

# Substation Data Integration & Information Exchange

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**Project objective:**

**Utilize data obtained from Intelligent Electronic Devices (IEDs) to enhance Power System State Estimation**

# Research Approach

## Concentrate on the following issues:

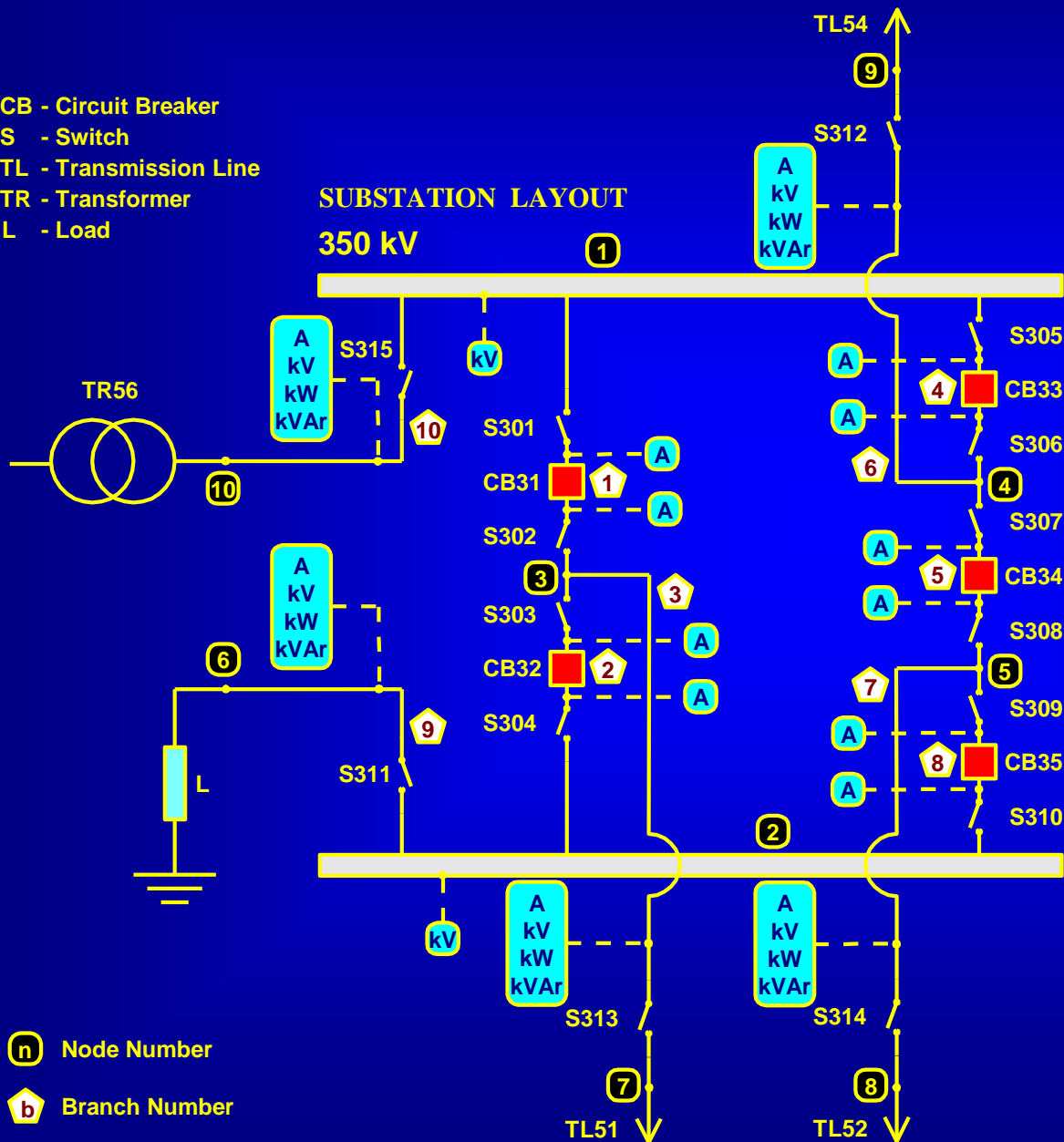
- Analyze digital relays and other Intelligent Electronic Devices installed in substations
- Explore modern trends in substation communications (IEC 61850)
- Collect data from various locations within substation and adjust the format
- Provide redundancy of measurements
- Write an application for data processing and consistency checking
- Communicate output to the higher level

# Substation Layout - One Line Representation

CB - Circuit Breaker  
 S - Switch  
 TL - Transmission Line  
 TR - Transformer  
 L - Load

