

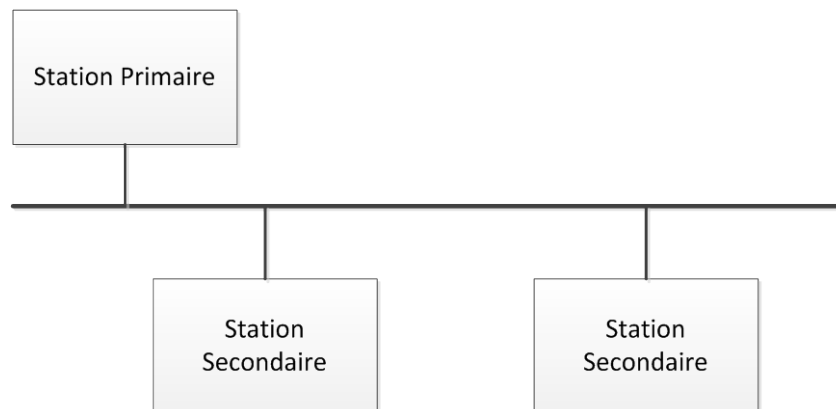


### CEG3585/SEG3555 – LABO 3

#### Le HDLC et le réseau multipoint

Objectifs: (1) se familiariser avec le réseau multipoint qui contient une station secondaire et plusieurs stations secondaires; (2) mieux comprendre l'importance et rôle des protocoles; (3) maîtriser le mécanisme de la fenêtre d'anticipation; et (4) étudier un protocole concret de la couche liaison de données, le HDLC.

Le réseau de ce se labo est réalisé en simulant la couche physique avec la programmation socket dans les classes `PhysicalLayer` et `PhysicalLayerServer`. Les entités de la couche liaison données sont réalisés par la classes `PrimaryHDLCDataLink` et `SecondaryHDLCDataLink` tel que présenté dans le tutorat trois. Les classes `PrimaryStation` et `SecondaryStation` représente les applications qui utilisent le service de la couche liaison de données pour échanger un message. Le réseau comprend 3 stations, une station primaire et deux stations secondaires branchées par une liaison multipoint.



Votre tâche est de compléter la méthode `dlDataRequest()` dans la classe `SecondaryHDLCDataLink`. Toutes autres méthodes des classes sont complètes. La méthode `dlDataRequest()` permet à la station secondaire d'envoyer un message à la station primaire avec plusieurs trames-I du HDLC. Voici des consignes pour compléter votre tâche :

- 1) La reprise d'erreur n'est pas considérer. Donc le champ FCS n'est pas inclus dans la trame-I et les trames REJ et SREJ ne sont pas utilisées.
- 2) Le champ de données (information) de la trame-I est limité à 32 octets (défini par la constante `HdlcDefs.MAX_DATA_SIZE_BYTES`). Le message à transmettre doit donc être diviser et transmit en plusieurs trames-I. La méthode `BitString.splitString()` permet de séparer une chaîne de caractères (`String`) en morceaux (produit un tableau de `String`s`).
- 3) La variable `vs` détermine le numéro de séquence pour la prochaine trame-I à transmettre. Elle est incrémentée après la création/transmission de chaque nouvelle trame-I. Pour circuler à travers les

numéros de séquences, utilisé l'opération modulo avec `HdlcDefs.SNUM_DATA_SIZE` qui donne le nombre de numéros de séquences.

