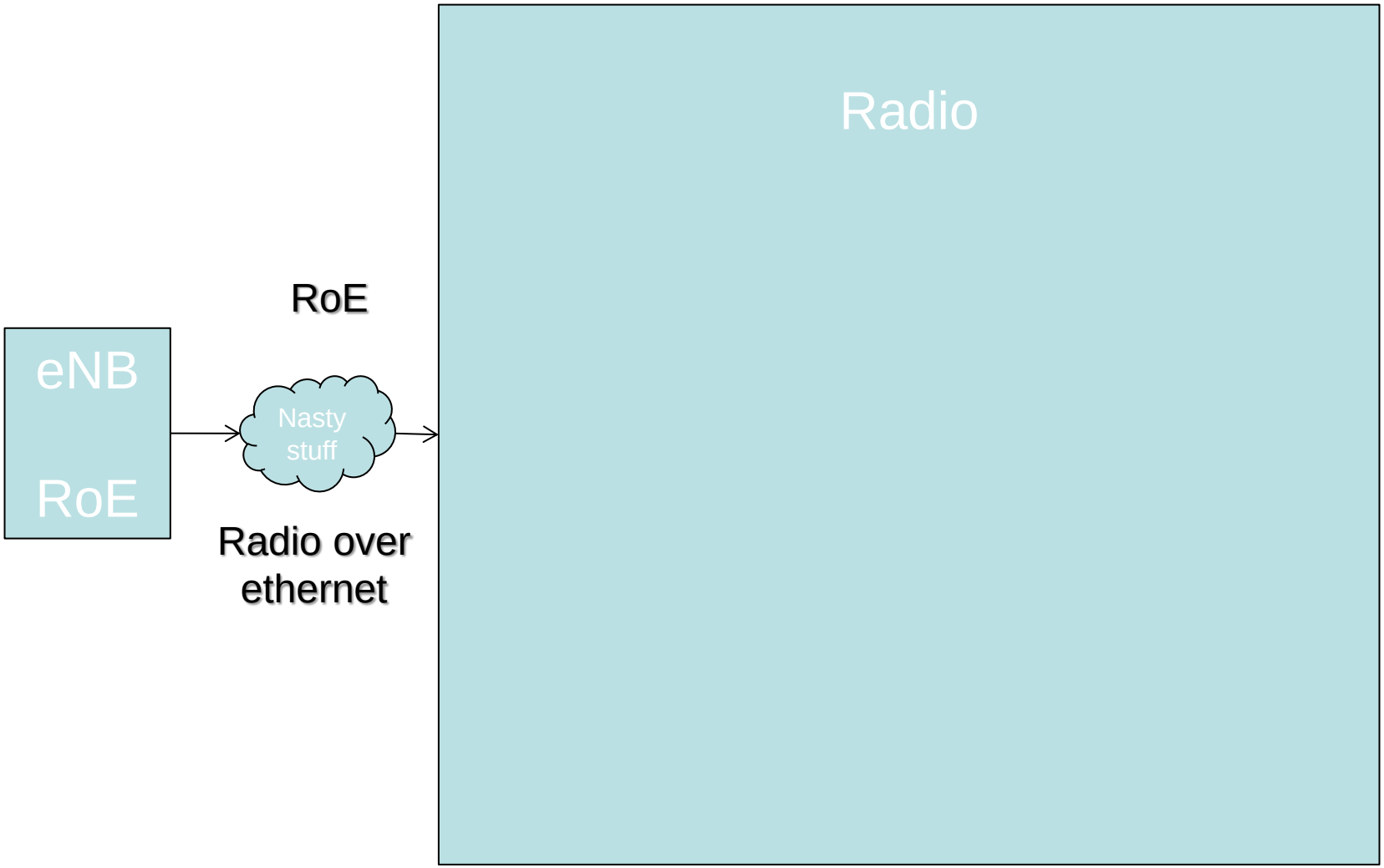
RF Accuracy

