The Architecture of System Protection Schemes (SPS) Implemented in the Sarawak Power System

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Background for System Protection Schemes

- Implemented since 2009
- **Purpose** :
  - To safeguard Sarawak power system against major system disturbance:
    - Frequency Instability
      - N-2 275kV transmission Line contingency (System Islanding)
    - 275kV Transmission line exceed its stated capability limit
      - N-2 275kV Transmission Line contingency
      - N-1 275kV Transmission Line contingency
    - System Overvoltage during system islanding condition
  - Allow GSO more flexibility in operating the power system and utilize the generation resources more efficiently
- **Performance of SPS:**
  - Successfully protect Sarawak Power System from collapse
    - 31 Oct2009 – Loss of Oya-Selangau 275kV double circuits (System Islanding)
    - 28 Nov 2010 – Loss of Engkilili-Mambong 275kV double circuits (System Islanding)
    - 19 Dec 2011 – Loss of Bintulu-Kemena 275kV double circuits (System Islanding)
    - 18 July 2012 – Loss of Engkilili-Mambong 275kV double circuits (System Islanding)

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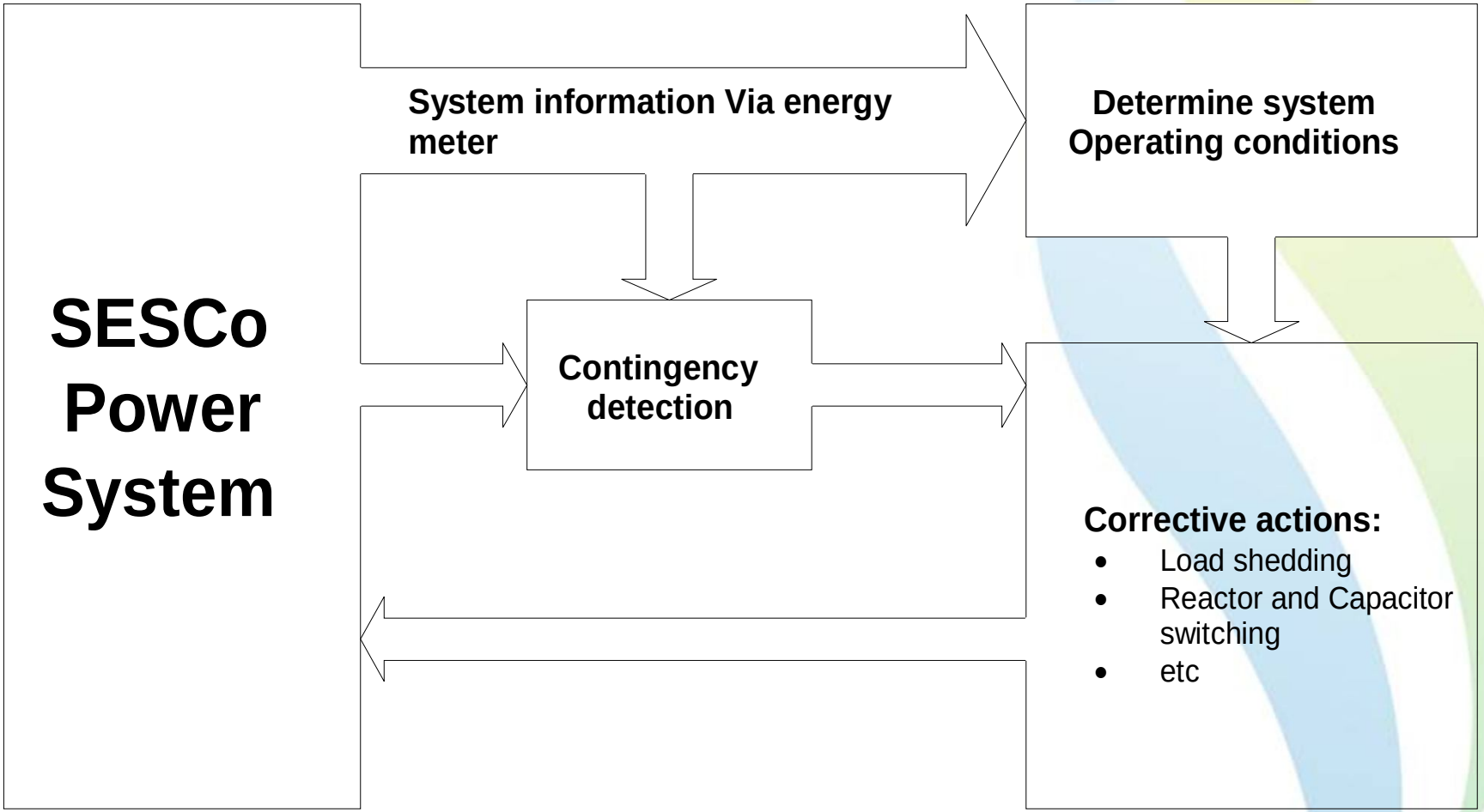
Concept Designs for SPS



