

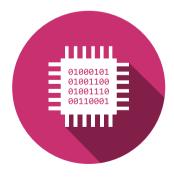


Conception numérique (DiD)

Eléments de mémoire et bascule LAT

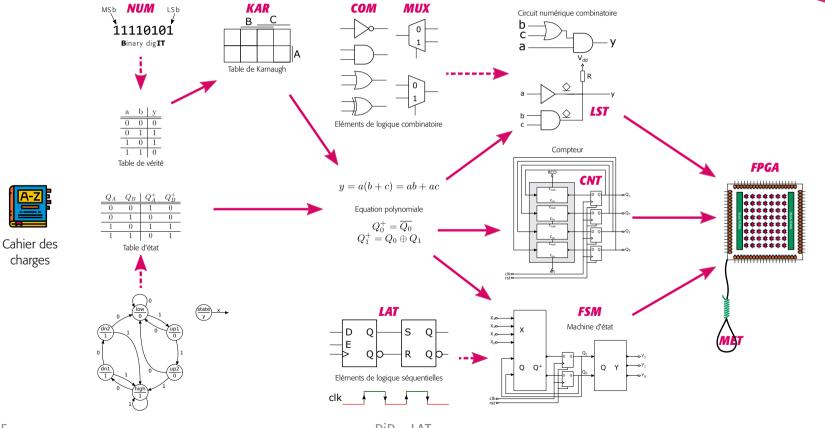
Filière Systèmes industriels Filière Energie et techniques environmentales Filière Informatique et systèmes de communications

Silvan Zahno <u>silvan.zahno@hevs.ch</u> Christophe Bianchi <u>christophe.bianchi@hevs.ch</u> François Corthay <u>francois.corthay@hevs.ch</u>



Situation du thème dans le cours

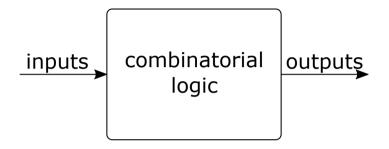


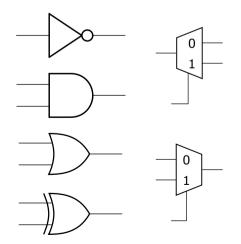


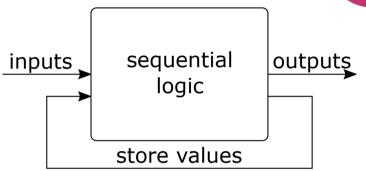
ZaS, BiC, CoF DiD LAT

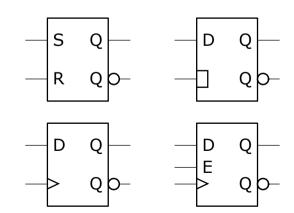
Logique combinatoire et séquentielle











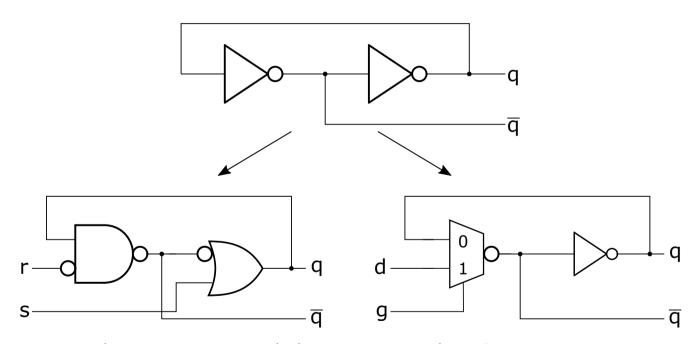
Contenu



- Eléments de mémoire (Latch)
 - Elément de mémoire SR (SR-Latch)
 - Equation caractéristique
 - Elément de mémoire D (D-Latch)
- Bascules (FlipFlop)

