Lucerne University of
Applied Sciences and Arts

HOCHSCHULE
LUZERN

Technik & Architektur

Source: Dilbert.com

I STARTED A TASK FORCE TO ELIMINATE REDUNDANCIES IN OUR INTERNAL PROCESSES.
REALLY? I'M DOING THE SAME THING.
Dilbert.com DilbertCartoonist@gmail.com
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Tacho

“Speed is everything.”

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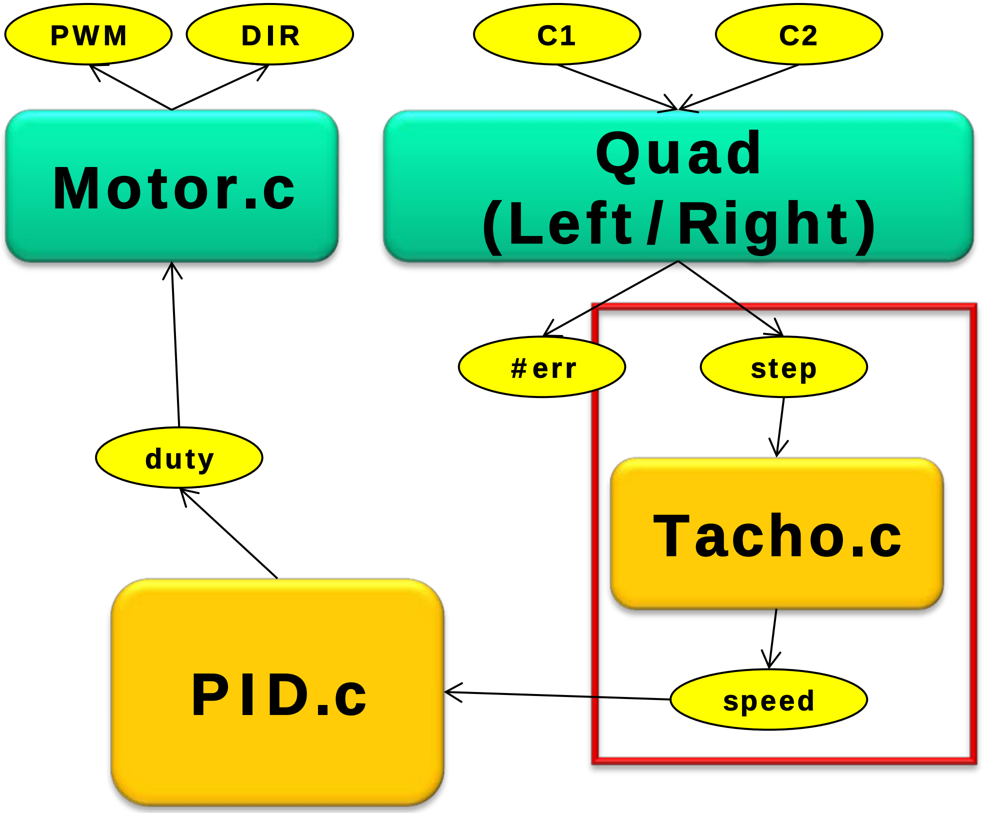
High Level Overview

