



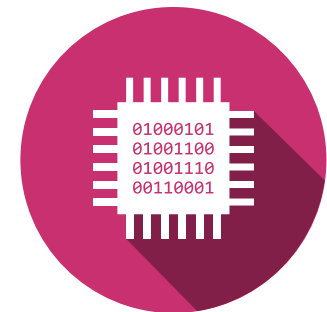
# Conception numérique (DiD)

## Multiplexeurs et démultiplexeurs

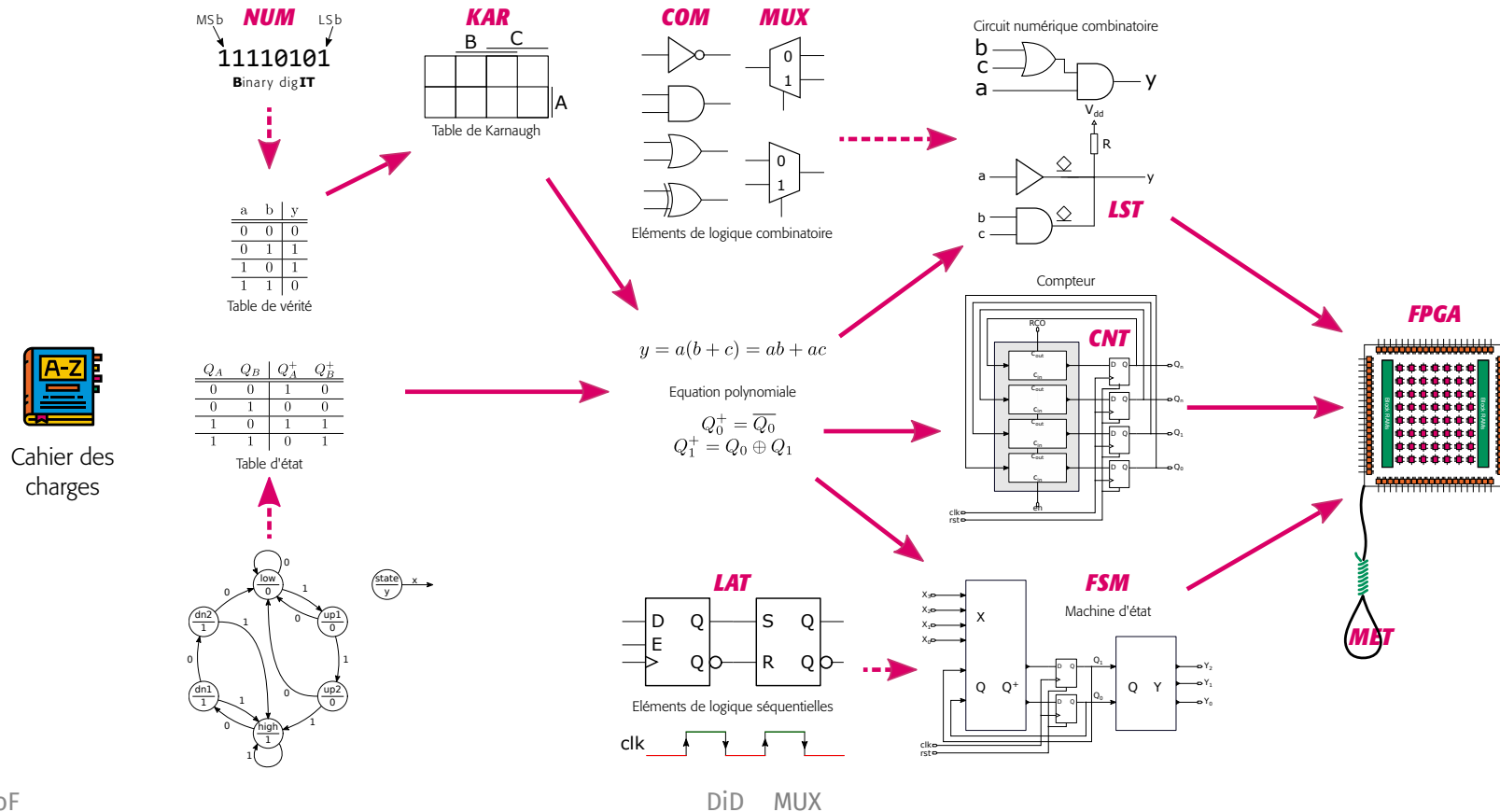
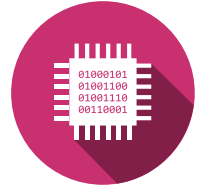
### MUX

Filière Systèmes industriels  
Filière Energie et techniques environnementales  
Filière Informatique et systèmes de communications

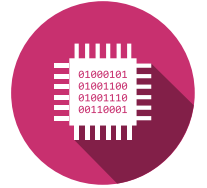
Silvan Zahno [silvan.zahno@hevs.ch](mailto:silvan.zahno@hevs.ch)  
Christophe Bianchi [christophe.bianchi@hevs.ch](mailto:christophe.bianchi@hevs.ch)  
François Corthay [francois.corthay@hevs.ch](mailto:francois.corthay@hevs.ch)



# Situatuiou du thème dans le cours



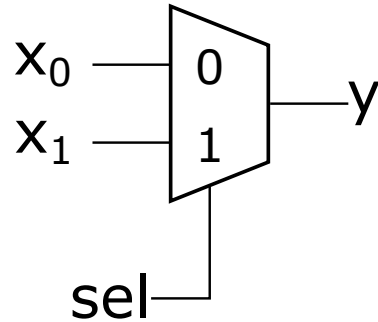
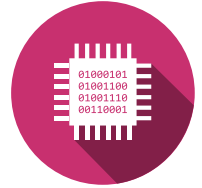
# Contenu



- **Multiplexeurs**
  - Fonction
  - Fonction logique universelle
  - Réalisation à l'aide de portes logiques
  - Réalisation en forme d'arbre
  - Simplifications
- Démultiplexeurs

# Multiplexeurs fonction

## Multiplexeur de 2 à 1

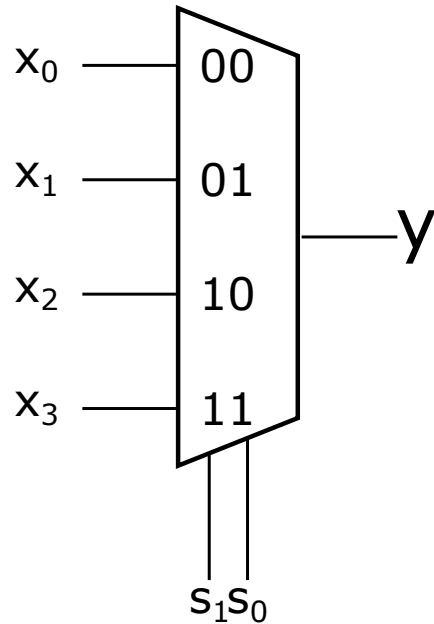
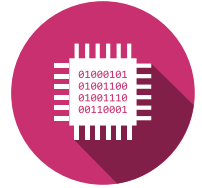


| <b>sel</b> | <b>y</b> |
|------------|----------|
| 0          | $x_0$    |
| 1          | $x_1$    |