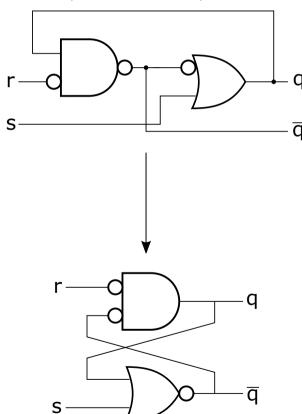
SR-Latch



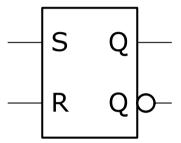


2 inverseurs couplés forment un élément de mémoire

SR-Latch (set-reset)



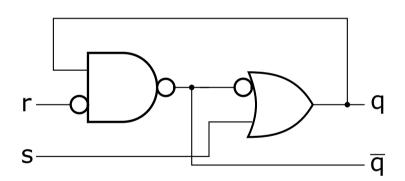




S	r	q	qn	Fonction
0	0	Inch	angé	Mémorisation
0	1	0	1	Mise à 0 (reset)
1	0	1	0	Mise à 1 (set)
1	1	0	0	Interdit

SR-Latch équation caractéristique

L'équation caractéristique décrit la fonctionnalité de l'élément de mémoire



$$q = s + \overline{r}q$$

« q » des 2 côtés de l'équation montre la boucle de mémorisation (q=q pour s=0 et r=0)

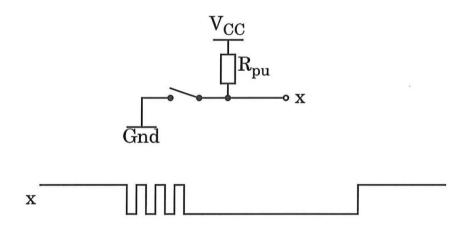
Exercise 2.1

Circuit anti-rebonds



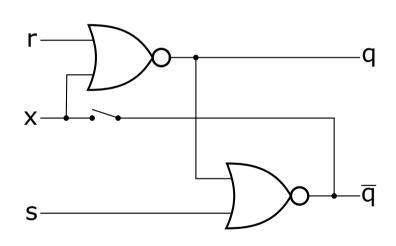


A l'aide d'un commutateur et d'un élément de mémoire, concevoir un circuit qui fournit un signal exempt de rebonds.



Analyse de fonctionnement (modèle combinatoire)

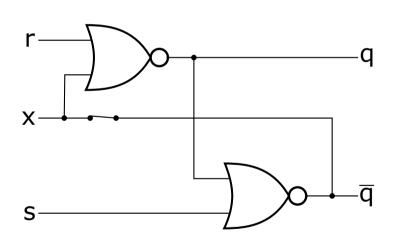




S	r	Х	q	qn	
0	0	0	1	0	
0	0	1	0	1	
0	1	0	0	1	
0	1	1	0	1	
1	0	0	1	0	
1	0	1	0	0	
1	1	0	0	0	
1	1	1	0	0	

Analyse de fonctionnement (modèle combinatoire)

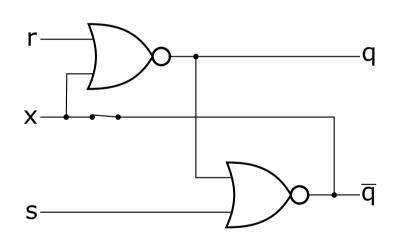




S	r	Х	q	qn	Valide
0	0	0	1	0	✓
0	0	1	0	1	✓
0	1	0	0	1	×
0	1	1	0	1	\checkmark
1	0	0	1	0	✓
1	0	1	0	0	×
1	1	0	0	0	✓
1	1	1	0	0	×

Analyse de fonctionnement (modèle combinatoire)