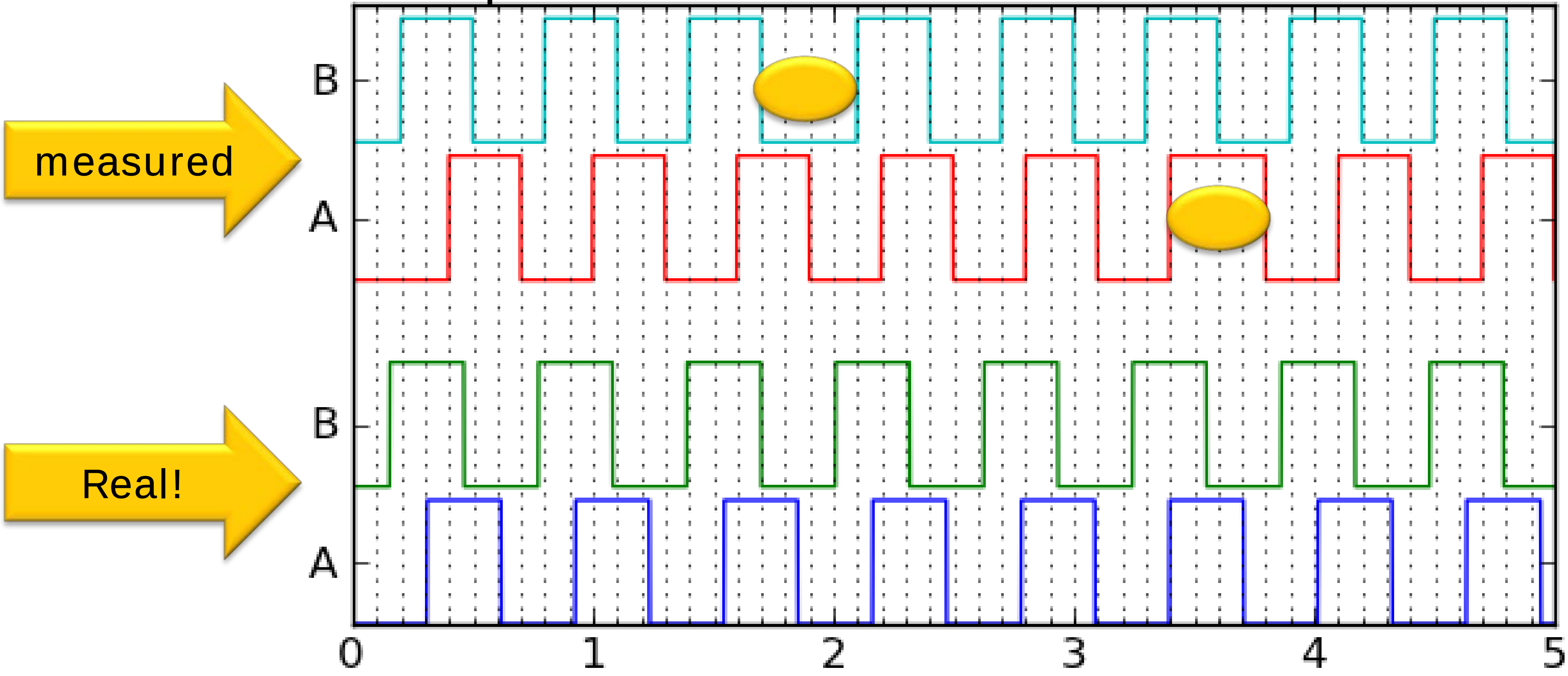


Tacho Interface

```
/*! \brief Returns the previously calculated speed of the motor.
    \param isLeft TRUE for left motor, otherwise right motor.
 *  \return Actual speed value */
int32_t TACHO_GetSpeed(bool isLeft);

/*! \brief Calculates the speed based on the position information from the
  encoder.
 * \return Actual speed value */
int32_t TACHO_CalcSpeed(void);

/*!
 * \brief Sampling routine to calculate speed, must be called periodically with
  a fixed frequency.
 */
void TACHO_Sample(void);

uint8_t TACHO_ParseCommand(const unsigned char *cmd, bool *handled, const
  CLS1_StdIOType *io);

void TACHO_Deinit(void);
void TACHO_Init(void);
```

Real vs. Measurement

- http://www.embeddedrelated.com/showarticle/158.php
- Measuring at fixed frequency
- No fixed interval pulse train!



