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How to Configure and Use System Detectors with icons®

Purpose

It can be a difficult task to configure and use System Detectors in ***icons***®[1] *(icons).* Not only are there many decisions, but some of the decisions can have a large effect on system performance and operation. This application note helps a qualified Technician or System User to choose applicable configuration parameters that supply reliable and useable data with minimum effect on the System Communications performance and other system operations.

Introduction

In the paragraphs that follow, you will find information about:

- Some of the many factors to consider when you set up System Detectors in *icons*
- Many of the System Detector configuration parameters
- How to use the System Detector configuration parameters.

At the end of this document is a procedure, in a Question-and-Answer flow chart, by which you can choose applicable configuration parameters and enter these parameters into the system.

System Detector Hardware

When you set up System Detectors, the first decision is what type of hardware to use in the field. Now, there are two main types of detection hardware:

- Inductive Loop Detectors and
- Video-based Wide-Area Vehicle Detection Systems, such as Autoscope®[2] (*Autoscope*).

Each of these types has its advantages and disadvantages.

Inductive Loop Detectors

To supply accurate information to *icons*, you must operate Inductive Loop Detectors in the **Presence Mode**. Both Traffic Responsive operation and LINKs use a Volume-plus-Weighted Occupancy algorithm in *icons*. Units that have only a "Count" or pulse-type output do NOT supply the Occupancy component, which may affect performance.

[1] ***icons***® is a Registered Trademark of Econolite Control Products, Inc.
[2] Autoscope® is a Registered Trademark of Image Sensing Systems and Econolite Control Products, Inc.

Video-Based Detection Systems

Both Traffic Responsive operation and LINKs use a Volume-plus-Weighted Occupancy algorithm in *icons*. Video-based systems generally do NOT provide accurate Occupancy values. The primary cause for this is that the physical factors involved (such as the height, distance, and angle of the camera and the size of the lens) make it difficult to define detection areas with a known and consistent physical size relationship. The *Autoscope* product does have an option to normalize the occupancy to the equivalent of a 6 X 6 Loop. However, if you use this option, it could impair or affect other functions and features in the *Autoscope*. For more details, call or e-mail your *Autoscope* Technical Support representative.

System Detector ID Numbering

System Detectors in *icons* are treated as separate Entities or Assets from the controller that physically supplies the data. Thus, each System Detector has a unique ID number in the 1 to 9999 range just like any other device in the system. One of the disadvantages from this distinction is in maintaining the relationship between a location (usually defined by the controller) and a System Detector defined in *icons*. Different agencies have developed many methods to assign ID numbers that help maintain the relationship between System Detector and Controller.

For small systems (with only a few hundred controllers), where each controller has 10 System Detectors or less:

1. Assign a 3-digit ID number for each controller.
2. Assign 4-digit System Detector ID numbers where:
   - The first 3-digits are the controller number and
   - The last digit, 0 through 9, identifies the specific System Detector.

System Detector Primary and Secondary Names

During the System Configuration process, as with other Entities in *icons*, you also enter a Primary and Secondary Name in each System Detector. Each field is limited to 35-characters. However, because the Secondary Name is NOT in all forms and reports, we strongly recommend that you put as much information as possible in the Primary Name, and include (if possible) their Controller ID Number and physical detector number. Where possible, use standard abbreviations to help limit the length of the description to 35 characters.

EXAMPLE: SBLT L1 Main&5th #1234-15. This Primary Description is only 25 characters long, but identifies the movement (South Bound Left Turn), the lane (inner-most Lane #1), the Intersection and the Controller ID (1234) and the physical detector input on that controller (15). Then put any other information in the Secondary Name field.

Locating System Detectors within the *icons* System Configuration Tree

Like other Entities or Assets within an *icons* System, each System Detector is defined as a Child Node somewhere in the System Configuration Tree. The allowed options for a Detector are:

- Under the System Node
- Under a Zone Node
- Under a Section Node or
- A Child of a Controller (Signal).

