

Flexlink Lab Tutorial for BCU

1. Introduction

To help researchers quickly become familiar with the Aubergine switch and the Flexilink protocol, this document provides a clear and reproducible set of experiments. The tasks progress from basic management connection, switch-based forwarding, to transparent tunneling, and finally to preliminary fibre-port behaviour. Each experiment is designed to be straightforward to follow and to highlight the practical characteristics of Flexilink in real setups.

2. Preparation

2.1 Hardware identification & Software Requirements

We inspected all Aubergine units available in the lab. Six devices are currently present: **15, 16, 17, 25, 26, and 35**.

Among them:

Unit 17 is completely non-functional.

Unit 35 cannot be detected via Port 3 when using the maintenance-mode Controller as documented.

Therefore, only **15, 16, 25, and 26** are suitable for use in this lab.

For software, ensure you are running the latest Controller version (**3.1.0c** at the time of writing). Older versions may be incompatible with the hardware.

Likewise, confirm that each Aubergine unit is updated to the latest hardware image (**3-0-5-0** when this document was written).

2.2 Run-time Precaution

To use the Controller in **maintenance mode**, the end device must be connected to the Aubergine **via Port 3**.

According to the documentation, all network adapters except Ethernet should be disabled.

However, in practice we observed the following difference:

Manual IP assignment is not required — the Controller can still operate correctly without configuring a fixed IP for the PC, contrary to what the documentation states.

Finally, ensure that the system firewall allows the Controller program to access the network.

2.3 Adding or Removing Transparent Tunnels / Checking Hardware & Software Versions

See Appendix for details.

3. Experiments

This section presents a series of reproducible experiments designed to help researchers

understand the practical behaviour of the Aubergine switch and the Flexilink protocol. Unless otherwise stated, all experiments are performed by connecting the Controller PC to Port 3 of an Aubergine unit and running the Controller in maintenance mode.

Each subsection follows the same structure: Objective, Topology, and Result.

3.1 Experiment A — Direct Management Connection via Port 3

Objective

To verify that an Aubergine unit can be directly managed through Port 3, and to establish a baseline configuration for subsequent experiments.

Topology

PC → Aubergine (Port 3)

Result

- The Controller successfully discovers the unit.
- All management functions, including maintenance-level operations, work as expected.
- This confirms that Port 3 behaves as the dedicated entry point for maintenance-mode management.

3.2 Experiment B — Management Connection Through a Switch

Objective

To confirm whether an Ethernet switch affects the Controller's ability to reach an Aubergine unit on Port 3.

Topology

PC → Switch → Aubergine (Port 3)

Result

- The Controller can still discover the Aubergine normally.
- Passing through an L2 Ethernet switch does **not** interfere with Port-3-based management.

Extended Test

We also tested adding a second Aubergine behind the first one:

PC → Switch → Aub1 (Port 3) → Aub2 (Port 4)

Aub2 becomes visible in the Controller's device list. This extended case is not discussed in detail, as its behaviour aligns with expectations from the 2023 Flexilink extension.

3.3 Experiment C — Exploring IP-over-Flexlink Tunneling (Transparent Tunnel)

Objective

To evaluate whether Transparent Tunnels can bridge two Ethernet segments and allow end-to-end communication between PCs behind separate Aubergine units.

Topology

PC1 → SW1 → Aub1 (Port x) —— Transparent Tunnel —— Aub2 (Port x) → SW2 → PC2

Result

- After configuring the tunnel on both units (maintenance mode required), the link

- becomes active. See how to configure Transparent Channel at Appendix
- **PC1 and PC2 can successfully communicate at L2**, e.g., ICMP ping works normally.
- As expected, the Transparent Tunnel forwards only Ethernet traffic.
 - It does **not** forward Flexilink control-plane or management messages.
 - The Controller therefore cannot discover additional units beyond the directly attached Port-3 device.

This confirms that Transparent Tunnels act as pure L2 bridges and do not extend Flexilink discovery or management domains.

3.4 Experiment D — Fibre Port Behaviour (Preliminary, Not Completed)

Objective

To observe the behaviour of ports 10/11 (SFP) when two Aubergine units are connected via fibre, and to check whether the ports transition into Flexilink physical-link mode.

Topology

Aub1 (Port 10/11) → Fibre Link → Aub2 (Port 10/11)

Current Status

This experiment could not be completed due to SFP compatibility issues:

- The Controller reports errors such as
“*Fail to set I2C register address for SFP module*”.
- Ports 10/11 remain inactive and do not enter Flexilink MAC mode.
- Fibre-based Flexilink links therefore could not be validated.

This test will be revisited once compatible SFP modules are available.

4. Interpretation for Typical Problems

This section provides concise explanations for several common observations during the experiments. The focus is on the underlying mechanisms relevant to this document.

