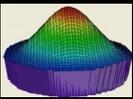


Where this technology is applied in India together with our partner EIP



| | Project/Customer | Application | Remarks |
|-----|-----------------------------|--------------------|----------------------------|
| 8) | Tata power | Coal Bunker | Replaced with Radar |
| 9) | Penden Cement Bhutan | Cement Silo | Replaced with Radar |
| 10) | Maducon Project | Coal bunker | Replaced with Radar |
| 11) | Tata Steel | Iron Ore | Replaced with radar |
| 12) | And many more | | |

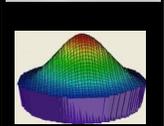


Revolutionizing the market and replacing existing technologies

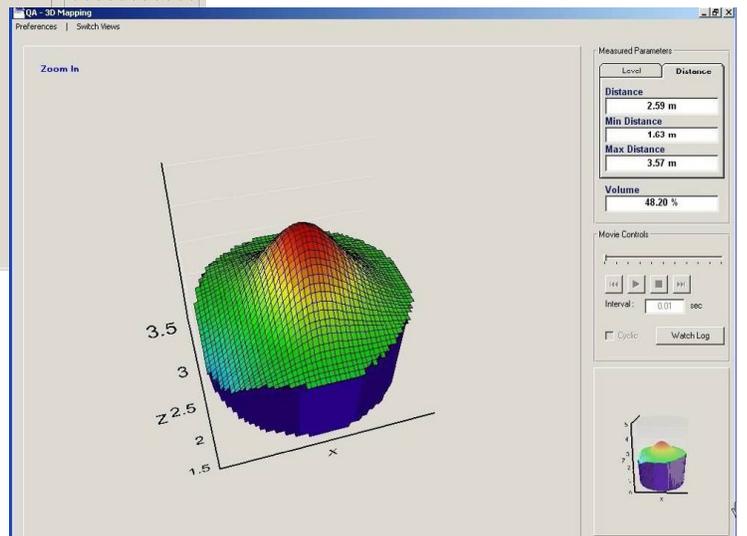
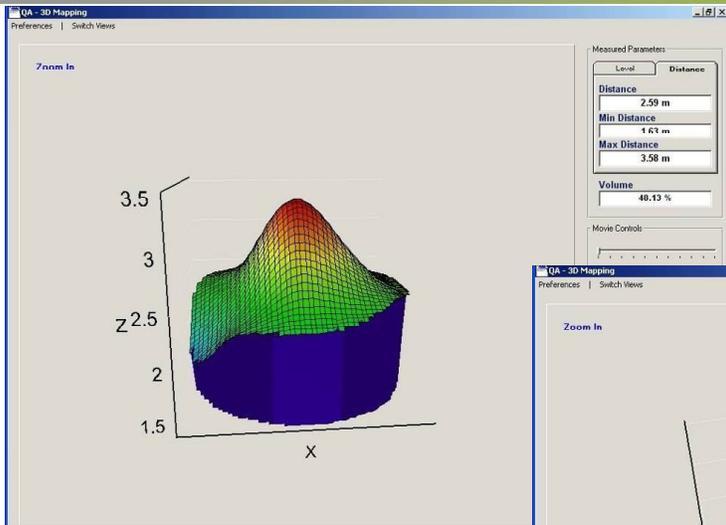


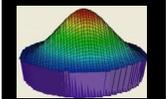
Delhi
Section





3D surface mapping





Thank You!