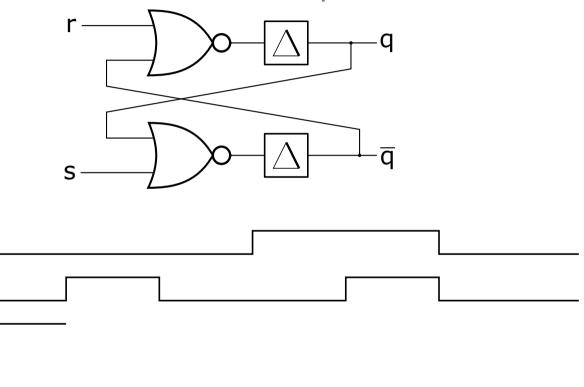


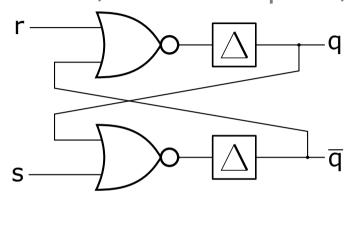


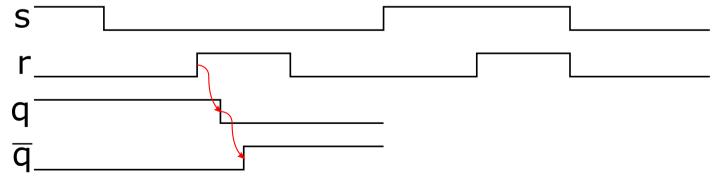
S	r	q	qn	Opération
0	0	1	0	Mémorisation
0	0	0	1	Memorisation
0	1	0	1	reset
1	0	1	0	set
1	1	0	0	Interdit

S

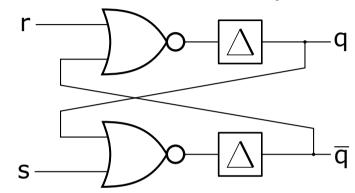


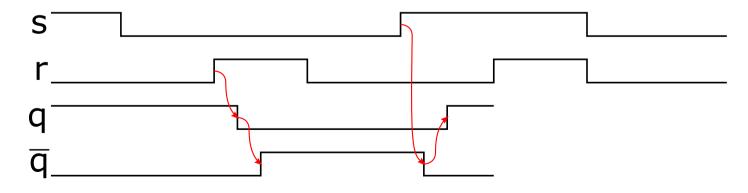




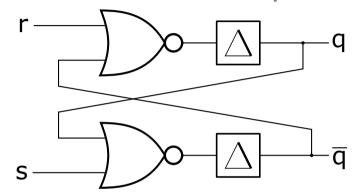


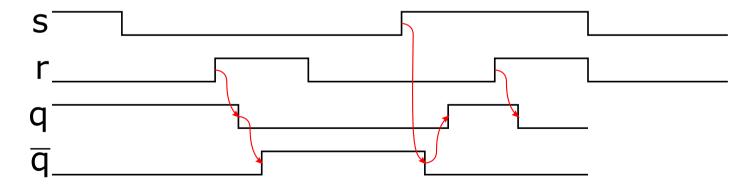
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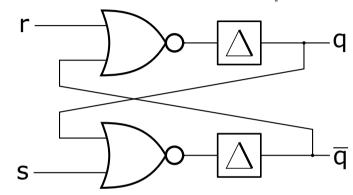


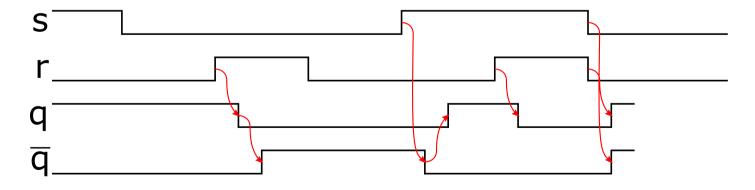
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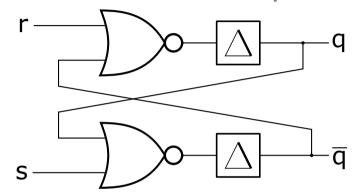


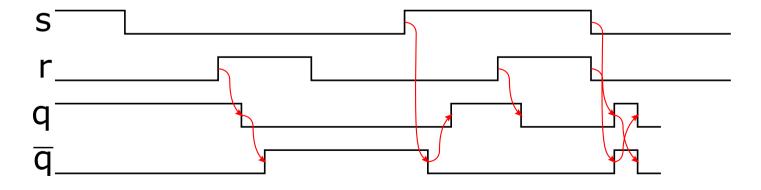
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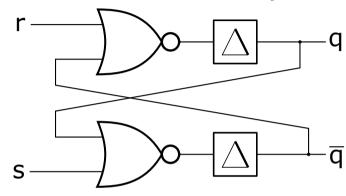


