ABB FOX Switch (AFS) Family for utility applications
Utility Communications

Driven by IEC61850 and other Ethernet based communication protocols such as IEC 60870-5-104, switches have found their way into utility networks. Critical applications such as IEC61850 signals or SCADA data can be transmitted via Ethernet networks designed to be robust and reliable. Green field developments are an ideal opportunity to consider such solutions in substation and distribution communication networks.

The AFS650 and AFS670 Family offers many features which are required in the utility environments, including fast protection schemes, redundant power supply and alarm contacts, and enables the stepwise introduction of Smart Grid applications, such as integration of renewable energy sources, advanced distribution automation solutions and similar.

The AFS Family products are compliant to IEEE standards and enhance ABB's product portfolio for distribution networks, In-plant communication and substation automation applications.

AFS Family at a Glance
– Fully managed modular switches
– Utility grade switches
  - IEC61850 and IEEE1613 approved
  - Extended temperature rating from -40°C up to 85°C (continuous) as an option
– 19" or DIN rail mounting
– FE or GbE version available
– Fast protection scheme in case of link failure
– Automatic topology discovery using LLDP
– Local alarm indication (LED) and alarm contacts

Power and productivity
for a better world™

ABB

Typical Applications for AFS

Substation Automation

Distribution communication

In-plant communication

Typical Topology

State of the art substation automation systems use the IEC61850 protocol for communication between IEDs (Intelligent Electronic Device), as well as from IEDs to the station control computer. The IEC61850 protocol transmits different signals, such as GOOSE messages (e.g. interlocking, trip, ...), Sampled Values and Client Server communication via an Ethernet network. Since these are mission critical services, the data packet should reach its receivers with highest security and minimum delay.

Communication networks applicable to substations based on IEC61850 require a network with high availability. Accordingly, the requirements for the communication network include beside IEC61850 specific features, fast network recovery time in case of link failures and high MTBF figures.

As communication equipment has to work in harsh electromagnetically polluted environments, mainly optical connections are used, with distances to be covered of maximum a few 100 meters.

Today's SCADA Systems for distribution networks often use the IEC60870-5-104 protocol which is based on TCP/IP protocol stack.

The communication network for SCADA systems, which has to transmit real time and mission critical data, requires a redundant network topology and enhanced traffic engineering capabilities.

Besides SCADA data communication, distribution control centers have additional requirements. It might be necessary to provide a telephony system for operational purpose or channels for Renewable Energy (e.g. wind farms).

Since MV networks might be restricted to city areas or larger rural areas, the network design needs to be adapted as per actual requirements. Accordingly communication networks providing L2 Ethernet switching or L3 IP routing might be required. For installation in MV substations extended temperature range and immunity against EMC/EMI is required.

Distances to be overcome are typically in the range of a few kilometers.

Today's In-plant applications require enhanced Ethernet communication functionality. Various services such as CCTV, public address or access control systems require communication with a central server or operator console.

In-plant communication refers to applications dealing with security of the infrastructure and recovery to normal operation after an incident. Therefore high availability of the communication network and high performance features are required.

Some of the In-Plant applications require significant bandwidth (e.g. CCTV), therefore a proper planning of the network for the initial and future expansion is needed.

To allow supervision and historical analysis it is necessary to synchronize end devices (e.g. cameras) from a central time server.