Le multiplexeur fonctionne comme un aiguillage

# Multiplexeurs fonction

## Multiplexeur de 4 à 1

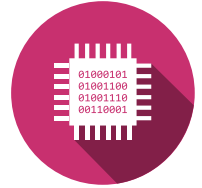


| $s_1 s_0$ | $y$   |
|-----------|-------|
| 00        | $x_0$ |
| 01        | $x_1$ |
| 10        | $x_2$ |
| 11        | $x_3$ |

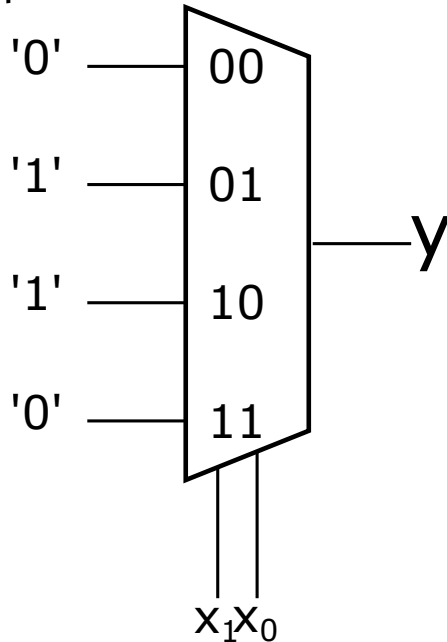
N signaux de sélection,  $2^N$  entrées

# Multiplexeurs fonction

## Fonction logique universelle



- Example: fonction XOR
- Les valeurs de sortie de la table de vérité nous donne les entrées du multiplexeur
- Les entrées de la table de vérité nous donnent les signaux de sélection du multiplexeur
- S'utilise pour la réalisation de circuits programmables



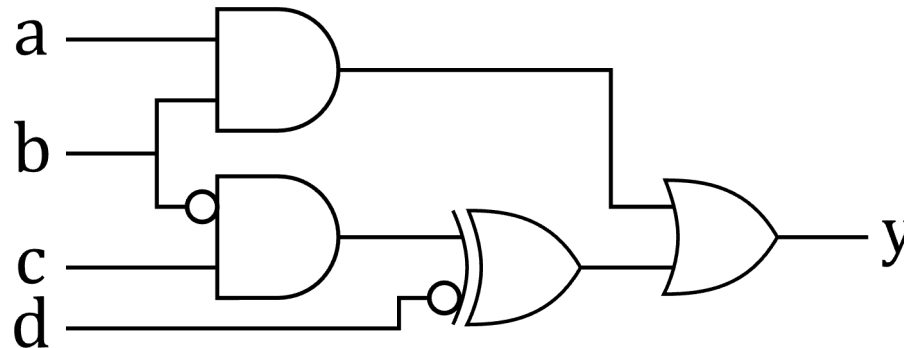
| $x_1 x_0$ | $y$ |
|-----------|-----|
| 00        | 0   |
| 01        | 1   |
| 10        | 1   |
| 11        | 0   |

## Exercise 1.1 (mux/mux-01)



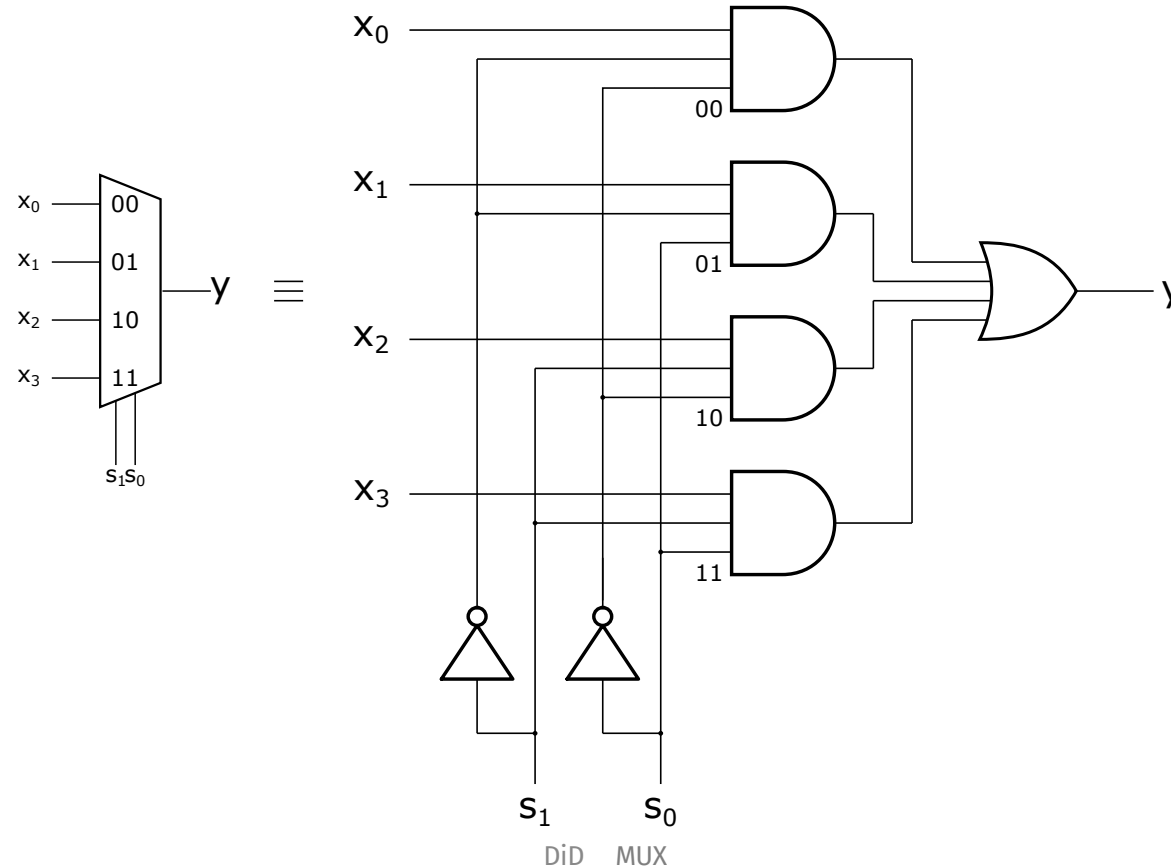
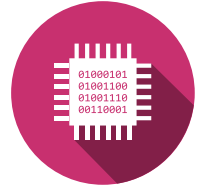
- Réalisation de circuit à l'aide de multiplexeurs

Dessinez, à l'aide d'inverseurs et de multiplexeurs de 8 à 1, un circuit qui réalise la même fonction que le circuit de la figure ci-dessous.