- 4) Une fenêtre d'anticipation est utilisée avec une taille de fenêtre 4 (définie dans la variable `windowSize`). Le bord droit de la fenêtre est défini par `rhsWindow` qui donne le numéro de séquence juste à droite de la fenêtre; donc la variable `vs` (le prochain numéro de séquence valide) ne doit pas être égale à `rhsWindow`. Le bord gauche de la fenêtre (le premier numéro de séquence dans la fenêtre) peut être déterminé à partir de `rhsWindow` :
  - a. Si  $\text{rhsWindow} - \text{windowSize} \geq 0$ , alors le bord gauche = `rhsWindow - windowSize`
  - b. Autrement le bord gauche = `rhsWindow - windowSize + HdlcDefs.SNUM_SIZE_COUNT`.
- 5) La classe `HdlcDefs` contient des constantes pour faire la mise en trame ainsi que faire l'extraction des champs de trames reçues. Vous avez vu comment ces constantes sont utilisées au Tutorat 3.
- 6) Pour transmettre le message (référé par `sdu`), la station secondaire devrait :
  - a. Attendre une sonde (trame-RR avec le bit P/F = 1) avant de transmettre les trames-I.
  - b. Divisez le message en morceaux de 32 octets (voir le point 2).
  - c. Traduire chaque morceaux en un `bitString` (voir la méthode `BitString.stringToBitString()`).
  - d. Dans une boucle :
    - i. S'il reste un morceau de message à transmettre et qu'un numéro de séquence est disponible, créer et transmettre une trame-I pour transmettre le prochain morceau de message (en bits), ajouter la trame au tampon de trames `frameBuffer`, et mettre à jour la variable `vs`;
    - ii. Si une trame RR est reçue (utilisez la méthode `getFrame(true)` pour interroger la couche physique pour une trame), extraire le numéro d'acquittement et ajuster la fenêtre d'anticipation (la variable `rhsWindow`), et enlever le nombre approprié de trames du tampon `frameBuffer`.
    - iii. Après la transmission d'une trame-I et la réception d'une trame-RR, exécuter la méthode `displayDataXchngState` qui affichera les valeurs de `vs`, `vr`, les bordures de la fenêtre d'anticipation et le nombre de messages dans le tampon `frameBuffer`. Les appels appropriés sont déjà présent dans le code fourni. Voir la sortie des stations secondaires dans l'annexe.
    - iv. Rester dans la boucle sous les conditions suivantes : il existe un morceau de message à transmettre, il existe une trame-I à acquitter (le tampon de trames n'est pas vide).
- 7) Quelques indices pour réaliser l'étape 6 :
  - a. Créer une méthode séparée pour détecter l'arrivée d'un trame-RR. La méthode devrait ignorer les trames autres que les trames-RR. La méthode devrait avoir un paramètre booléen qui a la valeur vrai si la méthode bloque jusqu'à l'arrivée d'une trame-RR (voir 6a) et faux pour interroger la couche physique l'arrivée de la trame-RR (voir 6d-ii). Un gabarit `getFrame()` est fourni.
  - b. Créer une méthode séparée pour déterminer à partir de `nr` (numéro d'acquittement reçu dans une trame-RR) le nombre de trames acquittées. Ce nombre est ensuite utilisé pour mettre à jour la fenêtre d'anticipation (`rhsWindow`) et enlever les trame-I du tampon `frameBuffer`. Un gabarit `checkNr()` est fourni.

## Annexe A – Sortie des programmes

Pour exécuter le logiciel fournie, ouvrez 4 fenêtres « cmd » et dans chaque fenêtre exécuter les commandes suivantes dans l'ordre donné et chacune dans une fenêtre différente :

- java PhysicalLayerServer
- java SecondaryStation 1
- java SecondaryStation 2
- java PrimaryStation

Vous pouvez examiner la sortie des programmes soit à l'écran, soit dans des fichiers si vous redirigez les sorties à des fichiers (e.g. java PrimaryStation >PrimLog.txt).

