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IBIS [Driver Schedule] modeling

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Summary

IBIS driver schedule modeling

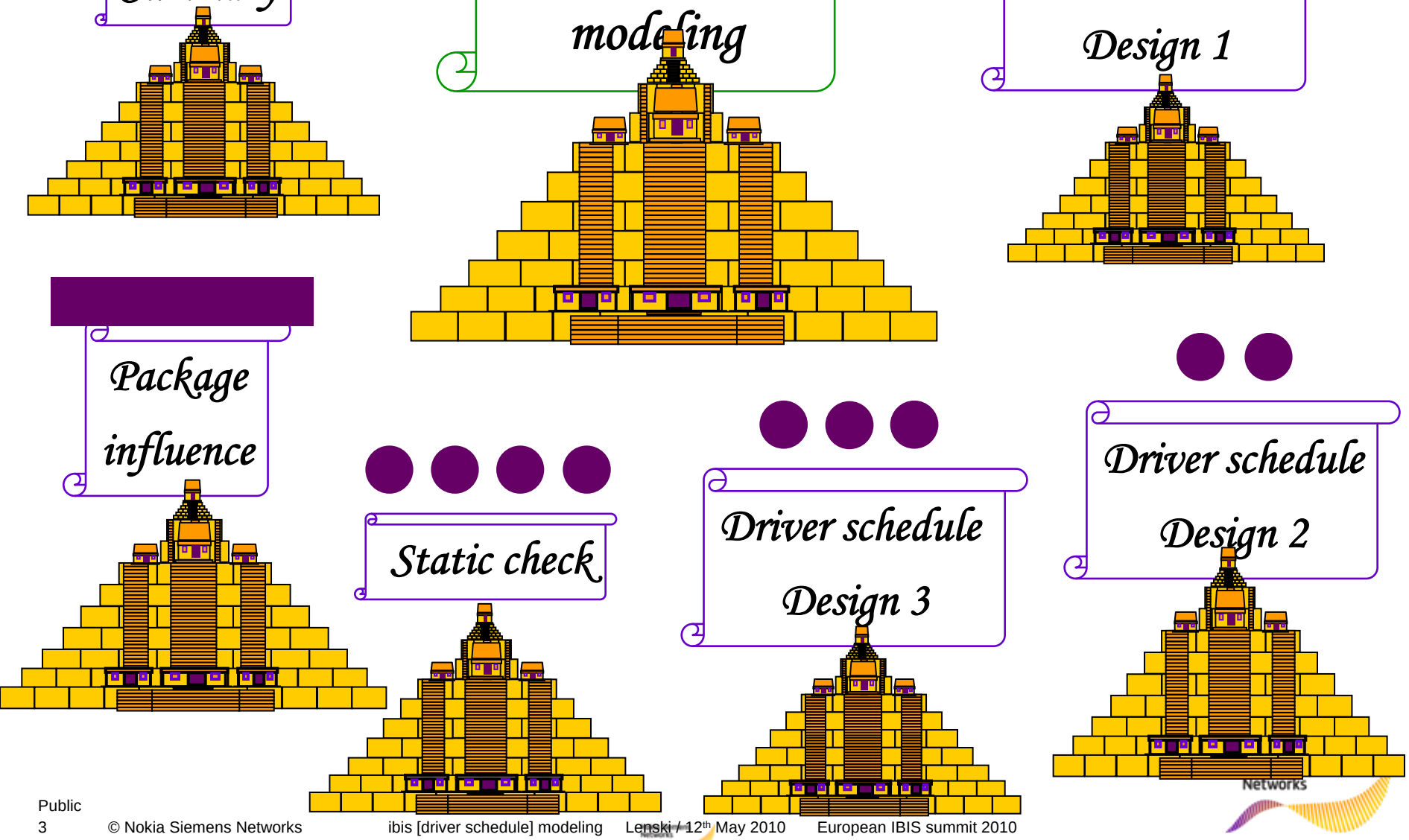
Driver schedule Design 1

Package influence

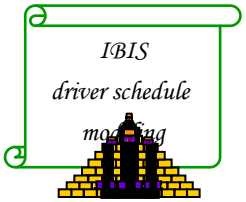
Static check

Driver schedule Design 3

Driver schedule Design 2



driver schedule static curves



[Model] 2-Driver-schedule

[Voltage Range] 3.30V 3.1350V 3.4650V

[GND Clamp]

