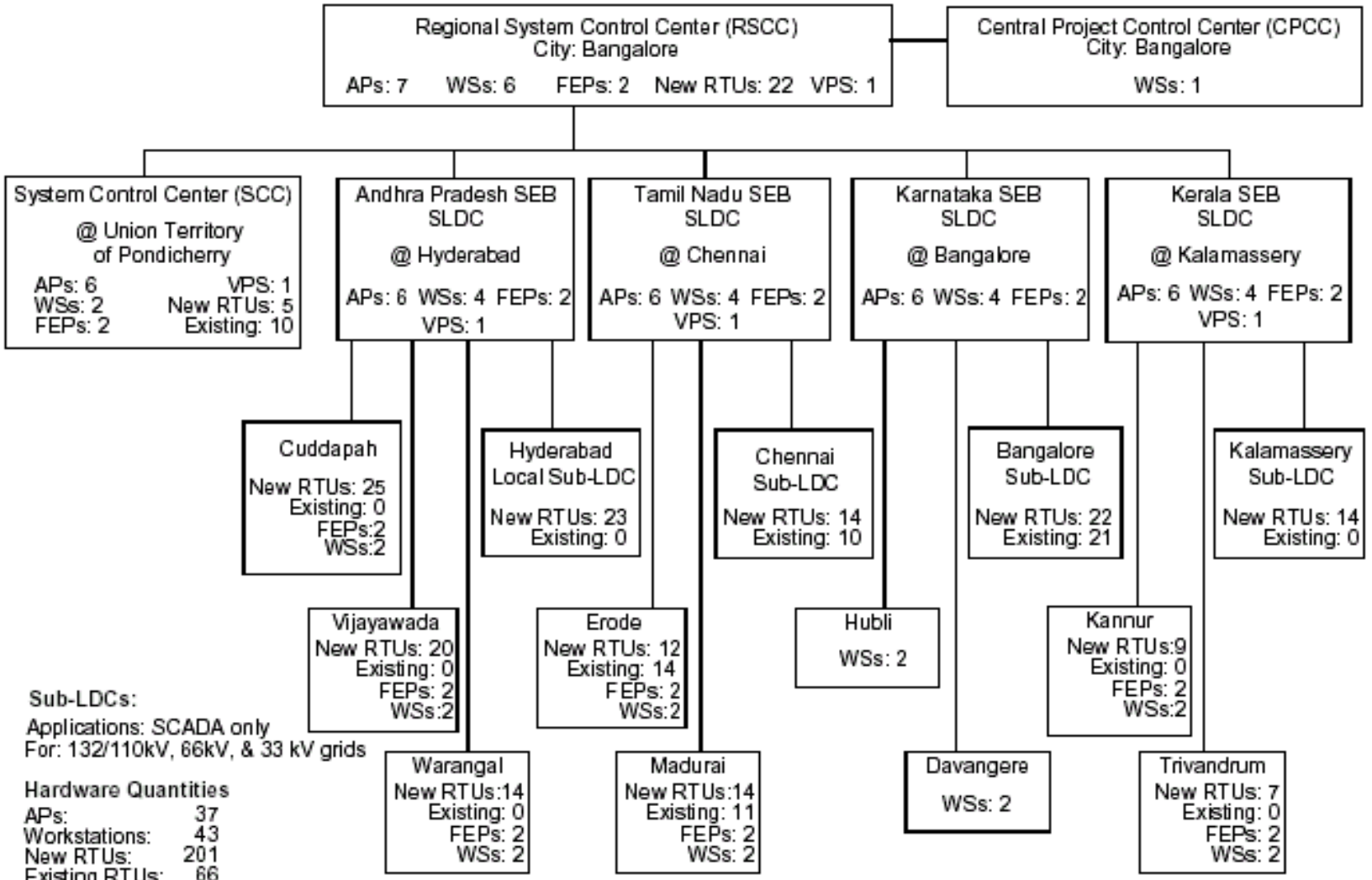
