Technical Bulletin

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Subject: Using the JAGXTREME Terminal and Qi™ Matroller in a ControlNet or EtherNet/IP Network

The JAGXTREME® and Qi terminals are capable of communicating with PLC's using a variety of fieldbus protocols. Two of the fastest growing application protocols are those using either ControlNet or EtherNet/IP. When using these terminals in such networks it is important to follow "best practices", some of which are described below.

Background Information:

A description of how to apply the JAGXTREME terminal in ControlNet and EtherNet/IP applications is found in the CIP Interface Technical Manual, A16760300A, provided as part of the JAGXTREME documentation cd. For Qi information consult Technical Manual A16506600A. In summary, the following capabilities are supported:

The optional JAGXTREME and Qi CIP interface card enables a JAGXTREME terminal to communicate to CIP (Common Industrial Protocol, also known as Control and Information Protocol) networks, ControlNet, and EtherNet/IP. The CIP network ControlNet and EtherNet/IP connections are mutually exclusive (only one connection may be configured on the JAGXTREME terminal at once).

The JAGXTREME and Qi ControlNet and EtherNet/IP interface is classified as a CIP Adapter Class device that supports the following types of CIP messaging:

- Class 1 cyclic scheduled messaging – ie. weight data, updated at 17 Hz for JAGXTREME and 1 Hz for Qi
- Class 3 unscheduled messaging – access limited set of JAGXTREME shared data values, ie. setpoint status

Characteristics of the JAGXTREME and Qi:

- Each JAGXTREME terminal can support a maximum of four connected individual scales.
- A JAGXTREME terminal or Qi matroller can act as a bridge to other JAGXTREME terminals connected to it via a non-CIP JAGXTREME cluster network. This cluster network is limited to six JAGXTREME terminals or 20 Qi Matrollers. All terminals on a cluster must be running the same version of firmware.
- A JAGXTREME cluster network can contain a maximum of 24 scales. A Qi cluster can contain up to 200 channels of instrument data, 80 of which can be scales, and up to 200 of which can be flowmeters.
- Any number of RA Logix controllers can reside on the CIP network and any of those controllers can communicate either directly with a JAGXTREME terminal on the CIP network, or indirectly, using unscheduled messaging, with a JAGXTREME terminal on the non-CIP JAGXTREME cluster network.
- A JAGXTREME terminal on the CIP network may also communicate with one (and only one) Logix controller on that network via scheduled messaging. Scheduled messaging is only supported by JAGXTREME terminals that are directly connected to the network via a JAGXTREME CIP interface card.
- A JAGXTREME scheduled message may only be configured to handle four scales. A Q.i scheduled message may only refer to a single channel.

- Generally the PLC Network Update Time/Request Packet Interval setting should be less than 58 msec, however, faster update rates can adversely affect the performance of certain PLC/CPU combinations. The Request Packet Interval should be an exact multiple of the Network Update Time.
- As equipment is added to a plant network the performance of the JAGXTREME or Qi can be negatively affected depending on overall system data load. Large data transfers occurring on a network (such as print spools, system backups, and program downloads) can disrupt Qi/ JAGXTREME communications. Users should proceed with caution before adding additional devices to the network on which the JAGXTREME or Qi reside.

Network Structure

It is important that the network structure be such that communications between JAGXTREME or Qi in a cluster are separated from both general facility network communications, and from communications between the "bridge" JAGXTREME or Qi and the process controller (PLC). In summary, the structure should have three separate networks. See Figure 1.

1. A dedicated LAN or VLAN for the communications between multiple JAGXTREME or Qi in a cluster.
2. A dedicated LAN or VLAN for EtherNet/IP communication between a "bridge" JAGXTREME or Qi and a PLC other process controller
3. A separate LAN for general plant network traffic

In EtherNet/IP applications the JAGXTREME and Qi communicates Unicast (point to point) messages using UDP (User Datagram Protocol). The JAGXTREME and Qi are not capable of Multicast or Broadcast messaging. As UDP messaging is fault intolerant, any network implementation must not interfere with UDP messaging. Therefore, while the network implementation is up to the users' discretion, METTLER TOLEDO strongly recommends that JAGXTREME and Qi be kept on a separated, dedicated LAN network (or sub-network), where LAN network lines are not shared with standard data processing or office communication networks in the factory. Also, the cluster Ethernet LAN communications should be on a separate network (or sub-network) from the EtherNet/IP PLC communications.