Integration Considerations For large Scale

IEC 61850 Systems

.....*A new approach for a Power Utility*



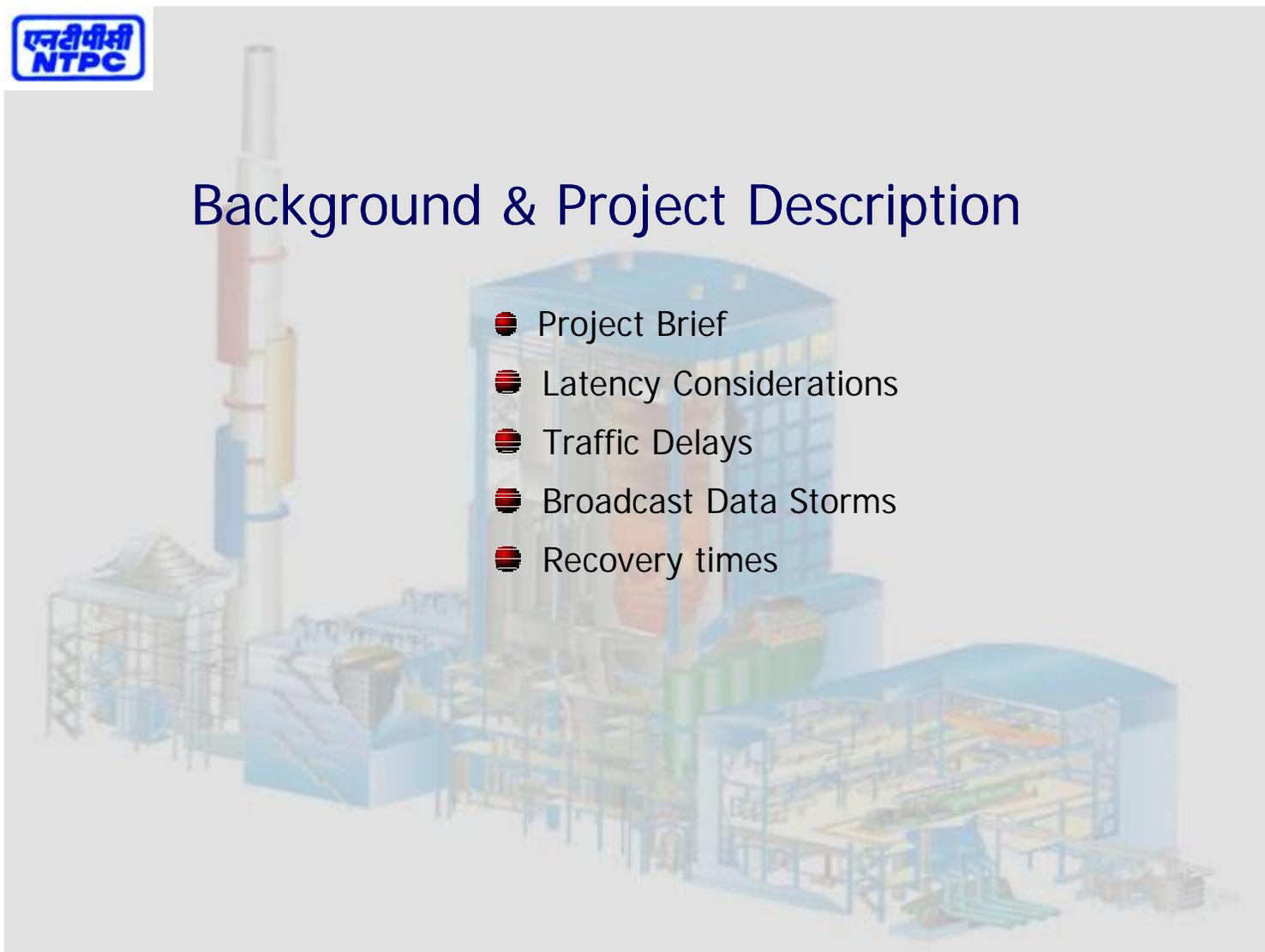


Presentation Overview

- Introduction
- Background & Project Description
- Band Width Usage Simulation
- Bandwidth Management Strategies
 - Data sets
 - Buffered Reports
 - Un Buffered Reports
 - Multicast Traffic
 - Proper Configuration of IED Capability Description
- Other Network Considerations
- Recommendations

Background & Project Description

- Project Brief
- Latency Considerations
- Traffic Delays
- Broadcast Data Storms
- Recovery times





Introduction

Since its inception IEC 61850 has been demonstrating a world wide acceptance. The paper is the Case study on Design and Implementation of IEC 61850 Substation automation system solution to integrate about 600 IED devices. Indira Gandhi Super Thermal Power Project (3 X 500 MW) is being Constructed at Jhajjhar, Haryana near Delhi. The first unit of the Project is expected to be commissioned by Oct 2010.





Brief about the Project

- All the 11 KV ,3.3 KV Systems and LT (MV and LT Switchgears) have Communicable Numerical Relays on IEC 61850.
- The Breaker control is Performed from the DCS system
- Modern IEDs & Numerical Relays being used for typical protection functions can also capture all feeder data, records, events and monitor the equipment and also keep record of Energy Consumption.
- Such a real time data of the Complete Auxiliary System of the Power Utility is captured and displayed on HMI to help monitor the system from remote locations and send data in soft to Plant DCS systems.

Typically the various feeders are divided into Modular Basis

- **Incomers, Ties & Bus couplers : DC,DE &DD**
- **Transformer feeders : DBF/DB**
- **Motor Feeders : DAF/DA**
- **LV Feeders : DAET/DAE**



The Concept

- Each of the feeder types has a standardized configuration with respect to control schematic, data points and signals and other relay configurations. Typical signal Matrix is developed for type of Module As the No's of IED are large (say around 600). Such a Modular Concept helped in building the application for SAS faster and with accuracy
- The data from the IEDs is sent to the Data Concentrator system and then further to HMI system
- Data is also configured to be sent to the Plant DCS system on OPC
- The network system is also monitored with online real time status. Any Breakage/split in the network is immediately alarmed
- The SAS Consists of around 500000 data points generated by 600 IED's . The IEDS are distributed in 13 (Thirteen) 11 KV , 6 No's (Six) of 3.3 KV and 415 V LV Switchboards using 104 No's of Ethernet Switches on IEC 61850.

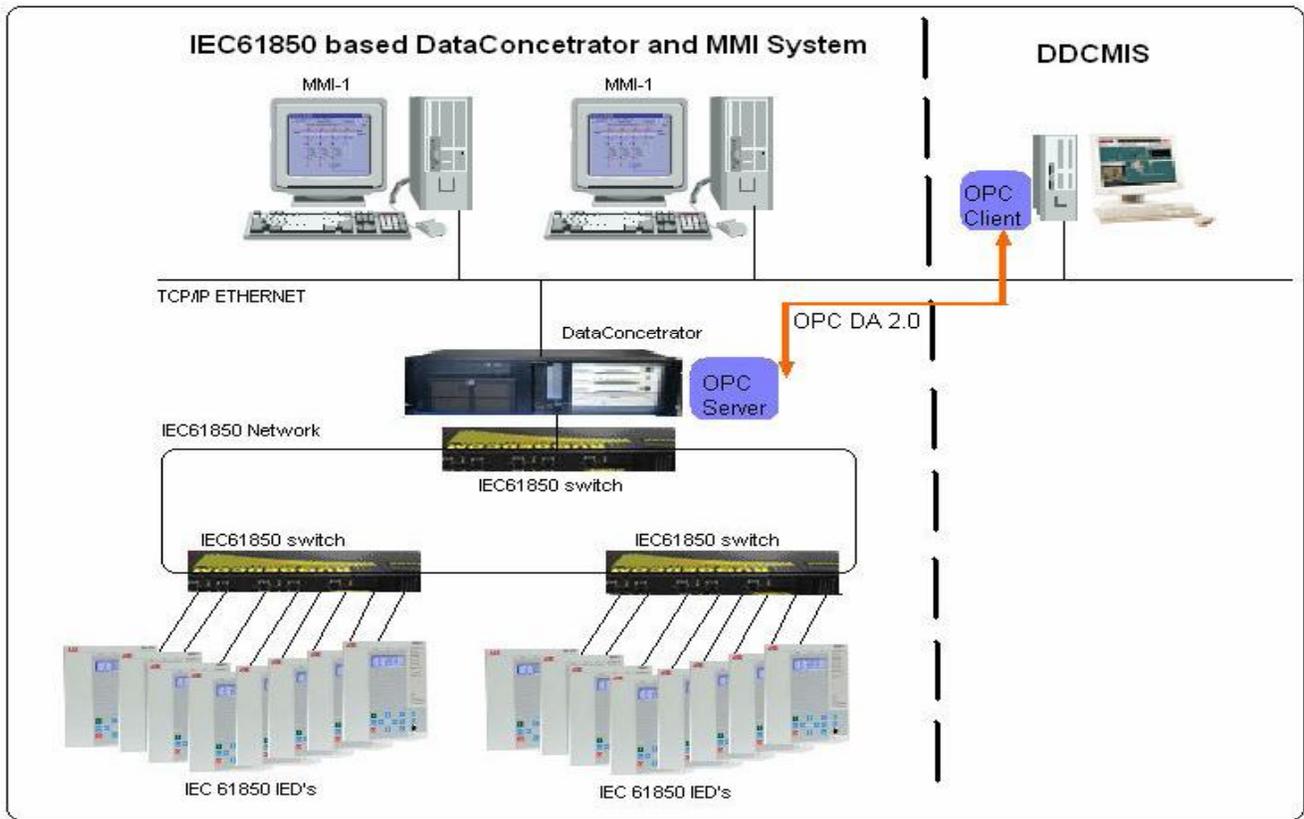
Dynamic Online Display systems of Auxiliary Power Supply System