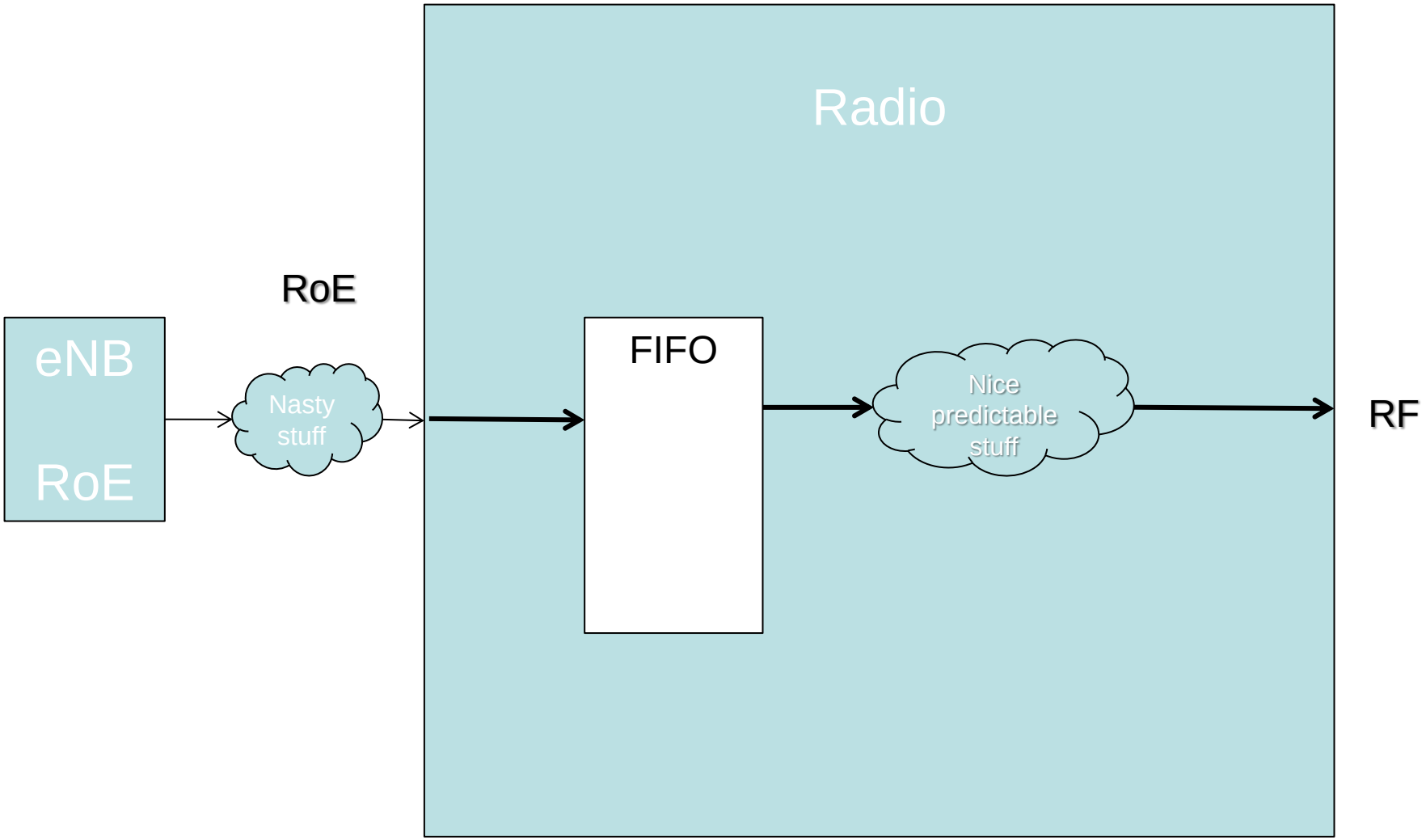
Presentation time & sequence numbers

Richard Maiden