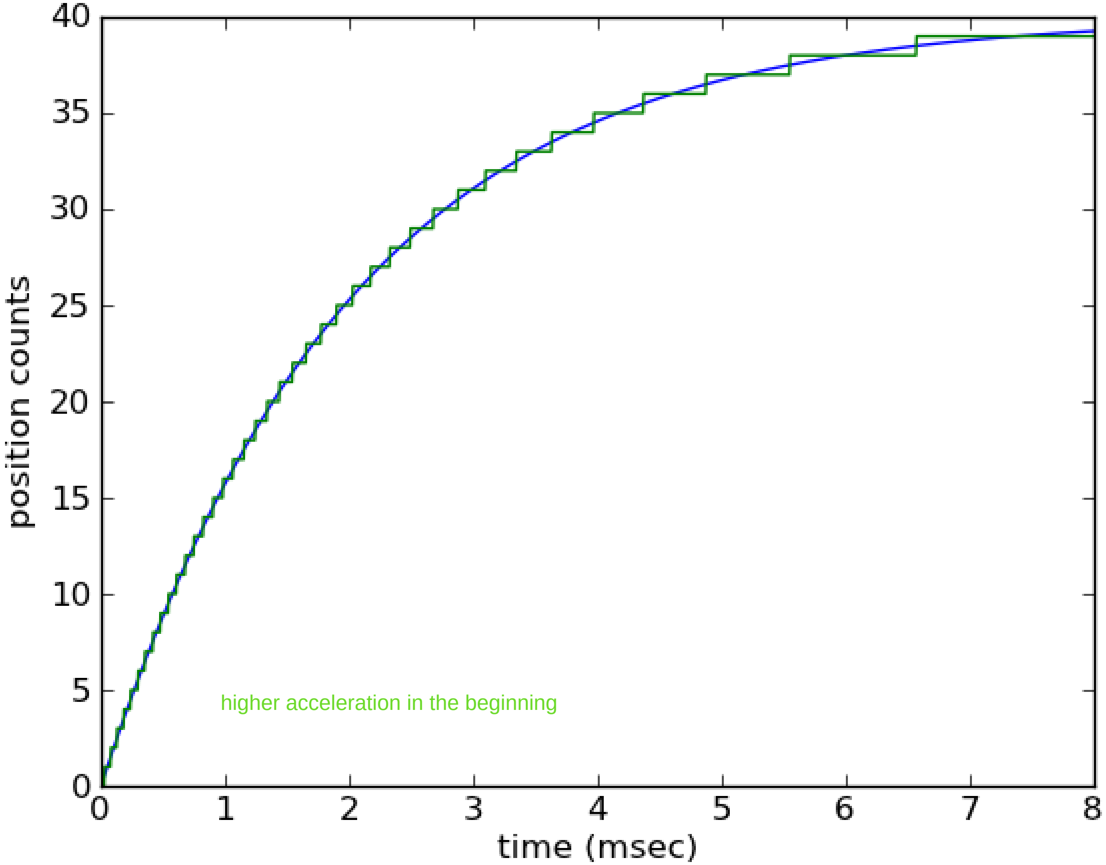
measured

Real!

Source: Jason Sachs

Quantization Effect

- Encoders are digital
- Limited number of steps per distance/revolution

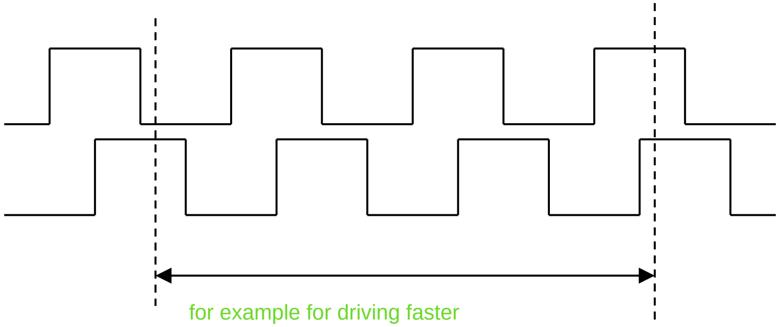


Source: Jason Sachs

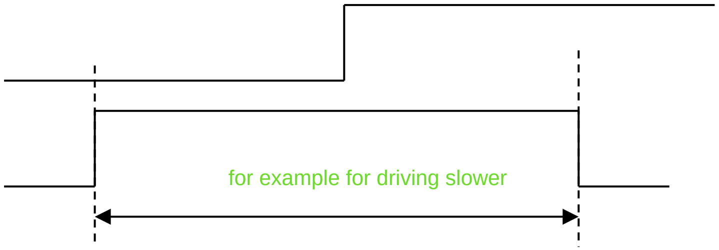
Measuring (Estimating) Speed?

- Δpos approach (better for fast moving)
  - Constant T
- ΔT approach (better for slow moving)
  - need timeout!