# Multiplexeurs fonction

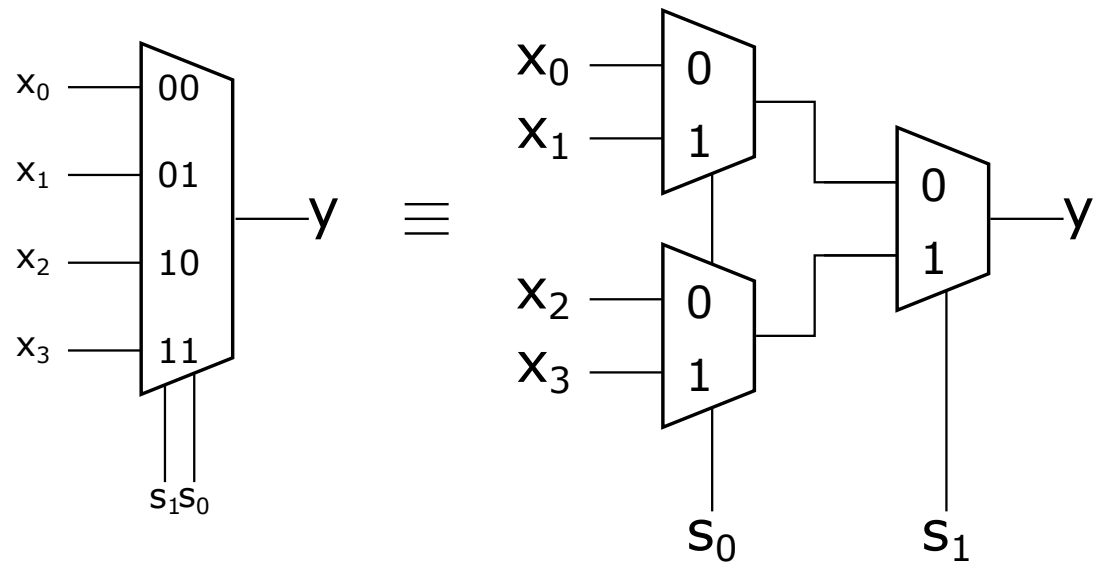
## Réalisation d'un multiplexeur à l'aide de portes logiques





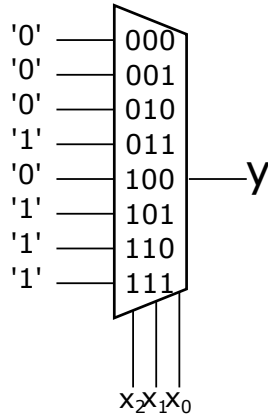
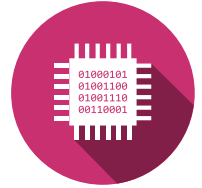
# Multiplexeurs fonction

## Réalisation de fonctions multiplexeur en forme d'arbre



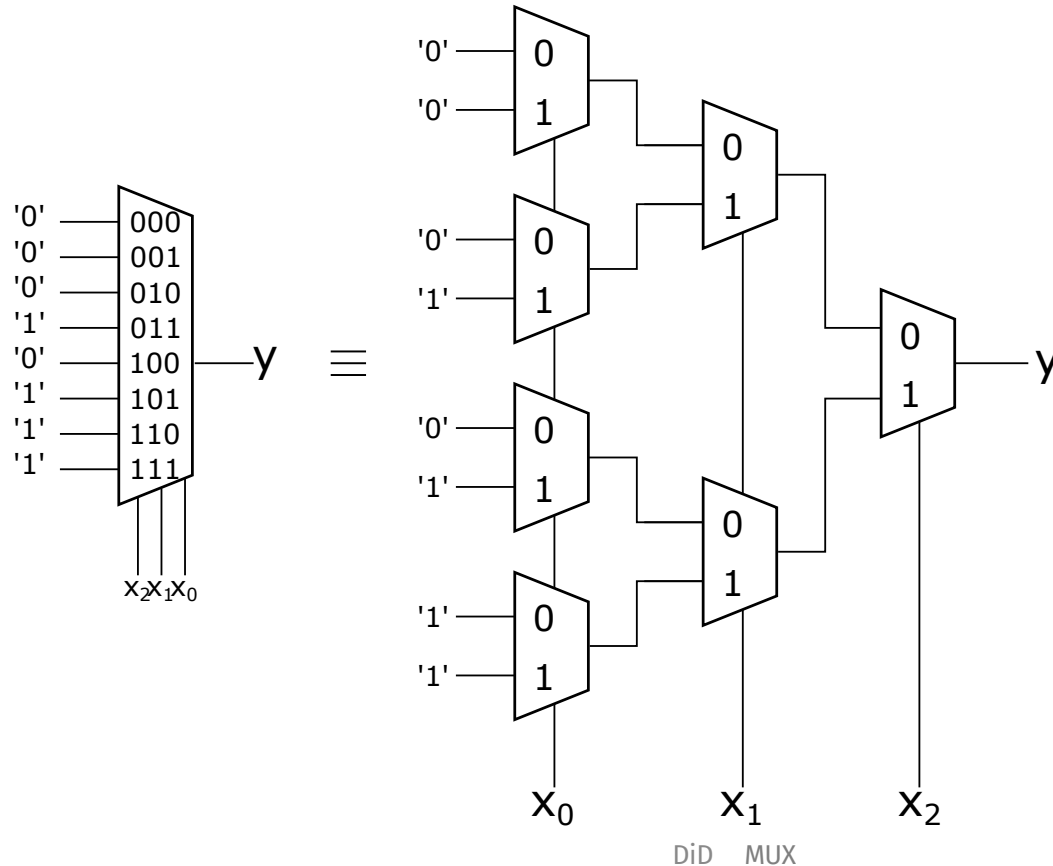
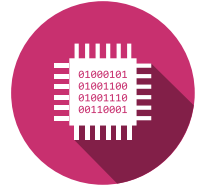
# Multiplexeurs fonction

## Simplification d'une fonction multiplexeur



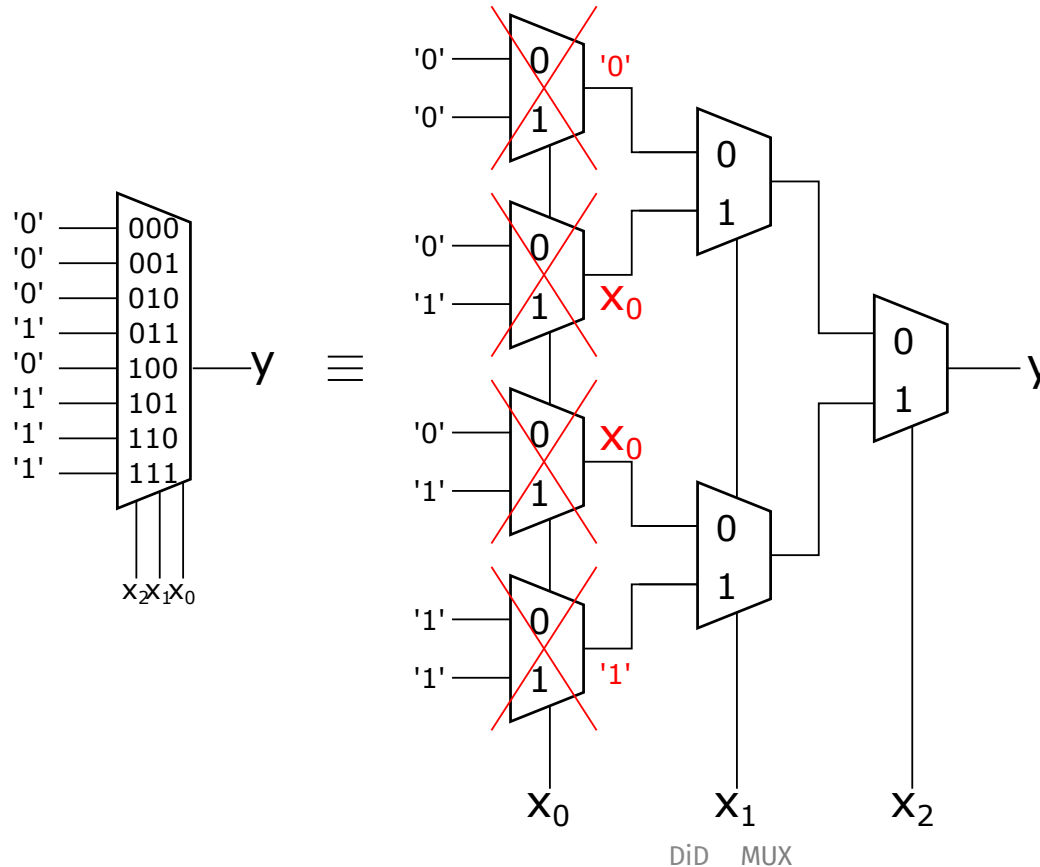
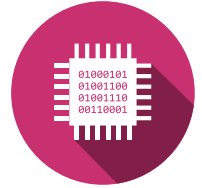
# Multiplexeurs fonction

