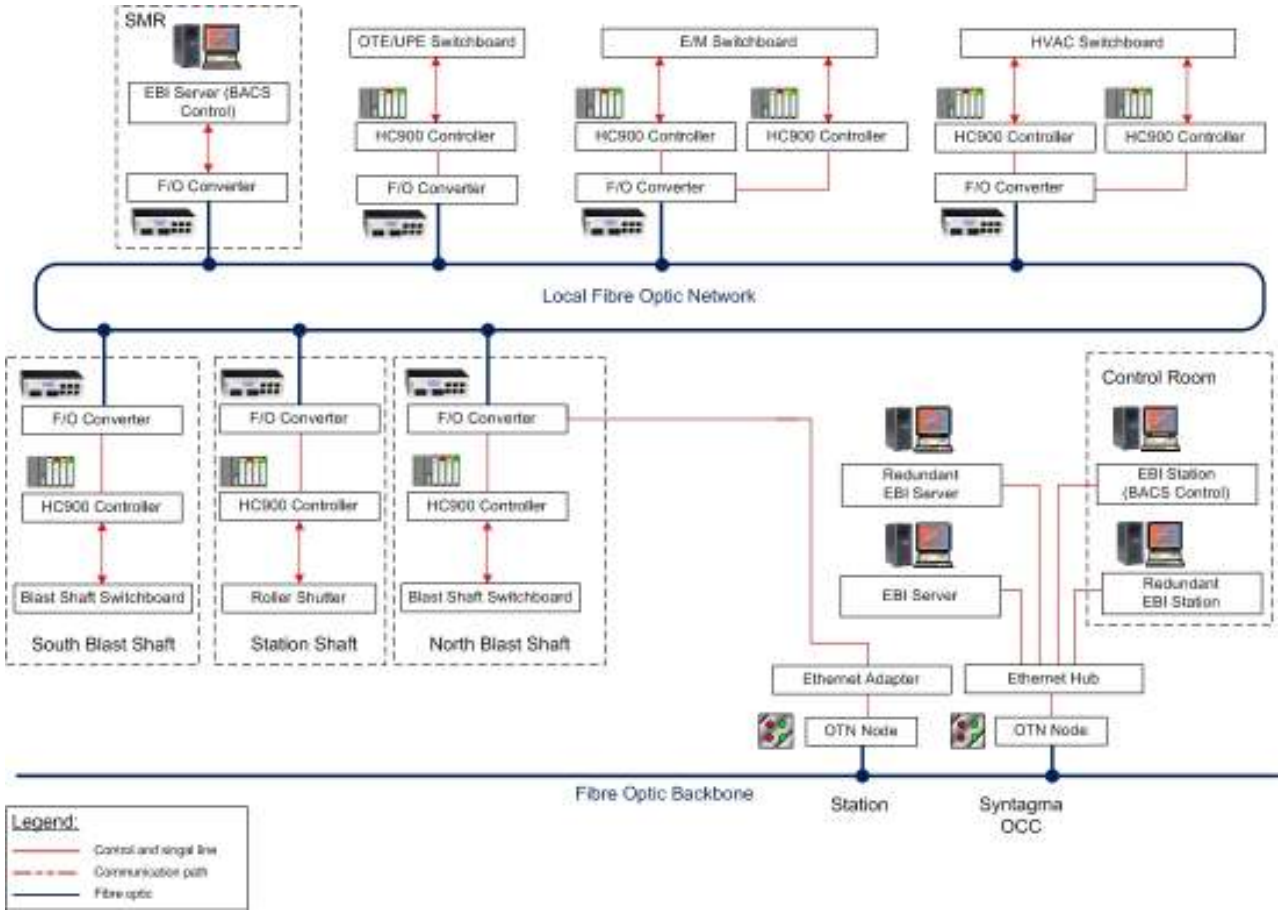
INFORMATION DOCUMENT

TECHNICAL DESCRIPTION OF THE BUILDING AUTOMATION & CONTROL SYSTEM (BACS) INSTALLED IN THE STATIONS OF THE EXTENSION

1. SYSTEM ARCHITECTURE / TECHNICAL DESCRIPTION

Station Architecture



Station Communications Network

An independent fiber optics network has been constructed in the station. This is a network in ring layout as shown in the above figure, with the two fiber optic lines following a different route. This way, in case of loss of one of the two fiber optic cables, the communication of the system is not affected. The use of monitored and programmed optic nodes (F.O. Switch) permits us to maintain control in case of loss of the optic connection. The connections of the optic nodes to the live equipment (HC900, EBI Server, OTN) are realized via a UTP network cable. The LAN (Local Area Network) within the station communicates with the WAN (Wide Area Network) of the Metro via the connection to the OTN. It is pointed out that the hardware used to build the aforementioned network permits data transmission speeds at 100Mbps and higher.

The above figure is a schematic diagram of system implementation in a typical station.

Station Monitoring System

The monitoring system installed in the Station Master Room of all stations is the EBI system (manufacturer: Honeywell), in its latest version, as released during the project implementation period. The connection of the EBI Server with the station's LAN network is ensured through an optic node serving exclusively this specific area.