[POWER Clamp]

[Pulldown]

[Pullup]

[Driver Schedule]

MODEL_1	0s	NA	0ns	NA
MODEL_2	0.5ns	NA	0ns	NA

[Model] Model_1

[GND Clamp]

[POWER Clamp]

[Pulldown]

[Pullup]

[Model] Model_2

[GND Clamp]

[POWER Clamp]

[Pulldown]

[Pullup]

Top level model tables

Driver schedule timing

Scheduled model tables

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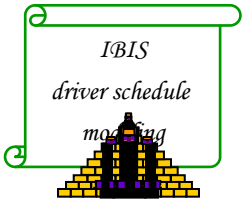
General timing schedule

[Driver Schedule]

|Model_name	Rise_on_dly	Rise_off_dly	Fall_on_dly	Fall_off_dly
MODEL_1	0.5ns	NA	0ns	NA
MODEL_2	1.0ns	NA	0ns	NA
MODEL_3	1.5ns	2.5ns	NA	NA



|Model_name Rise_on_dly Rise_off_dly Fall_on_dly Fall_off_dly

turn on pullup-structure	turn off pullup-structure	turn on pulldown-structure	turn off pulldown-structure
turn off pulldown-structure	turn on pulldown-structure	turn off pullup-structure	turn on pullup-structure

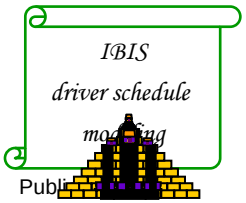
scheduled models timing parameter

rising edge (L->H)

falling edge (H->L)

Model_name	Rise_on_dly	Rise_off_dly	Fall_on_dly	Fall_off_dly
MODEL_1	**1.0ns**	**2.5ns**	**0ns**	**NA**

turn on pullup-structure	turn off pullup-structure	turn on pulldown-structure	turn off pulldown-structure
turn off pulldown-structure	turn on pulldown-structure	turn off pullup-structure	turn on pullup-structure



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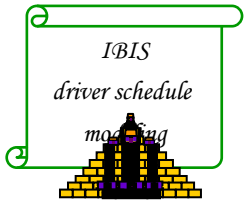
timing schedule vs datarate



