APPENDICES

Appendix A

Propose and Revise Inference Template

Define

1. Who
   - Utility
   - Consult
   - Supplier
2. Document
   - Operation & Maintenance Instruction Manual
   - Relay setting manual
   - Equipment Drawing and Manual
3. Information
   - MEA Intranet
   - MEA CIS and call center
   - GIS

1. Requirement

- Feasible and economic
- Ready to use in time
- Appropriated quality
- Simplicity
- Durability
- Openess

2. **Specify**

- Self design
- Consultant design

3. Skeletal Design

- Scope of work

    - Control center for zone and area
    - Number of substations
    - Number of feeders
    - Numbers of Remote I/O (RTU and switches)
- Functional specification
    - Core
        - System model and state estimation
        - 3 phase power flow and connectivity analysis
        - Single line and connection diagram, location, route coloring
        - Temporary modifications (cuts, jumpers)
        - Volt/Var control
        - Loss minimization
        - Fault location and service restoration
        - Switching management system
        - Planned outage
        - Authentication and report
        - SOE/Alarm
        - Trend and Archive
- Inspection existing primary equipment characteristics
    - Substation
    - Distribution feeder
- Configuration design
    - Single line and layout
    - Conceptual and preliminary drawing
- Equipment specification
    - Primary equipment
        - Switching control device: CB, DS, ES, LBS, RR
        - S-RTU, F-RTU
        - Fault detectors
    - DMS hardware
    - DMS software
        - SCADA function

    - Network view
    - Network outage management
    - Network optimization
    - Network analysis
    - Historical information and reporting
    - Training simulator
    - External systems
- Reference standard
- Test and Commissioning

4. Operationalize

- Instruction manual
- Operation and Maintenance monthly report
- Switching order
- MEA intranet

5. Soft Requirement

- Distribution Equipment
    - Primary
        - Transformer
        - Station Bus
        - Distribution feeder: underground, overhead, mix
        - 3 pole operated disconnecting switch
        - Asset management
            - CB monitoring
            - Transformer monitoring
    - Secondary
        - S-RTU
        - F-RTU
        - DAS
- Operation
    - Offline analysis
    - Power quality: harmonics measurement

- Automatic transfer function (ATF)
- Operator training simulation
- Load profile
- Exactly location of double pole dead-end: to disconnect specific line fault and maximam load recovery
- Crew management

– Control and Protection
  - Protection scheme on/off
    - Earth fault on/off
    - Autoreclose on/off
  - Synchrocheck before switching

– Information and Communication Technology

6. Hard Requirement

– Distribution Equipment
  - Primary
  - Secondary

– Operation →Operation manual, Switching guideline
  - Safety operation: minimum outage time, no equipment damage risk, no human risk
  - Remote control for current,voltage, power and frequency within the limit
  - Online monitoring
  - Navigation: panning,zooming, decluttring, navigator, snap, overlays, grey scaling, object search, back/undo
  - Locate fault, generate switching orders and guide for fast service restoration
  - Switching plan scenarios for maintenance, load transfer, contingency cases
  - Emergency information and switching guideline
  - Communication between operator and crew
  - Loss minimization

- Control and Protection →Typical control and protection scheme and Relay setting manual
    - Safety operation: Interlocking
    - No autoreclose for underground cable
    - 3 shot autoreclose for overhead line and mix
    - Block instantaneous charactristic in 2nd shot of autoreclose
    - Dynamic protection coordination (if it's possible)
    - Avoid parallel transformer
- Information and Communication Technology
    - Interoperability, integration
    - Protocol
    - Switch
    - Media
    - Application

7. Propose

8. Extension

- Scope of work
    - Control center for zone and area
    - Number of substations
    - Number of feeders
    - Numbers of Remote I/O (RTU and switches)
- Functional specification
    - Core
        - System model and state estimation
        - 3 phase power flow and connectivity analysis
        - Single line and connection diagram, location, route coloring
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        - Volt/Var control
        - Loss minimization
        - Fault location and service restoration
        - Switching management system
        - Planned outage