The Server, installed in all stations, is manufactured by Dell and is in a RAID 5 layout. The computer is connected with the EBI Server in SYNTAGMA Station as a EBI Station.

The central computer of the station operates both as a data collection and data processing Server and a workstation. All software processes involving database updating, communication with the field controllers (HC900) and with the central monitoring system in SYNTAGMA are not visible by users and do not affect the monitoring of the system (they will be running in the background) – Server processes.

Honeywell Universal Modbus interface (for HC900 controllers) is part of the EBI Server and has been developed to ensure full communication between the data tables of HC900 controller and the EBI Server data base. All available information and actions are transferred respectively to the EBI Server data base and through direct local connection to the controller (physical input port status, physical output ports activation, physical output port status, information on the HC900 controller status, the status of all programmable false-points).

A grouped equipment operation layout has been developed to reduce delays during operation featuring connections on the screen for navigation to other pages:

- General view of the station's plan through which users can access lower levels of the system,
- Schematic diagrams of various systems,
- Schematic diagrams of equipment,
- Tabular presentation of alarms, alarm summary,
- Tabular presentation of status or incident messages,
- Tabular presentation of sensor's values,
- Display of all relevant scenarios per Station,
- Display of all emergency scenarios statuses,
- Mimic display of FB,
- Fire alarms and information on the status of fire dampers,

- Trends and background data.

Other features also include automatic navigation at the alarm source upon alarm detection, enlarge /minimize, scroll up/down.

The EBI Server ensures, *inter alia*, the following:

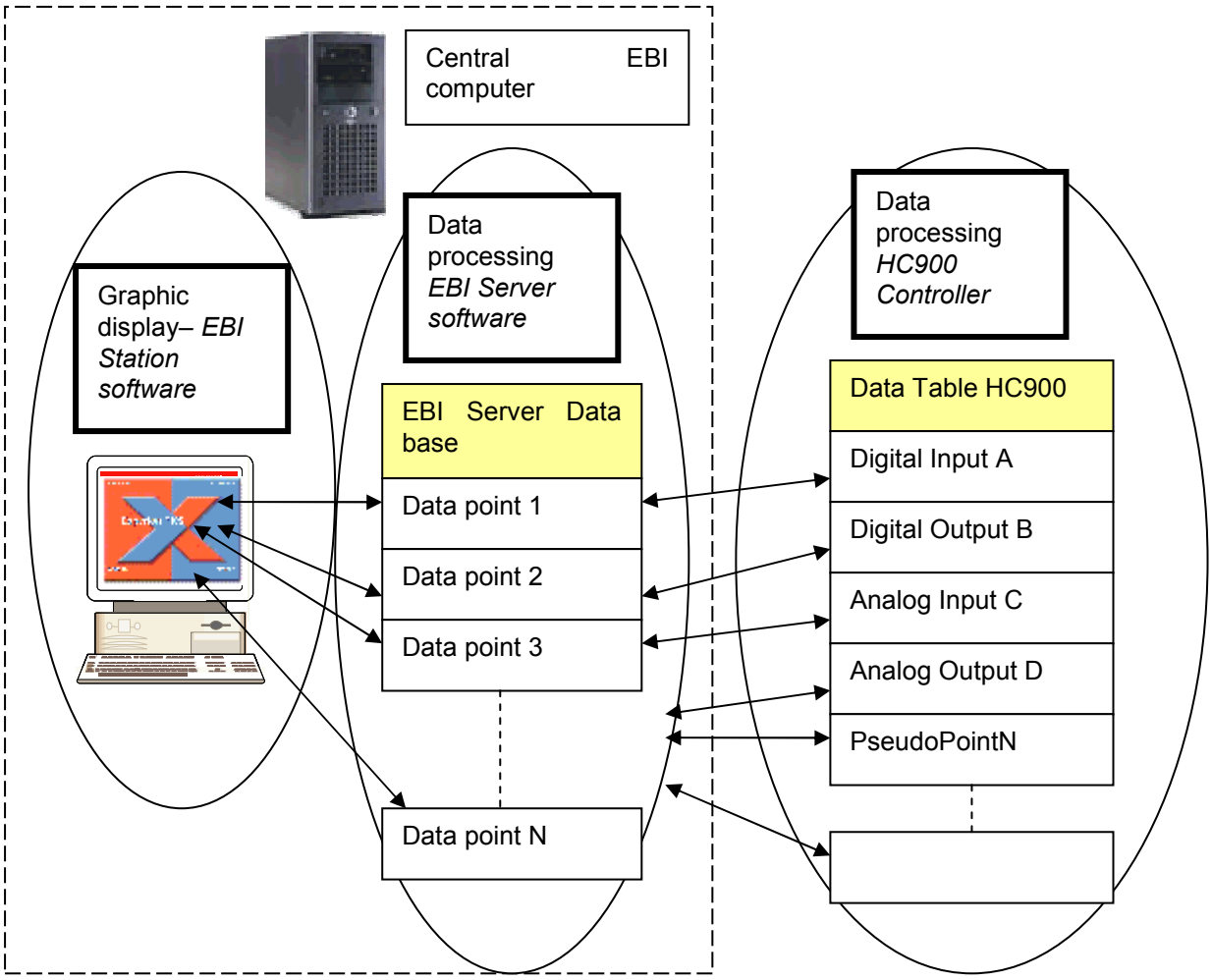
- Supervision and operation of active equipment through graphic displays.
- Overall supervision of communication channels and controllers.
- Grouping of various points/ false-points.
- Development and use of time-tables.
- Supervision of analogue values through trend charts.
- Complete alarm list where alarms are classified based on priority.
- Event list presenting all recorded EBI Server operations and interfaced workstations, depicting also any status change in check points.
- Automatic event archiving.
- Users with graded access levels, with possibility to assign multiple access levels to all users.