This method may make it difficult to locate System Detectors within the Tree, unless you remember where they were put originally. For this reason, we recommend that you put System Detectors in one of two positions:

- In their own Section under a Zone Node or
- In the same Section as their parent controllers.

NOTE: We do NOT recommend you make the System Detector a Child of a controller.

Controller Physical Detector to *icons* System Detector Mapping

As part of the data entry when you define System Detectors in *icons*, it is necessary to define both the controller and its physical detector number. For example, so that *icons* could make the association between System Detector #1234 and Controller #9876, Detector #9. However, this mapping also depends on the communications protocol that the system uses.

When you use any of the different AB3418( ) Protocols, the mapping is a 2-layer process, divided between the Controller Programming and *icons*:

1. The Controller Programming maps a Physical Detector Input to one of 16 possible System Detectors.
2. *icons* maps the Controller System Detector to the *icons* System Detector.

EXAMPLE: A System Detector is connected to the Detector #9 input on Controller #1234. The controller programming makes the association between Detector #9 and its System Detector #3. When *icons* receives the Detector Data from the controller, it makes the association between Controller #1234, System Detector 3 and *icons* System Detector #9876.

When you use the NTCIP Protocol, the process is easier. With this, *icons* makes the association between Controller #1234, Detector 9 and *icons* System Detector #9876. However, when you use NTCIP, to get the correct Detector Data from the controller, it is necessary to define specific messages. These message definitions are part of the ITMS Relay INI file found on each Communication server computer.

Controller Coordinator Transition Times

Usually, both the ASC/2 series controller and the ASC/3 series controller Coordinators synchronize their Offset within three Cycles. However, under certain circumstances, it may take the Coordinator up to six Cycles to synchronize its Offset. If the Traffic Responsive Program changes Patterns more often than six times the longest Cycle length, we run the risk of having the controller always in Transition and **never** In-Sync. Other controllers may take fewer or more cycles to synchronize their Offset. Thus, the Traffic Responsive Period should **always** be **more than six times the longest Cycle Length**.

LINKs

A LINK in *icons* has two very different uses:

- A graphical display object that shows one of four traffic flow parameters in six color-coded levels.
- To accumulate combined traffic flow data by individual approach to an intersection when System Detectors are installed by-lane. This information would then typically be exported to a third-party analysis program such as Synchro®[3].

A LINK in *icons* can NOT be updated **more often** than the System Detector data used to generate the LINK.

EXAMPLE: If you were to set the LINK update interval to 5 minutes with a Detector Period of 10 minutes, there would be a valid LINK for 5 minutes after the Detector data update and an INVALID LINK for the next 5-minute interval.

System Detector Reports

Some System Detector Reports generated by *icons*, such as the Periodic Volume Report, list the Detector Volumes by Detector Period.

EXAMPLES: A 15-minute period produces 15-minute Volume counts on the report. A 60-minute period produces hourly counts on the report.

[3] SYNCHRO is a Registered Trademark of TrafficWare Corporation.

How *icons* Processes System Detector Data

The *icons* ATMS processes System Detector data by performing a data smoothing function over multiple valid[4] data samples that occur during the Detector Period. For example, a system may use a Detector Period of 15 minutes where each period is made up of 15 one-minute samples. This procedure allows for a certain number of "missed samples" due to communication errors or other interruptions, and will still produce valid data for the period by allowing *icons* to calculate a typical per-minute Volume and then produce a 15-minute value based on the per-minute value. Occupancy values are averaged together to yield the average Occupancy during the Detector Period. The table below shows this operation for a 5-minute period with five one-minute samples. To show how the system handles bad or missing data samples, two 'missing samples' are in red.