$$v(k) \approx \frac{x(k) - x(k-1)}{T} = \frac{\Delta X}{T}$$



$$v(k) \approx \frac{X}{t(k) - t(k-1)} = \frac{X}{\Delta T}$$

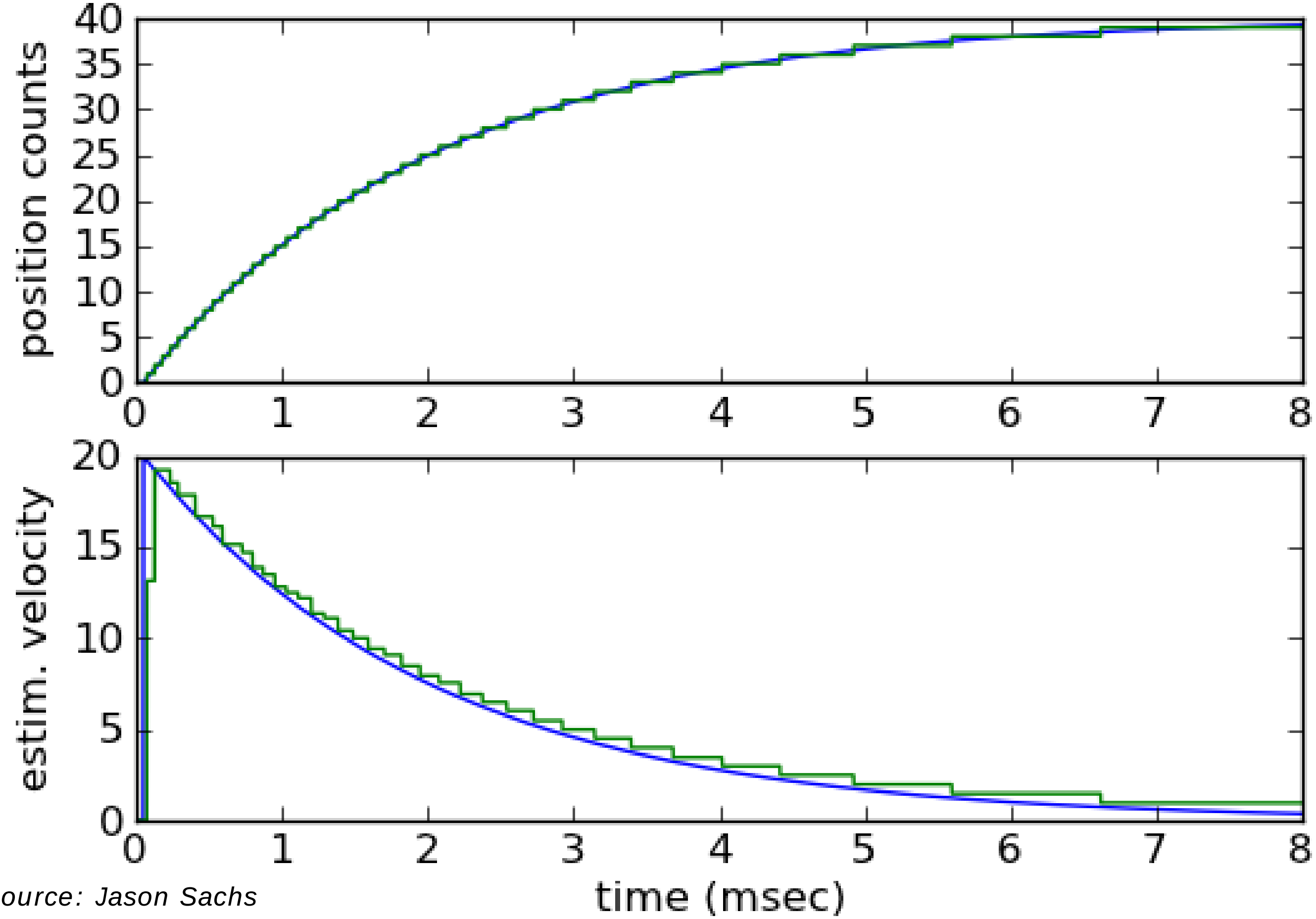


Source: TI TMS320x280x Datasheet

Link: http://www.ti.com/lit/ug/spru790d/spru790d.pdf

Position vs. Speed

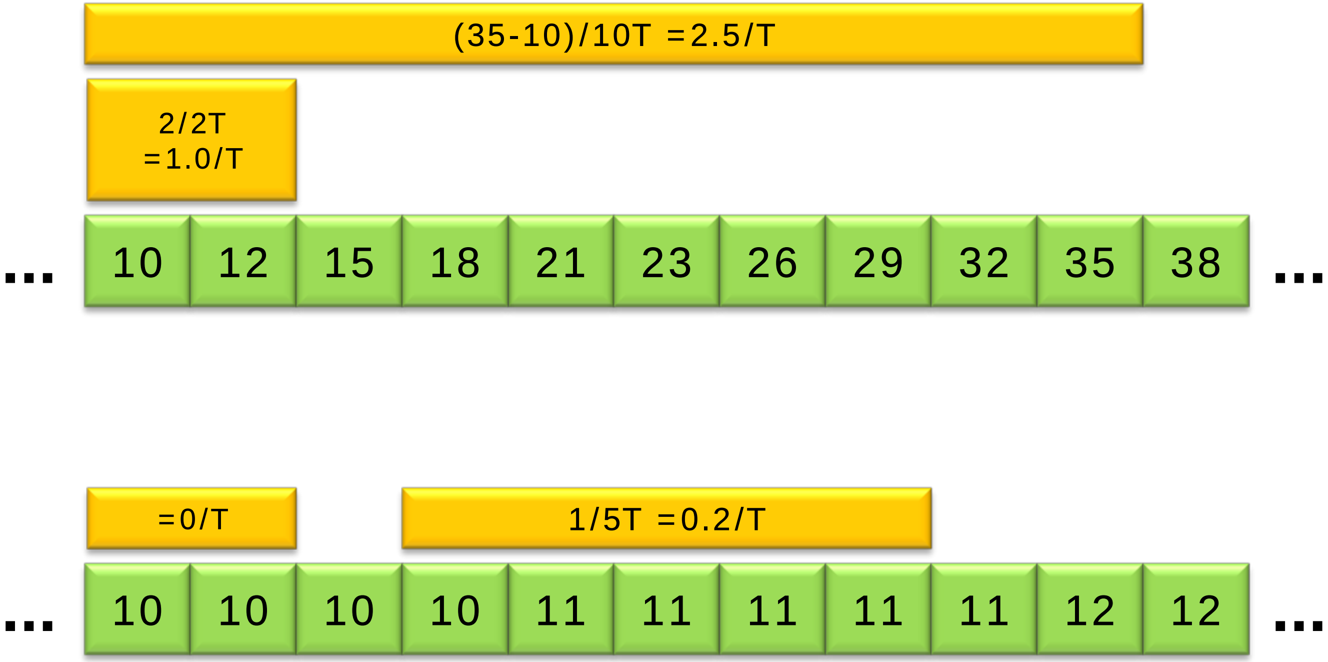
- Backward looking
- Speed is lagging behind position
- Speed is only an estimation!