The operator of the BACS system can execute all monitoring and supervisory control operations from this workstation. The common commands that the operator can activate include *inter alia*:
Modification of control loops set points, alarm response and set points regulation, automatic/ manual switchover and field devices on/off control, activation/de-activation of points and setting devices.

The OCC operator can access all information or graphic displays of the Tunnel Ventilation System, the stations' HVAC system and the E/M systems of the network stations and tunnels. Moreover, he/she will be informed on the status of any alarm through a sound signal, a message displayed on the screen or any animations combination on the screen.

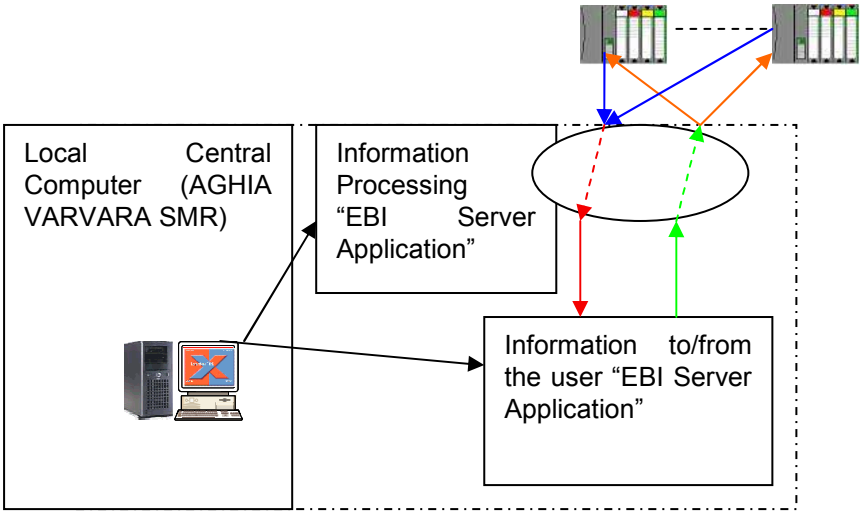
The operator can also select and identify alarms separately, per group or per section under examination. Moreover, the operator can select an alarm from the summary view of the alarms and the system shall take him to the corresponding screen of the control system.

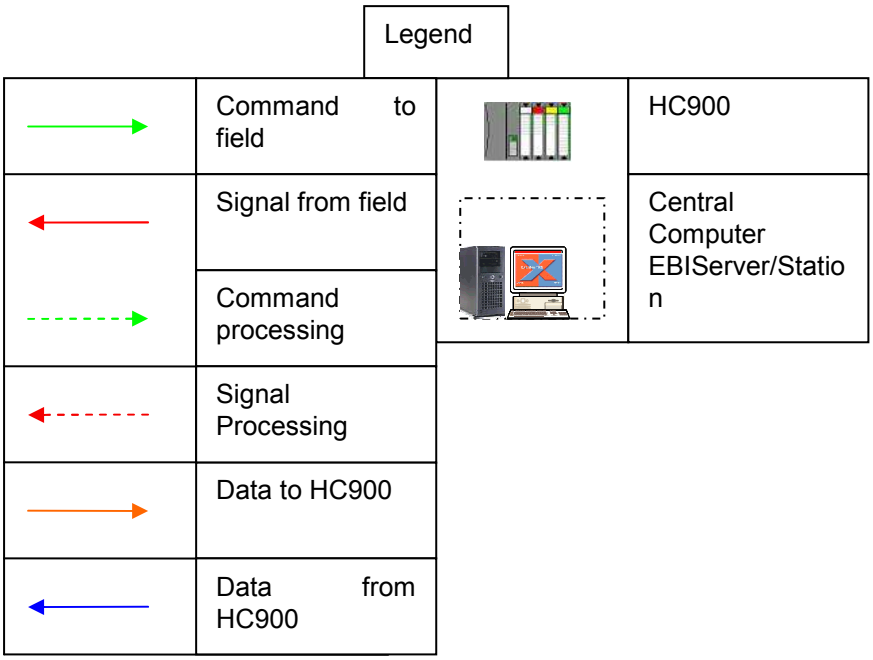
BACS software supports simultaneous user access to multiple screens, including split windows, where the user can see more than one areas of process each time.