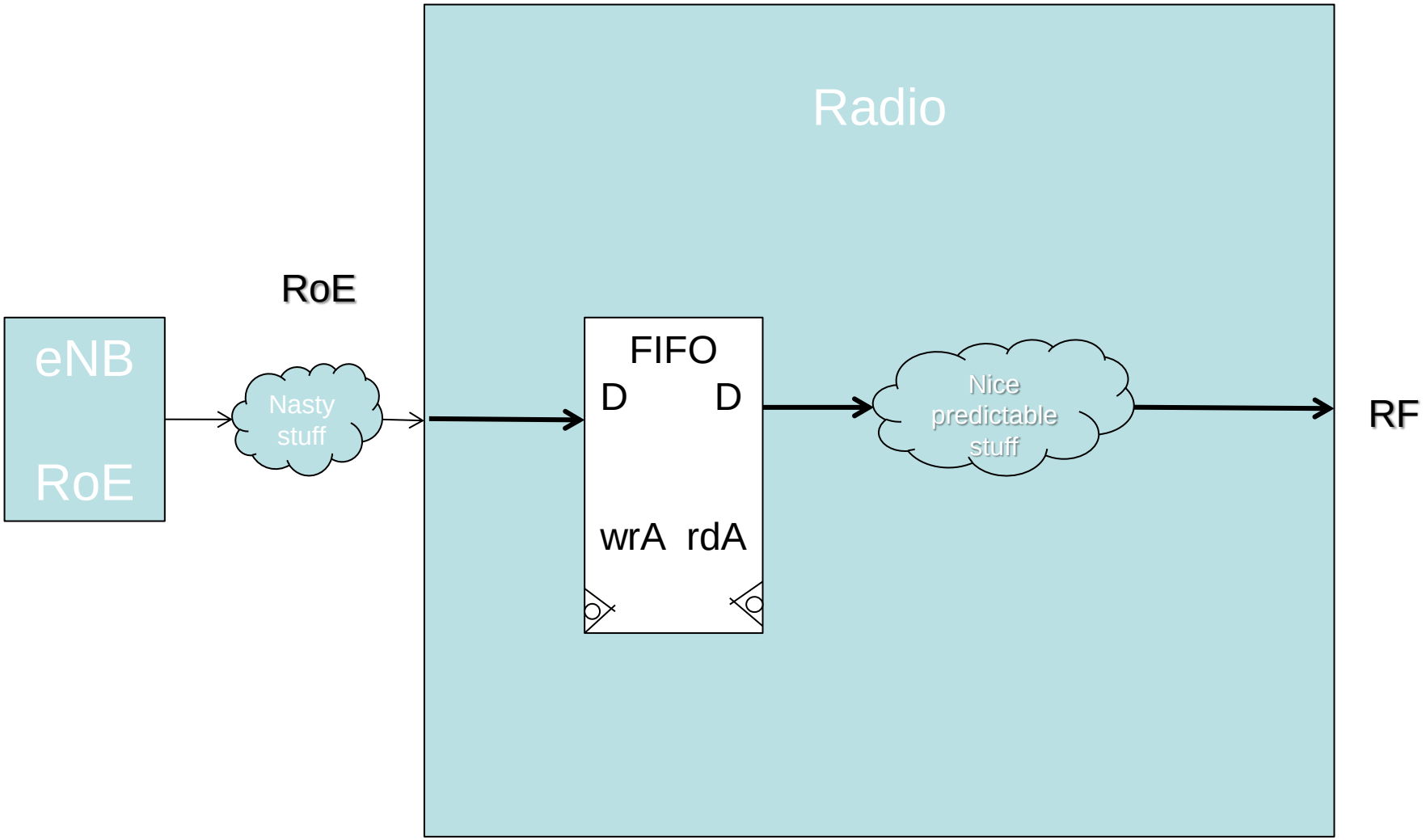
What do we care about?