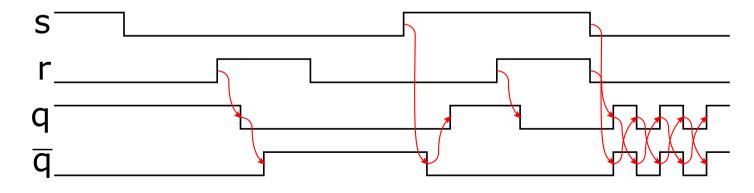
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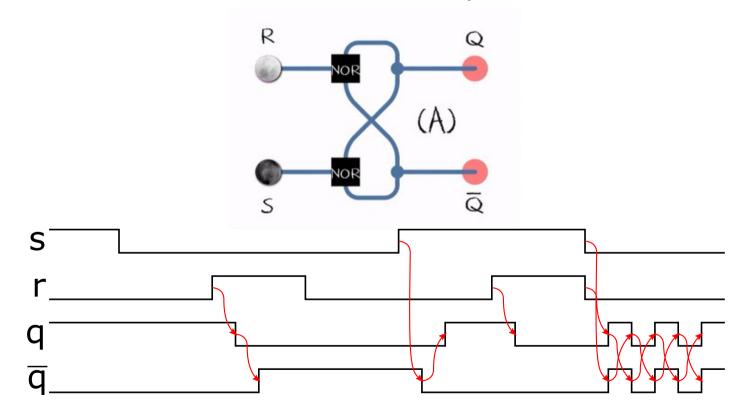




Analyse de fonctionnement (modèle temporel)



20



Exercise 2.1

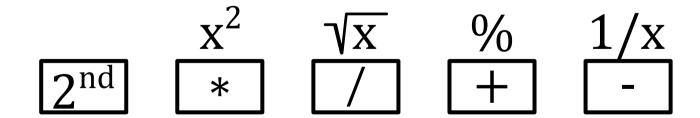
Sélection de touches





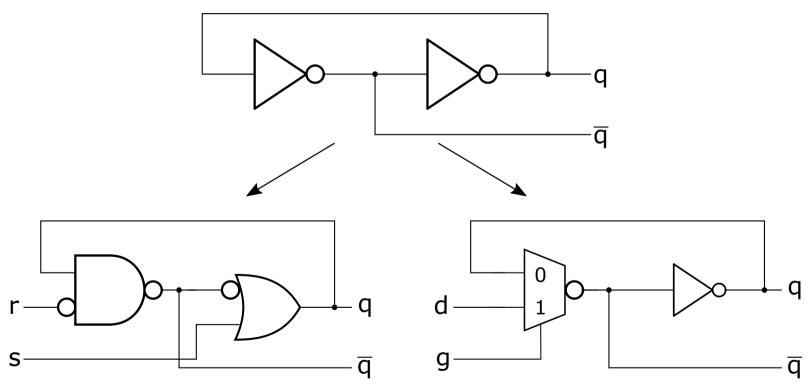
Un clavier de calculatrice comporte 5 touches pour sélectionner une opération parmi 8. L'opération x^2 est sélectionnée en appuyant sur la touche « 2^{nd} » puis sur la touche de multiplication *.

Concevoir un circuit à 8 sorties qui délivre une impulsion sur la sortie correspondant à la fonction désirée.



Eléments de mémoire

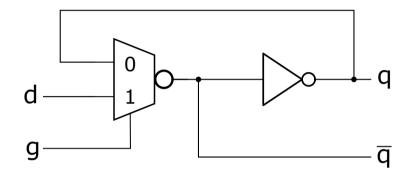


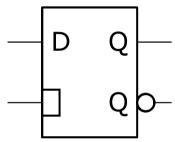


Eléments de mémoire

Eléments de mémoire D (D-Latch)







g	d	q	qn	Fonction
0	0	inch	angé	Mémorisation
0	1	IIICII	ange	Memorisation
1	0	0	1	Chargement de D
1	1	1	0	Chargement de D

$$q = gd + \overline{g}q$$

Exercise 2.5

Synchronisation





Un système commandé par une horloge, génère un signal de sortie qui varie uniquement quand le signal d'horloge est à '0'.