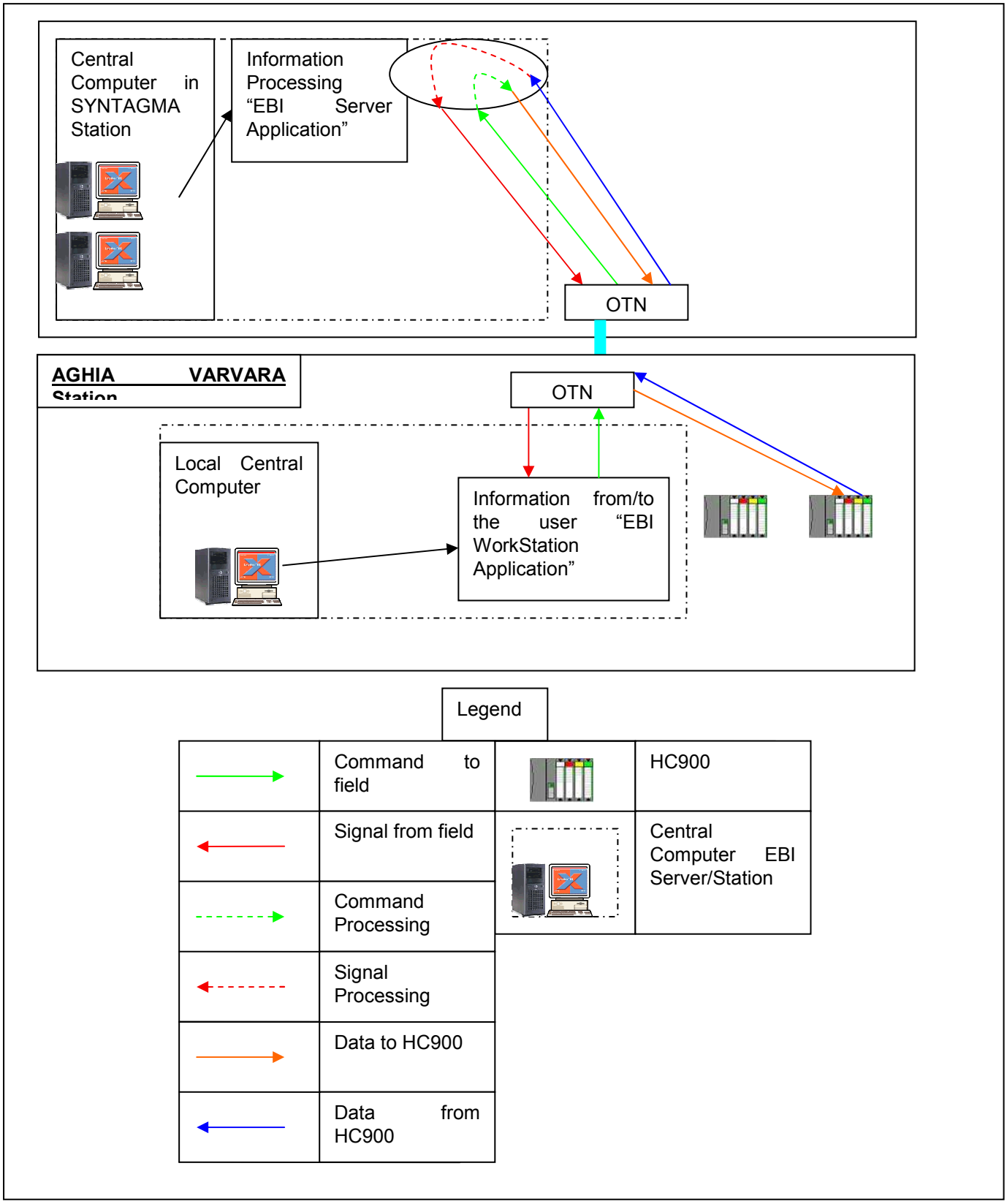
The workstation can communicate with both EBI Servers (SYNTAGMA Servers and local station Servers) of the Metro network which collect information and control the equipment of the local station. More precisely:

- The workstation operates as a workstation of the station's EBI Server, while information flow is local inside the LAN. For example, if a user activates a fan from the graphics mask, the command will be transferred to the local application of the EBI Server, which will react accordingly in order to convey the command to the HC900controllers. The data to update the graphics and to notify the user on the result of his action shall also derive from the local application of the EBI Server.


Local Central Computer (AGHIA VARVARA SMR)
Information Processing "EBI Server Application"
Information to/from the user "EBI Server Application"


Legend
Command to field
Signal from field
Command processing
Signal Processing
Data to HC900
Data from HC900
HC900
Central Computer EBIServer/Station