## Simplification d'une fonction multiplexeur



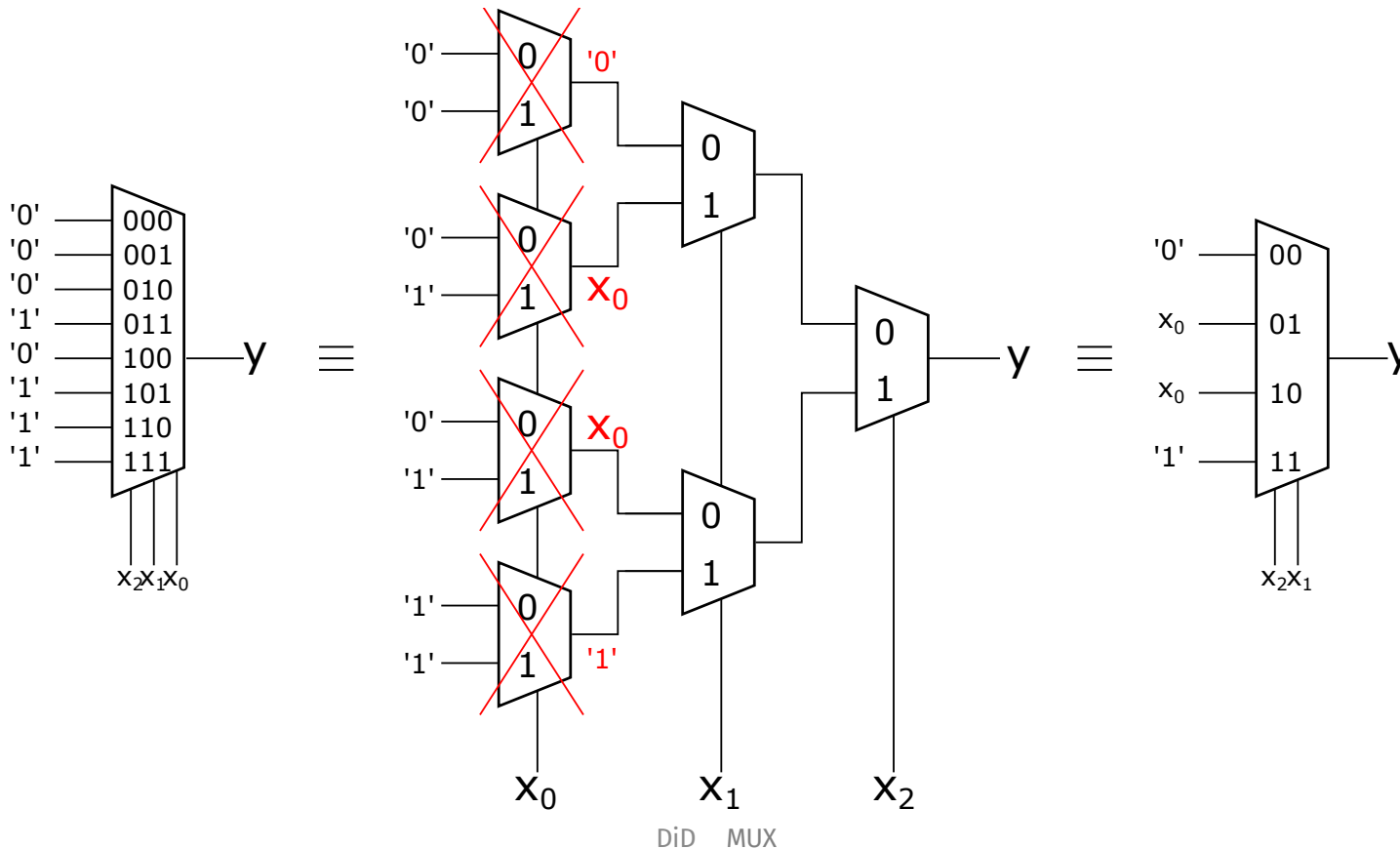
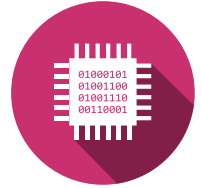
# Multiplexeurs fonction

## Simplification du premier étage



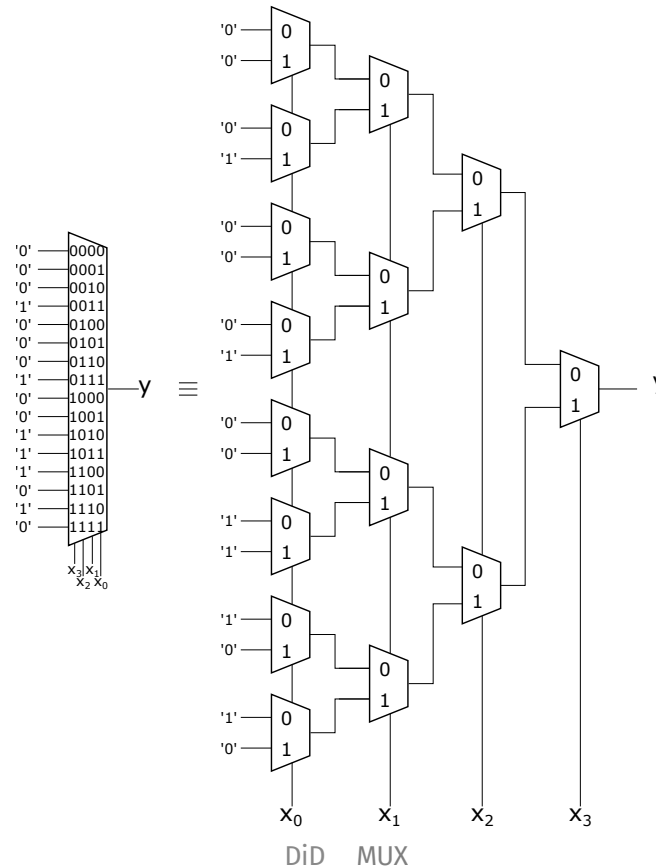
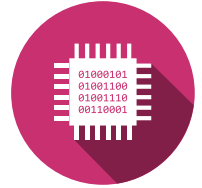
# Multiplexeurs fonction