## SUBSTATION LAYOUT

350 kV



(n) Node Number

(b) Branch Number

## Modeling Issues

Power Apparatus:

- Circuit Breakers
- Disconnect Switches
- Busbars
- Load - Reactor

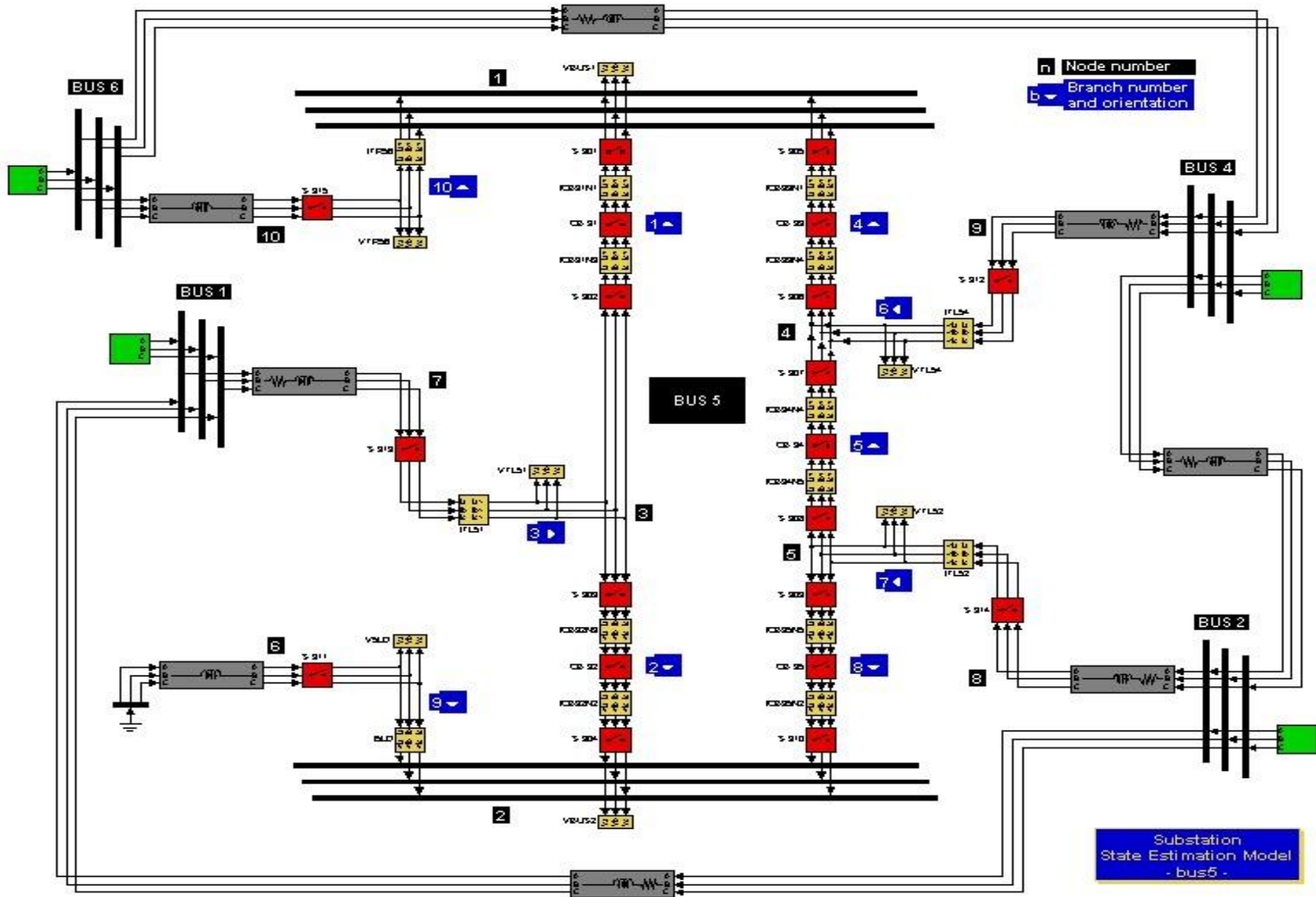
Analog Measurements:

- Currents [A]
- Voltages [kV]
- Power Flows [kW, kVAr]
- Power Injections [same]

Digital Measurements:

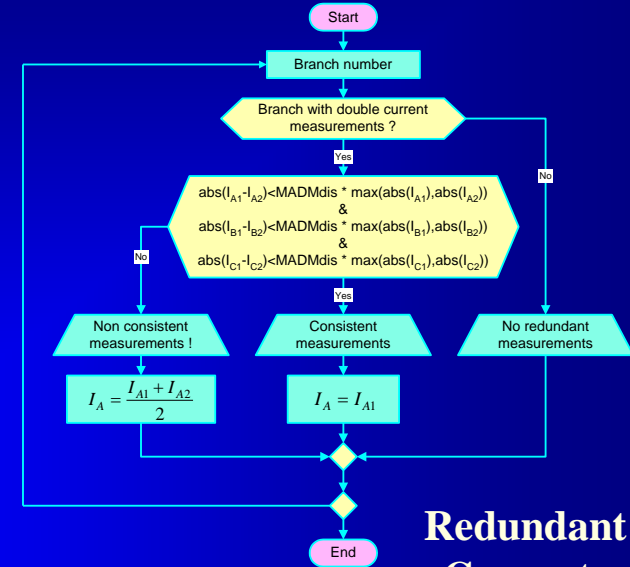
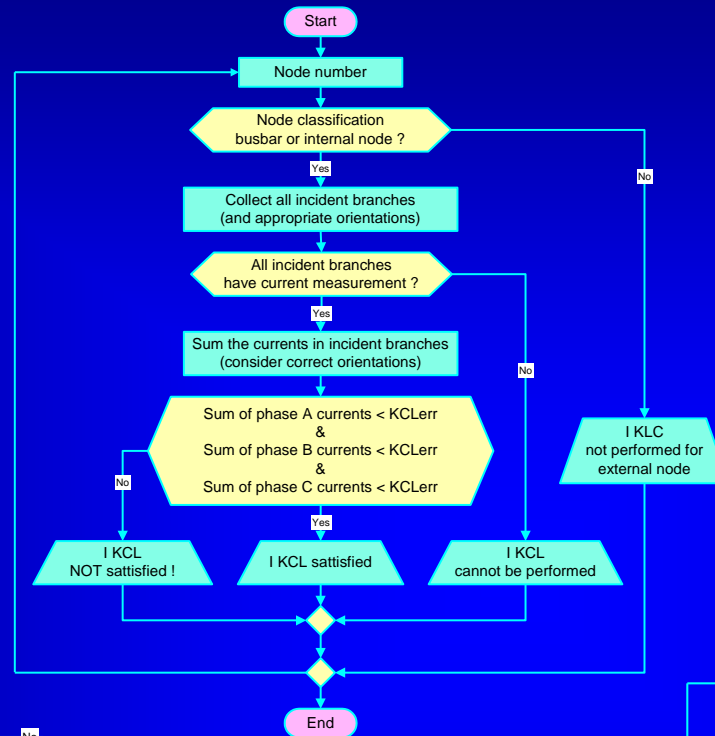
- CB Statuses
- DS Statuses
- Ground Switches