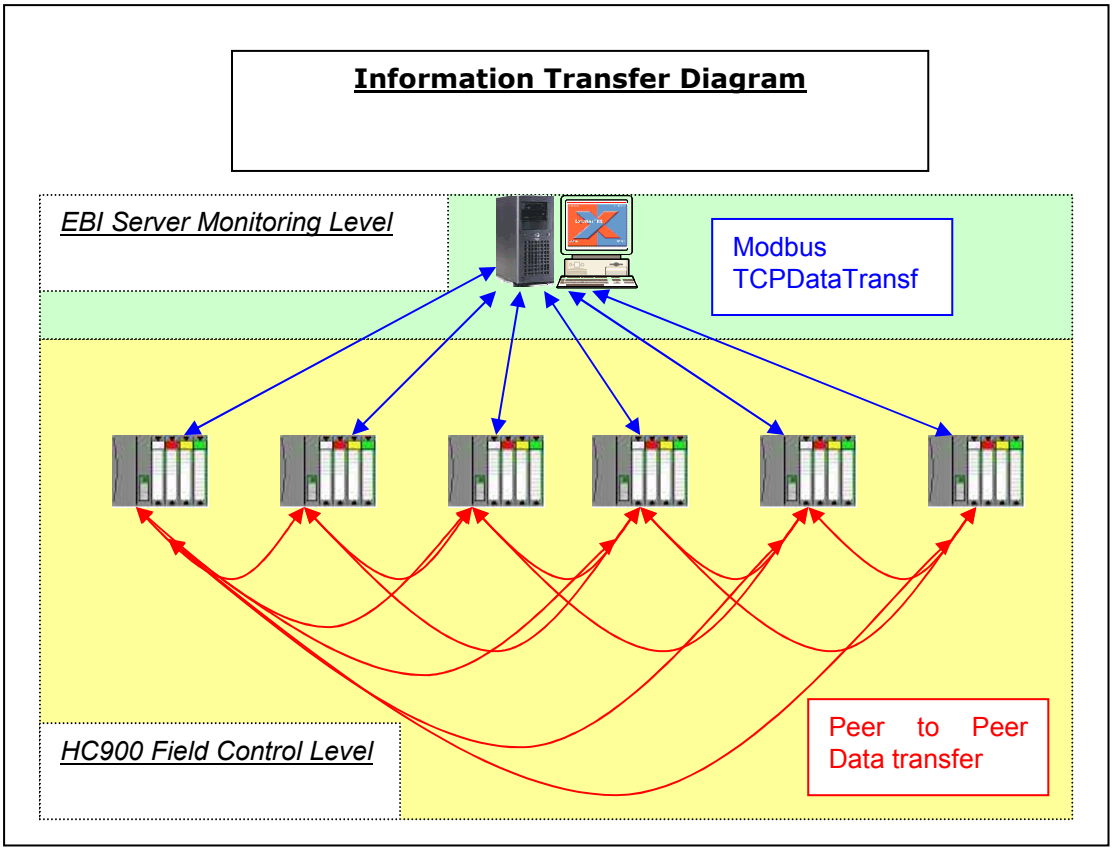
- the workstation operates as a workstation of the Redundant EBI Server of SYNTAGMA Station and information flow is ensured through the WAN.



For example, if the user activates a fan from the graphics mask, the command will be transferred through to the EBI Server in SYNTAGMA Station, where all necessary actions are performed, before it is transferred to the HC900 controllers of the station. The data to update the graphics and to notify the user on the result of his action shall equally derive from the EBI Server of SYNTAGMA Station.

HC900 field controllers network

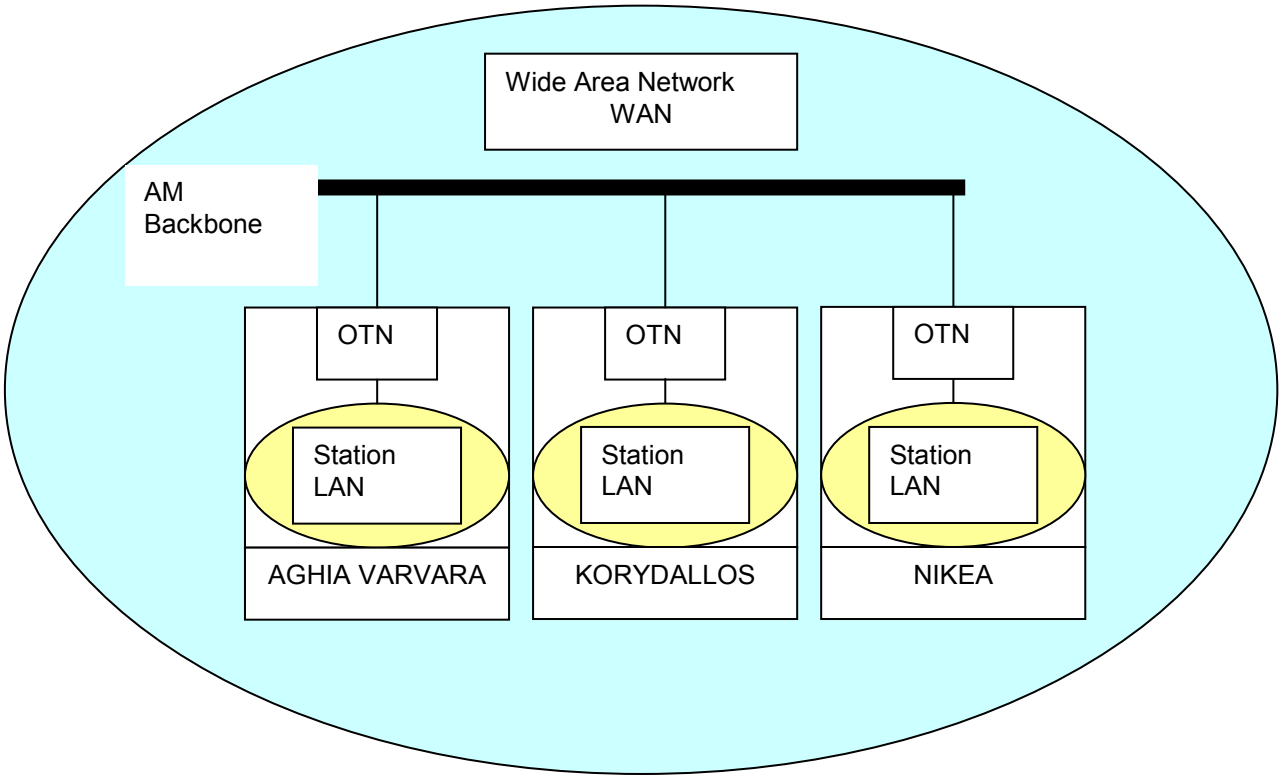
HC900 controllers are controlled autonomously, while the control function operates independently of the EBI monitoring level. All information necessary for the execution of algorithms is exchanged between HC900 controllers via PEER-to PEER communication. It is pointed out that all station HC900 controllers operate as master controllers and exchange information directly with the monitoring level, i.e. there is no master/slave structure.