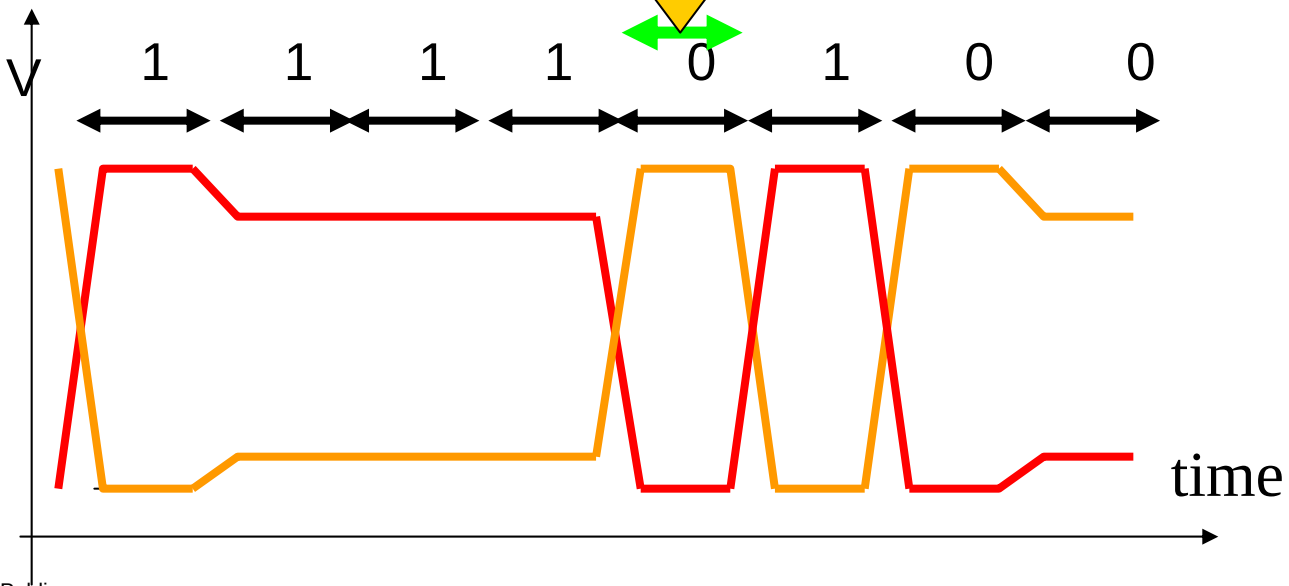
[Driver Schedule]

|Model_name	Rise_on_dly	Rise_off_dly	Fall_on_dly	Fall_off_dly
MODEL_1	0.0ns	NA	0ns	NA
MODEL_2	NA	0.4ns	NA	0.4ns