Event-Based Activation Scheme

Performance Requirement for SPS

- **Security**
  - only operate for conditions which required its control actions
  - Avoid False operation under all system condition
- **Selectivity**
  - Able to select and determine the right corrective measure according to system contingency
- **Dependability**
  - Single component failure will not affect the operation of the SPS system
- **Compatibility**
  - Support different hardware vendors
  - Support different protocols i.e Modbus and IEC 61850
- **Scalability**
  - Ability to monitor and control at least 100 substation s with 20 IED per substation
- **System Response times**
  - Detection of system disturbance and execution of mitigation measures within the time frame of 150ms (excluding the CB opening time)

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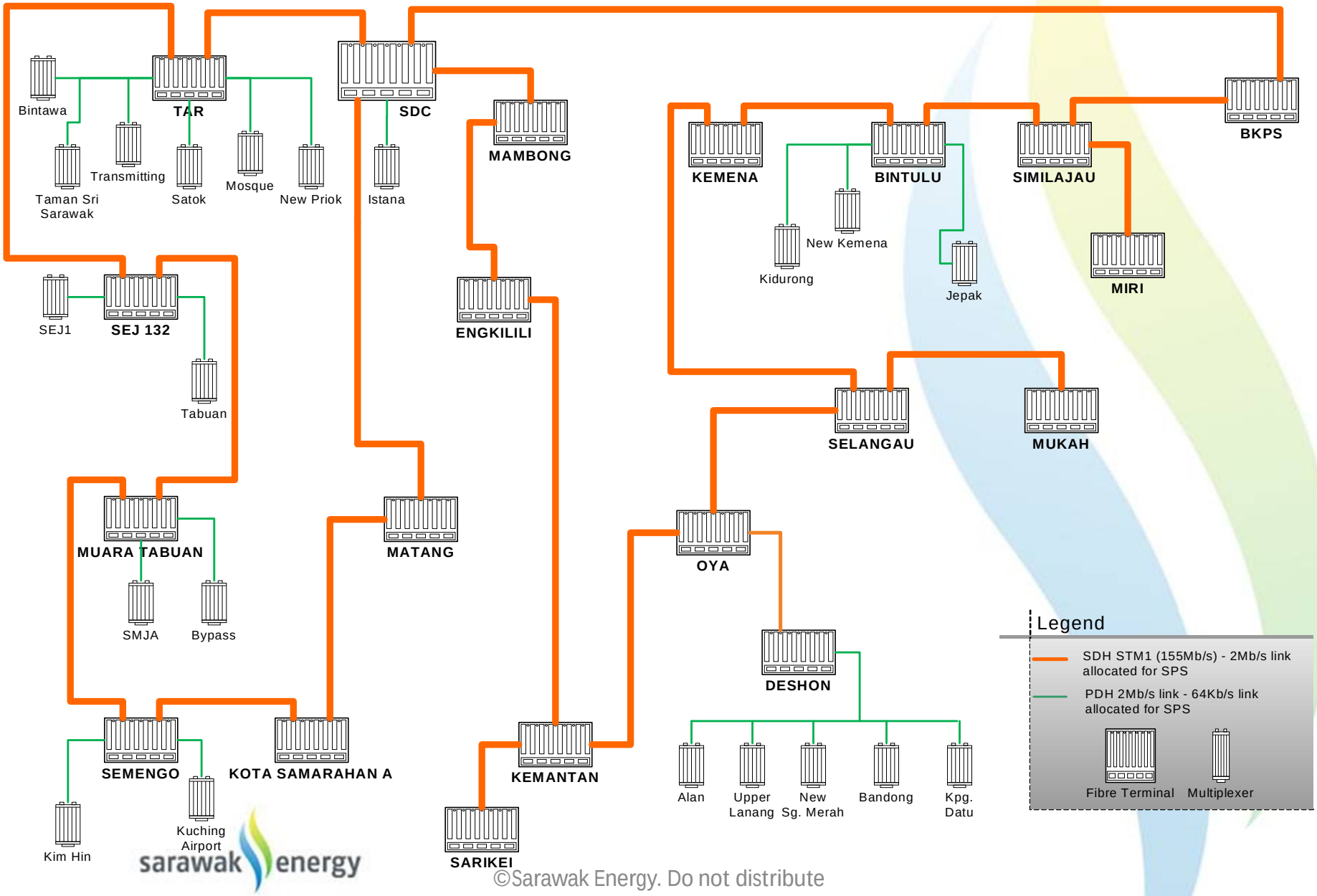
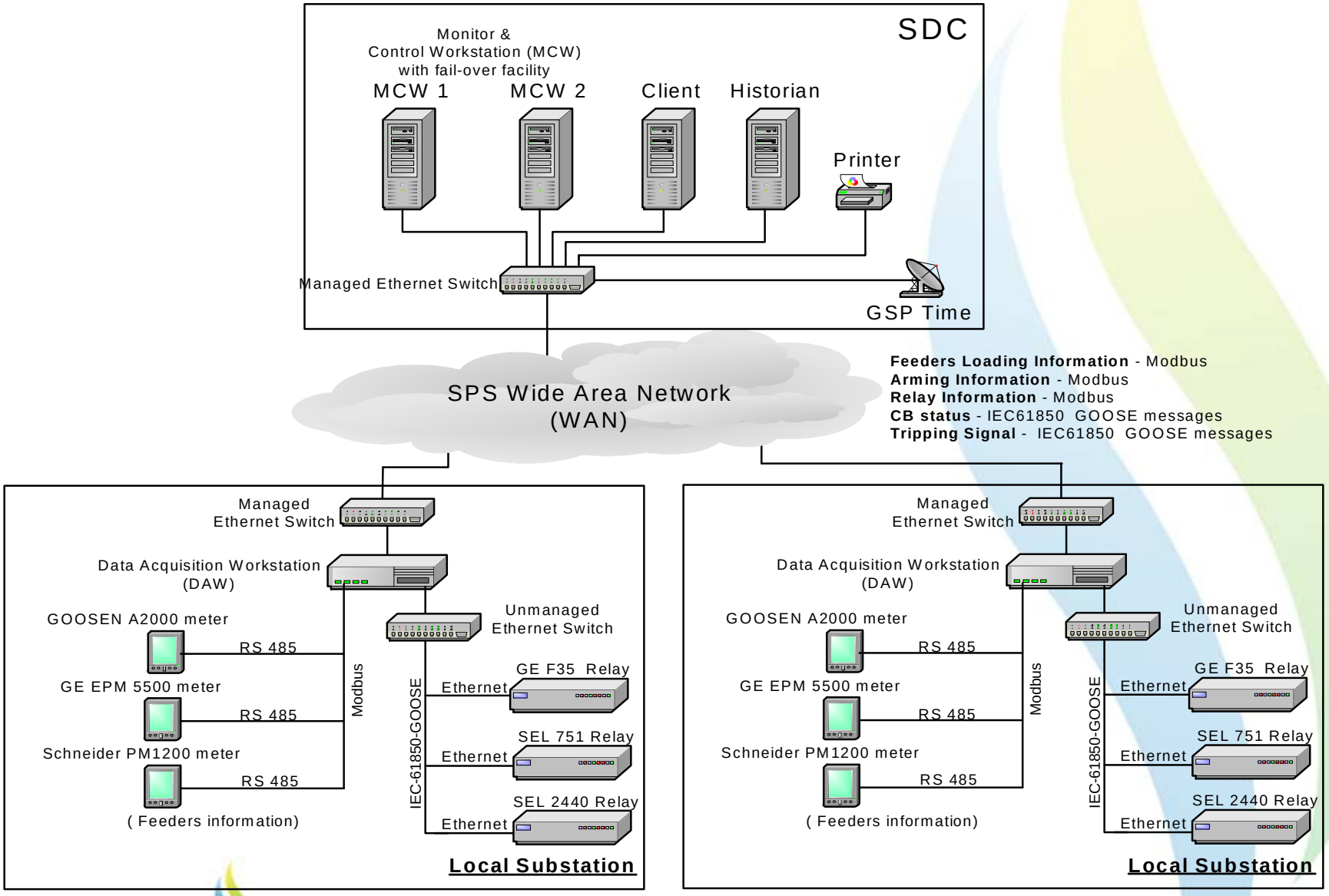
Design of SPS Communication