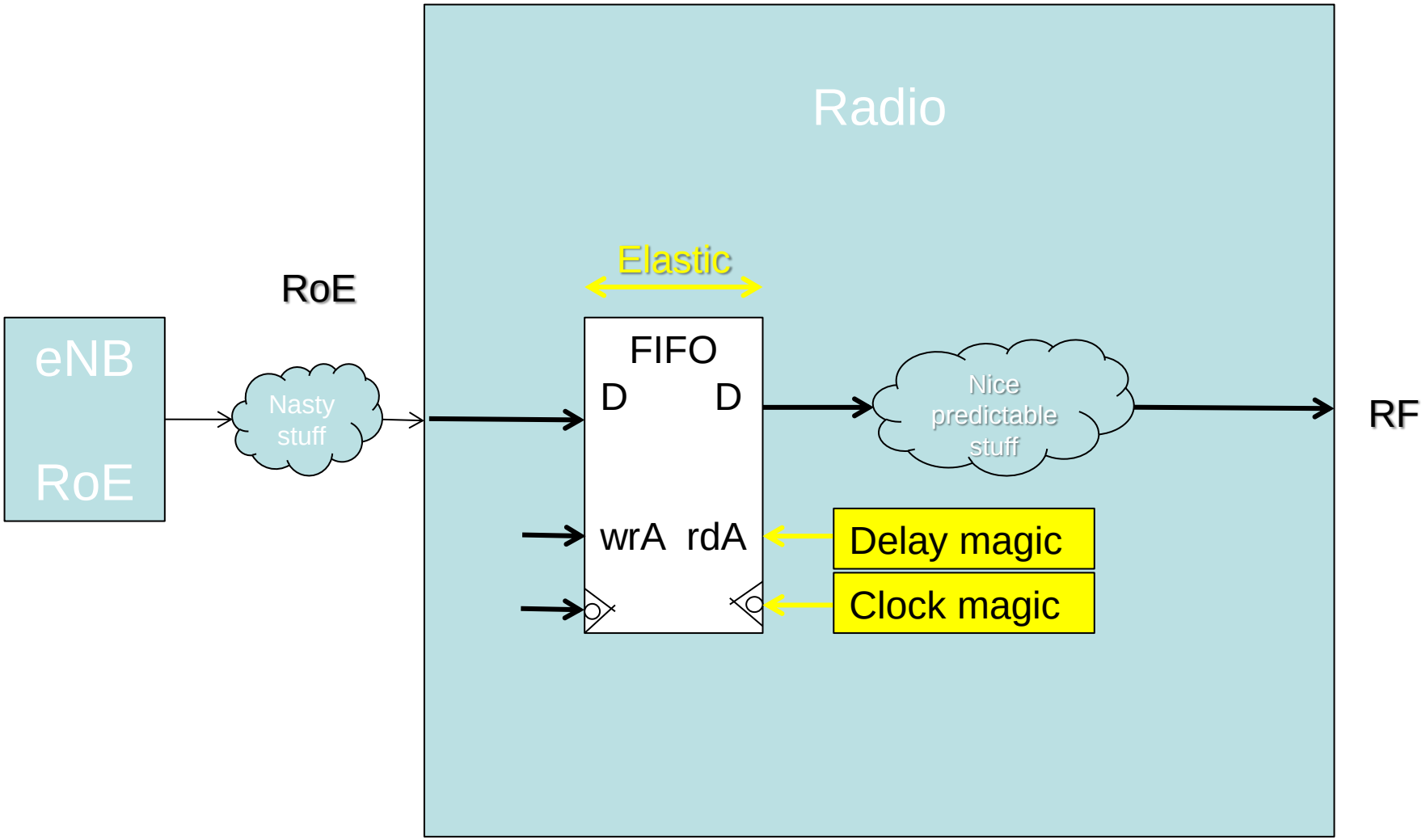
What do we care about?



What do we care about?



What do we care about?