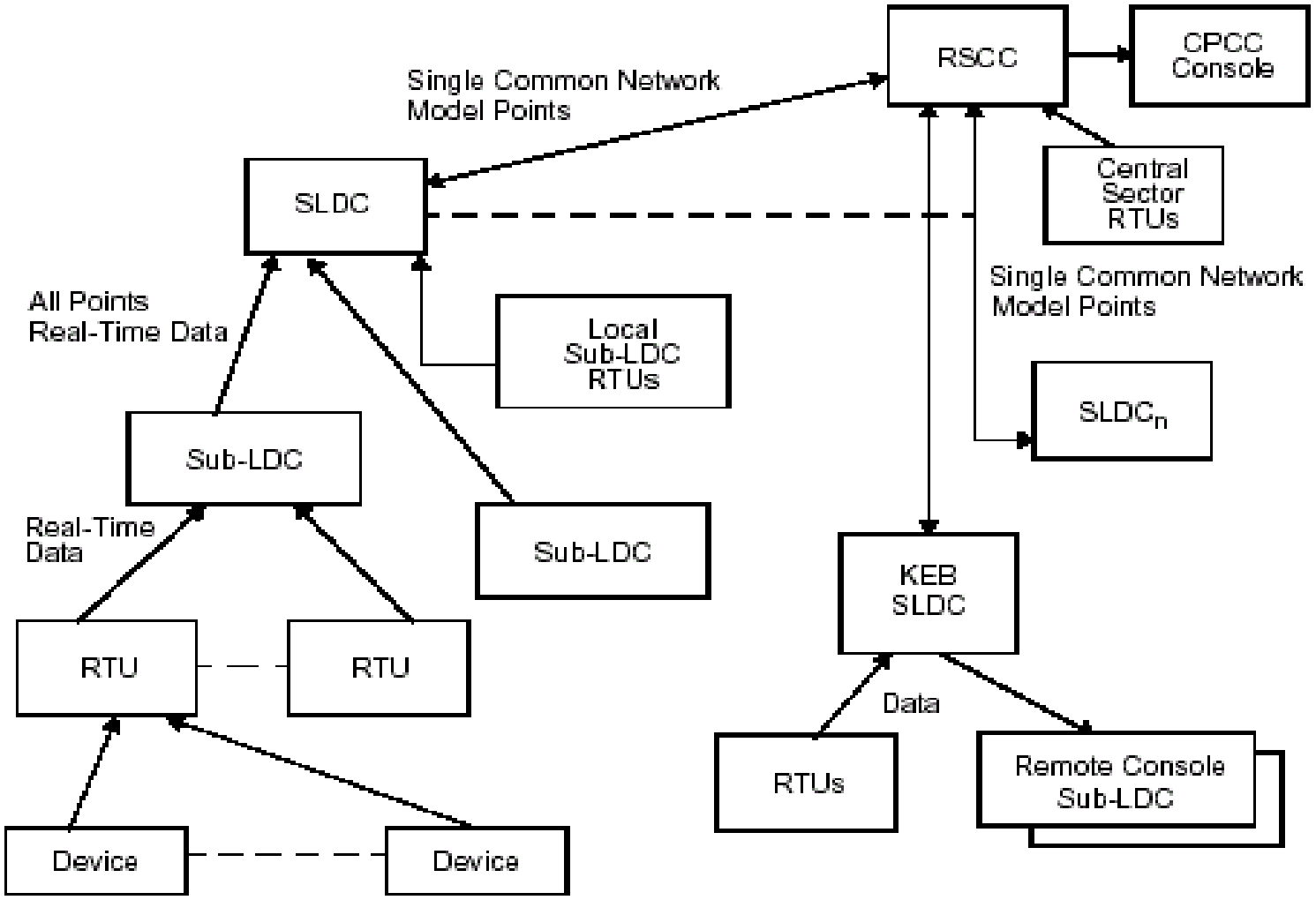