Technical solution

– **Intra Substation communication solution**
  – Utility hardened switches supporting IEC61850
  – High number of optical ports required, mainly fiber optical ports (multimode)
  – Pure Layer 2 (switched) Ethernet network
  – Need for redundant network topology
  – Fast redundancy protocol needed (for fast network recovery time)
  – QoS (Quality of Service) and VLANs used to provide performance levels needed for Substation Automation
  – Management of the network via SNMP
 – IEEE1613 compatibility for EMC/EMI
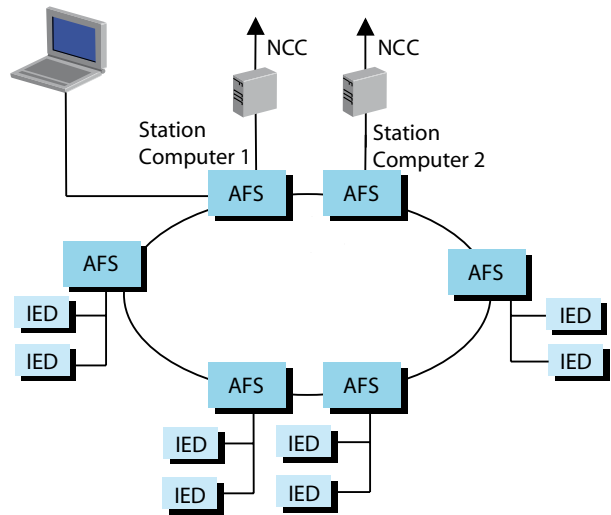
– **Communication between Distribution Substations**
  – FE/GbE backbone for distribution SCADA systems providing data channels e.g. for:
    - SCADA communication as per IEC60870-5-104
    - Voice over IP
    - CCTV (video)
  – High number of electrical ports required, FO ports are typically singlemode (uplink ports)
  – Need for highly secured and reliable communication
  – Depending on network design switching or routing functionality required
  – Need for redundant network topology
  – Fast redundancy protocol needed (e.g. MRP/E-MRP)
  – Temperature rating of up to +85°C continuous operation required
  – Management System for supervision of the communication network
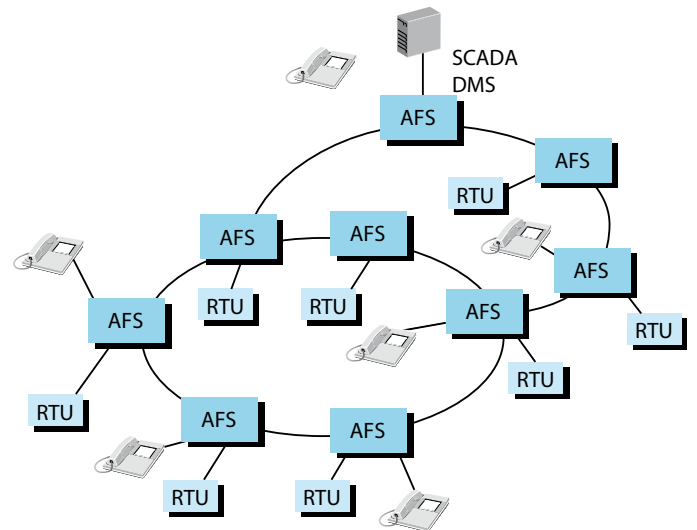
– **In-plant communication**
  – FE/GbE Backbone for In-plant applications
    - GbE uplinks for connection to server
  – Optical access ports for distances longer than 100m
  – Power over Ethernet (PoE)
  – Port based rate control
  – 802.1x Port Authentication for maximized security on outdoor cameras
  – SNTP (Simple Network Time Protocol) for time distribution down to end devices for accurate time stamping of video, audio and log files
  – Fast reboot after power failure
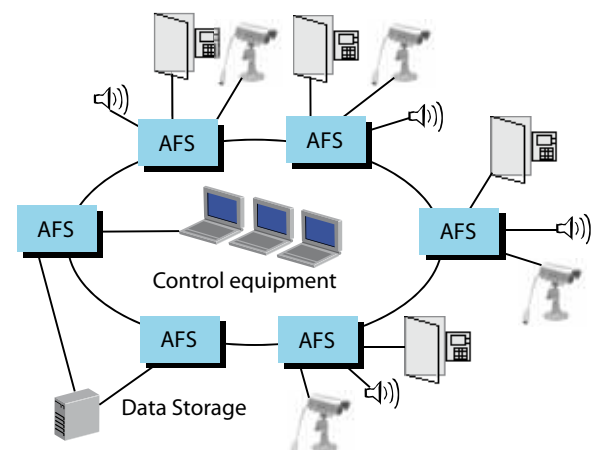
Applicable standards

Utility grade Switch

IEC61850 approved	
IEEE1613 approved	

EMC/ EMI

EN61000-4-2 (ESD):	8kV contact discharge,15kV air discharge
EN61000-4-3:	35Vpp/m (80–2700 MHz); 1kHz, 80% AM
EN61000-4-4 (Burst):	4kV power line, 4kV signal- and data line
EN61000-4-5 (Surge):	power line: 2kV (line/earth),1kV (line/line)
EN61000-4-12:	2,5kV line/earth,1kV line/line (1MHz)
EN61000-4-16:	30V; 50Hz continuous; 300V, 50Hz 1s
IEEE C37.90	HV impulse ±5 kV line/earth
IEEE C37.90.1	Burst ±4 kV, damped vibr. ±2.5 kV line/earth, ±1 kV line/line
IEEE C37.90.2	Electromagnetic field 80 - 1000 MHz 35 v/m (peak)
IEEE C37.90.3	ESD; contact discharge ±8 kV; air discharge ±15 kV

Mechanical Tests

IEC60068-2-27 Shock:	15g,11ms duration,18 Shocks
IEC60068-2-6 Vibration:	1mm, (2–13,2Hz), 90min.; 0,7g, (13,2–100Hz), 90min.; 3,5 mm, (3–9Hz),10 cycles, 1 octave/min.;
	1g, (9–150Hz),10 cycles,1 octave/min.

