Defining Traffic with N2X

Agilent N2X

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Application Note
Preface

The Agilent N2X helps you build up real-world network traffic scenarios in just a few simple steps.

Defining traffic is an essential part of the network equipment testing process. Network equipment manufacturers should measure the performance of their products by testing traffic forwarding, policing, and QoS with different protocol encapsulations. Service providers select network equipment by testing them under rigorous conditions. With a test tool that defines realistic traffic, discovering the weaknesses of network equipment is much easier.

The rising number of protocols and the increasing complexity of network traffic require easy, realistic and flexible ways to define traffic. The Agilent N2X is capable of generating a traffic load and variety that resemble real-world scenarios, and it has many easy-to-use features that help improve and accelerate test processes.

N2X enables users to build multi-layer Protocol Data Units (PDUs) from a wide range of predefined protocols, or even write their own proprietary protocols with Extensible Markup Language (XML), to perform a test. While the traffic is running, you can observe real-time measurements on a per port, per stream, or per field basis. The N2X’s PDU Builder is a flexible software tool for creating PDUs. A key feature is that it can easily generate a series of values by applying a modifier to certain fields, such as specifying a range of IP addresses. This application note provides an illustrated tutorial on how to define and modify traffic on the N2X.
Introduction

Features of the N2X PDU Builder

A powerful component of the Agilent N2X, the flexible PDU Builder offers you the following advantages:

- Quickly create multi-layered PDUs (Layers 2 – 7) containing multiple standardized or user-defined encapsulations for traffic generation and analysis.
- Edit any PDU field, then check its value in the received traffic to verify your device’s implementations. You can also edit PDU payloads, or you can select an auto-fill option. PDUs can be saved and restored.
- Conduct negative testing using unexpected protocol encapsulations, incorrectly formatted PDUs, illegal field values, and all combinations of Layer-2/Layer-3 PDU lengths and addresses.
- Create millions of flows or thousands of separate, measurable streams by applying a field modifier to generate a range of values. N2X can report statistics on individual or aggregated ports, streams or special fields.
- Use linked field modifiers to generate traffic based on many combinations of field modifiers.
- Test a new protocol under development or a custom PDU format with the PDU builder’s powerful XML capabilities.
- Stretch a PDU to a specified length. N2X automatically adjusts all necessary field values.
- Quickly duplicate any stream/profile.
- Build up to 15 individual traffic profiles per port, then change the offered load of each while sending traffic to see the immediate effect on throughput, latency, and other performance measurements.

Some Traffic Definitions

Here is a hierarchical view of test traffic on the N2X traffic generation and analysis application:

```
Port traffic
  Profiles (15 per port)
    Stream groups (1,023 - 4,095 per port)
      Streams (32,768 per port)
        Flows (millions per stream)
```

Figure 2: Test Traffic on the N2X

- Traffic consists of Layer-2 PDUs, Layer-3 PDUs, or any custom PDU defined in an XML file.
- A profile refers to how the traffic is sent (constant or bursty), the traffic load, and the number of frames to send (continuous or a specific number). You can use the slider bar on the GUI to dynamically change a profile’s offered load while you observe the effect on performance.
- A stream group is a set of streams with a common PDU header type and PDU length distribution. You can edit the PDU header or payload from the stream group’s packet template, or you can apply field modifiers to generate a range of values.
A stream can be either a single flow or a set of flows with a unique stream ID. When you vary a field’s values with a field modifier, you have the choice of generating only one stream, or a separate measurable stream for each value. Statistics are collected on a per-port, per-stream or per-field (such as VLAN ID) basis.

A flow is traffic with a unique PDU header (i.e. specific header field values).
How to Use N2X PDU Builder To Define Traffic

Select test modules and ports

1. On the Port Selection dialog, select the cards you want to use for the test.
2. Select ports.
3. Click OK to apply selection

![Figure 3: Selecting the cards and ports](image)

Tip: You can select/deselect a card to select/deselect all ports on the card.