The screenshot displays a dynamic online display system for an Auxiliary Power Supply System. The interface is divided into two main sections: 'Unit Overview' and 'Station Overview'. Both sections show detailed electrical diagrams with various components like breakers, busbars, and control panels. The 'Unit Overview' section shows three units (10A, 20A, 30A) with their respective busbars and control panels. The 'Station Overview' section shows a larger network of buses, breakers, and auxiliary power components like air compressors and pumps. At the bottom of the interface, there is a data table with 600 IEDS (Interlocking Elements Data Set) entries. The table has the following columns: Name, Value, Tag Comment, Time, Alarm Comment, Type, Priority, and State.

| Name | Value | Tag Comment | Time | Alarm Comment | Type | Priority | State |
|-------------------------|-------|-------------|------|---------------|------|----------|-------|
| Aux Generator Break 1 | | | | | | | |
| Aux Generator Break 2 | | | | | | | |
| Aux Generator Break 3 | | | | | | | |
| Aux Generator Break 4 | | | | | | | |
| Aux Generator Break 5 | | | | | | | |
| Aux Generator Break 6 | | | | | | | |
| Aux Generator Break 7 | | | | | | | |
| Aux Generator Break 8 | | | | | | | |
| Aux Generator Break 9 | | | | | | | |
| Aux Generator Break 10 | | | | | | | |
| Aux Generator Break 11 | | | | | | | |
| Aux Generator Break 12 | | | | | | | |
| Aux Generator Break 13 | | | | | | | |
| Aux Generator Break 14 | | | | | | | |
| Aux Generator Break 15 | | | | | | | |
| Aux Generator Break 16 | | | | | | | |
| Aux Generator Break 17 | | | | | | | |
| Aux Generator Break 18 | | | | | | | |
| Aux Generator Break 19 | | | | | | | |
| Aux Generator Break 20 | | | | | | | |
| Aux Generator Break 21 | | | | | | | |
| Aux Generator Break 22 | | | | | | | |
| Aux Generator Break 23 | | | | | | | |
| Aux Generator Break 24 | | | | | | | |
| Aux Generator Break 25 | | | | | | | |
| Aux Generator Break 26 | | | | | | | |
| Aux Generator Break 27 | | | | | | | |
| Aux Generator Break 28 | | | | | | | |
| Aux Generator Break 29 | | | | | | | |
| Aux Generator Break 30 | | | | | | | |
| Aux Generator Break 31 | | | | | | | |
| Aux Generator Break 32 | | | | | | | |
| Aux Generator Break 33 | | | | | | | |
| Aux Generator Break 34 | | | | | | | |
| Aux Generator Break 35 | | | | | | | |
| Aux Generator Break 36 | | | | | | | |
| Aux Generator Break 37 | | | | | | | |
| Aux Generator Break 38 | | | | | | | |
| Aux Generator Break 39 | | | | | | | |
| Aux Generator Break 40 | | | | | | | |
| Aux Generator Break 41 | | | | | | | |
| Aux Generator Break 42 | | | | | | | |
| Aux Generator Break 43 | | | | | | | |
| Aux Generator Break 44 | | | | | | | |
| Aux Generator Break 45 | | | | | | | |
| Aux Generator Break 46 | | | | | | | |
| Aux Generator Break 47 | | | | | | | |
| Aux Generator Break 48 | | | | | | | |
| Aux Generator Break 49 | | | | | | | |
| Aux Generator Break 50 | | | | | | | |
| Aux Generator Break 51 | | | | | | | |
| Aux Generator Break 52 | | | | | | | |
| Aux Generator Break 53 | | | | | | | |
| Aux Generator Break 54 | | | | | | | |
| Aux Generator Break 55 | | | | | | | |
| Aux Generator Break 56 | | | | | | | |
| Aux Generator Break 57 | | | | | | | |
| Aux Generator Break 58 | | | | | | | |
| Aux Generator Break 59 | | | | | | | |
| Aux Generator Break 60 | | | | | | | |
| Aux Generator Break 61 | | | | | | | |
| Aux Generator Break 62 | | | | | | | |
| Aux Generator Break 63 | | | | | | | |
| Aux Generator Break 64 | | | | | | | |
| Aux Generator Break 65 | | | | | | | |
| Aux Generator Break 66 | | | | | | | |
| Aux Generator Break 67 | | | | | | | |
| Aux Generator Break 68 | | | | | | | |
| Aux Generator Break 69 | | | | | | | |
| Aux Generator Break 70 | | | | | | | |
| Aux Generator Break 71 | | | | | | | |
| Aux Generator Break 72 | | | | | | | |
| Aux Generator Break 73 | | | | | | | |
| Aux Generator Break 74 | | | | | | | |
| Aux Generator Break 75 | | | | | | | |
| Aux Generator Break 76 | | | | | | | |
| Aux Generator Break 77 | | | | | | | |
| Aux Generator Break 78 | | | | | | | |
| Aux Generator Break 79 | | | | | | | |
| Aux Generator Break 80 | | | | | | | |
| Aux Generator Break 81 | | | | | | | |
| Aux Generator Break 82 | | | | | | | |
| Aux Generator Break 83 | | | | | | | |
| Aux Generator Break 84 | | | | | | | |
| Aux Generator Break 85 | | | | | | | |
| Aux Generator Break 86 | | | | | | | |
| Aux Generator Break 87 | | | | | | | |
| Aux Generator Break 88 | | | | | | | |
| Aux Generator Break 89 | | | | | | | |
| Aux Generator Break 90 | | | | | | | |
| Aux Generator Break 91 | | | | | | | |
| Aux Generator Break 92 | | | | | | | |
| Aux Generator Break 93 | | | | | | | |
| Aux Generator Break 94 | | | | | | | |
| Aux Generator Break 95 | | | | | | | |
| Aux Generator Break 96 | | | | | | | |
| Aux Generator Break 97 | | | | | | | |
| Aux Generator Break 98 | | | | | | | |
| Aux Generator Break 99 | | | | | | | |
| Aux Generator Break 100 | | | | | | | |