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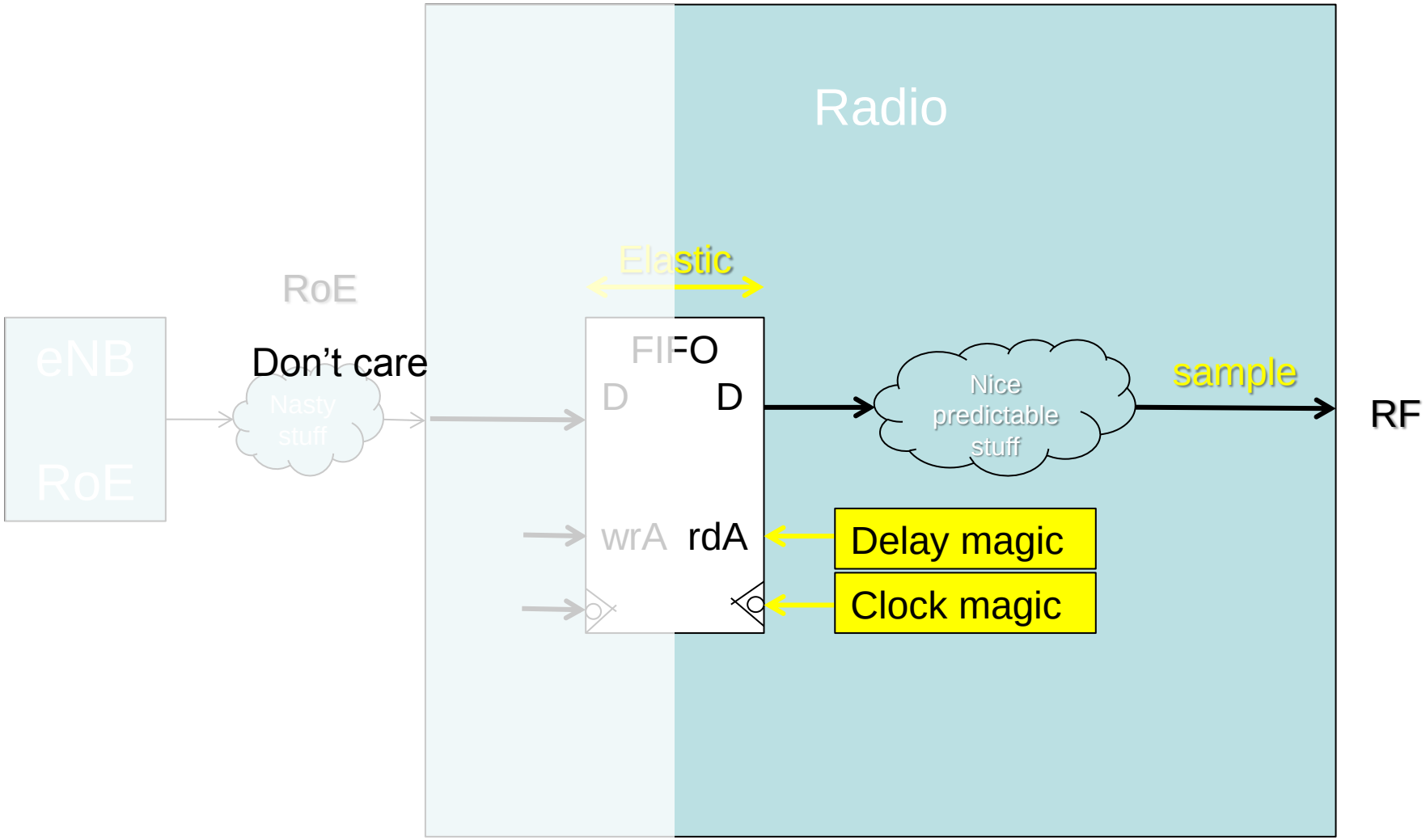


Clock and delay magic

- Out of scope

- Many, many possible schemes
  - SyncE
  - 1588v2
  - GPS
  - PWM
  - RTT measurements
  - etc.
- Many, many concerns
  - Frame delay variation
  - One time / regular
  - Closed/open loop
  - PLL, OVCXO, fiber length, #hops
  - Jitter, Wander