Defining PDUs

Step 1: Create a stream group

1. In the Main View Traffic area, select the port from which to send traffic.
2. Right click a profile and select New Stream Group.
3. Double click the stream group to open the PDU builder’s Stream Group Properties dialog.

![Figure 4: Stream Group Properties dialog](image)

Tip: You can define 15 traffic profiles per port, and up to 1023 – 4095 stream groups per port, depending on the port type.
Step 2: Configure the traffic type and length

1. Click here to access the General tab.
2. Specify the number of times the transmitter sends each PDU in the current stream group before moving to the next stream group in the profile.
3. Important: The “insert test payload in packets” option, adds 20 bytes of test information to the payload and must be enabled if you want to gather stream-level statistics for the stream group.
4. Specify the type of PDU (Layer-2 or Layer-3) and its length.
5. Specify whether PDUs have a fixed length (None) or a range of incrementing, decrementing, or randomized lengths.
6. Important: You must indicate the port(s) on which the traffic is expected to enable stream-level statistics.

![Figure 5: Specify PDUs length](image)

Step 3: Create protocol encapsulations

1. Click here to access the Packet Template tab.
2. Create a new PDU.
3. Add, change, delete a protocol, or repeat a field of the PDU.
4. Vary the value of a field of interest by adding a field modifier.
5. Expand to view all encapsulations and fields.
Enable/Disable viewing the entire PDU in hexadecimal format.

Tip: The Packet Template tab contains N2X’s PDU builder, where you can define the structure and contents of the PDUs to be transmitted.

Example Encapsulating a protocol layer

For each protocol you want to add...
1. Click the Add Protocol button.
2. Select the protocol to add.

![Add Protocol](image)

**Figure 8:** Select the protocol to add

3. New encapsulated layer

![StreamGroup 1 Properties](image)

**Figure 9:** Properties window

**Tip:** The number of layers you can encapsulate is limited only by the length of the PDU. You can add protocol layers in any order, or create multiple instances of the same protocol in non-standard ways to enable negative testing.
Example Replacing an entire PDU

1. Click the New Packet button.

![Figure 10: Selecting the new packet type](image)

2. Select the Layer-2 encapsulation for the new PDU.

3. Select the new packet type.

![Figure 11: Selecting the new packet type](image)
4. New encapsulated PDU in place of old one.

![StreamGroup 1 Properties](image)

*Figure 12: Replaced PDU*
Step 4: Edit PDU fields

Overview: Editing and modifying fields

1. Apply a field modifier to vary the value of a header field of interest. Modifiers can increment, decrement, or randomize a range of values. You can also create a custom list of field values.
2. Select Override to modify the default value – very useful for negative testing.
3. Define a fixed field value for all packets in the stream group, or apply a field modifier to vary the field’s value within the PDU.
4. Indicates the total length of the frame/packet, the number of field modifiers and the number of streams defined in the stream group (if applicable).

Example Applying a field modifier and creating separate streams

Tip: A flow is traffic with a unique PDU header. A stream is a set of flows with a unique stream ID. Field modifiers allow you to quickly generate multiple streams or one stream with multiple flows. Since statistics are usually measured on a per-stream basis, you should generate multiple streams when you want to measure the result of each field value on the device’s performance.

1. Select an editable header field.
2. Select the type of field modifier.
3. Type the required parameters for the field modifier.
4. Choose Yes to generate separate streams for each field value, or choose No to generate one stream with separate flows for each field value.

You can use up to four field modifiers in the packet template.

Example Linking field modifiers together

1. Click Packet Preview to preview the packet format.
2. Apply field modifiers to the Source Address and the Destination Address fields. See previous page for details.

For convenience of illustration, we set the count of both fields to 5.
Observe that the pairs (192.1.x.2, 192.2.x.2) are always together. When the two modifiers are independent, their field values have a one-to-one relationship. When the modifiers are linked, streams will be created for all combinations of values.

Figure 16: Packet preview window

Tip: The diagram in Preview shows the pattern of the resulting streams.