Source: Jason Sachs

Δpos Implementation

- Simple Δpos
  - Delta between curr and prev
- Δsteps with History
  - Sampling into array with fixed frequency (Window)
  - Averaging and simple ΔT possible



(35-10)/10T =2.5/T

2/2T
=1.0/T

... 10 12 15 18 21 23 26 29 32 35 38 ...

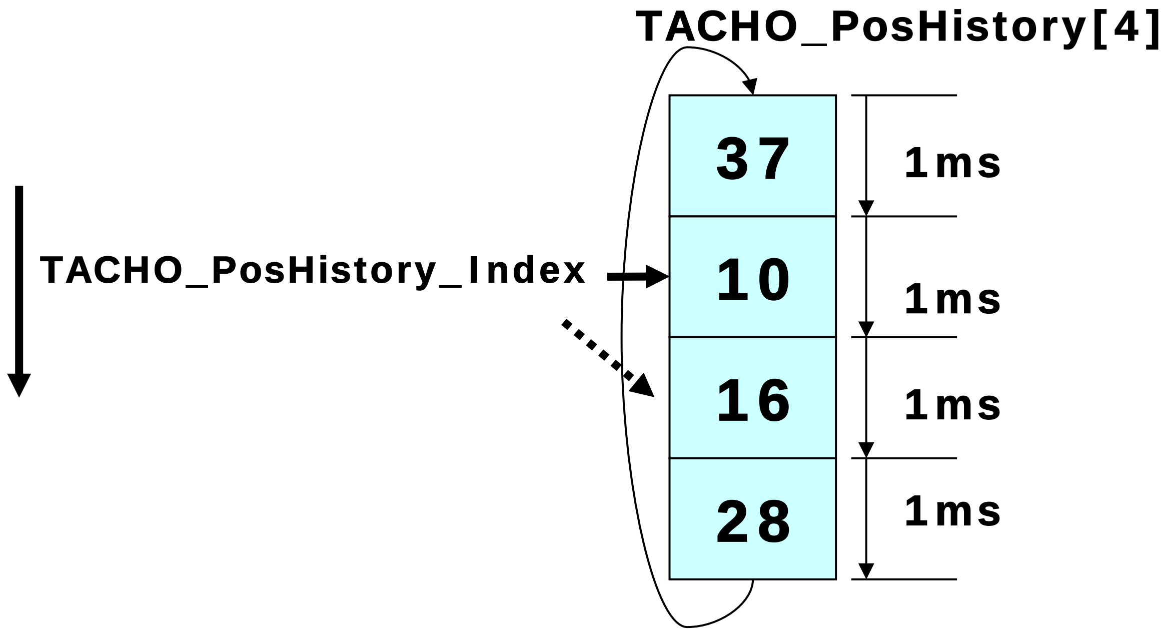
=0/T

1/5T =0.2/T

... 10 10 10 10 11 11 11 11 11 12 12 ...