Concevoir un circuit qui retarde ce signal jusqu'à ce que le signal d'horloge soit à '1'.

Contenu

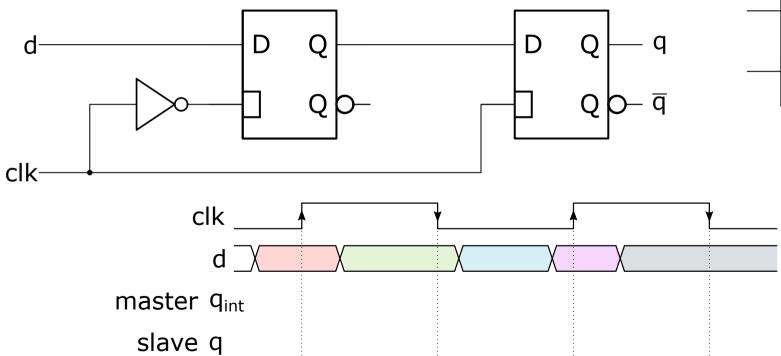


• Eléments de mémoire (Latch)

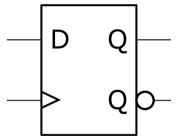
Bascules (FlipFlop)

- Bascule D (D-FlipFlop)
- Equation caractéristique
- Bascule SR (SR-FlipFlop)
- Bascule E (E-FlipFlop)
- Bascule T (T-FlipFlop)
- Entrées asynchrones

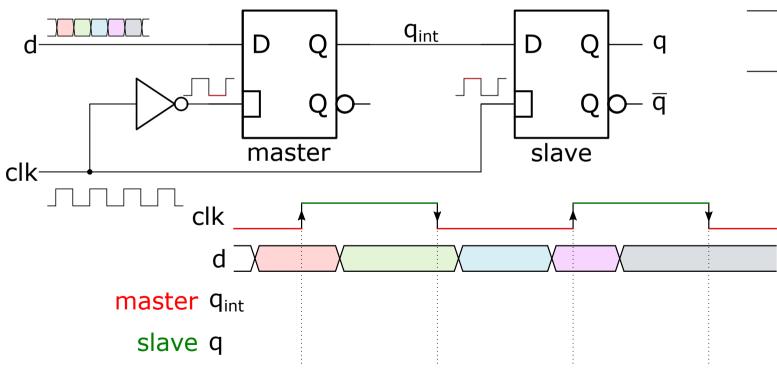
Bascule D (D-FlipFlop)



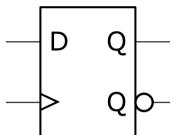




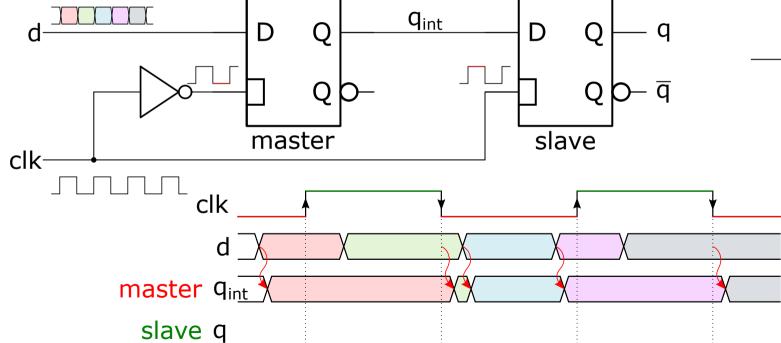
Bascule D (D-FlipFlop)



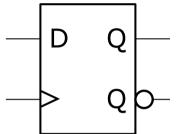




Bascule D (D-FlipFlop)