### Sortie de la Station Primaire (PrimaryStation)

```
-----Connection to Station 1-----
Primary Station: Requesting connection to station 1
Data Link Layer: prepared SNRM frame >01111110 00000001 11001001 01111110<
Physical layer: transmitted frame >01111110 00000001 11001001 01111110<
Physical layer: received frame >01111110 00000001 11001110 01111110<
Data Link Layer: received UA frame >01111110 00000001 11001110 01111110<
Primary Station: Received connect confirmation from station 1
-----
-----Connection to Station 2-----
Primary Station: Requesting connection to station 2
Data Link Layer: prepared SNRM frame >01111110 00000010 11001001 01111110<
Physical layer: transmitted frame >01111110 00000010 11001001 01111110<
Physical layer: received frame >01111110 00000010 11001110 01111110<
Data Link Layer: received UA frame >01111110 00000010 11001110 01111110<
Primary Station: Received connect confirmation from station 2
-----
-----Get Message from Station 2-----
Data Link Layer: sending RR frame (poll) >01111110 00000010 10001000 01111110<
Physical layer: transmitted frame >01111110 00000010 10001000 01111110<
Physical layer: received frame >01111110 00000010 00000000 01010011 ... 01101111 01111110<
Data Link Layer: received I frame >01111110 00000010 00000000 01010011 ... 01101111 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000001 01111110<
Physical layer: transmitted frame >01111110 00000010 10000001 01111110<
Physical layer: received frame >01111110 00000010 00010000 01110010 ... 01001000 01111110<
Data Link Layer: received I frame >01111110 00000010 00000010 00010000 01110010 ... 01001000 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000010 01111110<
Physical layer: transmitted frame >01111110 00000010 10000010 01111110<
Physical layer: received frame >01111110 00000010 00100000 01000100 ... 01110000 01111110<
Data Link Layer: received I frame >01111110 00000010 00100000 01000100 ... 01110000 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000011 01111110<
Physical layer: transmitted frame >01111110 00000010 10000011 01111110<
Physical layer: received frame >01111110 00000010 00110000 01101111 ... 01101001 01111110<
Data Link Layer: received I frame >01111110 00000010 00110000 01101111 ... 01101001 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000100 01111110<
Physical layer: transmitted frame >01111110 00000010 10000100 01111110<
Physical layer: received frame >01111110 00000010 01000000 01100011 ... 01101110 01111110<
Data Link Layer: received I frame >01111110 00000010 01000000 01100011 ... 01101110 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000101 01111110<
Physical layer: transmitted frame >01111110 00000010 10000101 01111110<
Physical layer: received frame >01111110 00000010 01010000 01100101 ... 01110000 01111110<
Data Link Layer: received I frame >01111110 00000010 01010000 01100101 ... 01110000 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000110 01111110<
Physical layer: transmitted frame >01111110 00000010 10000110 01111110<
Physical layer: received frame >01111110 00000010 01100000 01110010 ... 01110100 01111110<
Data Link Layer: received I frame >01111110 00000010 01100000 01110010 ... 01110100 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000111 01111110<
Physical layer: transmitted frame >01111110 00000010 10000111 01111110<
Physical layer: received frame >01111110 00000010 01110000 01110111 ... 01110011 01111110<
Data Link Layer: received I frame >01111110 00000010 01110000 01110111 ... 01110011 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000000 01111110<
Physical layer: transmitted frame >01111110 00000010 10000000 01111110<
Physical layer: received frame >01111110 00000010 00000000 01110011 ... 01100100 01111110<
Data Link Layer: received I frame >01111110 00000010 00000000 01110011 ... 01100100 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000001 01111110<
Physical layer: transmitted frame >01111110 00000010 10000001 01111110<
```

```

Physical layer: received frame >01111110 00000010 00010000 01100001 ... 01101110 01111110<
Data Link Layer: received I frame >01111110 00000010 00010000 01100001 ... 01101110 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000010 01111110<
Physical layer: transmitted frame >01111110 00000010 10000010 01111110<
Physical layer: received frame >01111110 00000010 00100000 01111001 ... 01101111 01111110<
Data Link Layer: received I frame >01111110 00000010 00100000 01111001 ... 01101111 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000011 01111110<
Physical layer: transmitted frame >01111110 00000010 10000011 01111110<
Physical layer: received frame >01111110 00000010 00111000 00100000 ... 01100101 01111110<
Data Link Layer: received I frame >01111110 00000010 00111000 00100000 ... 01100101 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000010 10000100 01111110<
Physical layer: transmitted frame >01111110 00000010 10000100 01111110<
Primary Station: Received from Station 2 >Station 2 to Primary: Message for testing data transfer.
The HDLC protocol is designed to support communication over
a physical link between physically connected stations.
In this lab a primary station is connected to two secondary stations.
This message will be sent by each Secondary station to the Primary.
Many HDLC I frames shall be used to send this message<