4.1 Physical vs Virtual Connections, and Guaranteed vs Normal Flows

In Flexlink, **physical links** (Flexlink MAC) and **virtual links** (Ethernet/UDP encapsulation) behave fundamentally differently.

Likewise, Flexlink traffic is divided into:

- **Guaranteed-service flows** – tightly scheduled, low-latency, only available on physical links
- **Normal-service flows** – best-effort traffic, used on both physical and virtual links

Because the **management session** (including maintenance mode) relies on control-plane signalling that behaves like a normal-service flow, its reachability depends entirely on the type of link in use:

- **Physical links** support full Flexlink signalling and allow the Controller to discover other units within the same island.
- **Virtual links** and **transparent tunnels** only forward Ethernet frames and do **not** forward Flexlink control-plane flows.

Therefore, when a PC runs the Controller in **maintenance mode**, it can only discover:

1. The Aubergine directly reachable through **Port 3**, and
2. Any additional units connected through **physical Flexlink links**,
but **cannot** discover units behind virtual links, routers, or transparent tunnels.

This explains why maintenance mode does not traverse broadcast domains and why discovery stops at the first Flexlink-island boundary.

4.2 Interpretation of LED Indicators

A full explanation of LED states is provided in the Appendix (see LED table and screenshots).

Here we only supplement the cases relevant to **transparent tunneling**, because they differ from normal Flexlink behaviour:

Left LED	Right LED	Meaning (Transparent Mode)
Off	Green (flashing)	Link is down
Off	Red	Link is up, but the tunnel is not connected
Red	Red	Link is up and the tunnel is connected

In addition, due to historical or unknown configuration states preserved in the hardware, the LED behaviour during link-up is **not always strictly aligned with the documentation**.

For example, in Experiment A (PC connected to Port 3), the indicator may appear as **left green / right yellow, or left red / right green**.

This variation is likely caused by **different port priorities or internal state transitions** and does not indicate an error.

These behaviours are expected and may persist until the port returns to a clean configuration or the device is fully reinitialised.

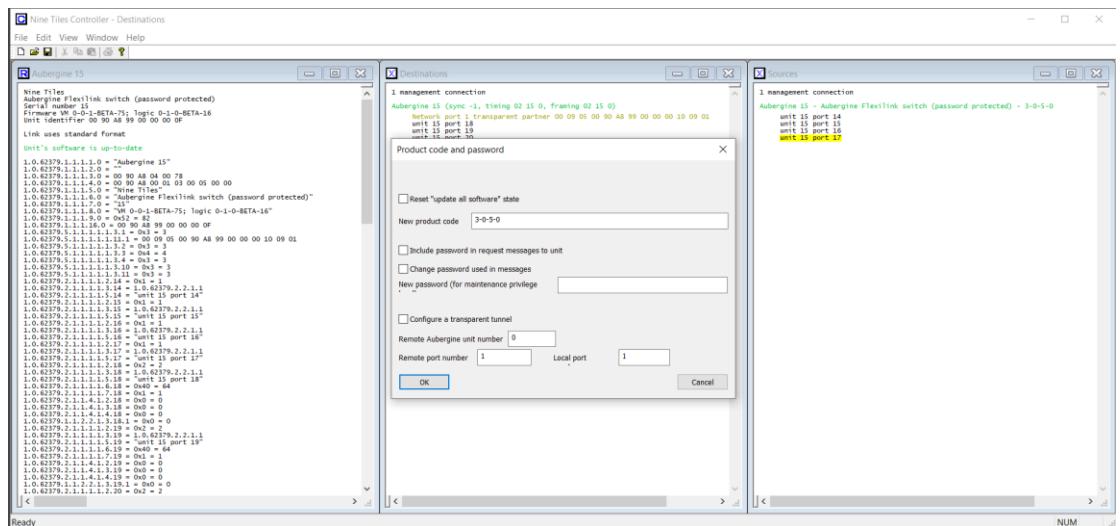
5. Appendix

Updating Product Code

To update a unit's product code:

1. Connect the PC directly to the Aubergine via port 3.
2. Run Controller.exe in maintenance mode (create a shortcut with **-maintenance appended**).
3. In the Destinations window, right-click the green-labelled Aubergine unit.
4. Select Update product code, then enter the new value.

This operation requires maintenance privilege and can only be performed when the Controller is directly connected to port 3.