    - Authentication and report
    - SOE/Alarm
    - Trend and Archive
  - Advanced
    - Fault analysis, Post mortem analysis
    - Demand estimation
    - Trouble call and outage management
    - Load shedding and restoration
    - Automatic meter reading
    - Peak load reduction
- Configuration design
  - Single line and layout
  - Conceptual and preliminary drawing
- Equipment specification
  - Primary equipment
    - Switching control device: CB, DS, ES, LBS, RR
    - S-RTU, F-RTU
    - Fault detectors
  - DMS hardware
  - DMS software
    - SCADA function
    - Network view
    - Network outage management
    - Network optimization
    - Network analysis
    - Historical information and reporting
    - AMR
    - Training simulator
    - External systems
      - Asset model/GIS
      - Call center
      - CIS

        - AMR
        - Resource mgmt
        - Mobile work force
        - Maintenance planning
        - Engineering and plannnig
        - Crew callout
        - Mailing system
    - Reference standard
    - Test and Commissioning
9. **Verify**
    - Standard
    - Specification
    - Test Certification
    - Commissioning
10. **Violation**
11. **Critique**
    - Distribution Equipment
        - Primary
        - Secondary
    - Operation
    - Control and Protection
    - Information and Communication Technology
12. **Action list**
13. **Select**
14. **Action**
15. **Modify**
16. **Design**
    - Scope of work
        - Control center for zone and area
        - Number of substations
        - Number of feeders

- Numbers of Remote I/O (RTU and switches)

- Functional specification
  - Core
    - System model and state estimation
    - 3 phase power flow and connectivity analysis
    - Single line and connection diagram, location, route coloring
    - Temporary modifications (cuts, jumpers)
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– Reference standard
– Test and Commissioning

Appendix B

DMS Information from Suppliers

1. **Hitachi (**Hitachi,DORA**)**

   DMS Core Requirement

   1. Single line for simplify switching
   2. Map for location
   3. Color and Tracking
   4. Automating for data acquisition
   5. Software for analyse data and guide decision making

   Function detail

   1. Man Machine Interface
   2. Modelling
   3. Basic SCADA
   4. On line
      a. Fault Isolation and Service Restoration (FISR)
      b. Violation Resolution (VR)
      c. Distribution Work Management (DWR)
   5. Off line
      a. Decision Making Support Software (DSS)
      b. Optimum Distribution Network (ODN)
      c. Distribution Network Anlysis (DNA)
      d. Dispatch Training Simulator (DTS)
   6. Exchange with other system
   7. Load flow and Short Circuit
   8. Dynamic Network Coloring (Navigation)
   9. Switching Order Management
   10. Loss Reduction

2. VATECH CNI-PSI

110 Online/Study mode

119 Navigation&orientation: panning,zooming, decluttring, navigator, snap, overlays, grey scaling, object search, BACK/UNDO

120 Geospatial Network Diagram

125 Switching Sequences: Switching programs, Sequential Switching Controls, Switching Reports.

126 Alarm Concept: Acoustic, visual, navigation to single alarm

127 Post mortem analysis

128 Training simulator: scenarios

129 Multiple versions of data models

130 Interpretative data engineering

200 Distribution Network Management

211 Outage Management1: Trouble call management, FISR, outage record keeing

212 Outage Management2: Work order management, crew dispatch

213 Distribution power flow

214 Feeder optimization and equalizing current

300 Transmission Network Operation

3. Areva DMS (e-terra)

Unified User Interface

- DMS network operation and analysis
- SCADA
- Outage Management
- Switching Management
- Crew Management

GUI on Web technology

- Include electric and non-electric
- Multiple views (geographic, schematic)
- Real time, dynamic model
- Support advance analysis and optimum tools
- Combine all available input information