```

-----Get Message from Station 1-----

```

Data Link Layer: sending RR frame (poll) >01111110 00000001 10001100 01111110<
Physical layer: transmitted frame >01111110 00000001 10001100 01111110<
Physical layer: received frame >01111110 00000001 00000000 01010011 ... 01101111 01111110<
Data Link Layer: received I frame >01111110 00000001 00000000 01010011 ... 01101111 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000001 01111110<
Physical layer: transmitted frame >01111110 00000001 10000001 01111110<
Physical layer: received frame >01111110 00000001 00010000 01110010 ... 01001000 01111110<
Data Link Layer: received I frame >01111110 00000001 00010000 01110010 ... 01001000 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000010 01111110<
Physical layer: transmitted frame >01111110 00000001 10000010 01111110<
Physical layer: received frame >01111110 00000001 00100000 01000100 ... 01110000 01111110<
Data Link Layer: received I frame >01111110 00000001 00100000 01000100 ... 01110000 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000001 01111110<
Physical layer: transmitted frame >01111110 00000001 10000001 01111110<
Physical layer: received frame >01111110 00000001 00110000 01101111 ... 01101001 01111110<
Data Link Layer: received I frame >01111110 00000001 00110000 01101111 ... 01101001 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000100 01111110<
Physical layer: transmitted frame >01111110 00000001 10000100 01111110<
Physical layer: received frame >01111110 00000001 01000000 01100011 ... 01101110 01111110<
Data Link Layer: received I frame >01111110 00000001 01000000 01100011 ... 01101110 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000101 01111110<
Physical layer: transmitted frame >01111110 00000001 10000101 01111110<
Physical layer: received frame >01111110 00000001 01010000 01100101 ... 01110000 01111110<
Data Link Layer: received I frame >01111110 00000001 01010000 01100101 ... 01110000 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000110 01111110<
Physical layer: transmitted frame >01111110 00000001 10000110 01111110<
Physical layer: received frame >01111110 00000001 01100000 01110010 ... 01110100 01111110<
Data Link Layer: received I frame >01111110 00000001 01100000 01110010 ... 01110100 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000111 01111110<
Physical layer: transmitted frame >01111110 00000001 10000111 01111110<
Physical layer: received frame >01111110 00000001 01110000 01110111 ... 01110011 01111110<
Data Link Layer: received I frame >01111110 00000001 01110000 01110111 ... 01110011 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000000 01111110<
Physical layer: transmitted frame >01111110 00000001 10000000 01111110<
Physical layer: received frame >01111110 00000001 00000000 01110011 ... 01100100 01111110<
Data Link Layer: received I frame >01111110 00000001 00000000 01110011 ... 01100100 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000001 01111110<
Physical layer: transmitted frame >01111110 00000001 10000001 01111110<
Physical layer: received frame >01111110 00000001 00010000 01100001 ... 01101110 01111110<
Data Link Layer: received I frame >01111110 00000001 00010000 01100001 ... 01101110 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000010 01111110<
Physical layer: transmitted frame >01111110 00000001 10000010 01111110<
Physical layer: received frame >01111110 00000001 00100000 01111001 ... 01101111 01111110<
Data Link Layer: received I frame >01111110 00000001 00100000 01111001 ... 01101111 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000011 01111110<
Physical layer: transmitted frame >01111110 00000001 10000011 01111110<
Physical layer: received frame >01111110 00000001 00111000 00100000 ... 01100101 01111110<
Data Link Layer: received I frame >01111110 00000001 00111000 00100000 ... 01100101 01111110<
Data Link Layer: prepared RR frame(ack) >01111110 00000001 10000100 01111110<
Physical layer: transmitted frame >01111110 00000001 10000100 01111110<

```

Primary Station: Received from Station 2 >Station 1 to Primary: Message for testing data transfer.  
 The HDLC protocol is designed to support communication over  
 a physical link between physically connected stations.  
 In this lab a primary station is connected to two secondary stations.  
 This message will be sent by each Secondary station to the Primary.  
 Many HDLC I frames shall be used to send this message<

----- Disconnect Station 1-----  
 Primary Station: Requesting disconnect from station 1  
 Data Link Layer: prepared DISC frame >01111110 00000001 11000010 01111110<  
 Physical layer: transmitted frame >01111110 00000001 11000010 01111110<  
 ----- Disconnect Station 2-----  
 Primary Station: Requesting disconnect from station 2  
 Data Link Layer: prepared DISC frame >01111110 00000010 11000010 01111110<  
 Physical layer: transmitted frame >01111110 00000010 11000010 01111110<  
 -----