Sample	Volume	Occupancy	Speed
Minute #1	5	3.5%	N/A
Minute #2	9	3.0%	N/A
Minute #3	8	3.5%	N/A
Minute #4	3	3.5%	N/A
Minute #5	6	3.0%	N/A

Actual Data (includes missing)	31 in 300 Seconds	3.3% average	N/A

Calculated Value	(31.666 in 300 seconds) ≈ 32 Counts	3.333% Avg. ≈ 3.5%	69.369 MPH

In the above example, the three 'good' samples are averaged to yield the Occupancy for the Interval. The three valid Volume counts are also averaged to get a one-minute Volume value which is then multiplied by 5 (minutes) to get the calculated 5-minute Volume. The resulting 31.666 counts would then be rounded to the nearest whole number (32 counts) and the 3.333% Occupancy would be rounded to the nearest ½ %[5] (3.5%). From the calculated Volume and Occupancy, a Speed is then calculated as:

$S = \sqrt{0.682 \times V \times L \times O}$ where:

S = Speed in MPH

V = Volume Count

L = Average Vehicle Length plus Loop Size, in feet

O = Occupancy in Seconds

[4] The Occupancy value returned by the controller to ***icons*** contains diagnostic information to validate the sample data. Refer to NTCIP 1202-2.3.5.4.2

[5] Occupancy is measured by the controller to the nearest ½% (refer to NTCIP 1202-2.3.5.4.2). *icons* will therefore round its values to the nearest ½ %.

When you substitute values you get:

$$S = \sqrt{0.682 \times 32 \times (15+6) \times (3.5\%\ of\ 300)}$$

$$S = \sqrt{0.682 \times 32 \times 21 \times 10.5)} = 69.369 \text{ MPH}$$

As you can see above, the greater the number of samples per Detector Period, the more accurate the results.

Select a Sample Period

When you select a sample period, there are several factors to consider, in the order listed below:

1. The maximum sample period that a controller can contain. Per the NTCIP Standard[6], this period is 255 seconds.
2. The maximum Volume Count that the controller can contain within the sample period. Per the NTCIP Standard[7], this value is 254 Counts.
3. The actual 'expected' traffic flow.
   EXAMPLE: There is a rural freeway where:
   - Vehicles are traveling at 70 MPH
   - Average spacing is three Vehicle Lengths
   - Average length is 15 feet per vehicle and
   - Detector Loop size is 6 feet.

   We could expect one detection every 0.6 second (110 feet/sec at 66 feet = 0.6 second). At this rate, the Volume count would exceed the 254 maximum in approximately 153 seconds. To make sure that it does not overflow and yield an error, we would need to 'sample' the data from the controller at least every 152 seconds.
4. The available communications bandwidth between *icons* and the controllers. The NTCIP messaging to get the System Detector Data from a controller can be very lengthy:
   - Two bytes per detector,
   - Two bytes general detector data and
   - NTCIP overhead.

   In most applications, getting the Detector Data every second or even every 10 seconds is just not possible. A final consideration is that the Secondary (Detector) messaging in *icons* is subject to being suspended or not included by higher priority operations such as Uploading and Downloading of the controller database. If a database Upload or Download is in progress when it is time for *icons* to sample the Detector Data, *icons* will NOT include the Detector Data and wait until the next scheduled interval.

[6] Volume-Occupancy Period – NTCIP 1202-2.3.5.2
[7] Volume Count – maximum of 254 counts, 255 = count overflow, NTCIP 1202-2.3.5.4.1

In summary, it is advantageous to have as many sample periods in a Detector Period as possible, subject to the available communications bandwidth to the controllers. Typical values that have given acceptable results on some systems are:

- A sample period of 60 seconds, which works very well with just about all Detector Periods, along with a Secondary Poll Period of 30 seconds or
- A sample period of 120 seconds with a Secondary Poll period of 60 seconds.

In all cases, the minimum recommended number of samples per Detector Period is five.