Timing accuracy

Classes and granularity

From 802.1CM (Apr 6th)

Requirements summary

	Synchronization Stream	IQ data	C&M data
Traffic type repartition	-	> 90%	< 10%
Traffic pattern	-	Periodic (1~67µs)	Burst
Traffic QoS type	Very High	High	Best Effort
Security	Under study	Under study	-
End-to-End Latency	-	<100µs	-
FDV	-	Not specify	-
FLR	-	$<10^{-9}$	$<10^{-6}$
Sync. timing error	Class A+: <= 10 ns Nice to have– MIMO Class A: <= 45 ns Must – Carrier aggregation Class B: <= 110 ns Must – Carrier aggregation Class C: <= 1.36 µs Must – LTE TDD		-
Sync. freq. error	Under study	-	-

Jitter scenario

- CPRI focus here (#1 use case)
- CPRI basic frame is 1/3.84MHz
  - 260.41666666'ns
- Our timeStamp is 0.25ns

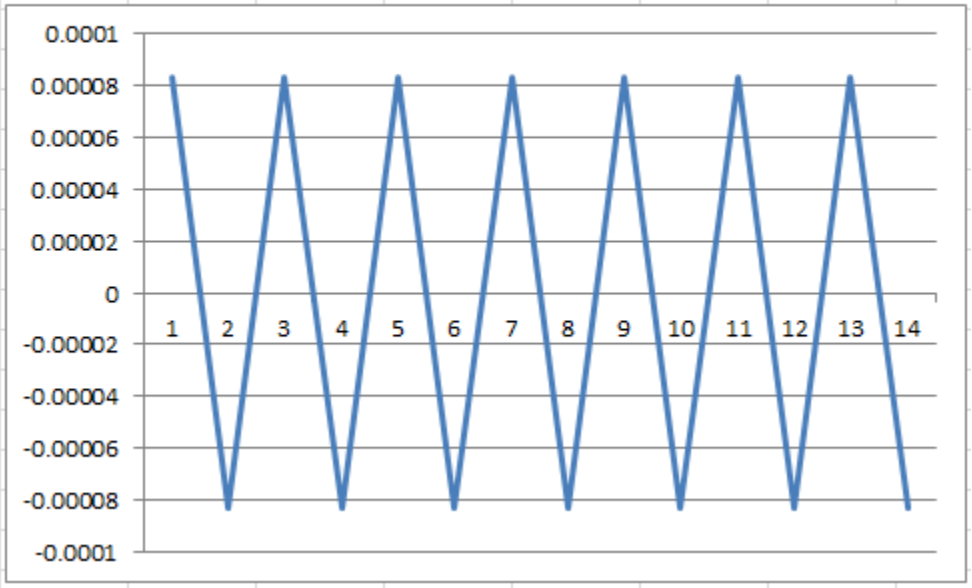
Scenario 1

basic frame count / 3.84

Round(Prefect presentation time / 0.25ns)