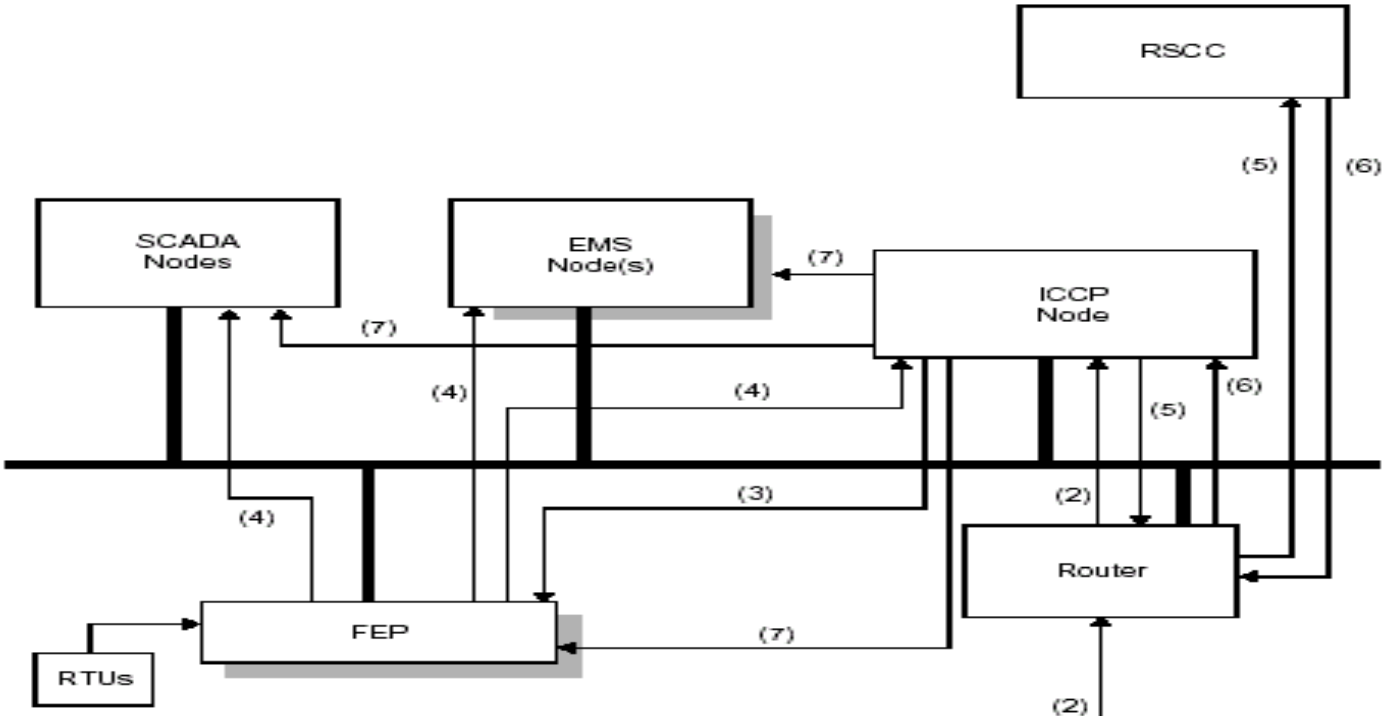