NOTE: In all cases, the sample period should be an integer divisor of the Detector Period and the Secondary Poll Period should be one-half the Sample Period. Having the Secondary Poll Period twice the rate of the Sample Period, allows for both communication errors and other system operations that might result in missed samples. Since each sample period data set, that is sent to *icons* by the controller, contains a Sequence Number[8], if *icons* receives two or more valid samples for the same sample period, it will discard the extra data samples.

Select an Allowable Error Parameter

Since *icons* uses multiple data samples over a Detector Period, it is necessary to define an Allowable Error parameter to use to determine if there are enough valid samples for *icons* to perform the Detector Period processing. For this, *icons* uses a percentage value that defines how many samples out of the total expected samples that may be bad or missing or invalid over the Detector Period and still perform the Detector Period processing.

EXAMPLE: In the example in the paragraph, *How icons Processes System Detector Data*, there were two 'missing' samples out of five total samples — in other words, 40% of the samples were bad and we still were able to get very valid data for that period.

Since this parameter is directly related to the Detector Period and Sample Period selections, there is no set rule for determining a reasonable value. The default value in *icons* is 50%.

[8] NTCIP 1202-2.3.5.1, Volume / Occupancy Sequence

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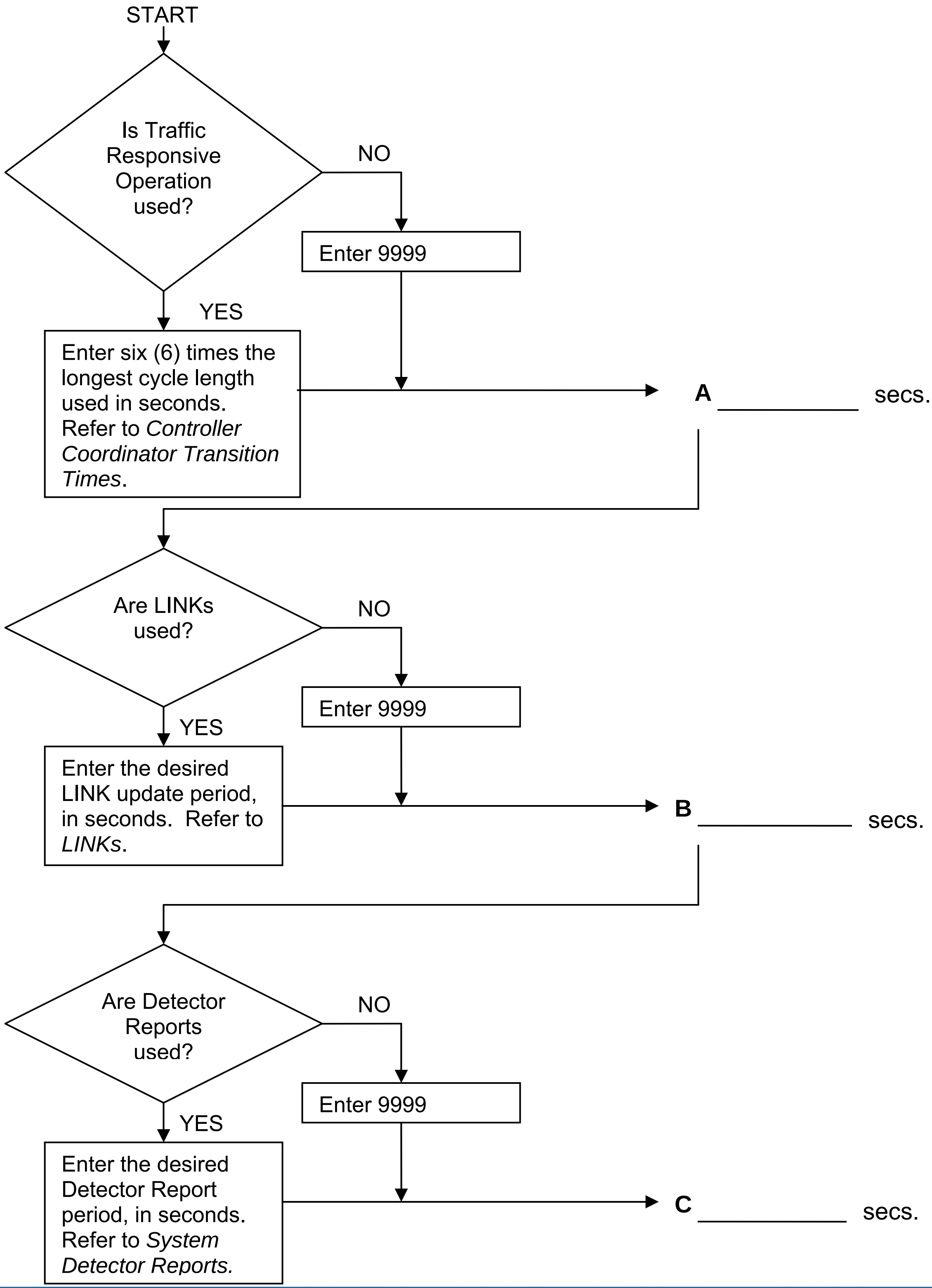