Quantized

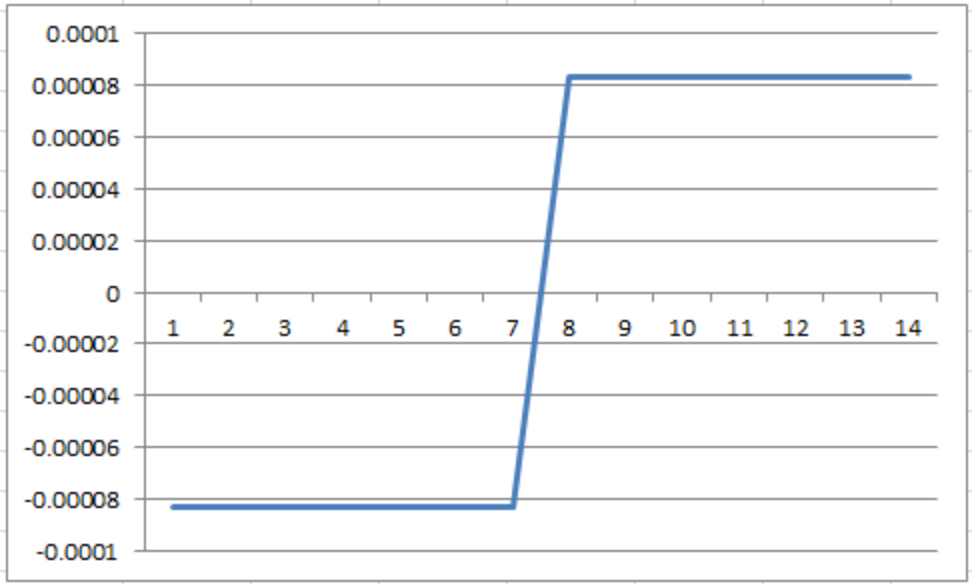
Basic frame count	Desired presentation time (us)	Timestamp in 0.25ns	Requested Presentation time (us)	Error (us)
149	38.80208333	155208	38.802	8.33333E-05
301	78.38541667	313542	78.3855	-8.33333E-05
449	116.9270833	467708	116.927	8.33333E-05
601	156.5104167	626042	156.5105	-8.33333E-05
749	195.0520833	780208	195.052	8.33333E-05
901	234.6354167	938542	234.6355	-8.33333E-05
1049	273.1770833	1092708	273.177	8.33333E-05
1201	312.7604167	1251042	312.7605	-8.33333E-05
1349	351.3020833	1405208	351.302	8.33333E-05
1501	390.8854167	1563542	390.8855	-8.33333E-05
1649	429.4270833	1717708	429.427	8.33333E-05
1801	469.0104167	1876042	469.0105	-8.33333E-05
1949	507.5520833	2030208	507.552	8.33333E-05
2101	547.1354167	2188542	547.1355	-8.33333E-05