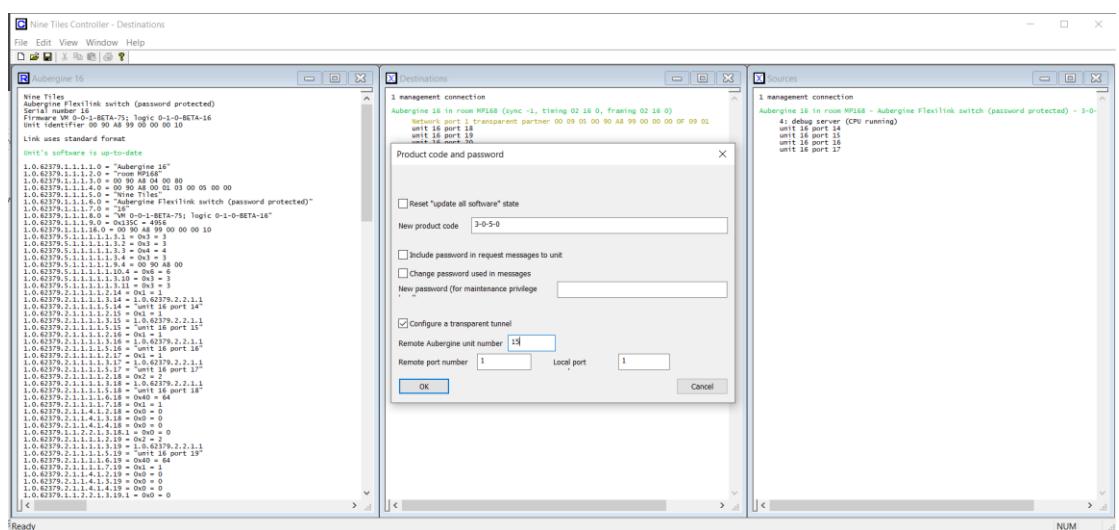
2 Configure Transparent Tunnel

Transparent tunnels allow two Ethernet segments to behave as if directly connected across a Flexilink cloud.

Configuration requires maintenance level.

How to Configure

1. Right-click the Aubergine unit name (green text) in the Controller (maintenance mode).
2. Tick Configure a transparent tunnel.
3. Fill in:
 - o Remote unit number
 - o Remote port number
 - o Local port number
4. Click OK.



The selected local port immediately enters transparent mode and begins attempting the tunnel setup.

Per design:

- If the remote port is up and using the Ethernet MAC, the tunnel connects.
- If the remote port is down or in Flexilink physical-link mode, the call is rejected and retried every ~7.5 s.
- Configuring both ends is safer and ensures instant connection when the second link comes up.

(Ref: Transparent tunnels section)

Removing a Tunnel

Repeat the process above but set Remote unit = 0.

Remote port is ignored; the port returns to normal Ethernet/Flexilink behaviour.

Status in Controller

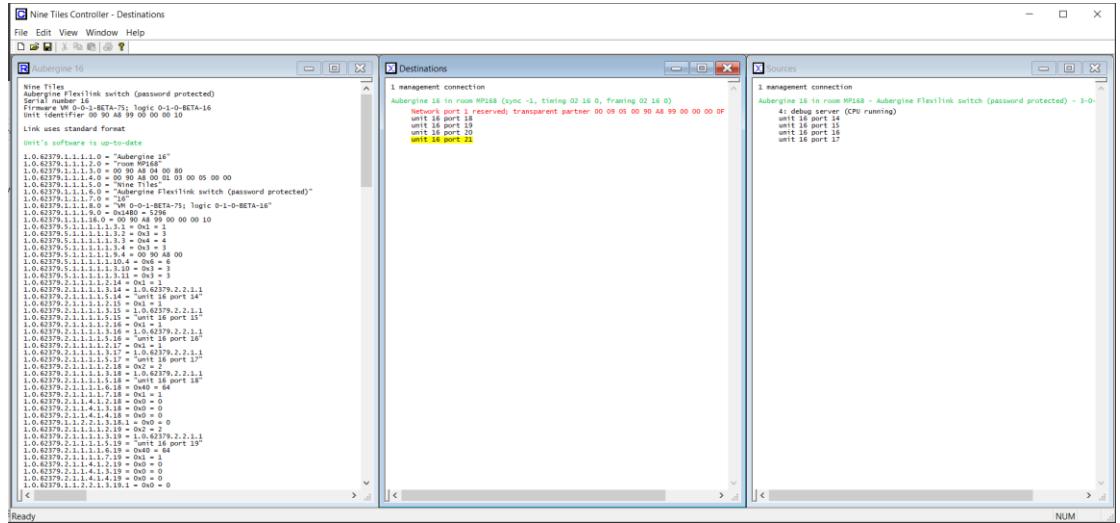
Ports involved in transparent tunnels show an entry in the Destinations window with:

- Partner address (unit + port)

- Colour status:

- Brown-yellow: link down
- Green: tunnel connected
- Red: link up but tunnel not connected

The diagram below shows the status of the controller after transparent tunnel configured successfully. The ports run the transparent tunnel would turn to red.



For the indicator, there are 3 behaviors:

Left Off, right Green: Link is down

Left Off, Right Flashing Red: Link is up, but no connection

Left Off, Right Red: Link is up and connected.