## Simplification du premier étage



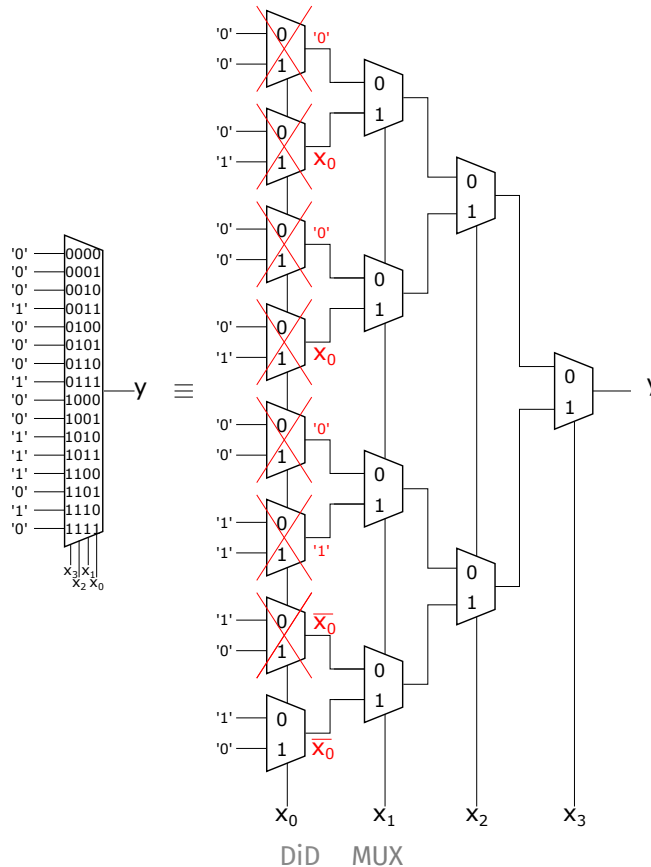
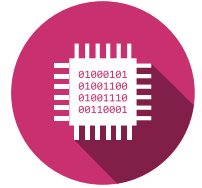
# Multiplexeurs fonction

## Simplification en mux 2 à 1



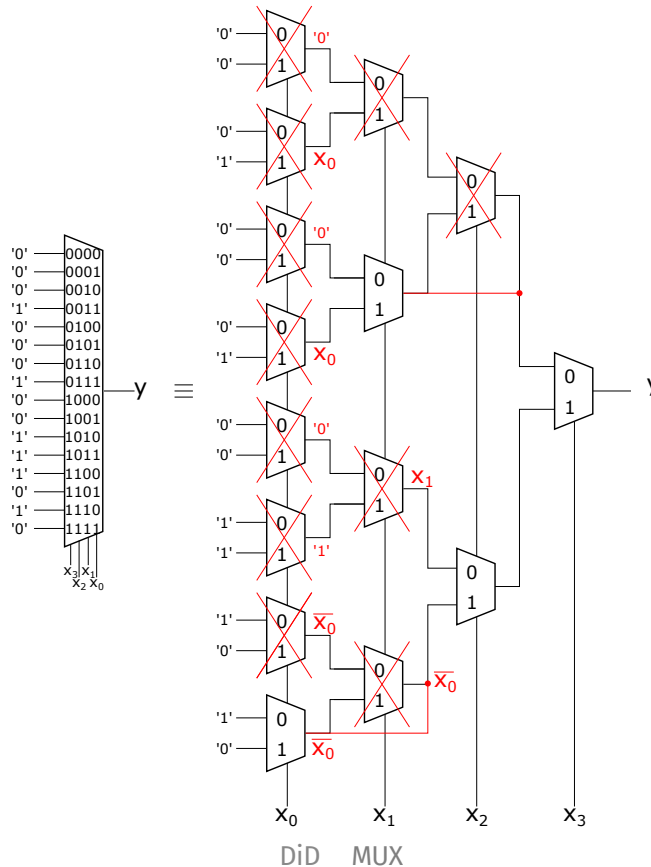
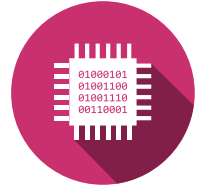
# Multiplexeurs fonction

## Simplification en mux 2 à 1



# Multiplexeurs fonction

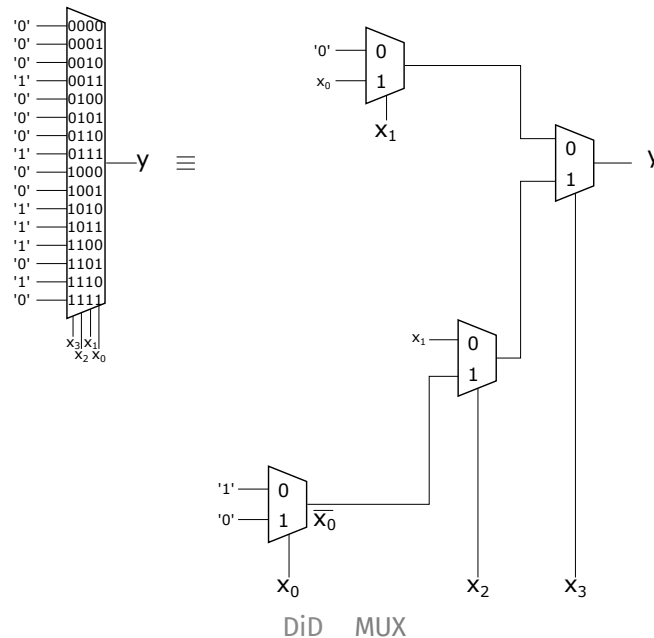
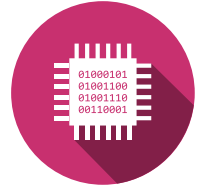
## Simplification en mux 2 à 1



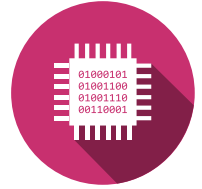


# Multiplexeurs fonction

## Simplification en mux 2 à 1



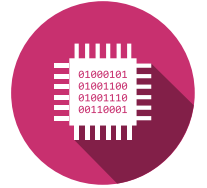
## Exercise 1.4 (mux/mux-02)