- Asset data (including spatial and connectivity)
- SCADA
- Manually updated switch statuses
- Temporary modifications (cuts, jumpers)
- Phone calls
- Fault detectors, AMR, IED
- Consolidated view of network conditions
- Energization and abnormal states
- Outage extents/ critical customers
- Geographic and schematic views
- Land base information/ Crew locations
- Suspect Protection Devices
- Operation Tagging

DMS

- Customer care
  - Outage management
  - CIS, AMR, Billing
- Operation Management
  - GIS, network analysis&planning
  - Network operation
  - Crew management
- Asset management
  - Maintenance planning&execution
  - Equipment maintenance
- Distribution network

Function

- Network analysis
  - Topology processing (feeder coloring, tracing, loop detection)
  - Real time&study power flow (balance or unbalance)
  - Short circuit
  - Optimum switching
- Network optimization

- Network reconfiguration (fault isolation and service restoration)
- Volt var control&optimal
- Trouble call&outage management
- Work orders

Software overview

- SCADA function
- Network view
- Network outage management
- Network optimization
- Network analysis
- Historical information and reporting
- AMR
- Training simulator
- External systems
  - Asset model/GIS
  - Call center
  - CIS
  - AMR
  - Resource mgmt
  - Mobile work force
  - Maintenance planning
  - Engineering and plannnig
  - Crew callout
  - Mailing system

Trend and vision

- Hardware: server
- Operating system
  - Portable and multiplatform
  - Unix,window,linux
- Security for permission management
- Window and Linux
- Integration

- CIM for data modeling and easy interface with asset and network data base

Appendix C

Reliability and Response Time Calcultion

1. Reliability calculation method

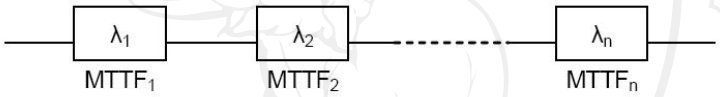
Mean Time to Fail (MTTF) = $1 / \lambda$

Mean Time to Repair (MTTR) = $1 / \mu$

where λ is failure rate and μ is repair rate.

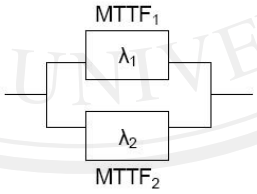
Availability = MTTF / (MTTF+MTTR)

MTTF of the serial model below is calculated as follows;



$$MTTF = 1/\Sigma\lambda = 1/\{(1/MTTF_1)+(1/MTTF_2)+... +(1/MTTF_n)\}$$

MTTF of the redundant model (parallel model) below is calculated as follows supposing $\lambda=\lambda_1=\lambda_2$;



$$MTTF = (3\lambda+\mu)/2\lambda^2 = (3MTTF/2)+(MTTF^2/2MTTR)$$

2. Response time calculation method

Latency is time delay can be categoried into

1. Store and Forward Latency (L_{SF})

$$L_{SF} = \frac{FS}{BR}$$

FS = the frame size in bits

BR =the bit rate in bits/s

2. Switch Fabric Latency (L_{SW}) is intermal latency depend on supplier
3. Wireline Latency (L_{WL})

$$L_{WL} = \frac{1 \times 10^5 m}{(0.67 \times 3 \times 10^8) m/s} = 500 \mu s$$

4. Queuing Latency (L_Q)

$$L_Q = \frac{Network\_Load}{L_{SF(\max)}}$$

5. Total Worst Case Latency Calculation (L_{TOTAL})

$$L_{TOTAL} = \sum_{SWITCHES} [L_{SF} + L_{SW} + L_{WL} + L_Q]$$

CURRICULUM VITAE

Name Mr. Knathip Spuntupong

Date of Birth July 3th, 1970

Education B.Eng. in Electrical Engineering

Kasetsart University, Bangkok, Thailand.

M.Sc. in Electric Power Engineering

Rensselaer Polytechnics Institute, USA.

Employment Chief of protection relay and control system design section