3. Right click Source Address, choose Field Modifier Options.
4. Choose Linked.

![Figure 18: Select linked](image)

Tip: Link order can be changed. Choose Selected fields to manipulate the sequence of the fields.

5. Close the dialog.

![Figure 19: Field Modifier dialog box](image)

6. Observe that there are $5 \times 5 = 25$ streams in StreamGroup 1 now. Click Packet Preview to preview the packet format.

![Figure 20: Preview the packet format](image)
The packets now contain all possible source-destination address combinations of (192.1.x.2, 192.2.y.2) in the specified order.

Example Customizing the location of a field modifier in the PDU builder’s Advanced tab

Tip: The Advanced tab provides greater flexibility by allowing you to apply a field modifier to one or more contiguous bits located anywhere within the first 256 bytes of the PDU, regardless of normal field boundaries. The maximum size of this custom field is 32 bits.

1. Select the type of field modifier to apply (Increment, Decrement, Random, or List).
2. Type the offset, the length of the field, the starting value for the range, the starting value of the range, and the step with which to increment or decrement the values.

The offset is the starting location of the custom field within the packet header. It can be from 1 to 2048 bits, where 1 indicates the most significant bit of the first byte of the packet header template.

The To field is automatically calculated when you type values for the From and Count fields and press Enter. If you select a modifier other than Increment or Decrement, the Count and Step fields do not apply.
Step 5: Save the PDU to file

Tip: When you save a test session from the Main View menu’s Session -> Save, all defined PDUs will be saved along with other configurations. However, you can also save a single PDU definition, as illustrated below.

1. Right click the root node of the PDU tree.

   Tip: Right click the root node of the PDU tree and select Open to open a saved PDU file. The PDU you open will replace the existing PDU.

2. Select Save.

   ![Figure 23: Selecting “Save” to replace the existing PDU](image)

3. Type a file name and save to the desired directory as a PDU file.

   ![Figure 24: Name and save as a PDU file](image)
Creating custom protocol definitions

All protocol definitions and PDU formats are stored in external Extensible Markup Language (XML) files, which are automatically loaded each time you start N2X. You can also create your own definitions to test your device with newly-evolving protocols or customized formats.

Step 1: Write the new protocol description in XML

For more information about writing XML protocol definitions for the PDU builder, N2X includes a tutorial entitled “Writing XML Files for the Generic PDU Builder” in

<Drive>:\Program Files\Agilent\N2X\<SessionType>\<version>\protocols\doc\xml_intro.pdf

Step 2: Save the XML file in Agilent’s UserProtocols directory

The protocol definitions (XML files) provided by Agilent are found in

<Drive>:\Program Files\Agilent\N2X\<SessionType>\<version>\protocols\doc\xml_field_ref.htm

Important: Although these files can serve as a good model to create your own definitions, the Protocols directory is intended only for Agilent XML files. To avoid your custom files being overwritten or deleted when you install new versions of the software, you should store these files in

<Drive>:\Program Files\Agilent\N2X\<SessionType>\UserData\UserProtocols

Custom XML files must have a unique name within the application.

Step 3: Launch N2X

N2X automatically loads XML files from both the Protocols and UserProtocols directories each time you start it. Any new XML files you place in the UserProtocols directory will also be loaded.

If you add a new XML file while N2X is running, you may have to restart N2X for the file to load.

In this example, we have created an XML file that describes a custom protocol called MyProtocol in the UserProtocols directory.

Step 4: Open the PDU builder’s StreamGroup Properties dialog

For detailed instructions, see Figure 5.
Defining Traffic with N2X

Step 5: Select the new protocol from the Packet Template tab

1. Click the Add Protocol button.

   ![Figure 25: Add Protocol button](image)

2. Select the custom protocol.

   ![Figure 26: Selecting the custom protocol](image)
Custom protocol layer.

Defining traffic profiles

A traffic profile defines the traffic load, how the traffic is sent (constant or bursty), and the number of frames to send (continuous or an exact number). Each port can contain up to 15 traffic profiles.