# Three-phase Substation Model in SIMULINK

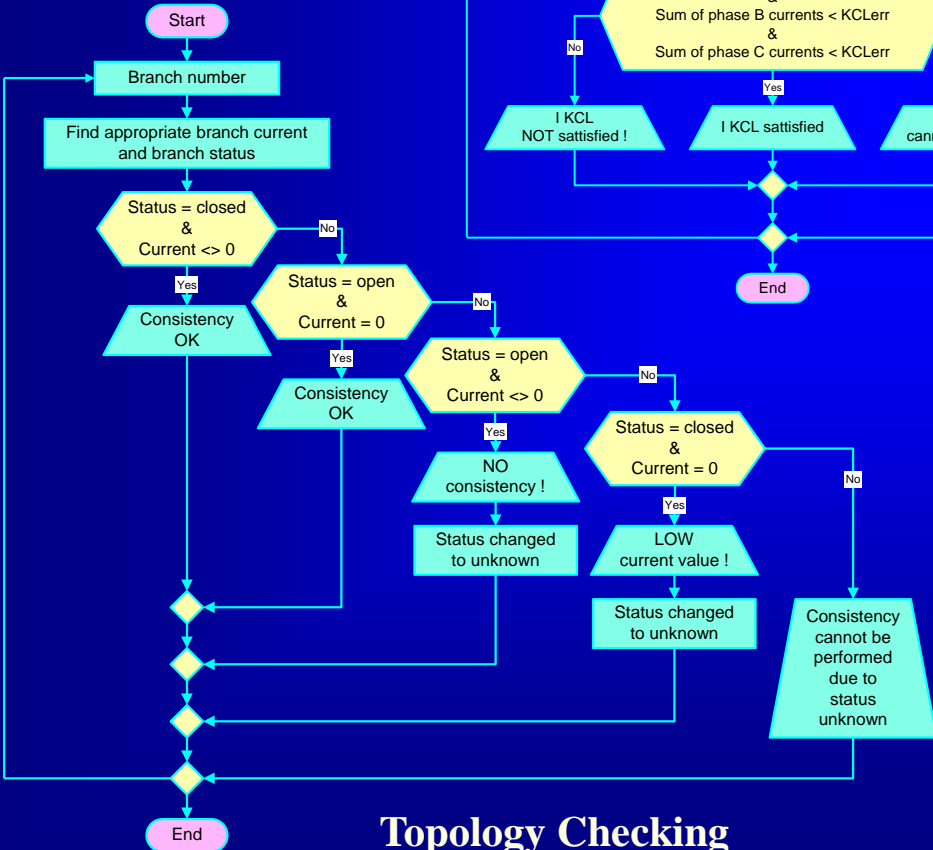


# Processing Algorithms in MATLAB

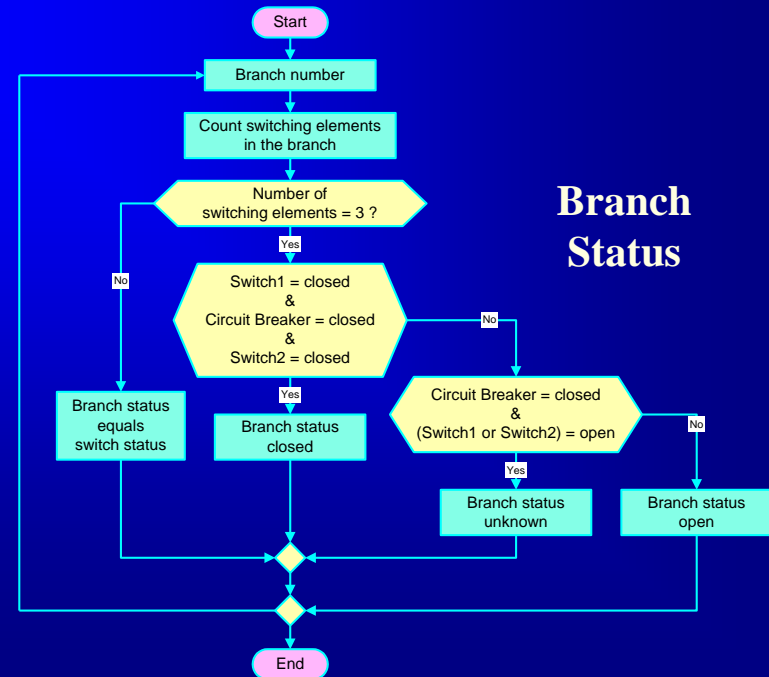
## Kirchoff's Current Law



## Redundant Currents



## Topology Checking



## Branch Status

# Project Results - Future Work

## Output Tables

Communicated Data:

- Three-phase or single-phase output
- Possible errors filtered out
- More reliable data

Future Work:

- Substation transition analysis
- Switching sequences & interlocking
- State tracking & predicting
- Writing user friendly software

<i>Node #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>...</i>
<i>Voltage (mag)</i>	0.99206	0.99206	0.99206	0.99206	0.99207	
<i>Voltage (ang)</i>	0.208	0.208	0.207	0.207	0.208	
<i>Injection (act)</i>	n/a	-0.0235	n/a	n/a	n/a	
<i>Injection (react)</i>	n/a	-0.9814	n/a	n/a	n/a	

**Node Table**

<i>Branch #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>...</i>
<i>Current (mag)</i>	1.62494	1.02758	2.59226	1.42991	1.95869	
<i>Current (ang)</i>	176.539	-158.331	-173.769	179.742	-2.489	
<i>Flow (act)</i>	-	-	-2.55749	-	-3.35952	
<i>Flow (react)</i>	-	-	-0.26988	-	-0.10291	
<i>Status</i>	1	1	1	1	1	

**Branch Table**



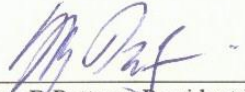
SECOND PRIZE/GRADUATE LEVEL

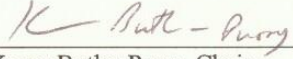
*Sasa Jakovljevic*

*Substation Data Integration and Information Exchange*

Student Poster-Paper Session and Contest  
2002 Winter Meeting of the Power Engineering Society  
January 28, 2002



  
Hans B. Puttgen, President-Elect  
Power Engineering Society

  
Karen Butler-Purry, Chair  
Student Poster Session