### Sortie de la Station Secondaire 1 (SecondaryStation)

-----Connection to Primary-----  
 Physical layer: received frame >01111110 00000001 11001001 01111110<  
 Data Link Layer: received SNRM frame >01111110 00000001 11001001 01111110<  
 Secondary Station (1): Received conenct indication  
 Secondary Station (1): Issuing connect confirmation  
 Data Link Layer: prepared UA frame >01111110 00000001 11001110 01111110<  
 Physical layer: transmitted frame >01111110 00000001 11001110 01111110<  
 -----  
 -----Send Message To Primary-----  
 Secondary Station (1): Issuing data request  
 Physical layer: received frame >01111110 00000010 11001001 01111110<  
 Physical layer: received frame >01111110 00000010 11001110 01111110<  
 Physical layer: received frame >01111110 00000010 10001000 01111110<  
 Physical layer: received frame >01111110 00000010 00000000 01010011 ... 01101111 01111110<  
 Physical layer: received frame >01111110 00000010 00010000 01110010 ... 01001000 01111110<  
 Physical layer: received frame >01111110 00000010 00100000 01000100 ... 01110000 01111110<  
 Physical layer: received frame >01111110 00000010 00110000 01101111 ... 01101001 01111110<  
 Physical layer: received frame >01111110 00000010 10000001 01111110<  
 Physical layer: received frame >01111110 00000010 10000010 01111110<  
 Physical layer: received frame >01111110 00000010 01000000 01100011 ... 01101110 01111110<  
 Physical layer: received frame >01111110 00000010 01010000 01100101 ... 01110000 01111110<  
 Physical layer: received frame >01111110 00000010 10000011 01111110<  
 Physical layer: received frame >01111110 00000010 10000100 01111110<  
 Physical layer: received frame >01111110 00000010 10000101 01111110<  
 Physical layer: received frame >01111110 00000010 01100000 01110010 ... 01110100 01111110<  
 Physical layer: received frame >01111110 00000010 01110000 01110111 ... 01110011 01111110<  
 Physical layer: received frame >01111110 00000010 00000000 01110011 ... 01100100 01111110<  
 Physical layer: received frame >01111110 00000010 10000110 01111110<  
 Physical layer: received frame >01111110 00000010 00010000 01100001 ... 01101110 01111110<  
 Physical layer: received frame >01111110 00000010 10000111 01111110<  
 Physical layer: received frame >01111110 00000010 10000000 01111110<  
 Physical layer: received frame >01111110 00000010 10000001 01111110<  
 Physical layer: received frame >01111110 00000010 00100000 01111001 ... 01101111 01111110<  
 Physical layer: received frame >01111110 00000010 00111000 00100000 ... 01100101 01111110<  
 Physical layer: received frame >01111110 00000010 10000010 01111110<  
 Physical layer: received frame >01111110 00000010 10000011 01111110<  
 Physical layer: received frame >01111110 00000010 10000100 01111110<  
 Physical layer: received frame >01111110 00000001 10001100 01111110<  
 Data Link Layer: Station 1: Data Link Layer: prepared and buffered I frame >01111110 00000001  
 00000000 01010011 ... 01101111 01111110<  
 v(s) = 1, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 1  
 Physical layer: transmitted frame >01111110 00000001 00000000 01010011 ... 01101111 01111110<  
 Data Link Layer: Station 1: Data Link Layer: prepared and buffered I frame >01111110 00000001  
 00010000 01110010 ... 01001000 01111110<  
 v(s) = 2, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 2  
 Physical layer: transmitted frame >01111110 00000001 00010000 01110010 ... 01001000 01111110<  
 Data Link Layer: Station 1: Data Link Layer: prepared and buffered I frame >01111110 00000001  
 00100000 01000100 ... 01110000 01111110<  
 v(s) = 3, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 3  
 Physical layer: transmitted frame >01111110 00000001 00100000 01000100 ... 01110000 01111110<

[illegible]

Data Link Layer: Station 1: received an RR frame (ack) >01111110 00000001 10000100 01111110<  
v(s) = 4, v(r) = 0, Window: lhs=4 rhs=0, Number frames buffered = 0

-----Disconnection-----

Physical layer: received frame >01111110 00000001 11000010 01111110<  
Data Link Layer: received DISC frame >01111110 00000001 11000010 01111110<  
Secondary Station (1): Received disconnect indication

## Sortie de la Station Secondaire 2 (SecondaryStation)

-----Connection to Primary-----

Physical layer: received frame >01111110 00000001 11001001 01111110<  
Physical layer: received frame >01111110 00000001 11001110 01111110<  
Physical layer: received frame >01111110 00000010 11001001 01111110<  
Data Link Layer: received SNRM frame >01111110 00000010 11001001 01111110<  
Secondary Station (2): Received connect indication  
Secondary Station (2): Issuing connect confirmation  
Data Link Layer: prepared UA frame >01111110 00000010 11001110 01111110<  
Physical layer: transmitted frame >01111110 00000010 11001110 01111110<