- Réalisation de fonction à l'aide de multiplexeurs

| D | C | B | A | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - |
| 0 | 0 | 0 | 1 | - | - | - | - | - | - | - | - |
| 0 | 0 | 1 | 0 | - | - | - | - | - | - | - | - |
| 0 | 0 | 1 | 1 | 1 | - | 1 | - | - | 1 | - | 0 |
| 0 | 1 | 0 | 0 | 0 | - | - | 1 | 1 | - | 1 | - |
| 0 | 1 | 0 | 1 | 0 | - | - | 0 | 0 | - | - | 1 |
| 0 | 1 | 1 | 0 | 0 | - | - | 0 | - | 1 | 1 | - |
| 0 | 1 | 1 | 1 | 0 | - | - | 0 | - | 0 | - | 1 |
| 1 | 0 | 0 | 0 | - | 1 | 1 | - | 1 | - | 1 | - |
| 1 | 0 | 0 | 1 | - | 0 | 0 | - | 0 | - | - | 1 |
| 1 | 0 | 1 | 0 | - | 0 | 0 | - | - | 1 | 1 | - |
| 1 | 0 | 1 | 1 | - | 0 | 0 | - | - | 0 | - | 1 |
| 1 | 1 | 0 | 0 | - | 0 | - | 1 | 1 | - | 1 | - |
| 1 | 1 | 0 | 1 | - | 0 | - | 0 | 0 | - | - | 1 |
| 1 | 1 | 1 | 0 | - | - | - | - | - | - | - | - |
| 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - |

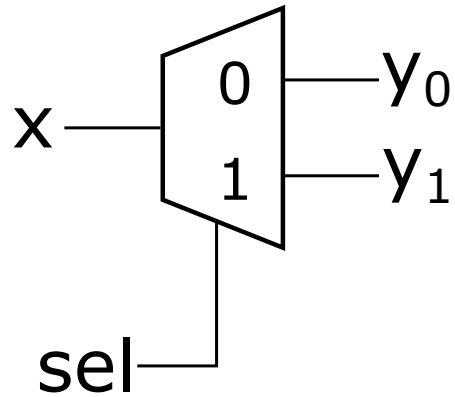
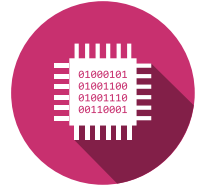
# Contenu



- Multiplexeurs
- **Démultiplexeurs**
  - Fonction
  - Réalisation à l'aide de portes logiques
  - Réalisation en forme d'arbre

# Démultiplexeurs

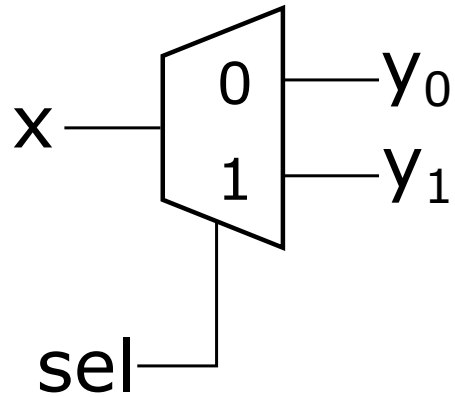
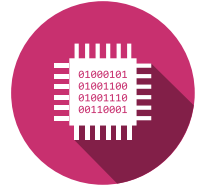
## Démultiplexeur 1 vers 2



| sel | y <sub>0</sub> | y <sub>1</sub> |
|-----|----------------|----------------|
| 0   | x              |                |
| 1   |                | x              |

# Démultiplexeurs

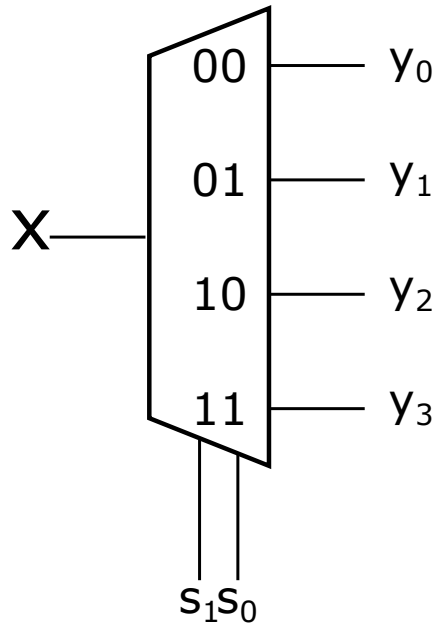
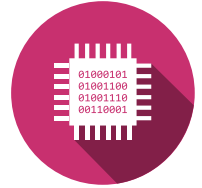
## Démultiplexeur 1 vers 2



| sel | y <sub>0</sub> | y <sub>1</sub> |
|-----|----------------|----------------|
| 0   | x              | 0              |
| 1   | 0              | x              |

# Démultiplexeurs

## Démultiplexeur 1 vers 4

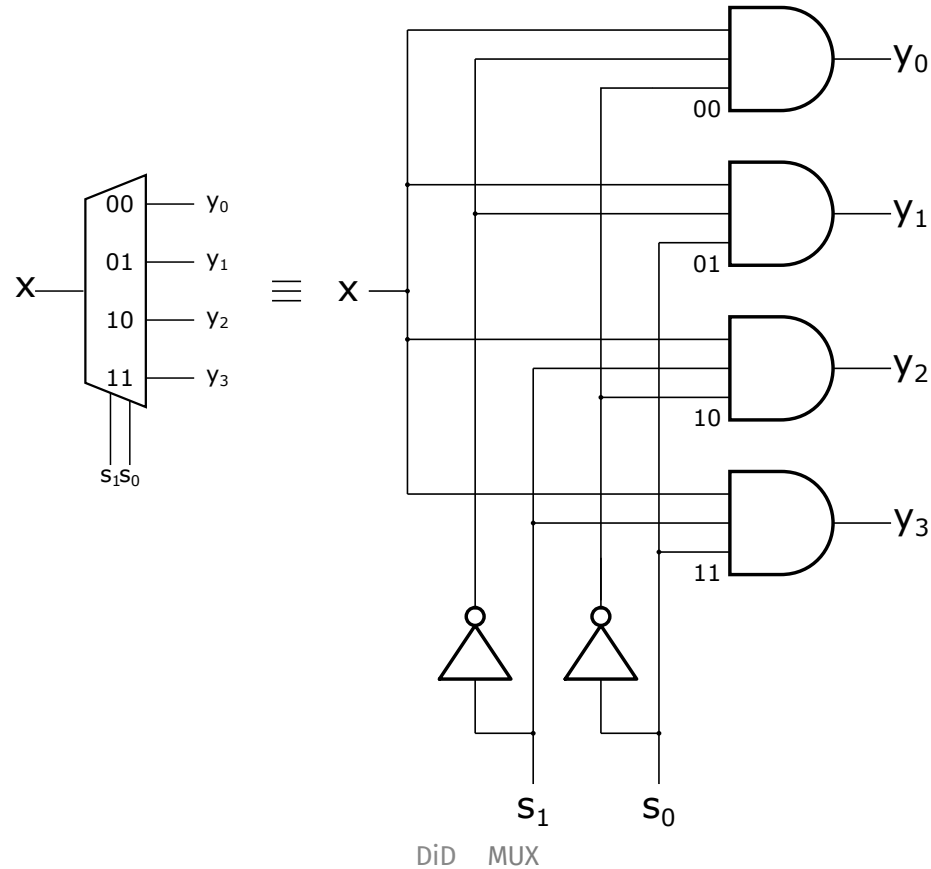


| $s_1 s_0$ | $y_0$ | $y_1$ | $y_2$ | $y_3$ |
|-----------|-------|-------|-------|-------|
| 00        | x     | 0     | 0     | 0     |
| 01        | 0     | x     | 0     | 0     |
| 10        | 0     | 0     | x     | 0     |
| 11        | 0     | 0     | 0     | x     |