Figure 3–1. Overview of Powergrid EMS

DATA FLOW DIAGRAM



SLDC DATA FLOW

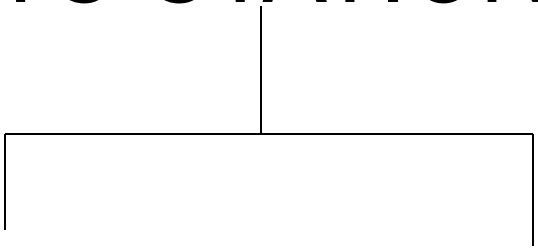


(1) RTU sends data to the FEP at SLDC
(2) Sub-LDC transfers data to SLDC ICCP node via ICCP dataset
(3) ICCP at SLDC sends data to FEP at SLDC
(4) FEP updates Real-Time database and broadcasts the update to all nodes in XA/21
(5) ICCP sends the updates for 110 Kv and above points to RSCC
(6) RSCC sends Common Network Model data to SLDC ICCP node
(7) SLDC ICCP updates Real-Time database and broadcasts the update to all nodes

Drawing shows Functional nodes – not Physical nodes

Figure 2–5. SLDC Data Flow

RTU STATIONS



Critical

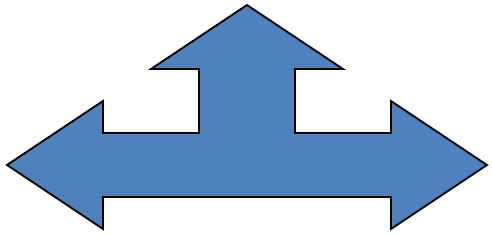
Non - Critical

Critical RTU Station – Capacity More than **50** MW

Non Critical RTU Station – Capacity Less than **50** MW

Two Exclusive DATA Channel From the SUB LDC, main and standby.