+/-83ps

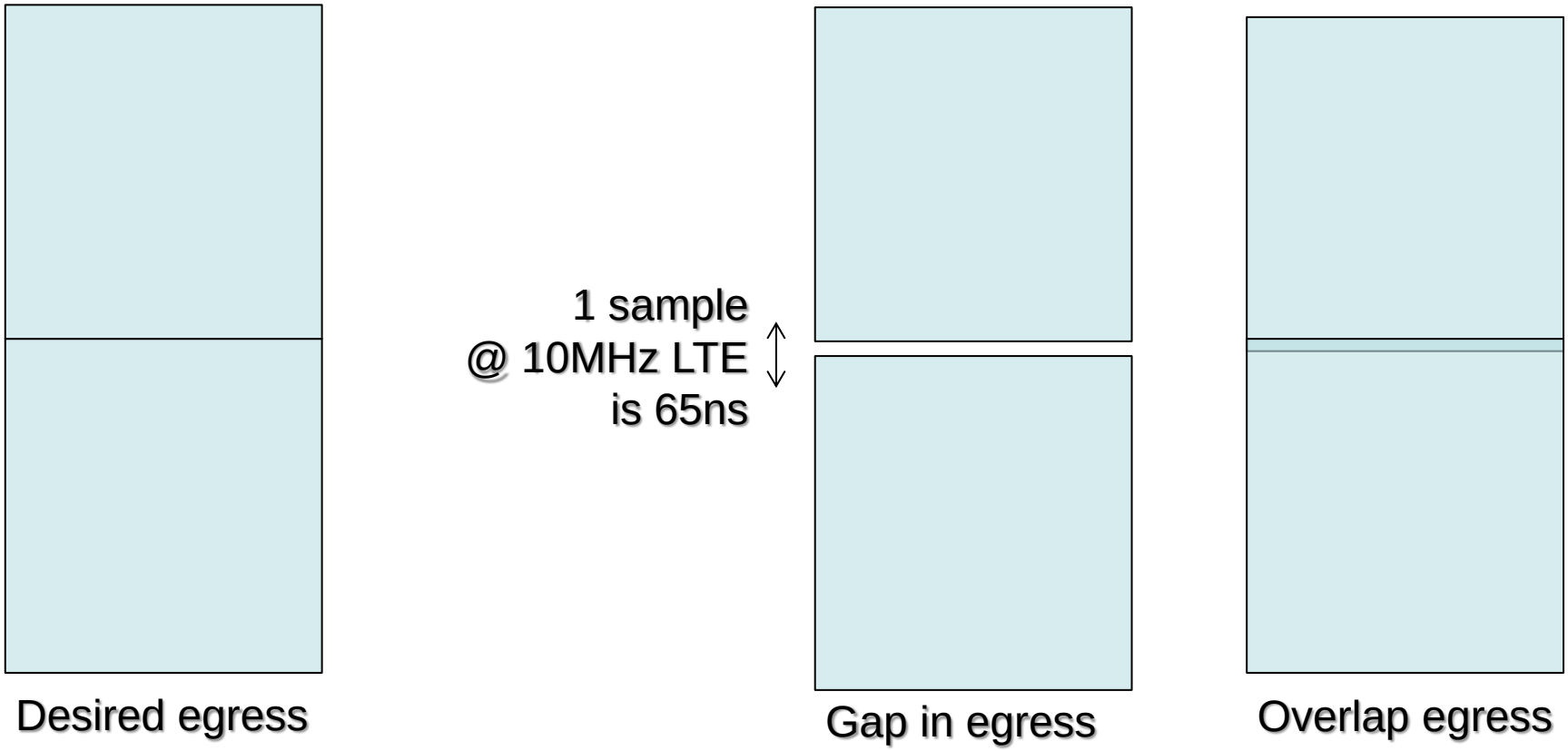
Scenario 2

Basic frame count	Desired presentation time (us)	Timestamp in 0.25ns	Requested Presentation time (us)	Error (us)
151	39.32291667	157292	39.323	-8.33333E-05
301	78.38541667	313542	78.3855	-8.33333E-05
451	117.4479167	469792	117.448	-8.33333E-05
601	156.5104167	626042	156.5105	-8.33333E-05
751	195.5729167	782292	195.573	-8.33333E-05
901	234.6354167	938542	234.6355	-8.33333E-05
1051	273.6979167	1094792	273.698	-8.33333E-05
1199	312.2395833	1248958	312.2395	8.33333E-05
1349	351.3020833	1405208	351.302	8.33333E-05
1499	390.3645833	1561458	390.3645	8.33333E-05
1649	429.4270833	1717708	429.427	8.33333E-05
1799	468.4895833	1873958	468.4895	8.33333E-05
1949	507.5520833	2030208	507.552	8.33333E-05
2099	546.6145833	2186458	546.6145	8.33333E-05



+/-83ps is pretty small

- But we either transmit a sample or we don't. A drifting clock would be worse



Alternatives…

- Do nothing– its out of scope
- Force / suggest nice increments
  - Anything divisible by 3 works ok
- Increase accuracy
  - Reduces error but not slip?
- Variable step size
  - 1/3.84 rather than 0.25ns

Basic frame count	Desired presentation time (us)	Timestamp in 0.25ns	Requested Presentation time (us)	Error (us)
150	39.0625	156250	39.0625	0
300	78.125	312500	78.125	0
450	117.1875	468750	117.1875	0
600	156.25	625000	156.25	0
750	195.3125	781250	195.3125	0
900	234.375	937500	234.375	0
1050	273.4375	1093750	273.4375	0
1200	312.5	1250000	312.5	0
1350	351.5625	1406250	351.5625	0
1500	390.625	1562500	390.625	0
1650	429.6875	1718750	429.6875	0
1800	468.75	1875000	468.75	0
1950	507.8125	2031250	507.8125	0
2100	546.875	2187500	546.875	0

Motion #x

- making the motion
- Seconded by

- Technical motion (>=2/3)

- Yes: -, no: -, abstain -