Further information on CIP networks can be obtained from the Open Device Vendor's Association (ODVA) web site at: http://www.odva.org/, and ControlNet International, http://ww.ControlNet.org.

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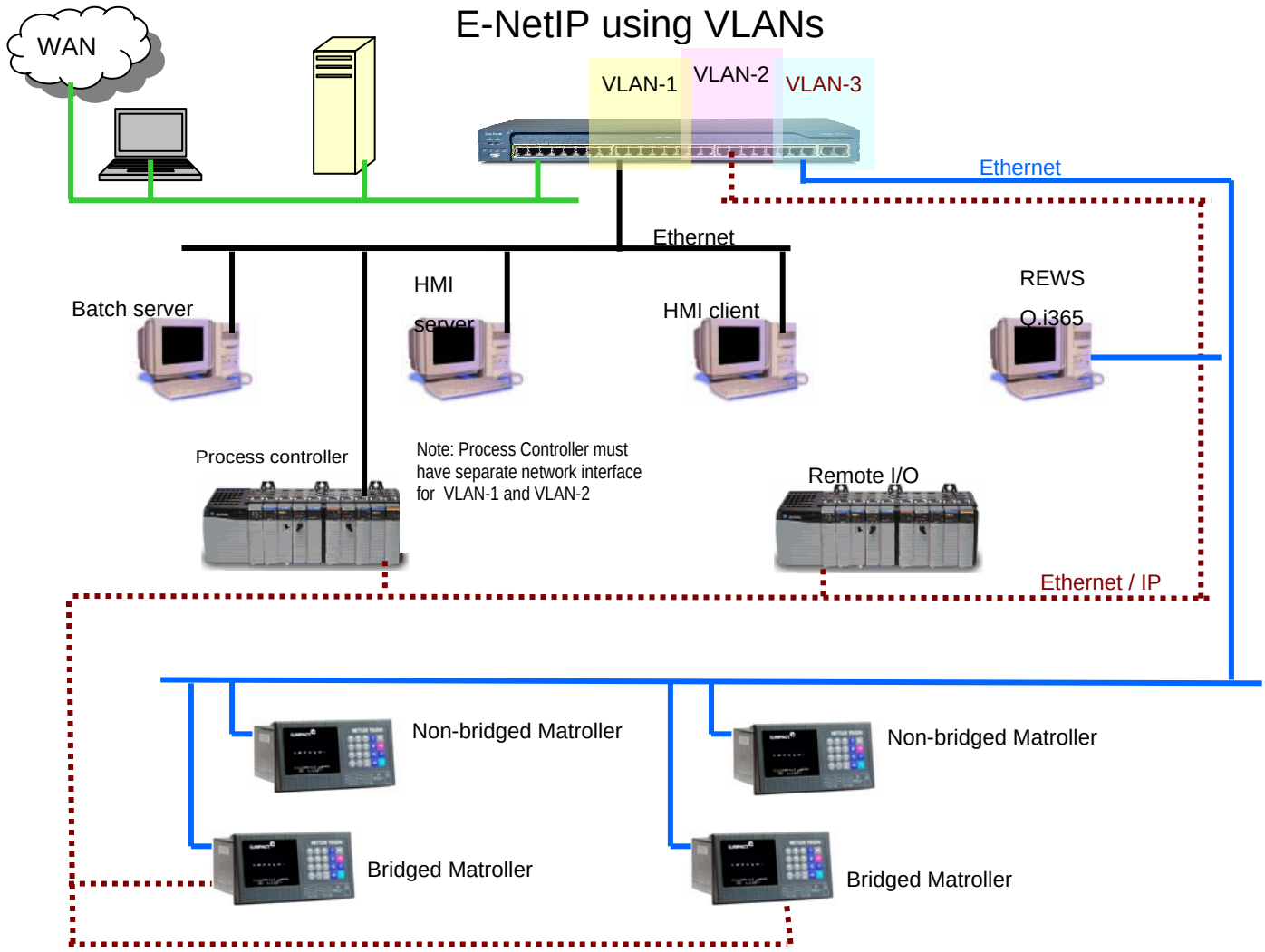