| Aux Generator Break 101 | | | | | | | |
| Aux Generator Break 102 | | | | | | | |
| Aux Generator Break 103 | | | | | | | |
| Aux Generator Break 104 | | | | | | | |
| Aux Generator Break 105 | | | | | | | |
| Aux Generator Break 106 | | | | | | | |
| Aux Generator Break 107 | | | | | | | |
| Aux Generator Break 108 | | | | | | | |
| Aux Generator Break 109 | | | | | | | |
| Aux Generator Break 110 | | | | | | | |
| Aux Generator Break 111 | | | | | | | |
| Aux Generator Break 112 | | | | | | | |
| Aux Generator Break 113 | | | | | | | |
| Aux Generator Break 114 | | | | | | | |
| Aux Generator Break 115 | | | | | | | |
| Aux Generator Break 116 | | | | | | | |
| Aux Generator Break 117 | | | | | | | |
| Aux Generator Break 118 | | | | | | | |
| Aux Generator Break 119 | | | | | | | |
| Aux Generator Break 120 | | | | | | | |
| Aux Generator Break 121 | | | | | | | |
| Aux Generator Break 122 | | | | | | | |
| Aux Generator Break 123 | | | | | | | |
| Aux Generator Break 124 | | | | | | | |
| Aux Generator Break 125 | | | | | | | |
| Aux Generator Break 126 | | | | | | | |
| Aux Generator Break 127 | | | | | | | |
| Aux Generator Break 128 | | | | | | | |
| Aux Generator Break 129 | | | | | | | |
| Aux Generator Break 130 | | | | | | | |
| Aux Generator Break 131 | | | | | | | |
| Aux Generator Break 132 | | | | | | | |
| Aux Generator Break 133 | | | | | | | |
| Aux Generator Break 134 | | | | | | | |
| Aux Generator Break 135 | | | | | | | |
| Aux Generator Break 136 | | | | | | | |
| Aux Generator Break 137 | | | | | | | |
| Aux Generator Break 138 | | | | | | | |
| Aux Generator Break 139 | | | | | | | |
| Aux Generator Break 140 | | | | | | | |
| Aux Generator Break 141 | | | | | | | |
| Aux Generator Break 142 | | | | | | | |
| Aux Generator Break 143 | | | | | | | |
| Aux Generator Break 144 | | | | | | | |
| Aux Generator Break 145 | | | | | | | |
| Aux Generator Break 146 | | | | | | | |
| Aux Generator Break 147 | | | | | | | |
| Aux Generator Break 148 | | | | | | | |
| Aux Generator Break 149 | | | | | | | |
| Aux Generator Break 150 | | | | | | | |
| Aux Generator Break 151 | | | | | | | |
| Aux Generator Break 152 | | | | | | | |
| Aux Generator Break 153 | | | | | | | |
| Aux Generator Break 154 | | | | | | | |
| Aux Generator Break 155 | | | | | | | |
| Aux Generator Break 156 | | | | | | | |
| Aux Generator Break 157 | | | | | | | |
| Aux Generator Break 158 | | | | | | | |
| Aux Generator Break 159 | | | | | | | |
| Aux Generator Break 160 | | | | | | | |
| Aux Generator Break 161 | | | | | | | |
| Aux Generator Break 162 | | | | | | | |
| Aux Generator Break 163 | | | | | | | |
| Aux Generator Break 164 | | | | | | | |
| Aux Generator Break 165 | | | | | | | |
| Aux Generator Break 166 | | | | | | | |
| Aux Generator Break 167 | | | | | | | |
| Aux Generator Break 168 | | | | | | | |
| Aux Generator Break 169 | | | | | | | |
| Aux Generator Break 170 | | | | | | | |
| Aux Generator Break 171 | | | | | | | |
| Aux Generator Break 172 | | | | | | | |
| Aux Generator Break 173 | | | | | | | |
| Aux Generator Break 174 | | | | | | | |
| Aux Generator Break 175 | | | | | | | |
| Aux Generator Break 176 | | | | | | | |
| Aux Generator Break 177 | | | | | | | |
| Aux Generator Break 178 | | | | | | | |
| Aux Generator Break 179 | | | | | | | |
| Aux Generator Break 180 | | | | | | | |
| Aux Generator Break 181 | | | | | | | |
| Aux Generator Break 182 | | | | | | | |
| Aux Generator Break 183 | | | | | | | |
| Aux Generator Break 184 | | | | | | | |
| Aux Generator Break 185 | | | | | | | |
| Aux Generator Break 186 | | | | | | | |
| Aux Generator Break 187 | | | | | | | |
| Aux Generator Break 188 | | | | | | | |
| Aux Generator Break 189 | | | | | | | |
| Aux Generator Break 190 | | | | | | | |
| Aux Generator Break 191 | | | | | | | |
| Aux Generator Break 192 | | | | | | | |
| Aux Generator Break 193 | | | | | | | |
| Aux Generator Break 194 | | | | | | | |
| Aux Generator Break 195 | | | | | | | |
| Aux Generator Break 196 | | | | | | | |
| Aux Generator Break 197 | | | | | | | |
| Aux Generator Break 198 | | | | | | | |
| Aux Generator Break 199 | | | | | | | |
| Aux Generator Break 200 | | | | | | | |
| Aux Generator Break 201 | | | | | | | |
| Aux Generator Break 202 | | | | | | | |
| Aux Generator Break 203 | | | | | | | |
| Aux Generator Break 204 | | | | | | | |
| Aux Generator Break 205 | | | | | | | |
| Aux Generator Break 206 | | | | | | | |
| Aux Generator Break 207 | | | | | | | |
| Aux Generator Break 208 | | | | | | | |
| Aux Generator Break 209 | | | | | | | |
| Aux Generator Break 210 | | | | | | | |
| Aux Generator Break 211 | | | | | | | |
| Aux Generator Break 212 | | | | | | | |
| Aux Generator Break 213 | | | | | | | |
| Aux Generator Break 214 | | | | | | | |
| Aux Generator Break 215 | | | | | | | |
| Aux Generator Break 216 | | | | | | | |
| Aux Generator Break 217 | | | | | | | |
| Aux Generator Break 218 | | | | | | | |
| Aux Generator Break 219 | | | | | | | |