Choose the lowest value (A, B, or C) above and record it here. This is the maximum Detector Period (in seconds) that can be used:
__________________ secs.

Choose a Detector Period that is less-than or equal-to the value above. We strongly recommend you use an interval such as 5, 10, 15, 30 or 60 minutes (300 to 3600 seconds). Record the desired period here:
D: ___________

Choose the interval, in seconds, for ***icons*** to use to get the System Detector Data from a controller (60 or 120 seconds). Refer to *Select a Sample Period*.
Record the desired interval here: **E**: ___________

Decide how many Detector Samples can be missing or invalid and still continue processing the Detector Data. Refer to *Select an Allowable Error Parameter*.
Record the desired percentage here: **F**: ___________

What is the average vehicle length for the system area? This is a global setting for all ***icons*** System Detectors and is used for calculating speed.
Record the Average Length here: **G**: ___________

What is the Detector Loop Size (Diameter) used for System Detectors? This is a global setting for all ***icons*** System Detectors and is used for calculating speed.
Record the size here: **H**: ___________

Edit the DM.INI file located on the File Server computer, C:\Program Files\Econolite\Icons\Bin folder:
Select the desired Units of Measurement, either a 0 or a 1.
Note: this selection only tells ***icons*** how to deal with the following entries only. It is NOT used anywhere else in the system.
Enter the value from "D" above for the CollectionTimePeriod value.
Enter the value from "F" above for the CollectionErrorThreshold value.
Enter the value from "H" above for the DetectionZoneLength value.
Enter the value from "G" above for the AverageVehicleLength value.
Save the modified file then Stop and Re-start the DetectorMapper service.

Edit the ITMSComm.INI file located on each COMM Server computer, C:\Program Files\Econolite\Icons\ITMS Communications folder:
For each Channel where System Detectors are used:

1. Enter one-half the value from "E" above for the SecondaryPollPeriod value.
2. If using NTCIP for the communications protocol, enter NTCIP_SEC for the SecondaryPollMessage entry.
   If using AB3418( ) for the communications protocol, enter AB3418_DD for the SecondaryPollMessage entry.
3. Enter STAGGERED for the SecondaryPollMode entry.
4. Save the modified file.
5. Stop and Re-start the ITMS Communications service.

Edit the ITMSRelay.INI file located on each COMM Server computer, C:\Program Files\Econolite\Icons\Bin folder:

1. Enter the value from "E" above for the VOS_Period value in the NTCIP Setup section.
2. If using NTCIP as the communications protocol, create the necessary "packets" to be used for getting the System Detector data from each controller.
3. Edit the NTCIP_Secondary_Polling_Message section.
4. Define which packet is used for each controllers System Detector data.
5. Save the modified file then Stop and Re-start the ITMS Relay service.