Figure 1

Network Design Considerations – EtherNet/IP:

Designing an industrial network requires special considerations typically not considered in "office" type networks. Traffic generated during programming, configuration, and diagnostics of EtherNet/IP devices as well as during exchange of non time-critical data is normally low-rate traffic. Traffic generated during time-critical data exchange consists, predominately, of UDP/IP unicast and multicast packets. IP multicast traffic generated in an EtherNet/IP network is a high-rate, short-packet traffic generated on a continuous basis. For this reason, EtherNet/IP networks differ considerably from typical office networks, where IP multicast traffic is generated sporadically and with much lower packet rates.

When an EtherNet/IP sub-net is connected to a plant network and propagation of multicast packets through this network is not blocked, it may cause a multicast storm of messages that will degrade the plant network performance. Rockwell Automation[1] has provided the following recommendations In order to optimize network performance when using EtherNet/IP:

1. Minimize device load due to unwanted IP multicast traffic. Depending on sub-net configuration and required device connectivity, this objective can be achieved using Ethernet switches supporting virtual LANs (VLANs) and IP multicast routing.
2. Minimize switch load due to unwanted IP multicast traffic. Use full duplex, managed industrial network switches capable of IGMP (Internet Group Multicast Protocol) snooping, port mirroring, VLAN set-up, SNMP statistical information, IP address blocking, auto-restore of configurations, per port broadcast and multicast storm control, spanning tree protocol, and frame prioritization.
3. Minimize network load due to unwanted incoming IP multicast traffic.
4. Block IP multicast traffic generated within the EtherNet/IPTM sub-net from propagation into the plant network.

Other networking hardware, such as cabling, designed to withstand the harsh environments found in many plant applications must be used. Network cable connectors with IP67 environmental ratings and extended temperature ratings to 80C are preferred. CAT6 or shielded twisted pair (STP) cabling must be used in high noise environments. Proper grounding of the cable shield in important in order to avoid ground loops.

The following considerations should be taken into account when determining if EtherNet/IP is the right network solution for a given application[2]:

- The number of nodes per segment
- The size of messages.
- The frequency of messages.
- Message traffic patterns.
- The events that trigger production of messages.
- The tolerance of the application to delayed message delivery due to a congested network.

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[1] UTILIZATION OF MODERN SWITCHING TECHNOLOGY IN ETHERNET/IP™ NETWORKS, Anatoly Moldovansky, Rockwell Automation

[2] General Recommendations for EthernNet/IP Developers, ODVA, Jan. 28, 2005

Further network design and installation support can be obtained from one of the Ethernet/IP assistance providers listed on the ODVA website.

Network Design Considerations – ControlNet:

Many of the same design considerations for EtherNet/IP also apply to ControlNet networks. Additionally, Rockwell Automation provides the following ControlNet guidelines[3]:

- For optimal network performance limit the number of nodes to 40
- Follow recommended layout and installation procedures, such as choosing the correct type of RG-6 quad shield cable and IP65 or IP67 connectors, based on the application – see the Rockwell ControlNet Coax Media Planning and Installation Guide, CNET-IN002.
- Design for at least 400 Kbytes of available, unscheduled network bandwidth
- To reduce the impact of network timing changes, place each CPU and its respective I/O on isolated ControlNet networks.
- Place shared I/O and produced/consumed tags on a common network available to each CPU that needs the information.

Further ControlNet network design and installation support can be obtained from Rockwell Automation or a Rockwell Automation Solution Provider – see http://www.rockwellautomation.com/integrators/index.html

[3] Rockwell Automation Publication 1756-RM094A-EN-P, May 2004