Applicable Standards

IEEE802.1d	MAC Bridges
IEEE802.1D/p	Port Priority
IEEE802.1D	Switching, GARP, GMRP, Spanning Tree (Supported via 802.1S implementation)
IEEE802.1D-2004	Media access control (MAC) bridges (includes IEEE 802.1p Priority and Dynamic Multicast Filtering, GARP, GMRP)
IEEE802.1Q-1998	Virtual Bridged Local Area Networks (VLAN Tagging, Port Based VLANs, GVRP)
IEEE802.1x	Port Authentication
IEEE802.1AB	LLDP (Link Layer Discovery Protocol) Topology Discovery
IEEE802.3 – 2002	Ethernet
IEEE802.3ac	VLAN Tagging
IEEE802.3ad	Link Aggregation
IEEE802.3af	PoE (Power over Ethernet)
IEEE1588	PTP (Precision Time Protocol)
Radius	Centralized Password Management
RMON	Remote Monitoring
SNMP V1/V2/V3	Simple Network Management Protocol
SNTP	Simple Network Time Protocol

RFC

RFC 768	UDP (User Datagran Protocol)
RFC 783	TFTP (Trivial File Transfer Protocol)
RFC 791	IP (Internet Protocol)
RFC 792	ICMP (Internet Control Message Protocol)
RFC 793	TCP (Transmission Control Protocol)
RFC 826	ARP (Address Resolution Protocol)
RFC 951	BOOTP (BOOTstrap protocol)
RFC 1112	IGMPv1 (Internet Control Message Protocol)
RFC 1157	SNMPv1 (Simple Network Management Protocol)
RFC 1155	SMIv1 (Service Management Interface)
RFC 1213	MIB2 (Management Information Base)
RFC 1493	Dot1d
RFC 1542	BOOTP-Extensions
RFC 1757	RMON (Remote Monitoring)
RFC 1769	SNTP (Simple Network Time Protocol)
RFC 1907	MIB2 (Management Information Base)
RFC 1945	HTTP/1.0 (Hyper Text Transfer Protocol)
RFC 2131	DHCP (Dynamic Host Configuration Protocol)
RFC 2132	DHCP-Options
RFC 2236	IGMPv2 (Internet Control Message Protocol)
RFC 2613	SMON (RMON analysis for switched networks)
RFC 2674	Dot1p/Q
RFC 3411	SNMP (Simple Network Management Protocol) Framework
RFC 3412	SNMP (Simple Network Management Protocol) MPD
RFC 3413	SNMP (Simple Network Management Protocol) Applications
RFC 3414	SNMP (Simple Network Management Protocol) USM
RFC 3415	SNMP (Simple Network Management Protocol) VACM

General AFS Family Features - Full managed Ethernet Switch supporting

Protection features
– RSTP (Rapid Spanning Tree Protocol) IEEE802.1D
– MRP (Media Redundancy Protocol) IEC62439
– E-MRP (Enhanced MRP)

Switching properties
– Switching: Store and Forward
– Switching latency: typ. 2.7us @ 100Mbit/s
– MAC Address Table size: 8000
– VLANs: 4042 (255 simultaneous)
– Traffic prioritization: 4 queues
– Port Rate Limiting (Ingress & Egress) in steps of kbps
– Flow Control
– Link Aggregation
– Configuration Recovery Adapter (CRA)
– Watchdog & Rollback feature

Management
– Port mirroring
– RMON (Remote Monitoring)
– IGMP snooping doe multicast filtering
– SNMP V1, V2, V3, Configuration
– Command Line Interface / Telnet access
– WEB Interface
– SFP Diagnostics
– LLDP topology discovery

Alarm indication
– Diagnostic LEDs
– 2 x Alarm contacts

Security
– Authentication (IEEE802.1x)
– Local Logfile and Syslog reporting
– SSH encryption
– Radius centralized password management
– Multi level user passwords
– Disabling of Ports
– SNMPv3 (Simple Network Management Protocol with en-crypted authentication)
– VLAN (Virtual LAN) IEEE 802.1Q

Ambient conditions
– Utility grade switches
– EMC hardened; IEEE1613 compliant
– IEC61850 approved
– Extended temperature rating 0° - 60°C (-40°C - +85°C as an option)
– Fan-less design
– Optional conformat coating
– CSA/UL approval