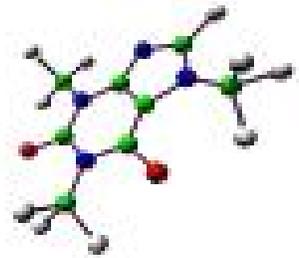
OPC Data Access





Latency Considerations

- Media
- Ethernet Switch Latency
- Traffic Delays
- Broadcast Data Storms
- Recovery Times





Latency Considerations

Media

- Category 5e (CAT 5e) or Category 6 (CAT 6) cables, designed to support 100 to 1 Gbps
- Fiber-optic cables (single mode or multimode), with a typical bandwidth of 1 Gbps (10 Gbps is now commercially available).

Ethernet Switch Latency

- Modern substation switches have fast switching capabilities. A 16-port switch operating at 100 Mbps per port needs to support a switching capacity of 1.6 Gbps
- Substation Managed Ethernet switches use "store and forward." to ensure only good packets are transmitted
- Other switching technologies such as "cut through," impose minimal frame latency, but they enable bad frames to propagate into the network, thus adding traffic



Latency ConsiderationsTraffic Delays

- SAS network architectures typically require all switch ports to send data to one uplink port
- At Peak activity, when an event triggers information reports and GOOSE messages from the IEDs, the likelihood of multiple users contending for the same Network port increases.
- Switches with priority queues help to reduce high-priority message delays due to traffic
- A GOOSE frame propagating through 10 switches of a 100 Mbps LAN with an event trigger burst of 12 GOOSE frames can introduce delays of more than 2 milliseconds.



Latency ConsiderationsTraffic Delays

| | Frame Duration at 100 Mbps | Frame Duration at 1 Gbps |
|----------------------------------|----------------------------|--------------------------|
| 64 octets (minimum allowed) | 7 μ s | 0.7 μ s |
| 300 octets (compact GOOSE frame) | 25 μ s | 2.5 μ s |
| 800 octets (large GOOSE frame) | 64 μ s | 64 μ s |
| 1,530 octets (maximum) | 124 μ s | 12.4 μ s |



Latency Considerations...Broadcast Data Storms

- An failed IED communications interface corrupts the network
- Broadcast Data storm occurs if an Ethernet network interface fails and continuously broadcasts messages, corrupting communication with any recipient of the data.
- Switches and routers prevent a broadcast data storm from influencing communication on other segments of the network, but no data are retrieved from the failed segments

| Medium | Time to Traverse a Link |
|-------------------------|-------------------------|
| CAT 5e and CAT 6 cables | 0.55 μ s per 100 m |
| Glass fiber optics | 0.49 μ s per 100 m |
| Wireless | 0.33 μ s per 100 m |



Recovery Times

- **Rapid Spanning Tree protocol (RSTP)** provides a way to interconnect managed switches in a ring configuration
- Managed industrial Ethernet switches running RSTP send inquiry packets actively seeking information from neighboring switches, providing fast network healing times
- Typical RSTP reconfiguration times are approximately 5 milliseconds per switch.
- Other protocols, such as **Parallel Redundancy Protocol (PRP)** or **High-Availability Seamless Ring (HSR)**, provide specialized redundancy methods but require specific implementations in IEDs and specialized network devices to connect to standard Ethernet networks