-----Send Message To Primary-----

Secondary Station (2): Issuing data request  
Physical layer: received frame >01111110 00000010 10001000 01111110<  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 00000000 01010011 ... 01101111 01111110<  
v(s) = 1, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 1  
Physical layer: transmitted frame >01111110 00000010 00000000 01010011 ... 01101111 01111110<  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 00010000 01110010 ... 01001000 01111110<  
v(s) = 2, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 2  
Physical layer: transmitted frame >01111110 00000010 00010000 01110010 ... 01001000 01111110<  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 00100000 01000100 ... 01110000 01111110<  
v(s) = 3, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 3  
Physical layer: transmitted frame >01111110 00000010 00100000 01000100 ... 01110000 01111110<  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 00110000 01101111 ... 01101001 01111110<  
v(s) = 4, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 4  
Physical layer: transmitted frame >01111110 00000010 00110000 01101111 ... 01101001 01111110<  
Physical layer: received frame >01111110 00000010 10000001 01111110<  
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000001 01111110<  
v(s) = 4, v(r) = 0, Window: lhs=1 rhs=5, Number frames buffered = 3  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 01000000 01100011 ... 01101110 01111110<  
v(s) = 5, v(r) = 0, Window: lhs=1 rhs=5, Number frames buffered = 4  
Physical layer: transmitted frame >01111110 00000010 01000000 01100011 ... 01101110 01111110<  
Physical layer: received frame >01111110 00000010 10000011 01111110<  
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000011 01111110<  
v(s) = 5, v(r) = 0, Window: lhs=2 rhs=6, Number frames buffered = 3  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 01010000 01100101 ... 01110000 01111110<  
v(s) = 6, v(r) = 0, Window: lhs=2 rhs=6, Number frames buffered = 4  
Physical layer: transmitted frame >01111110 00000010 01010000 01100101 ... 01110000 01111110<  
Physical layer: received frame >01111110 00000010 10000011 01111110<  
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000011 01111110<  
v(s) = 6, v(r) = 0, Window: lhs=3 rhs=7, Number frames buffered = 3  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 01100000 01110010 ... 01110100 01111110<  
v(s) = 7, v(r) = 0, Window: lhs=3 rhs=7, Number frames buffered = 4  
Physical layer: transmitted frame >01111110 00000010 01100000 01110010 ... 01110100 01111110<  
Physical layer: received frame >01111110 00000010 10000100 01111110<  
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000100 01111110<  
v(s) = 7, v(r) = 0, Window: lhs=4 rhs=0, Number frames buffered = 3  
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010 01110000 01110111 ... 01110011 01111110<  
v(s) = 0, v(r) = 0, Window: lhs=4 rhs=0, Number frames buffered = 4  
Physical layer: transmitted frame >01111110 00000010 01110000 01110111 ... 01110011 01111110<  
Physical layer: received frame >01111110 00000010 10000101 01111110<  
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000101 01111110<  
v(s) = 0, v(r) = 0, Window: lhs=5 rhs=1, Number frames buffered = 3

```

Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010
00000000 01110011 ... 01100100 01111110<
    v(s) = 1, v(r) = 0, Window: lhs=5 rhs=1, Number frames buffered = 4
Physical layer: transmitted frame >01111110 00000010 00000000 01110011 ... 01100100 01111110<
Physical layer: received frame >01111110 00000010 10000110 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000110 01111110<
    v(s) = 1, v(r) = 0, Window: lhs=6 rhs=2, Number frames buffered = 3
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010
00010000 01100001 ... 01101110 01111110<
    v(s) = 2, v(r) = 0, Window: lhs=6 rhs=2, Number frames buffered = 4
Physical layer: transmitted frame >01111110 00000010 00010000 01100001 ... 01101110 01111110<
Physical layer: received frame >01111110 00000010 10000111 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000111 01111110<
    v(s) = 2, v(r) = 0, Window: lhs=7 rhs=3, Number frames buffered = 3
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010
00100000 01111001 ... 01101111 01111110<
    v(s) = 3, v(r) = 0, Window: lhs=7 rhs=3, Number frames buffered = 4
Physical layer: transmitted frame >01111110 00000010 00100000 01111001 ... 01101111 01111110<
Physical layer: received frame >01111110 00000010 10000000 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000000 01111110<
    v(s) = 3, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 3
Data Link Layer: Station 2: Data Link Layer: prepared and buffered I frame >01111110 00000010
00111000 00100000 ... 01100101 01111110<
    v(s) = 4, v(r) = 0, Window: lhs=0 rhs=4, Number frames buffered = 4
Physical layer: transmitted frame >01111110 00000010 00111000 00100000 ... 01100101 01111110<
Physical layer: received frame >01111110 00000010 10000001 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000001 01111110<
    v(s) = 4, v(r) = 0, Window: lhs=1 rhs=5, Number frames buffered = 3
Physical layer: received frame >01111110 00000010 10000010 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000010 01111110<
    v(s) = 4, v(r) = 0, Window: lhs=2 rhs=6, Number frames buffered = 2
Physical layer: received frame >01111110 00000010 10000011 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000011 01111110<
    v(s) = 4, v(r) = 0, Window: lhs=3 rhs=7, Number frames buffered = 1
Physical layer: received frame >01111110 00000010 10000100 01111110<
Data Link Layer: Station 2: received an RR frame (ack) >01111110 00000010 10000100 01111110<
    v(s) = 4, v(r) = 0, Window: lhs=4 rhs=0, Number frames buffered = 0
-----
-----Disconnection-----
Physical layer: received frame >01111110 00000001 10001100 01111110<
Physical layer: received frame >01111110 00000001 00000000 01010011 ... 01101111 01111110<
Physical layer: received frame >01111110 00000001 00010000 01110010 ... 01001000 01111110<
Physical layer: received frame >01111110 00000001 00100000 01000100 ... 01110000 01111110<
Physical layer: received frame >01111110 00000001 00110000 01101111 ... 01101001 01111110<
Physical layer: received frame >01111110 00000001 10000001 01111110<
Physical layer: received frame >01111110 00000001 10000010 01111110<
Physical layer: received frame >01111110 00000001 10000011 01111110<
Physical layer: received frame >01111110 00000001 10000100 01111110<
Physical layer: received frame >01111110 00000001 01000000 01100011 ... 01101110 01111110<
Physical layer: received frame >01111110 00000001 01010000 01100101 ... 01110000 01111110<
Physical layer: received frame >01111110 00000001 01100000 01110010 ... 01110100 01111110<
Physical layer: received frame >01111110 00000001 01110000 01110111 ... 01110011 01111110<
Physical layer: received frame >01111110 00000001 10000101 01111110<
Physical layer: received frame >01111110 00000001 10000110 01111110<
Physical layer: received frame >01111110 00000001 10000111 01111110<
Physical layer: received frame >01111110 00000001 10000000 01111110<
Physical layer: received frame >01111110 00000001 00000000 01110011 ... 01100100 01111110<
Physical layer: received frame >01111110 00000001 00010000 01100001 ... 01101110 01111110<
Physical layer: received frame >01111110 00000001 00100000 01111001 ... 01101111 01111110<
Physical layer: received frame >01111110 00000001 00111000 00100000 ... 01100101 01111110<
Physical layer: received frame >01111110 00000001 10000001 01111110<
Physical layer: received frame >01111110 00000001 10000010 01111110<
Physical layer: received frame >01111110 00000001 10000011 01111110<
Physical layer: received frame >01111110 00000001 10000100 01111110<
Physical layer: received frame >01111110 00000001 11000010 01111110<
Physical layer: received frame >01111110 00000010 11000010 01111110<
Data Link Layer: received DISC frame >01111110 00000010 11000010 01111110<
Secondary Station (2): Received disconnect indication
-----

