**Safety issues** - equipment isolation, touch and step potentials, EMC

**Copper** - raw material cost has increased 400% in 10 years

**Material cost** - cubicle wiring and test costs, labour cost per wire end termination

**Schematic design** - verification cost, excessive on-site work content

**Civil work costs** - trays, troughing, cable access/egress...
From Conventional to Digital Substation

Suppress copper wiring on Station Bus
Suppress copper wiring between IEDs and Primary Equipment

DS Agile architecture
Alstom Grid’s Digital Substation: The process bus area

DS Agile Switches: interoperable architectures

DS Agile Switches
For various Ethernet redundant architectures: ring, multi-ring, star, double-star
- Inter-operable protocols (PRP/HSR)
- Gigabit switches
- Full compliance with electrical installation constraints (IEC61850-3)
- Internal PC and bay controller switches
- External rackable switches
Substation Bus

DS Agile Bay Controllers and MiCOM Protection relays

C264 IEC61850 Modular Substation Bay Controller
Substation control, communication, monitoring, protection and automation functions

- Open platform for real-time automation schemes
- Both legacy and cutting-edge communication protocols
- LCD graphical display for local control, monitoring and maintenance
- Suitable for retrofitting and modernising existing installations

Operator Interface

DS Agile Operator Interface (OI)
- Single-line dynamic diagram viewer and bay viewer
- Alarm viewer
- Select-before-operate configurable function
- Data monitoring, logging, archiving and curve trends
- Secure access control by user profile
- Phasor data concentrator
- Condition monitoring HMI's
- Protection and automation engineering toolsuite MiCOM 51
Substation Inter-Controls

Substation Area

Wide Area Control Unit (WACU)

- Inter-substation and inter-voltage exchange through IEC61850 automation
- IEC61850 compliant
- Hot stand-by redundancy

Substation Automation integrated into the Network System

NMS
Operation and management of the Network

Remote Access for Substation Management Engineering and Maintenance

Cyber Security

Substation Local Protection
Alstom’s Agile digital substation offers unprecedented performance through intelligent primary systems and tailored automation solutions.

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END
Wide Area Monitoring, Protection and Control Solutions

Synchrophasors:
- Improve security
- Increase transfer
- System analysis
- Manage renewables

Client Applications

EMS Integration

Online Condition Monitoring

<table>
<thead>
<tr>
<th>Device</th>
<th>Principal applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTWatch MS3000</td>
<td>Power transformer condition monitoring: expert system for data management along the life cycle of the power transformer, with scalable range of sensors and modules for on-line continuous monitoring of all major components of the transformer (active parts, bushings, tap changer and cooling system)</td>
</tr>
<tr>
<td>BWatch</td>
<td>GIS bay condition monitoring: interactive diagnostics, acquisition of pressure and temperature, threshold management, leakage, density and liquefaction calculation, internal arc location, enclosure overheating detection</td>
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<tr>
<td>PDWatch</td>
<td>Partial discharge condition monitoring for GIS</td>
</tr>
<tr>
<td>GISWatch</td>
<td>Integrated bay &amp; partial discharge condition monitoring for GIS</td>
</tr>
<tr>
<td>CBWatch</td>
<td>Circuit breaker condition monitoring: moving part timings and travelling curves, main contact wear, drive energy and auxiliary parts are continuously monitored</td>
</tr>
<tr>
<td>DWatch</td>
<td>Disconnector condition monitoring</td>
</tr>
</tbody>
</table>

Presented at 2012 3rd IEEE PES ISGT Europe, Berlin, Germany, October 14 -17, 2012
Preliminary cost evaluation (400 kV AIS)

Full digital VS conventional

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV Cables (material)</td>
<td>++</td>
</tr>
<tr>
<td>LV Cables (labour/installation)</td>
<td>++</td>
</tr>
<tr>
<td>Civil works</td>
<td>-</td>
</tr>
<tr>
<td>Landscaping</td>
<td>-</td>
</tr>
<tr>
<td>Earth works (earthing grid)</td>
<td>-</td>
</tr>
<tr>
<td>Busbars and connectors</td>
<td>++</td>
</tr>
<tr>
<td>Marshalling kiosks</td>
<td>--</td>
</tr>
<tr>
<td>Batteries &amp; charger</td>
<td>+++</td>
</tr>
<tr>
<td>Protection</td>
<td>+</td>
</tr>
<tr>
<td>DCS (inc. switches)</td>
<td>+</td>
</tr>
<tr>
<td>Engineering (man hours)</td>
<td>-</td>
</tr>
<tr>
<td>Commissioning</td>
<td>--</td>
</tr>
<tr>
<td>Transport costs</td>
<td>-</td>
</tr>
<tr>
<td>Erection</td>
<td>-</td>
</tr>
</tbody>
</table>