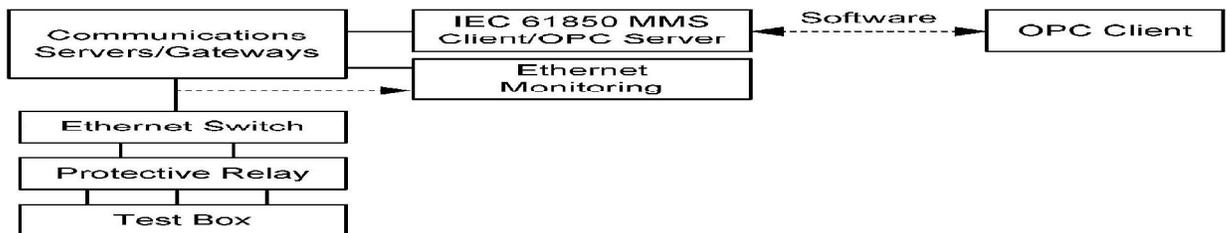
Band Width Usage Simulation

- Test Set up
- IEC 61850 MMS Client configuration
- Goose Traffic Simulation





Test Setup and Simulation



(Untitled) - Ethereal

File Edit View Go Capture Analyze Statistics Help

Filter: mms / Add Expression... Clear Apply

| No. - | Time | Source | Destination | Protocol | Info |
|-------|------------|-------------|-------------|----------|------------------------------------|
| • 6 | 2.125259 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| • 35 | 14.892338 | 10.42.50.31 | 10.42.50.42 | MMS | Conf Response: Read (InvokeID: 10) |
| • 66 | 33.902199 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| • 88 | 43.341926 | 10.42.50.31 | 10.42.50.42 | MMS | Conf Response: Read (InvokeID: 11) |
| • 130 | 64.562400 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| • 144 | 73.916710 | 10.42.50.31 | 10.42.50.42 | MMS | Conf Response: Read (InvokeID: 12) |
| ♦ 154 | 79.520375 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| ♦ 163 | 82.243696 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| • 189 | 95.359308 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| • 206 | 104.070823 | 10.42.50.31 | 10.42.50.42 | MMS | Conf Response: Read (InvokeID: 13) |
| • 255 | 127.149469 | 10.42.50.31 | 10.42.50.42 | MMS | Unconfirmed |
| • 269 | 133.290449 | 10.42.50.31 | 10.42.50.42 | MMS | Conf Response: Read (InvokeID: 14) |

- Reports sent periodically every 30 seconds.
- OPC read commands set for update rate of 30 seconds.
- ♦ Reports generated by data change.

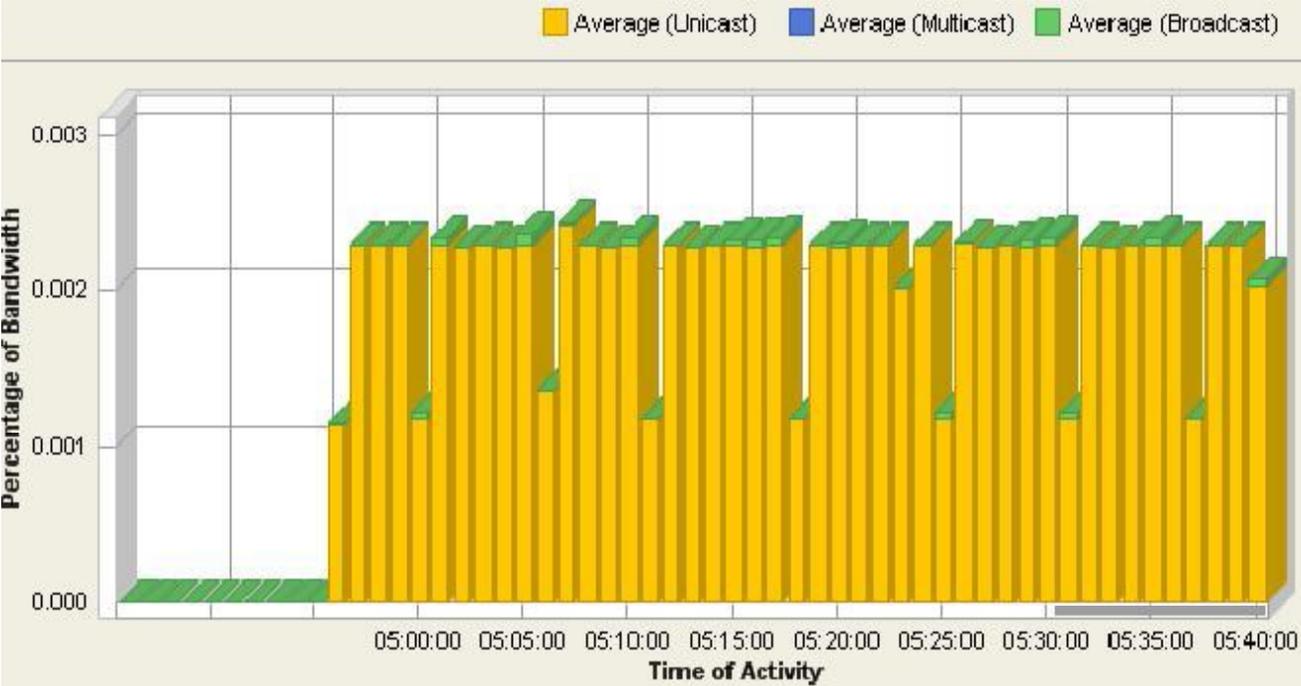


IEC 61850 MMS Client Configuration

- In IEC 61850 MMS Data transfer is optimized by the use of report by exception
- In this mode of operation, the integral polling period can be increased to several seconds (30 seconds was used during testing to refresh data points).