```



## Sortie de la couche physique (PhysicalLayerServer)

Physical Layer Server starting on port 4444

```
Connection from /169.254.151.92 accepted.
```

Accepted client

Physical Layer Server: connection from Physical Layer Client 0

Connection from /169.254.151.92 accepted.

Accepted client

```
Physical Layer Server: connection from Physical Layer Client 1
```

Connection from /169.254.151.92 accepted.

Accepted client

Physical Layer Server: connection from Physical Layer Client 2

```
Physical Layer Server: received frame from client 2: >01111110000000011100100101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 0: >01111110000000011100111001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >01111110000000101100100101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1: >01111110000000101100111001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >011111110000000101000100001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>01111111000000010000000000101001101110100011000010111010001101001011011110110111000100000001100100010000001110100011011110010000001010
00001110010011010010110110101100001011100100111100100111010001000000100110101100101011100110111001101100001011001110110010100100000011
001100110111101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>011111100000001000010000011100100010000000111010001100101011110011011101000110100101101110011001110010000001100100011000010111010001100
00100100000011101000111001001100001011011100111001101100110011001100101011100100010111000100000000110100001010010101000110100001100101001
0000001001000011111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>01111111000000010001000000100010001100010000110010000001110000011100100110111101110100011011110110001101101111011011000010000001101
00101110011001000000110010001100101011100110110100101100111011011100110010101100100001000000111010001101111001000000111001101110101011
1000001110000011111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>0111111000000010001100000110111101110010011101000010000001100011011011110110110101101101011011011011011001101001011000110110000101110
1000110100101101111011011100010000001101111011011001100101011100100010000000001101000010100110000100100000011100000110100001111001011
100110110100101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >011111100000000101000000101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >011111100000000101000001001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>01111111000000010010000000110001101100001011011000010000001101100011010010110111001101011001000000110001001100101011101000111011101100
1010110010101011100010000001110000011010000111100101110011011010010110001101100001011011000110110001111001001000000110001101101111011
011100110111001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>01111111000000010010100000110010101100011011101000110010101100100001000000111001101110100011000010111010001101001011011110110111001110
01100101110000011010000101001001001011011100010000001110100011010000110100101110011001000000110110001100001011000100010000001100001001
000000111000001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >011111110000000101000001101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >011111110000000101000010001111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 2: >011111110000000101000010101111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>01111111000000010011000000111001001101001011011010110000101110010011110010010000001110011011101000110000101110100011010010110111101101
110001000000011010010111001100100000011000110110111101101110011011100110010101100011011101000110010101100100001000000111010001101111001
0000001110100011111110<, sending to other clients.
```

```
Physical Layer Server: received frame from client 1:
```

```
>0111111110000000010011100000111011101101111001000000111001101100101011000110110111101101110011001000110000101110010011110010010000001110
```