The above diagram depicts how information is transferred to the system. HC900 controllers communicate via peer-to-peer communication irrespective of their location in the physical network (as shown on the aforementioned diagram for the first HC900 controller). They all carry information directly, also irrespective of where they are located in the physical network, to the EBI Server of the station via Modbus TCP protocol.

Station interconnection

Network architecture



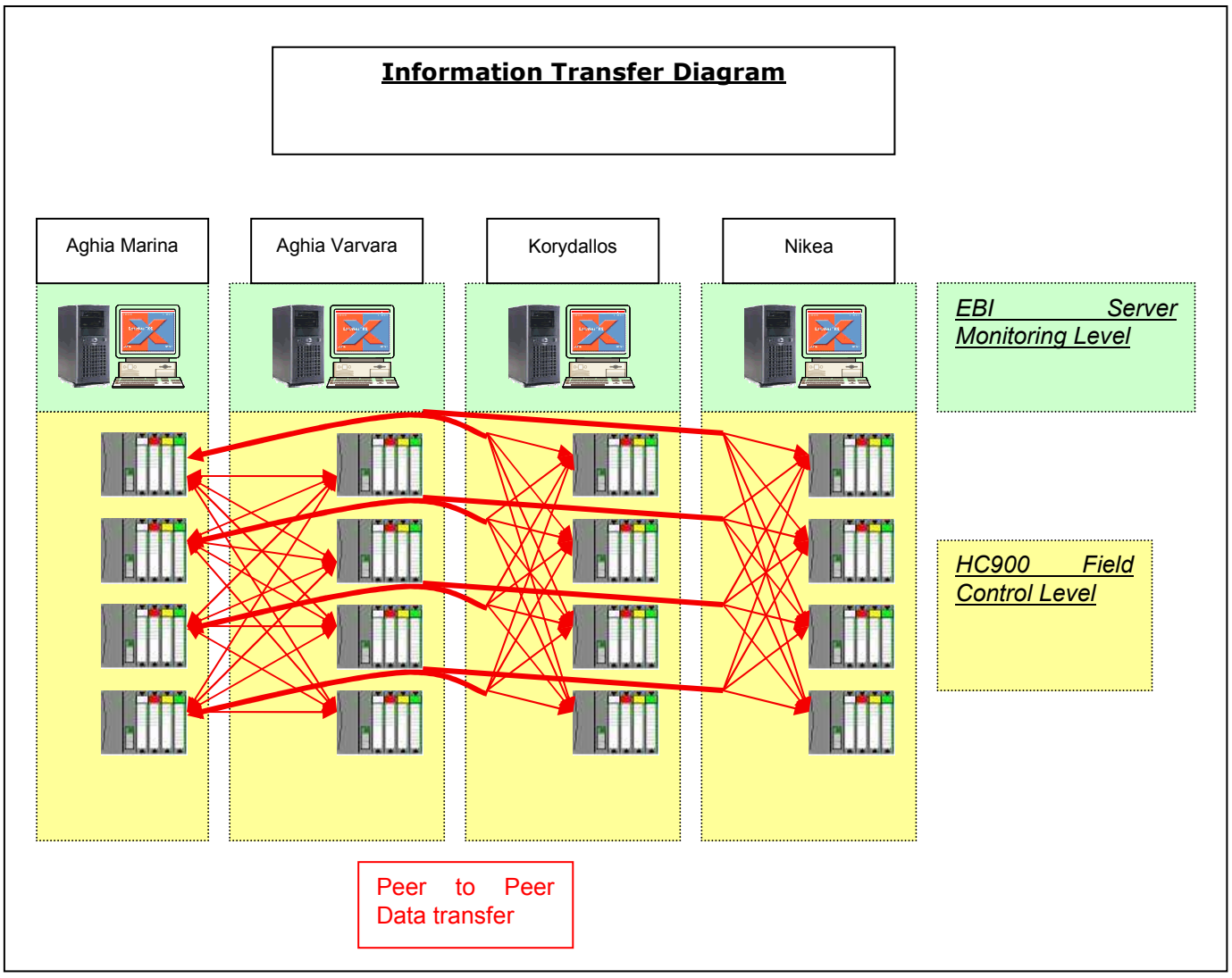
The LAN local networks of the stations communicate via the Metro's WAN. The coupling between the LAN and the WAN is ensured through OTN.