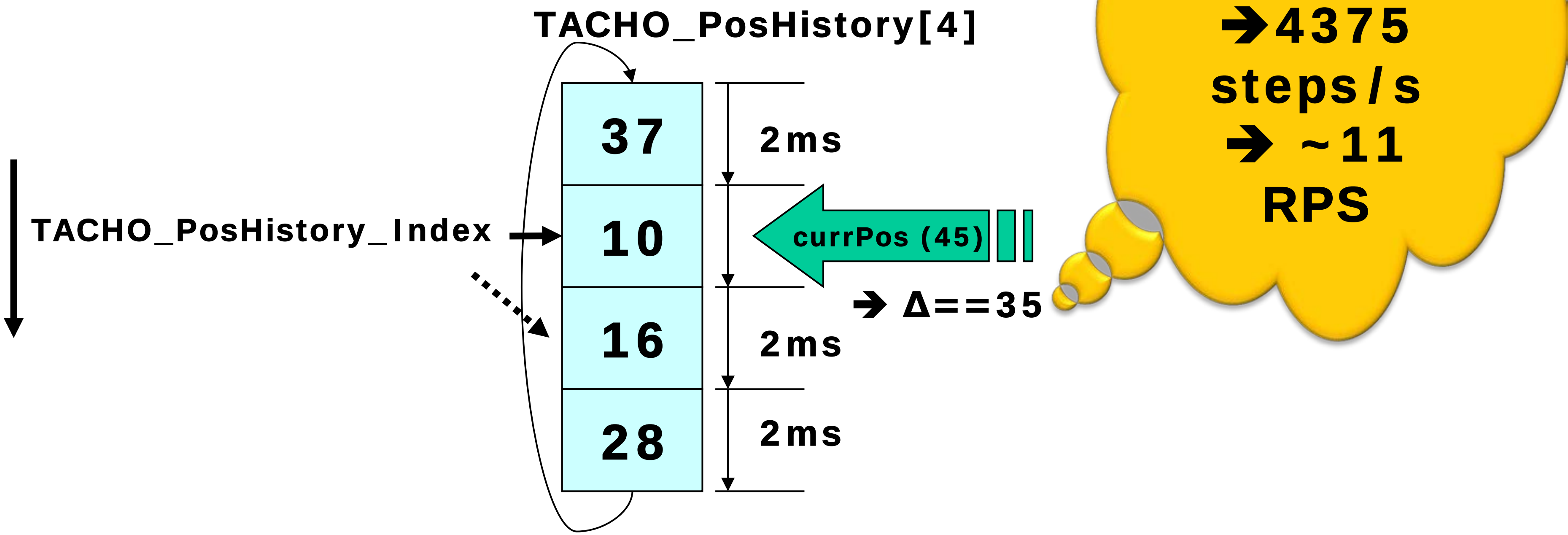
TACHO_Sample() Position sampling

- +/- Speed (steps/sec): forward/backward
- currPos: current position counter
- PosHistory[]: Array of history position
- PosHistory_Index: points to free element



TACHO_CalcSpeed()

- Known time (delta) distance between
  - Current position
  - Position to be overwritten
- Steps/second calculation
  - # steps per second



TACHO_PosHistory[4]

TACHO_PosHistory_Index

37
10
16
28

2ms

2ms

2ms

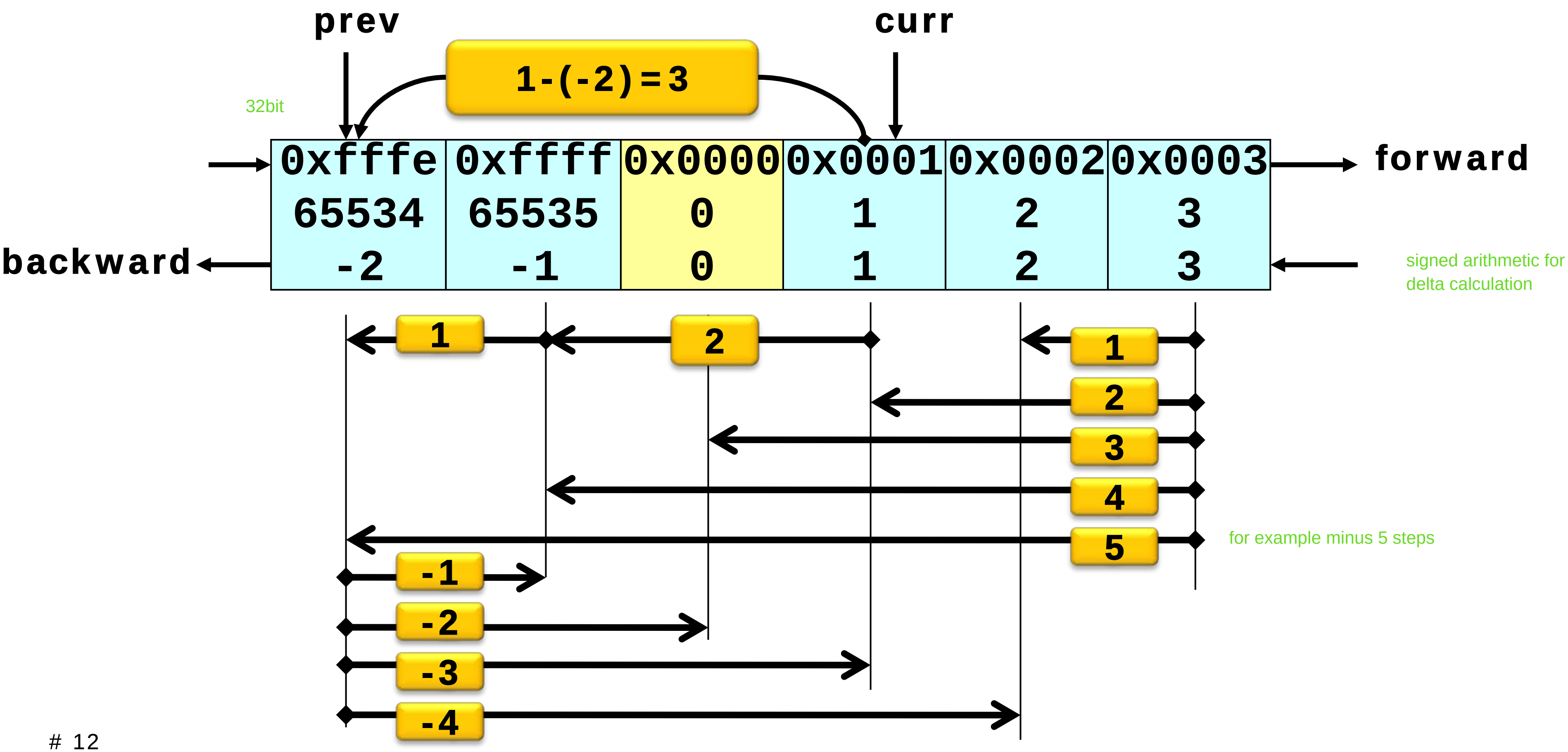
currPos (45)