01101110100011000010111010001101001011011110110111001110011001011100000110100001010010101000110100001101001011100110010000001101101011  
001010111001101111110<, sending to other clients.  
Physical Layer Server: received frame from client 1:  
>01111110000000100000000001100110110000101100111011001010010000001101110110100101101100011011000010000001100010011001010010000001110  
0110110010101101110011101000010000001100010011110010010000001100101011000010110001101101000001000000101001101100101011000110111011  
011100110010001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >011111100000001010000110011111110<, sending to other clients.  
Physical Layer Server: received frame from client 1:  
>01111110000000100001000001100001011100100111001001000000110011011101000110000101110100011010010110111101101110001000000111010001101  
11100100000011101000110100001100101001000000101000001110010011010010110110101100001011100100111100100101110000011010000101001001101011  
000010110111001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >011111100000001010000111011111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000101000000011111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000101000000101111110<, sending to other clients.  
Physical Layer Server: received frame from client 1:  
>01111110000000100010000001111001001000000100100001000100010001100100000010010001001000000110011001110010011000010110110101100  
10101110011001000000111001101101000011000010110110001101100001000000110001001100101001000000111010101110011011001010110010000100000011  
10100011011101111110<, sending to other clients.  
Physical Layer Server: received frame from client 1:  
>0111111000000010001110000010000001110011011001010110111001100100001000000111010001101000011010010111001100100000011011010110010101110  
0110111001101100001011001110110010101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >011111100000001010000010011111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000101000001101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000101000010001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000110001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001000000000101001101110100011000010111010001101001011011110110111000100000001100010010000001110100011011110010000001010  
00001110010011010010110110101100001011100100111100100111010001000000100110101100101011100110111001101100001011001110110010100100000011  
001100110111101111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001000100000111001000100000011101000110010101110011011101000110100101101110011001110010000001100100011000010111010001100  
001001000000111010001110010011000010110111001110011001100101011100100010111000100000000110100001010010101000110100001100101001  
0000000100100001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>011111100000000100100000010001000100110001000011001000000111000001110010011011110111011000110111011000110110111011000010000001101  
00101110011001000000110010001100101011100110110100101100111011011100110010101100100001000000111010001101111001000000111001101110101011  
100000111000001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>01111110000000010011000001101110111001001110100010000001100011011011101101101011011011011011011011001101100001011101000101110  
1000110100101101110110111000100000011011101101100110010101110010001000000001101000010100110000100100000011100000110100001111001011  
100110110100101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000000101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000001001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000001101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000010001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>011111100000000101000000011000110110000101101100001000000110110001101001011011100110010000001100010011001011101000111011101100  
10101100101011011100010000001110000011010000111100101110011011010010110001101100011011000111100100100000011000110110111011  
011100110111001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001010100000110010101100011011101000110010101100100001000000111001101110100011000010110100011010010110111011001110  
0111110000000110010101100011001000011000110110100011001001011011101100100000011000110110110111011001110

01100101110000011010000101001001001011011100010000001110100011010000110100101110011001000000110110001100001011000100010000001100001001  
000000111000001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001011000000111001001101001011011010110000101110010011110010010000001110011011101000110000101110100011010010110111101101  
110001000000110100101110011001000000110001101101110110111001100110011001100011011101000110010101100100001000000111010001101111001  
000000111010001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>011111100000000101110000011101101101111001000000111001101100101011000110110111101101110011001000110000101110010011110010010000001110  
0110111010001100001011101000110100101101111011011100111001100101110000011010000101001010100011010001101001011100110010000001101101011  
00101011100110111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000010101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000011001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000011101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >0111111000000001100000001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001000000000111001101100001011001110110010100100000011101110110100101101100011011000010000001100010011001010010000001110  
01101100101011011100111010000100000011000100111100100100000011001010110000101100011011010000010000001010011011001010110001101101111011  
011100110010001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001000100000110000101110010011110010010000001110011011101000110000101110100011010010110111101101110001000000111010001101  
1110010000001110100011010000110010100100000010100000111001001101001011011010110000101110010011110010010110001101101111011  
000010110111001111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>011111100000000100100000011110010010000001001000010001000110010000001001001001000000110011001110010011000010110110101100  
10101110011001000000111001101101000011000010110110001101100001000000110001001100101001000000111010101110011011001010110010000100000011  
10100011011110111110<, sending to other clients.  
Physical Layer Server: received frame from client 0:  
>0111111000000001001110000010000001110011011001010110111001100100001000000111010001101000011010010111001100100000011011010110010101110  
0110111001101100001011001110110010101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000000101111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000001001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000000110111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011000010001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000011100001001111110<, sending to other clients.  
Physical Layer Server: received frame from client 2: >01111110000000101100001001111110<, sending to other clients.