This coupling is indispensable for the BACS system in order to ensure information exchange between:

- the HC900 controllers of the adjacent stations
- the HC900 controllers and EBI Server in the OCC
- the EBI Servers of every new station and the EBI Server in the OCC

Communication between HC900 controllers of other stations

The communication between the HC900 controllers of the stations is necessary, in order to ensure control field independency. Thus, activation of a fire scenario from the graphics of the Fireman's Box in station N shall be successfully implemented irrespective of the status of the EBI Servers (operating or out of operation) of the remaining system, since it will be possible to activate the equipment of the adjacent stations.



Communication between HC900 controllers is ensured via Modbus Peer to Peer communication.

This connection also permits depicting all necessary information concerning the equipment of the adjacent stations at the local EBI Server e.g. depicting the entire line to confirm correct completion of the scenario involving the specific station. Thus, and as shown on the aforementioned figure, every HC900 controller communicates with the remaining controllers and executes the relevant actions when necessary, such as in case of activation of a fire scenario, where simultaneous functions in many HC900 controllers of different stations are involved. Peer to Peer communication enables to select the scenario in one controller and execute actions at the controllers of the local station but also to the controllers of the adjacent stations (UPE, BlastShaft, RS, etc.), as required by each different scenario.

2. LOCAL EQUIPMENT INTERFACE WITH THE OPERATION CONTROL CENTER AT SYNTAGMA AND THE LOCAL MONITORING SYSTEM

The key points to allow full interface of new stations and the OCC are the following:

a. The central monitoring systems at Syntagma
b. The local monitoring system in each new station
c. The HC900 controllers to be installed in the new stations.

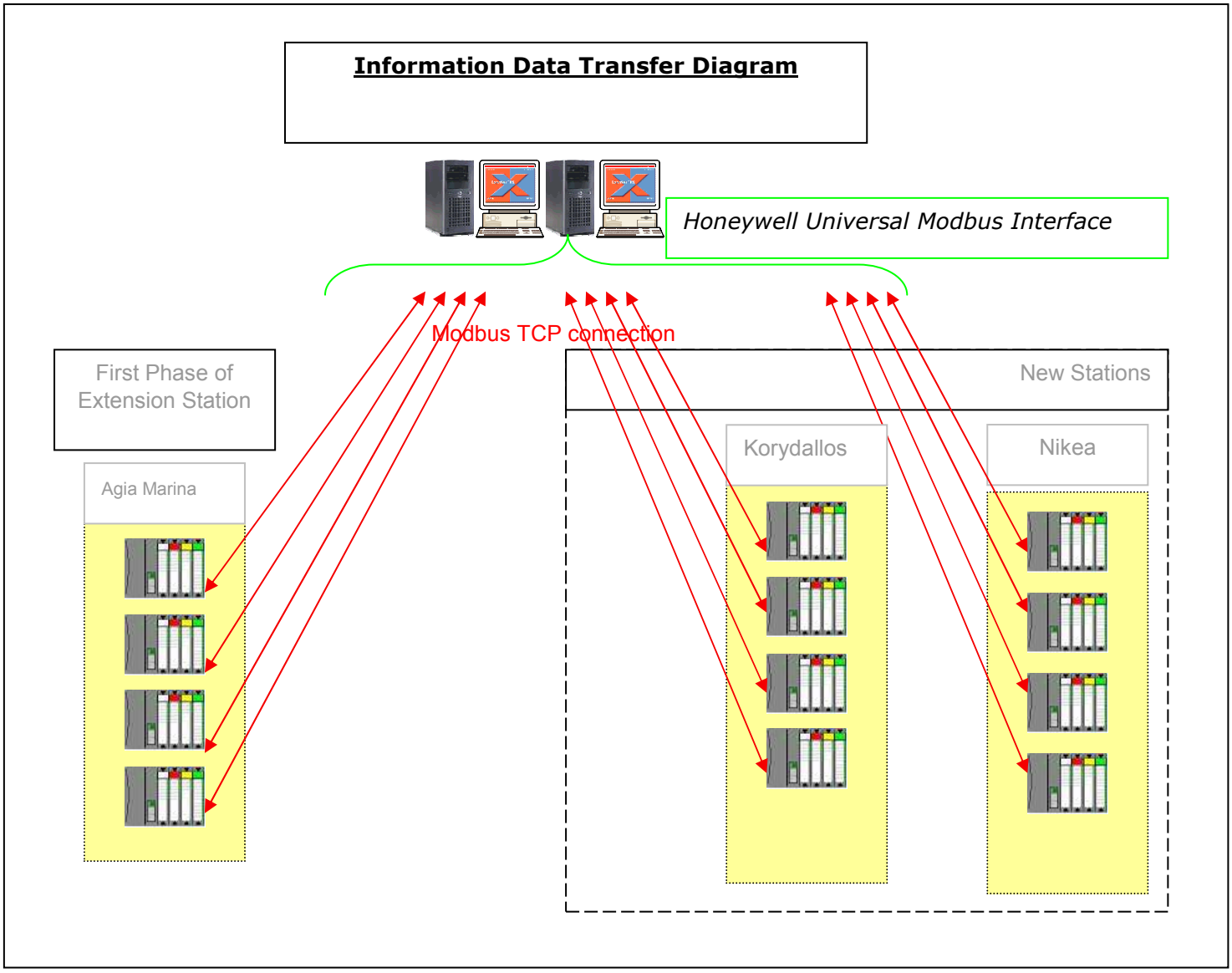
Our interface related requirements call for three (3) types of communication, namely:

1. Communication between the EBI Server (central monitoring system) at Syntagma and HC900 to achieve complete compatibility.
2. Communication between the EBI Server at Syntagma and the Station EBI (local monitoring system) to fully update the Power Controller on the actions of the local user.
3. Communication between the EBI Server of a local station and the HC900, to control the station at local level in case communication with the EBI Server at Syntagma is lost.

Interface beween the EBI Server at Syntagma and the Stations HC900

As of the first phase of the extensions program, the following communication protocol has already been installed in the EBI Server a Syntagma:
SWEBI-IF-UMC800 Honeywell Universal Modbus *(for the HC900 controller)* ***interface***

This protocol allows us to fully control and monitor the HC900.
Each of the controllers interfaced with the Metro WAN is identified through a unique TCP/IP address; via this address, the controller enters the database of the EBI Server and the option is provided for a two-way transfer of all parameters (programmable and physical control points) and data related to communication problems.



We should stress that the EBI Server at Syntagma operates the same way as the EBI Server local systems; the only difference is that data are transferred through the WAN network (a fact that does not affect the exchange of information). The EBI Server at Syntagma operates in parallel with the local EBI Server of each station, while these systems are equivalent and fully autonomous and independent.

The user of a EBI station of the EBI Server at Syntagma, having the proper rights, could:

- Activate / de-activate equipment, scenarios.
- Change set points.
- Monitor the status of the stations' equipment.
- Set time-programs.

All aforementioned is effected through a graphical environment and the information data is transferred via Modbus TCP. The exchange of information between the EBI Server at Syntagma and the local controllers HC900 is independent from the local EBI Server, and the information is

transmitted even if the local EBI Server is out of operation. All actions are recorded and are available to the OCC user via the EBI station application. Recording also includes timestamp and the details of the users who performed the subject action.

Interface between the EBI Server at Syntagma and the EBI Station/stations server

As mentioned above, in all new stations, the workstation can communicate with both EBI Servers (at Syntagma and in the station) of the Metro network, and all actions of the Station Master are effected through Syntagma, while local connection shall be used in case communication with Syntagma is lost.

3. SYSTEM REDUNDANCY ABILITY

In order to understand the ability of the system to respond in case of a failure, we shall present potential problems that could emerge and the way the system operates in each case.

Malfunctions at monitoring level (EBI)

- Failure of both EBI Servers at Syntagma:

  In this case, the EBI Server of the station operates regardless of the problem at Syntagma. The user in the station master room fully monitors and controls the local equipment of the shafts and the station (connected to the LAN). It can apply scenarios, which shall be successfully performed to adjacent stations through the Peer to Peer communication between HC900 controllers.

- Malfunctions in the Central Computer of the Station
  - Destruction of a feeder in the Central Computer of the Station:
    The computer of the station continues to operate normally since is it features a back up feeder.
  - Destruction of a hard disc in the Central Computer of the station:
    The computer of the station continues to operate normally due to RAID 5 layout.
  - Failure of the EBI Server software:
    In this case, the user in the station master room fully monitors and controls the equipment through the use of the EBI station application, which is connected with the data base of the EBI Server at Syntagma.
  - Destruction of the processor or the motherboard or both feeders or both hard discs of the Central Computer of the station:

In this case, the EBI Server at Syntagma operates regardless of the problem in the Station. The user in the OCC monitors and controls in full the local equipment in shafts and in the station. The user can implement scenarios that will be successfully performed.

Malfunctions in the communication network

- Loss of the OTN:
  In this case, the EBI Server of the station operates regardless of the problem at Syntagma. The user in the station master room monitors and controls in full the local equipment in shafts and in the station (connected to LAN).
- Loss of a fibre optic of the LAN network:
  No problem emerges in the communication activities of the station due to the ring layout; thus, the network remains active due to the existence of a second route for information transfer.
- Loss of a fibre optic switch feeder
  It does not entail any problems in the network due to the existence of a second feeder.