Setup of SPS system



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Monitor & Control Workstation (MCW)

- Collects the data i.e MW, MAVR, frequency, CB Status, MWH and voltage from all DAWs
- Performs data conversion from data collected and stores the data at its internal process database (PDB).
- Sends selected data to historian server for data archival and to client HMI for operator display.
- Performs deficit calculation on 3 minutes interval to update SPS load shedding table for each zones.
- Sends out arming or disarming signal to all affected feeders
- Disable or enable SPS scheme

Client HMI Workstation

- For Operator display
- No other actual SPS processing is being carried out inside the client
- Disable or enable SPS
- Display system information i.e MW, MVAR, Voltage & frequency
- Remove or add in substations/feeders from load shedding table
- Post-Disturbance Analysis
- Provides user with notification messages as follows:
  - SPS operation
  - SPS faulty
  - Automatic failover
  - Communication error at any of the substations
  - Double circuit Tripping detection
  - Line exceeds thermal limit detection

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Historian Workstation

- High performance data archiving system
- Collect, store and retrieve time-based information at a very high speed

Data Acquisition Workstation (DAW)

- Collects and stores SPS related data from protection relays and energy meters in real time using Modbus protocol
- Sends the data upon request by the MCW
- Receives arming information, selection criteria, and zone status from MCW and stores them in the internal table every 3 minutes
- Monitor and receives 275kV double circuit lines CB status (IEC 61850 GOOSE messages) from protection relays and relays them to the other substations
- Performs logic operations based on the arming table and predefined SPS logic scheme
- Send tripping signal to protection relay to execute tripping EHV substations

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Conclusion

- The success factors of the System Protection Schemes implemented in the Sarawak power System are :
  - Communications Infrastructure i.e. Fiber optic facility in place at all substation s
  - Advancement of the Protection & Meter Equipment i.e IEC 61850
  - Design scheme derived from comprehensive system study
- With the SPS in place, it shows that the reliability and security supply of Sarawak power system has been improved and allow GSO more flexibility in operating the power system and utilize the generation resources more efficiently

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Thank You