Simulation of % of Bandwidth Used

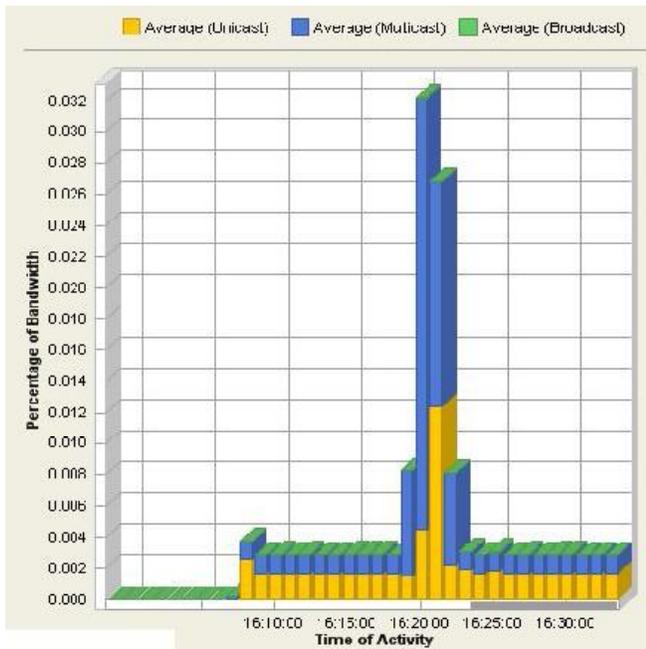


When GOOSE is enabled with a time-to-live (TTL) of 1 second, the expected result is an increase of bandwidth use, as shown above

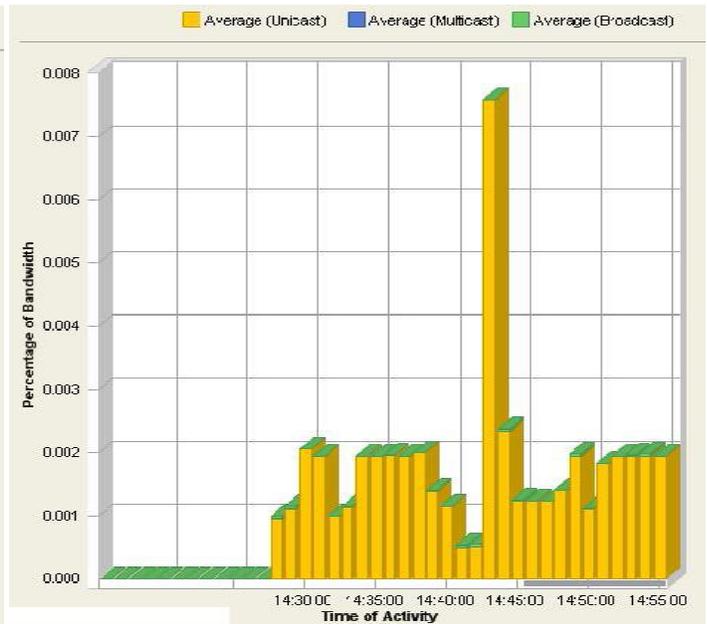
During the Test, Circuit breaker Changes Generated an Increase in GOOSE Publishing.



Traffic Simulation on a Electrical Fault



Increase in % of bandwidth used under heavy reporting condition with Goose messages.



Peak increase in the percentage of bandwidth used under heavy Reporting conditions with No Goose messages

BANDWIDTH MANAGEMENT STRATEGIES

- Data Sets
- Buffered Reports
- UnBuffered Reports
- Multicast Traffic
- Proper Configuration of IED
Capability Description (ICD) Files





Data Sets ... Customization of Data

Dataset
Drag-n-drop or right-click on a data item to rearrange.
Click column headers to sort.

GOOSE Capacity 74%

Report Capacity 4%

| Constraint | Item |
|------------|--------------------------|
| MX | MET.METMMXU1.TotW.* |
| MX | MET.METMMXU1.TotVAr.* |
| MX | MET.METMMXU1.TotVA.* |
| MX | MET.METMMXU1.TotPF.* |
| MX | MET.METMMXU1.Hz.* |
| MX | MET.METMMXU1.PPV.phsAB.* |
| MX | MET.METMMXU1.PPV.phsBC.* |
| MX | MET.METMMXU1.PPV.phsCA.* |
| MX | MET.METMMXU1.PhV.phsA.* |
| MX | MET.METMMXU1.PhV.phsB.* |
| MX | MET.METMMXU1.PhV.phsC.* |
| MX | MET.METMMXU1.PhV.res.* |
| MX | MET.METMMXU1.A.phsA.* |
| MX | MET.METMMXU1.A.phsB.* |
| MX | MET.METMMXU1.A.phsC.* |
| MX | MET.METMMXU1.A.neut.* |
| MX | MET.METMMXU1.A.res.* |
| MX | MET.METMDST1.SupVArh.* |
| MX | MET.METMDST1.DmdW/h.* |
| MX | MET.METMDST1.DmdVArh.* |

Logical Device ↕ Logical Node ↕

| DOI | Value | Units |
|------------------------|-------|--------|
| Logical Device: ANN | | |
| Logical Device: MET | | |
| Logical Node: METMDST1 | | |
| Logical Node: METMMXU1 | | |
| TotW | 1.00 | kWatts |
| TotVAr | 1.00 | kVAr |
| TotVA | 1.00 | kVA |
| TotPF | 0.05 | none |
| Hz | 0.5 | Hz |
| PPV.phsAB | 150 | V |
| PPV.phsBC | 150 | V |
| PPV.phsCA | 150 | V |
| PhV.phsA | 100 | V |
| PhV.phsB | 100 | V |
| PhV.phsC | 100 | V |
| PhV.res | 100 | V |
| A.phsA | 1.0 | A |
| A.phsB | 1.0 | A |
| A.phsC | 1.0 | A |

Properties | GOOSE Receive | GOOSE Transmit | Reports | Datasets | **Dead Bands**

In the IGSTPP, there are three data sets: one analog metering data set linked to an Unbuffered report and two discrete status data sets linked to buffered reports. The optimization of the data sets is shown above. Correct dead-band settings help to effectively manage the use of the network bandwidth.