Monitored Parameters and the Transmission Methods



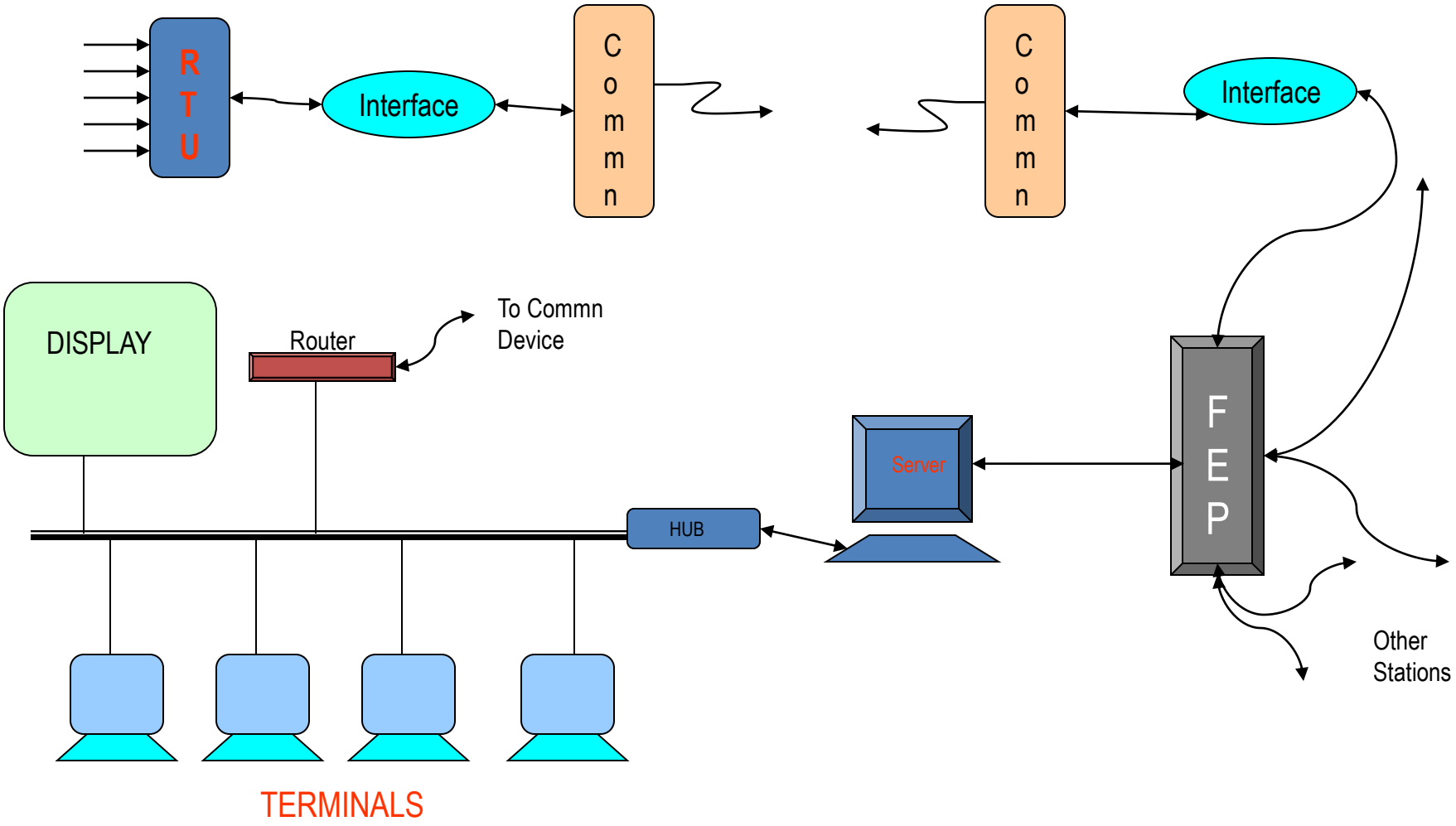
Analogue Values

MW, MVAR, V, F,
Tap Position, I etc

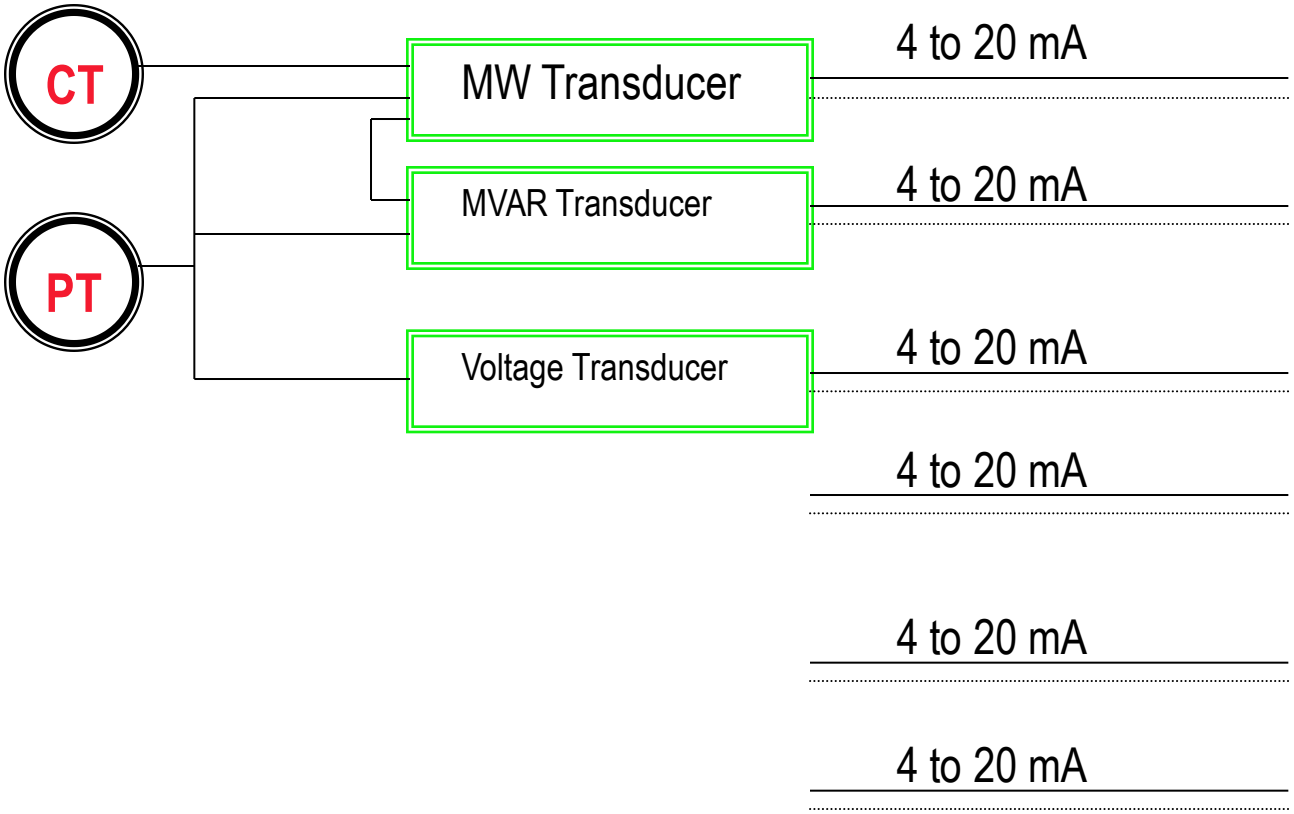
Digital Values

CB Position,
Isolator Position,
SOE Points, Relay
Indications

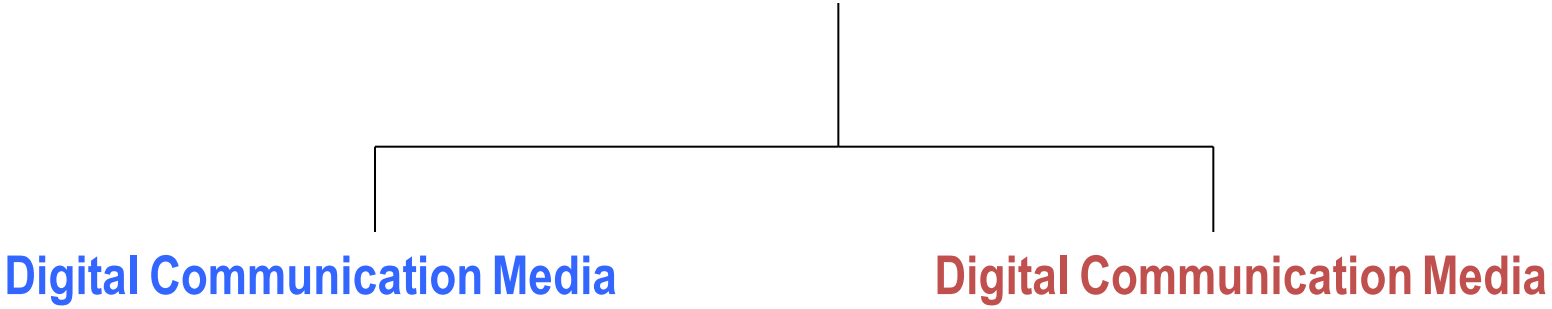
DATA Flow Path



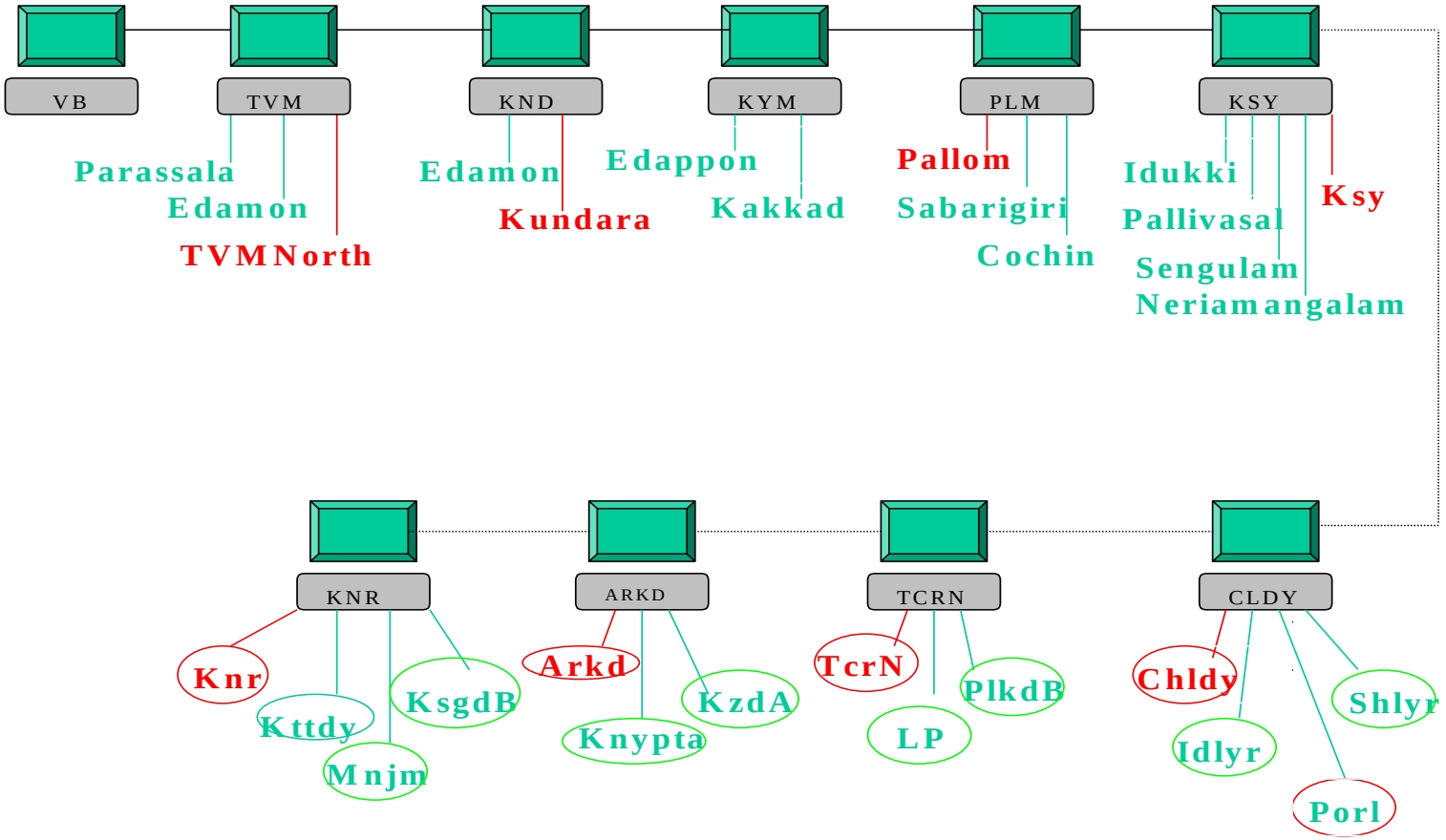
Transmission Circuits

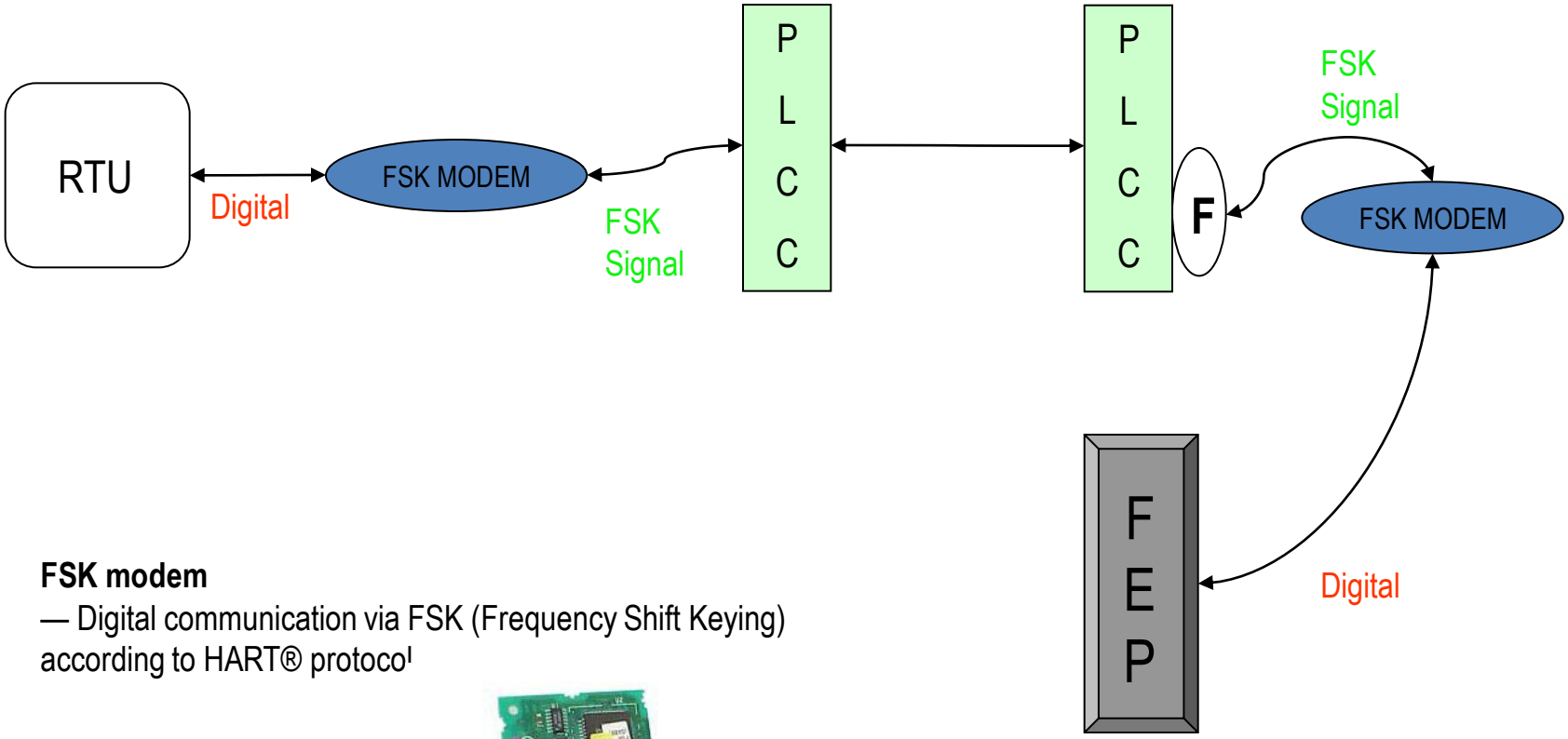