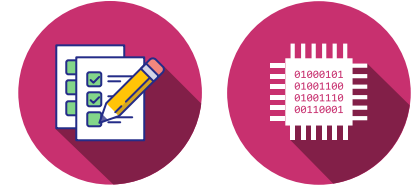
N signaux de sélection,  $2^N$  sorties

# Démultiplexeurs

## Réalisation de démultiplexeur à l'aide de portes logiques



## Exercise 2.1 (mux/demux-01)

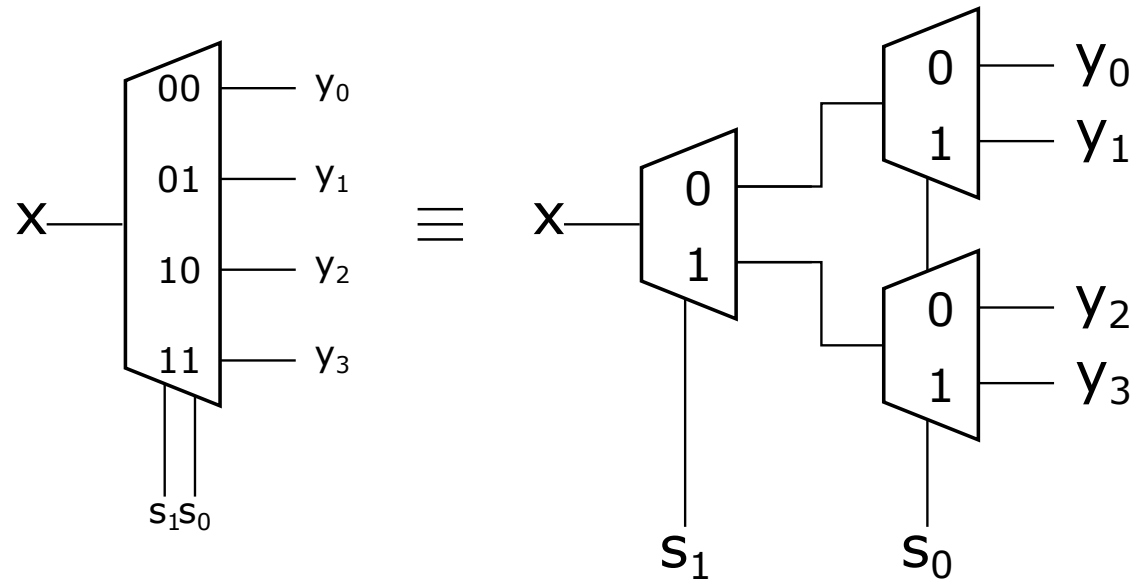


- Réalisation d'un démultiplexeur de 1 vers 8

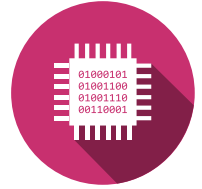


# Démultiplexeurs

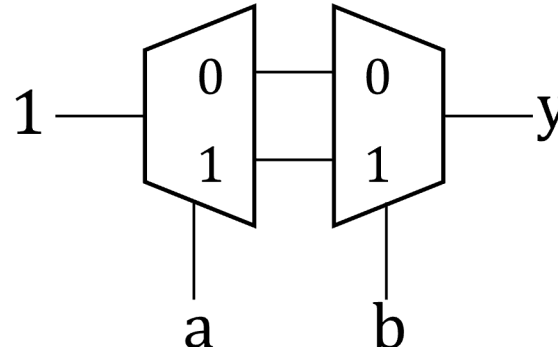
## Décomposition en arbre de démultiplexeurs



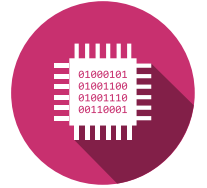
## Exercise 2.2 (mux/demux-02)



- Fonction logique d'un circuit composé d'un multiplexeur et d'un démultiplexeur



# Références



- [Com90] (anglais) Présentation complète
- [Wak00] (anglais) Circuits intégrés standard, code VHDL
- [Kat94] (anglais) Bonne présentation