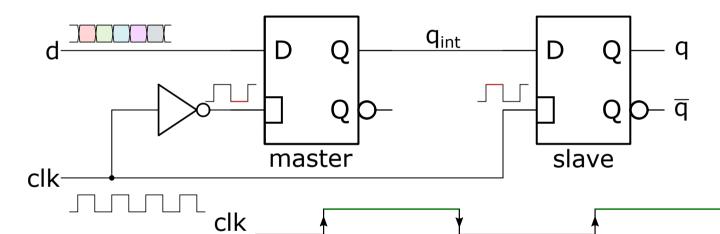




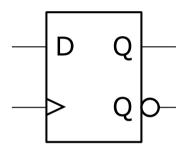
Bascule D (D-FlipFlop)

master q_{int}

slave q



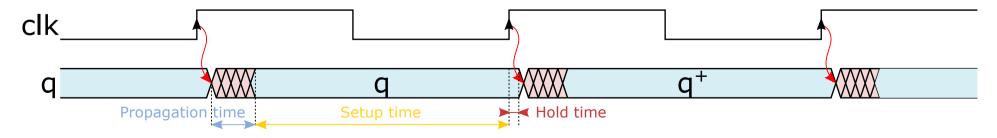




Bascule D (D-FlipFlop)



- Tous les signaux sont stables avant le flanc montant de l'horloge (respect du setup time et hold time)
- Après ce flanc montant, toutes les sorties des bascules changent, avec des retards divers (délai de propagation)
- La prochaine valeur que prend la sortie q au prochain flanc d'horloge se note "q+" (donnée par l'équation et le circuit situé sur l'entrée de la bascule)

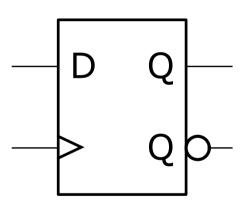


Bascule D (D-FlipFlop)

Equation caractéristique



D	Q	Q ⁺	Fonction
0	0	0	
0	1	0	Chargement de la
1	0	1	valeur D au flanc montant de l'horloge
1	1	1	



$$q^+ = d$$

Exercise 3.1

Détection des transitions





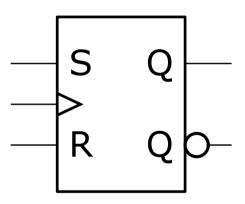
A l'aide d'une bascule D et de portes logiques, concevez un circuit qui détecte les transitions de son signal d'entrée.

Bascule SR (SR-FlipFlop)



Remplacée aujourd'hui par la bascule D

S	R	Q ⁺	Fonction
0	0	Q	Mémorisation
0	1	0	reset
1	0	1	set
1	1	1	-



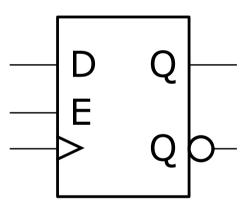
$$q^+ = s + \overline{r}q$$

Bascule E (E-FlipFlop)



Permet le fonctionnement à différentes vitesses

Ε	D	Q+	Fonction		
0	0		Mánasiadian		
0	1	Q	Mémorisation		
1	0	0	Chargement de D		
1	1	1	Chargement de D (Echanillonnage)		



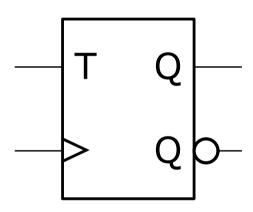
$$q^+ = ed + \overline{e}q$$

Bascule T (T-FlipFlop)