Now Our Requirement is Tx/Rx the Digital Serial Data From the RTU to the FEP through a Communication Media



Communication Network





FSK modem

— Digital communication via FSK (Frequency Shift Keying) according to HART® protocol

Regards,

Dr. Sasidharan Sreedharan

YBL Systems and Solutions

(Electrical Power System Research Consultants)

www.sasidharan.webs.com

Specification of 110 KV Transformer CT

	Core I Differential	Core II Back up	Core III Metering	Core IV REF
Accuracy Class	PS	5P10 (Over Current Protection	1.0 (Accuracy)	PS
Burden	**-**	**60 VA**	**60 VA**	**-**
Min. KPV (Knee Point Voltage)	**600V**	**-**	**-**	**600 V**
Max. Exciting Current.	**100 mA**	**-**	**-**	**100 mA**
Resistance at 75 ^{0} C	**4.5 0hm**	**-**	**-**	**4.5 ohm**

SCADA INFRASTRCUTURE ELEMENTS SECURITY

Application		Function	Security Technology
Wireless		3G/WIFI connectivity to RTU stations	Secured AP technology that includes AV, IPS, and application control
ICCP		Distributed control systems control systems integration to EMS systems	IPS protection from protocol anomalies and systems attacks
DNP V3		SCADA Main to SCADA remote RTU	Application control for TCP/IP DNP protocol control, IPS for buffer, header and network attacks
HMI		RTU control Terminal	AV/IPS to secure against Threats to terminal (no AV allowed on HMI Terminals)
Database Systems		Data storage for HMI and RTU systems	Database security control with schema, table auditing and control

CPRI

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