**Example** Defining profile properties

1. Double click the profile.
2. Select the traffic type.
   Constant gives an even traffic load. Bursty sends traffic in bursts.

3. For bursty traffic, specify the burst length and load.
   You can increase the Burst IDT (inter-departure time) by decreasing the average load or increasing the burst length.

4. Select the traffic mode.
   Single shot mode requires a manual start each time you send the PDUs.

5. Specify the traffic load in percentage value, frame/s, Layer-2 Mb/s or Layer-3 Mb/s.

![Profile 1 Properties](image)

**Example** Changing the traffic load dynamically

**Tip:** You can change the traffic load of any profile while the test is running. The traffic load applies to all the stream groups in the profile. However, if you want to add/remove stream groups or modify stream group properties, you must first stop the traffic by clicking the Traffic button.

1. Start the traffic.
2. Select one or more profiles. You can use Ctrl + Left click to select multiple profiles and change their traffic loads simultaneously.
3. Move the slider bar to increase or decrease the load.

Tip: Stream check boxes allow you to enable or disable individual stream groups at anytime. By deselecting the profile, you can disable all stream groups at once.

**Example** To control traffic load across multiple ports

Using the new Explorer view you can control the traffic load across more than one chassis, card, port, or profile at the same time. For example, you can select a chassis (to change the load across all cards/ports/profiles within that chassis), a port (to control the load on all profiles within the port), and an individual profile. In this example, you can change the load for each selection at the same time.

1. From the menu, choose View -> Options.

2. Figure 31: Select View -> Options
3. Select Explorer view.

4. Use Ctrl + Left click to select multiple chassis, ports and profiles in which you want to control the traffic load.

5. Position the traffic slider bar to the required position. The load is displayed next to each Port and Profile in the Explorer view.

6. **Figure 32: Displaying load in explorer view**

**Time-saving tips**

These short cuts show you how to minimize configuration time by manipulating stream groups and profiles on any port in your test.

**Example** Copying stream groups from one profile to another

1. Select the port.
2. Use Ctrl + Left click to select one or more stream groups on the source profile.
3. Right click and select Copy.

Tip: You can also duplicate streams by selecting Duplicate.

4. Select the target profile onto which the stream groups will be pasted.

5. Right click and select Paste.

Copied or duplicated stream groups have the same definitions as the originals.
**Example** Editing more than one stream group at a time

1. Select the port.
2. Use Ctrl + Left click to select multiple stream groups.
3. Right click and select Properties.

4. Make edits to all stream groups.

Tip: You can also Shift + Left click the first row and the last to select the rows in between.
Example: Editing more than one profile at a time

1. Select the port.
2. Use Ctrl + Left click to select multiple profiles.
3. Right click and select Properties.

4. Make edits to all profiles.

Tip: Simply click a cell displaying a PDU header field and edit it directly or add a field modifier with the new spreadsheet editing feature. The cell is editable when an I-beam cursor appears.
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Agilent N2X

Agilent's N2X multi-service tester combines leading-edge services with carrier grade infrastructure testing and emulation. The N2X solution set allows network equipment manufacturers and service providers to more comprehensively test new services end-to-end, resulting in higher quality of service and lower network operating costs.

Warranty and Support

Hardware Warranty
All N2X hardware is warranted against defects in materials and workmanship for a period of 1 year from the date of shipment.

Software Warranty
All N2X software is warranted for a period of 90 days. The applications are warranted to execute and install properly from the media provided. This warranty only covers physical defects in the media, whereby the media is replaced at no charge during the warranty period.

Software Updates
With the purchase of any new system controller Agilent will provide 1 year of complimentary software updates. At the end of the first year you can enroll into the Software and Support Agreement (SSA) contract for continuing software product enhancements.

Support
Technical support is available throughout the support life of the product. Support is available to verify that the equipment works properly, to help with product operation, and to provide basic measurement assistance for the use of the specified capabilities, at no extra cost, upon request.

Ordering Information
To order and configure the test system consult your local Agilent field engineer.

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