CAN Network Loading with Copley CANopen

Introduction

CAN Network loading calculations can be used as a first approximation of how many axes can be handled on a CANopen network.

Sr. Copley Firmware Engineer *"Unlike other networks, CAN is able to handle high bus loading. It is safe to make use of 80% of the CAN bus bandwidth."*

CANopen network bandwidth

CAN network overhead

Standard format (11 bit ID) has 48 bits of overhead for each CAN message transmitted. This includes the message ID, CRC, etc. Extended format (29 bit ID) has a total of 68 bits of overhead for each message. There's very little reason to use this type of message when working with CANopen since all the standard CANopen messages are 11-bit. Note that these numbers are the size of a message with no data. Some information is still conveyed since the message ID is included in the overhead. Each message can also include from 0 to 64 bits of data.

Copley CANopen network bandwidth use

This is for a Copley system with typical settings. Calculation approximations are in bits/sec and including the CAN network overhead. It would of course be unwise to count on 100% bus utilization, but bus loading is safe to count on 80% assuming the master controller can keep up.

Synchronization overhead: This allows us to synchronize the axes. It costs the same for 1 axis or 127.
~ 4800   SYNC message @ 10ms
~ 800   High Res. time stamp: PDO w/ 32 bits data @ 100ms
+ -------
~ 5600 bits/sec

Node guarding overhead: (per axis)
~ 480   RTR message from master @ 100ms
~ 560   Response w/ 1 byte data @ 100ms
+ -------
~ 1040 bits/sec

Status information: (per axis). Not required, but many customers like to feedback position & velocity for display.
~ 1120   PDO w/ 8 bytes data @ 100ms
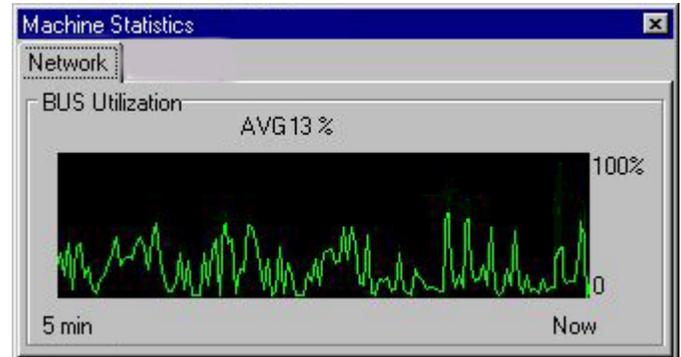
Image of typical CAN bus monitor screen with 32 simple axes.

Simple point-to-point move: (per axis) This is the overhead per move, so an assumed average of 1 move/second is reasonable (even conservative) for most applications.
~ 1568   7 SDOs, each with up to 7 bytes of data: Position, vel, acc, jerk (or decel), config, control, status

Complex PVT move using 10ms PVT segments: (per axis)
Note that 10ms segments is probably overkill. Most applications would work with 50ms or 100ms.
~11200   100 PDOs each w/ 8 bytes of segment data
~ 8000   100 PDOs each w/ 4 bytes of status info
+ ------
~19200 bits/sec

Total for each simple axis point to point moves:
~ 1040   Node guarding
~ 1120   Status info
~ 1568   Move SDOs
+ ------
 ~3728 bits/sec   Approx 0.4% of 1Mbit bus per axis.

Total for each complex axis PVT segments at 10ms
~ 1040   Node guarding
~ 1120   Status info
~19200   PVT profiles
+ ------
~21360 bits/sec   Approx 2.2% of 1Mbit bus per axis

–Provided by Copley Engineering

A system that uses simple point-to-point moves on all axes will be able to handle the full 127 axes allowed by CANopen and only use around 50% of the bus bandwidth at 1Mbit. This assumes that all axes are moving at an average of 1move/second.

A system that runs 30 complex axes all moving at the same time with 10ms PVT segments requires less then 70% of a 1Mbit bus.