WHY ARE THERE MIRRORS ABOVE BEDS

WHY DO I SAY UH

WHY IS SEA SALT BETTER

WHY ARE THERE TREES IN THE MIDDLE OF FIELDS

WHY IS THERE NOT A POKEMON MMO

WHY IS THERE LAUGHING IN TV SHOWS

WHY ARE THERE DOORS ON THE FREEWAY

WHY ARE THERE SO MANY SUCHOST-EXE RUNNING

WHY AREN'T ANY COUNTRIES IN ANTARCTICA

WHY ARE THERE SCARY SOUNDS IN MINECRAFT

WHY IS THERE KICKING IN MY STOMACH

WHY ARE THERE TWO SLASHES AFTER HTTP

WHY ARE THERE CELEBRITIES

WHY DO SNAKES EXIST

WHY DO OYSTERS HAVE PEARLS

WHY ARE DUCKS CALLED DUCKS

WHY DO THEY CALL IT THE CLAP

WHY ARE KYLE AND CARTMAN FRIENDS

WHY IS THERE AN ARROW ON AANG'S HEAD

WHY ARE TEXT MESSAGES BLUE

WHY ARE THERE MUSTACHES ON CLOTHES

WHY WUBA LUBBA DUB DUB MEANING

WHY IS THERE A WHALE AND A POT FALLING

WHY ARE THERE SO MANY BIRDS IN SWISS

WHY IS THERE SO LITTLE RAIN IN WALLIS

WHY IS WALLIS WEATHER FORECAST ALWAYS WRONG

WHY ARE THERE MALE AND FEMALE BIKES

WHY ARE THERE BRIDESMAIDS

WHY DO DYING PEOPLE REACH UP

HOW FAST IS LIGHTSPEED

WHY ARE OLD KLINGONS DIFFERENT

WHY ARE THERE TINY SPIDERS IN MY HOUSE

WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

WHY DO SPYDER BITES ITCH

WHY IS DYING SO SCARY

WHY IS THERE NO GPS IN LAPTOPS

WHY DO KNEES CLICK

WHY ARE THERE GHOSTS

WHY ARE THERE DOGS AFRAID OF FIRE

WHY ARE THERE NO KINGS IN EUROPE

WHY IS THERE CAFFEINE IN MY SHAMPOO

WHY HAVE DINOSAURS NO FUR

WHY DO IGUANAS DIE

WHY DO I FEEL DIZZY

WHY ARE THERE WEEKS

WHY DO I SAY UH

WHY ARE THERE TREES IN THE MIDDLE OF FIELDS

WHY IS THERE NOT A POKEMON MMO

WHY IS THERE LAUGHING IN TV SHOWS

WHY ARE THERE DOORS ON THE FREEWAY

WHY ARE THERE SO MANY SUCHOST-EXE RUNNING

WHY AREN'T ANY COUNTRIES IN ANTARCTICA

WHY ARE THERE SCARY SOUNDS IN MINECRAFT

WHY IS THERE KICKING IN MY STOMACH

WHY ARE THERE TWO SLASHES AFTER HTTP

WHY ARE THERE CELEBRITIES

WHY DO SNAKES EXIST

WHY DO OYSTERS HAVE PEARLS

WHY ARE DUCKS CALLED DUCKS

WHY DO THEY CALL IT THE CLAP

WHY ARE KYLE AND CARTMAN FRIENDS

WHY IS THERE AN ARROW ON AANG'S HEAD

WHY ARE TEXT MESSAGES BLUE

WHY ARE THERE MUSTACHES ON CLOTHES

WHY WUBA LUBBA DUB DUB MEANING

WHY IS THERE A WHALE AND A POT FALLING

WHY ARE THERE SO MANY BIRDS IN SWISS

WHY IS THERE SO LITTLE RAIN IN WALLIS

WHY IS WALLIS WEATHER FORECAST ALWAYS WRONG

WHY ARE THERE MALE AND FEMALE BIKES

WHY ARE THERE BRIDESMAIDS

WHY DO DYING PEOPLE REACH UP

HOW FAST IS LIGHTSPEED

WHY ARE OLD KLINGONS DIFFERENT

WHY ARE THERE TINY SPIDERS IN MY HOUSE

WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

WHY DO SPYDER BITES ITCH

WHY IS DYING SO SCARY

WHY IS THERE NO GPS IN LAPTOPS

WHY DO KNEES CLICK

WHY ARE THERE GHOSTS

WHY ARE THERE DOGS AFRAID OF FIRE

WHY DO TWINS HAVE DIFFERENT FINGERPRINTS

WHY ARE SWISS AFRAID OF DRAGONS

WHY IS THERE A SWARM OF ANTS

WHY IS THERE PILEGRIM

WHY ARE THERE SO MANY CROWS IN ROCHESTER

WHY IS TO BE OR NOT TO BE FUNNY

WHY DO CHILDREN GET CANCER

WHY IS POSEIDON ANGRY WITH ODYSSEUS

WHY IS THERE ICE IN SPACE

WHY ARE THERE ANTS IN MY LAPTOP

WHY IS THERE AN OWL IN MY BACKYARD

WHY IS THERE AN OWL OUTSIDE MY WINDOW

WHY IS THERE AN OWL ON THE DOLLAR BILL

WHY DO OWLS ATTACK PEOPLE

WHY ARE FPGA'S EVERYWHERE

WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE

WHY ARE THERE GODS

WHY ARE THERE TWO SPOCKS

WHAT IS <https://xkcd.com/1256/>

WHY DO THEY SAY T-MINUS

WHY ARE THERE OBELISKS

WHY ARE WRESTLERS ALWAYS WET

WHY ARE THERE GUNS IN

WHY AREN'T MY ARMS GROWING

WHY ARE THERE WEEKS

WHY DO I FEEL DIZZY

WHY ARE THERE GHOSTS

WHY ARE THERE DOGS AFRAID OF FIRE

WHY ARE THERE NO KINGS IN EUROPE

WHY ARE THERE BRIDESMAIDS

WHY DO DYING PEOPLE REACH UP

HOW FAST IS LIGHTSPEED

WHY ARE OLD KLINGONS DIFFERENT

WHY ARE THERE TINY SPIDERS IN MY HOUSE

WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

WHY DO SPYDER BITES ITCH

WHY IS DYING SO SCARY

WHY IS THERE NO GPS IN LAPTOPS

WHY DO KNEES CLICK

WHY ARE THERE GHOSTS

WHY ARE THERE DOGS AFRAID OF FIRE

WHY ARE THERE NO KINGS IN EUROPE

# QUESTIONS

CAN BE ASKED BY ANYONE ANYTIME

WHY AREN'T ECONOMISTS RICH

WHY DO AMERICANS CALL IT SOCCER

WHY ARE MY EARS RINGING

WHY IS 42 THE ANSWER TO EVERYTHING

WHY CAN'T NOBODY ELSE LIFT THORS HAMMER

WHY IS MARVIN ALWAYS SO SAD

WHY ARE THERE ANTS IN MY LAPTOP

WHY IS THERE AN OWL IN MY BACKYARD

WHY IS THERE AN OWL OUTSIDE MY WINDOW

WHY IS THERE AN OWL ON THE DOLLAR BILL

WHY DO OWLS ATTACK PEOPLE

WHY ARE FPGA'S EVERYWHERE

WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE

WHY ARE THERE GODS

WHY ARE THERE TWO SPOCKS

WHAT IS <https://xkcd.com/1256/>

WHY DO THEY SAY T-MINUS

WHY ARE THERE OBELISKS

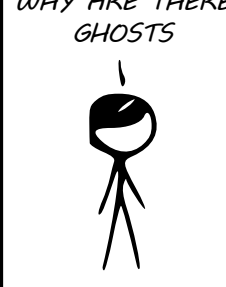
WHY ARE WRESTLERS ALWAYS WET

WHY ARE THERE GUNS IN

WHY AREN'T MY ARMS GROWING

WHY ARE THERE WEEKS

WHY ARE THERE GHOSTS



WHY AREN'T MY ARMS GROWING



WHY ARE THERE SQUIRRELS



WHY ARE THERE TINY SPIDERS IN MY HOUSE

WHY DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE

WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE

WHY ARE THERE SPIDERS IN MY ROOM

WHY ARE THERE SO MANY SPIDERS IN MY ROOM

WHY DO SPYDER BITES ITCH

WHY IS DYING SO SCARY

WHY IS THERE NO GPS IN LAPTOPS

WHY DO KNEES CLICK

WHY ARE MY BOOBS ITCHY

WHY ARE CIGARETTES LEGAL

WHY ARE THERE DUCKS IN MY POOL

WHY IS JESUS WHITE

WHY IS THERE LIQUID IN MY EAR

WHY DO Q TIPS FEEL GOOD

WHY DO PEOPLE DIE

WHY AREN'T THERE GUNS IN

WHY AREN'T MY ARMS GROWING

WHY ARE THERE WEEKS

WHY DO I FEEL DIZZY

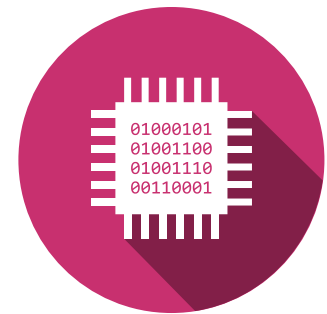
WHY ARE THERE GHOSTS



**Hes·so**  **VALAIS  
WALLIS**



**Haute Ecole d'Ingénierie**  
**Hochschule für Ingenieurwissenschaften**



Silvan Zahno [silvan.zahno@hevs.ch](mailto:silvan.zahno@hevs.ch)  
Christophe Bianchi [christophe.bianchi@hevs.ch](mailto:christophe.bianchi@hevs.ch)  
François Corthay [francois.corthay@hevs.ch](mailto:francois.corthay@hevs.ch)