Buffered Reports & Unbuffered Reports

Internal events are triggered by

- ✓ Data change or update
- ✓ Quality change

Buffering the events (to a practical limit) for transmission prevents the loss of data values due to transport flow control constraints or loss of connection

The Immediate sending of reports on a "best efforts" basis generate Unbuffered reports. The Network does not provide any Guarantee that the data are delivered. If no association exists or if the transport data flow is not fast enough to support the report, events are lost.



Multicast Traffic

- ⇒ GOOSE works with a dynamic repetition of multicast messages communicating on Ethernet Layer. If the data within the GOOSE frame do not change, the repetition period becomes longer (1 second or more), lowering the network load.
- ⇒ Ethernet switches do not prevent the unrestricted dissemination of these messages.
- ⇒ With a large Number of devices publishing multicast traffic there is a serious impact on the network.
- ⇒ Some devices do not have multicast filters, so GOOSE messages interrupt normal processes on these devices.

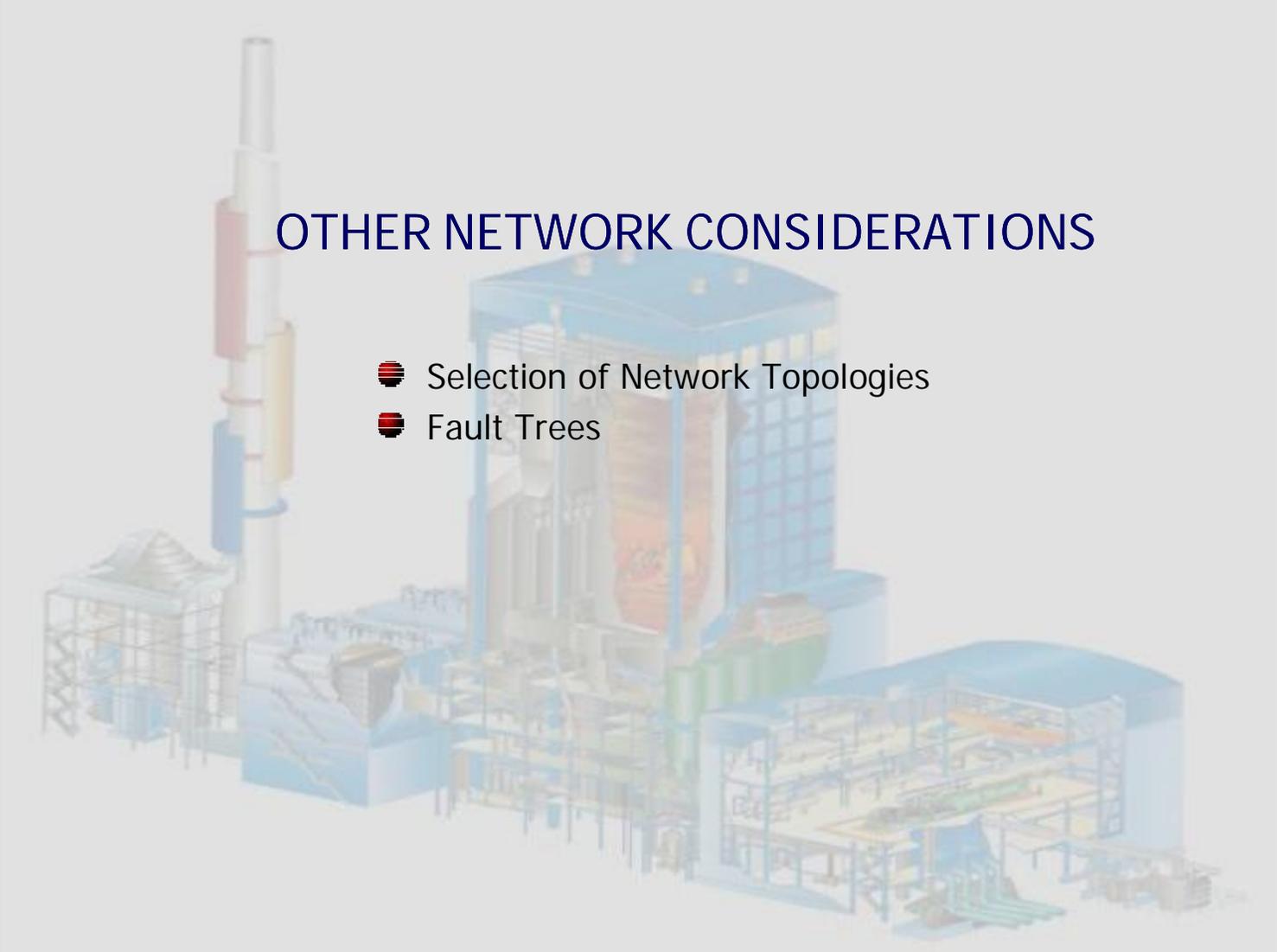
Multicast Filters or Virtual local-area Networks (VLANs), are necessary to control and restrict the dissemination of GOOSE Messages



IED Capability Description (ICD) Files

- ⇒ Vendors provide default ICD files with their products. This factory default capability file can have settings that require configuration.
- ⇒ During the Design phase Integrators need to modify the configuration in order to subscribe to
 - ⇒ Relay GOOSE messages
 - ⇒ Optimize Data sets & change dead bands
 - ⇒ Unnecessary GOOSE messages that introduce Multicast Traffic and are not used by IEDs on the network must be removed

Relay should be Configured for Optimal Network Performance.



OTHER NETWORK CONSIDERATIONS

- Selection of Network Topologies
- Fault Trees