Permet de simplifier le circuit d'un compteur

T	Q ⁺	Fonction
0	Q	Mémorisation
1	$ar{Q}$	Inversion



$$q^+ = t \oplus q$$

Exercise 3.6

Registre de décalage

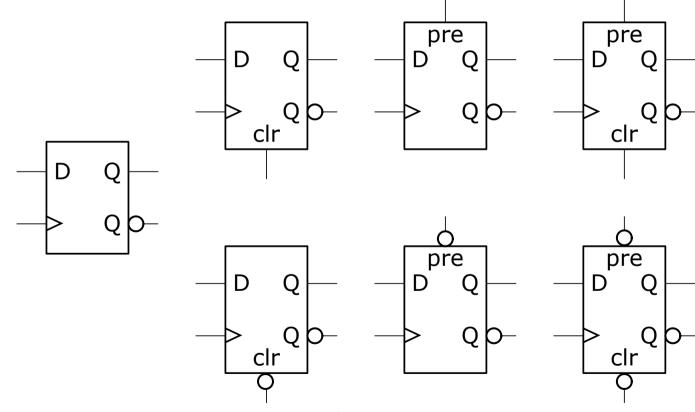




Réaliser un registre à décalage de 4 bits à l'aide de T-FlipFlop

Entrées asynchrones





ZaS, BiC, CoF DiD LAT 45

Exercise 3.7

Mise à zéro asynchrone





A l'aide d'un circuit RC et de portes logiques, créez un circuit d'initialisation des bascules à la mise sous tension de l'électronique.

Références



- [Wak00] (anglais) Présentation très complète
- [Kün97] (allemand) Bonne présentation
- [Max95] (français) Bonne présentation

WHY ARE THERE MIRRORS ABOVE BEDS

WHY DO I SAY WHY IS SEA SALT BETTER IN

WHY IS THERE NOT A POKEMON MMO WHY IS THERE LAUGHING IN TV SHOWS ARE THERE DOORS ON THE FREEWAY ARE THERE SO MANY SVCHOST-EXE RUNNING 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 X WHY ARE TEXT MESSAGES BLUE WHY ARE THERE MUSTACHES ON CLOTHES WHY WUBA LUBBA DUB DUB MEANING 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 HAVE DINOSAURS NO FUR WHY ARE SWISS AFRAID RWHY IS THERE A LINE THROUGH HI

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 S **SWHY IS THERE ICE IN SPACE** WHY IS MARVIN ALWAYS SO SAD

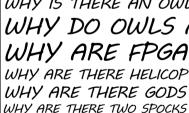
WHY IS SPACE BLACK WHY IS OUTER SPACE SO COLD WHY ARE THERE PYRAMIDS ON THE MOON WHY IS NASA SHUTTING DOWN A

THERE MALE AND FEMALE BIKES WHY ARE THERE BRIDESMAIDS WHY DO DYING PEOPLE REACH UP HOW FAST IS LIGHTSPEED WHY ARE OLD KLINGONS DIFFERENT E WHY ARE THERE TINY SPIDERS IN MY HOUSE ' DO SPIDERS COME INSIDE

WHY ARE THERE HUGE SPIDERS IN MY HOUSE $_{
m H}$ WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE $\overline{oldsymbol{\lambda}}$ 为WHY ARE THERE SO MANY SPIDERS IN MY ROOM

SPYDER BITES ITCH

WHY ARE THERE **GHOSTS**



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 MY BOOBS ITCHY WHY ARE THERE GODS

'IS https://xkcd·com/1256/ THEY SAY T-MINUS WHY ARE THERE OBELISKS MWHY ARE WRESTLERS ALWAYS WET

TO WHY IS THERE A RED LINE THROUGH HTTPS ON TWITTER

WHY AREN'T MY ARMS GROWING WHY ARE THERE SO MANY CROWS IN ROCHESTER &

WHY IS TO BE OR NOT TO BE FUNNY

WHY DO CHILDREN GET CANCER 🗢

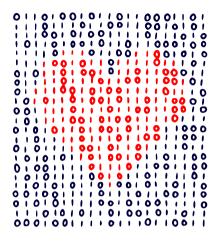
WHY IS POSEIDON ANGRY WITH ODYSSEUS

WHY DO Q TIPS FEEL GOOD

WHY AREN'T

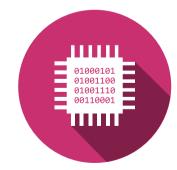
THERE GUNS IN

WHY ARE THERE SQUIRRELS









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