AFS670 / AFS675 / AFS677 / AFR677

– 19" managed switch
– Metal housing, ports on front or on rear (typical substation configuration)
– Up to 4 GbE ports (optical, electrical or combo ports)
– Up to 4 PoE ports (only with power supply type H/Z)
– Low voltage (18 - 60 VDC) or high voltage (77 - 300 VDC or 90 - 265 VAC) power supply
– Redundant power supply possible
– Spring clamps or connectors available
– Typical power consumption without PoE: 10 - 40 W

AFS670 / AFS675
– Modular concept, 1 module for 2 ports needed, any combi-nation possible (expect GbE & PoE); in total 12 slots
– High port density
Up to 28 ports (electrical, optical or SFP cages)
– Huge variety on optical ports (e.g. SFP cages, SC, ST) MM and SM SFP's in various versions available (MM, SM, single fibre)

AFS677 / AFR677
– 16 GbE combo ports (TX RJ45 or SFP slot)
– AFR offers L3 functionality RIPv1, RIPv2, OSPFv2 and router redundancy protocol VRRP

AFS650 / AFS655

– DIN Rail mounted managed Ethernet switch (wall mounting possible)
– Metal housing
– Up to 10 ports (electrical, optical or SFP cages)
– Up to 3 GbE ports (electrical, SFP or Combo ports)
– Multimode and Single Mode versions available
– Huge variety on optical ports (e.g. SFP cages, SC, ST)
– SFP's in various versions available (MM, SM, single fibre)
– Low voltage (18 - 60 VDC) or high voltage (48 - 320 VDC, 90 - 265 VAC) power supply
– Redundant power supply possible
– Typical power consumption: 12 - 21 W

Traffic Protection

In addition to standard Rapid Spanning Tree Protocol (RSTP), the AFS supports fast protection mechanisms such as Media Redundancy Protocol (MRP) or Enhanced-MRP. Very fast switchover times in ring configurations can be achieved by using these protection algorithms. Subring configurations, as well as redundant ring coupling, are also supported.
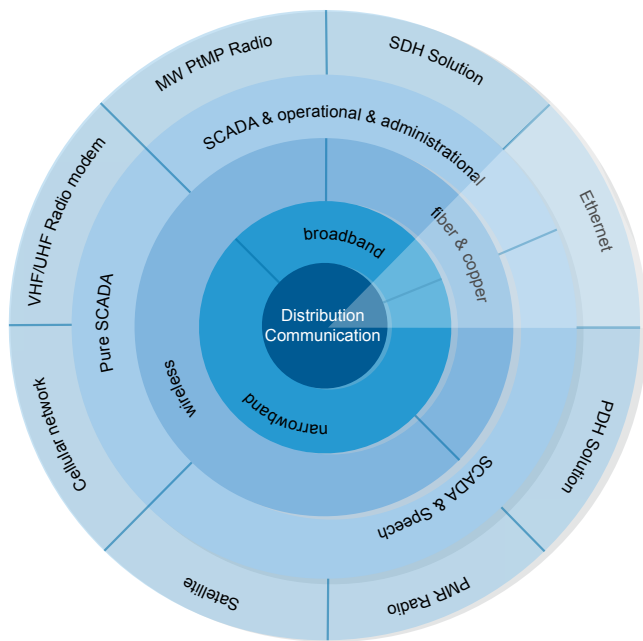
Customer Benefits

Utility Grade Products, specially designed for substation environment
– High EMC/EMI Immunity
– Extended temperature range
– Redundant power supply available for DIN rail & 19"
– AC/DC power supply
– Wide input range of power supply
– PoE as an option
– Enhanced protection schemes for traffic protection

Very high system availability because of:
– High MTBF
– Fan-less design
– Very fast switchover time in case of link disturbance

Scalable port density from 8 to 28 Ports, including GbE functionality

Overall ABB Communication Solution Suite
– Part of ABB Communication Solution Family
– Part of ABB Substation Solution

System integration covering all aspects and applications such as SCADA data traffic, IEC61850 and telephony. For packet switched solutions, design and system integration play a key role for network performance and availability.

Based on more than 60 years of experience, a broad solution portfolio and intensive application and system testing, ABB offers solutions designed according to utility requirements providing high-level system availability.

For more information please contact:

ABB Switzerland Ltd
Power Systems
Brown Boveri Strasse 6
5400 Baden, Switzerland
Phone: +41 58 589 37 35
or   +41 544 845 845 (Call Center)
Fax: +41 58 585 16 82
E-Mail: utility.communication@ch.abb.com

www.abb.com/utilitycommunications

Power and productivity
for a better world™

ABB