➔ Δ==35

35 steps for 4*2ms ➔4375 steps/s ➔ ~11 RPS

Step Arithmetic: Overflow / zero

- delta = curr – prev
  - signed arithmetic!



0xfffe	0xffff	0x0000	0x0001	0x0002	0x0003
65534	65535	0	1	2	3
-2	-1	0	1	2	3

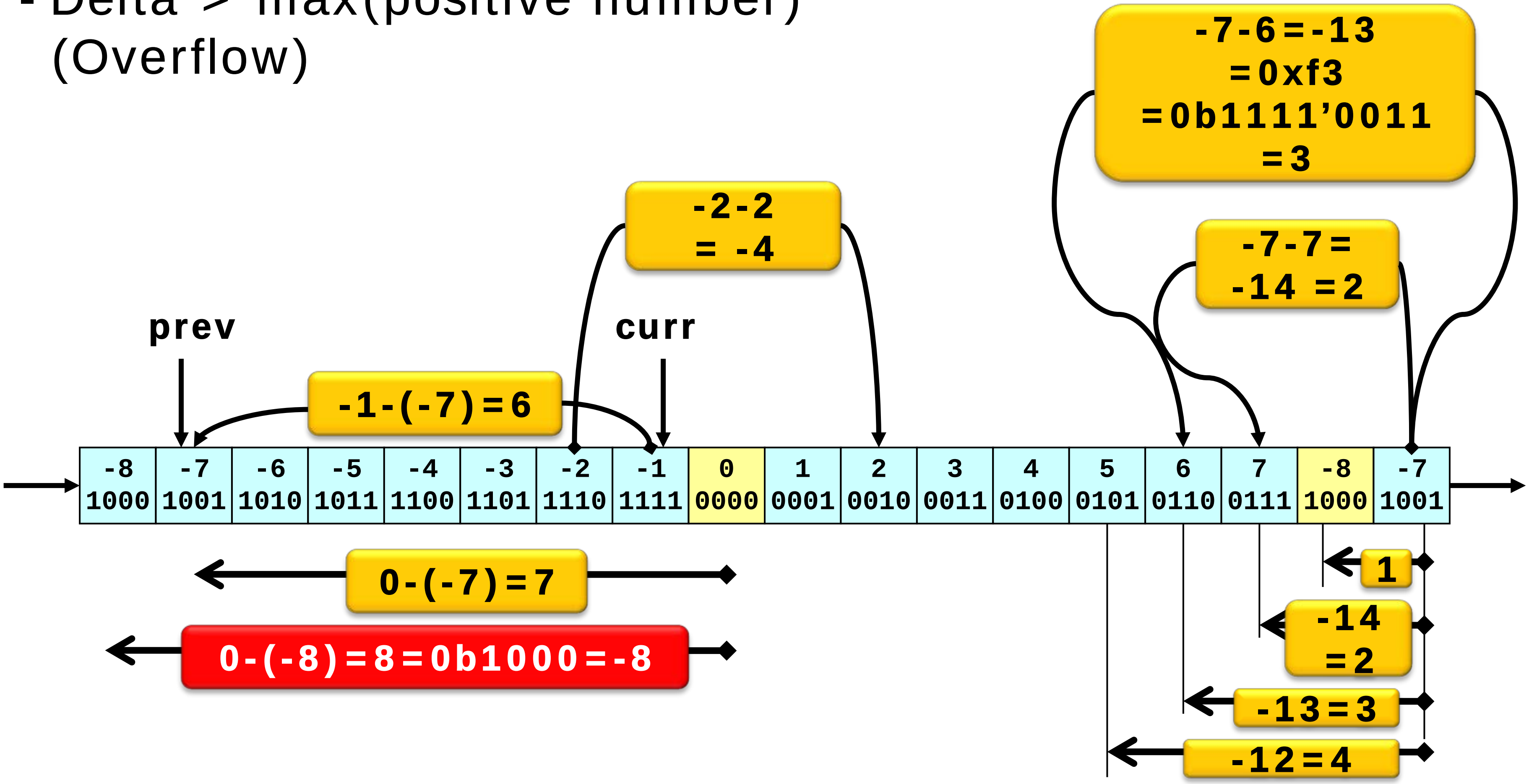
32bit

signed arithmetic for delta calculation

for example minus 5 steps

Step Arithmetic (4bit Signed Example)

- Delta > max(positive number) (Overflow)



-7-6=-13
=0xf3
=0b1111’0011
=3

-2-2
= -4

-7-7=
-14 =2

prev

curr

-1-(-7)=6

-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	-8	-7
1000	1001	1010	1011	1100	1101	1110	1111	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001

0-(-7)=7

0-(-8)=8=0b1000=-8

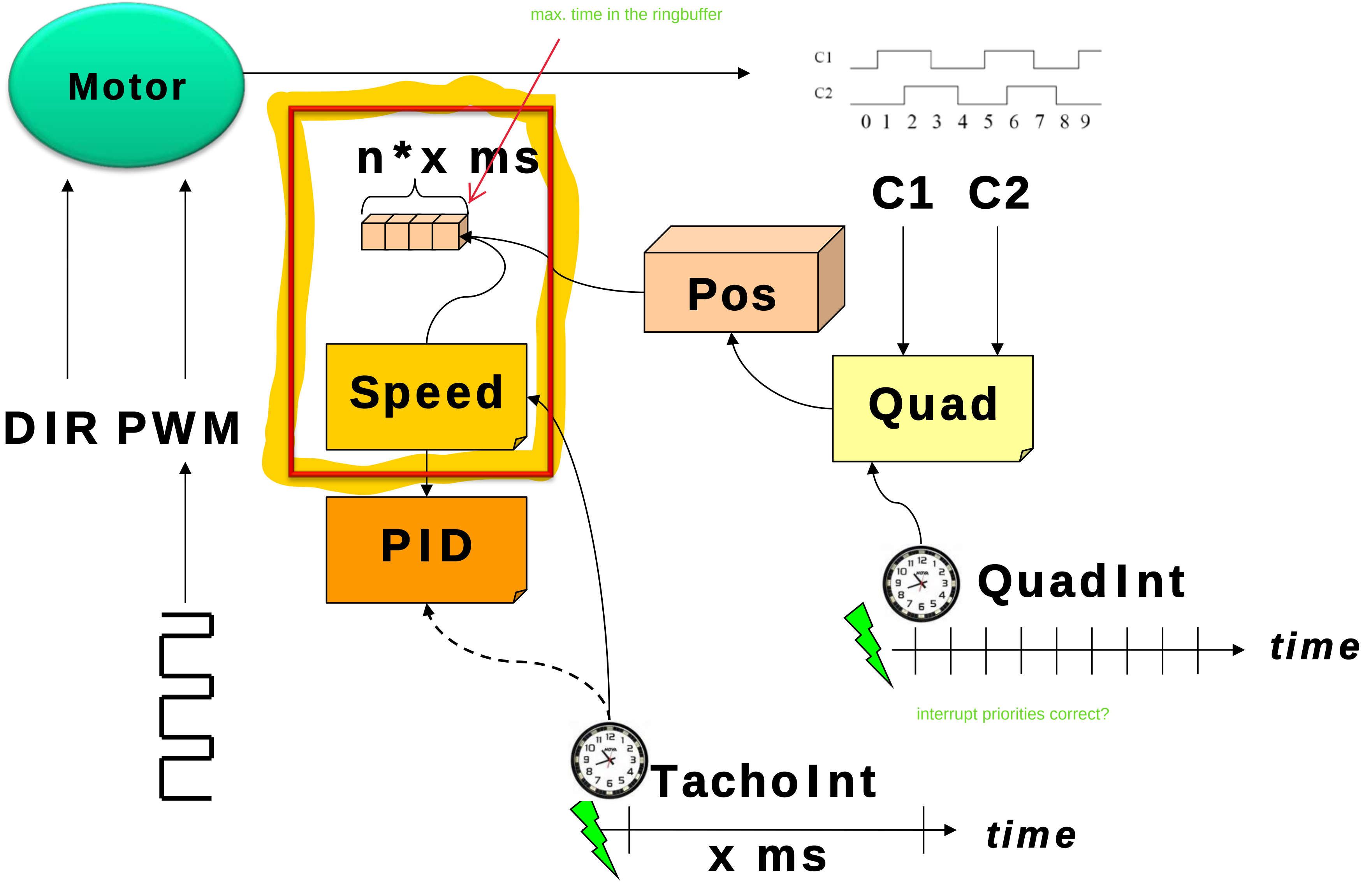
1

-14
=2

-13=3

-12=4

System Architecture & Timing



Lab: Tacho

- Implement/integrate
  - Tacho.c/Tacho.h

- Check steps/second on shell console
  - ‘status’ command

- Article by Jason Sachs:
  - http://www.embeddedrelated.com/showarticle/158.php?articleid=158