Model valid for
one specific datarate

UI corresponds to Datarate

Eg.
UI 400ps
2.5 Gbps



data pattern
11110100

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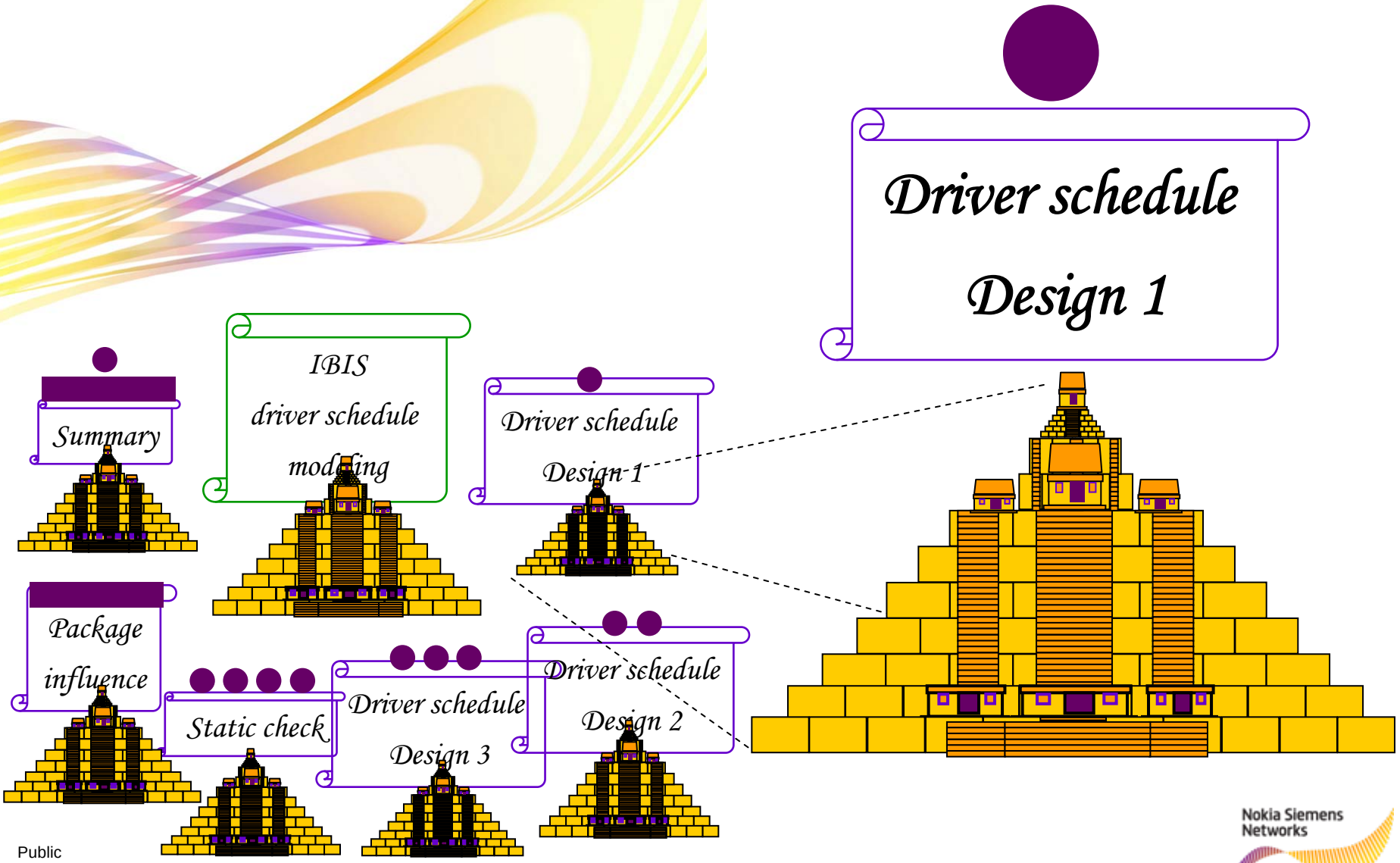
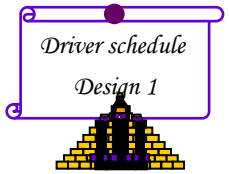
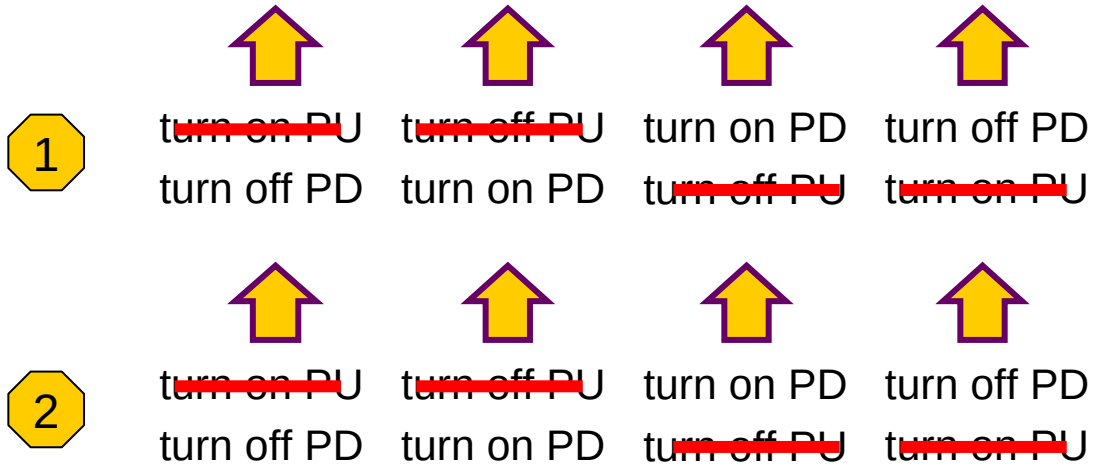

Driver schedule
Design 1
Summary
IBIS
driver schedule
modeling
Driver schedule
Design 1
Package
influence
Static check
Driver schedule
Design 3
Driver schedule
Design 2

Example 1 timing schedule opsink plus opsink



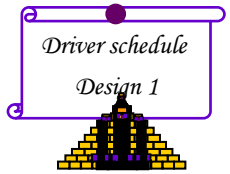
[Driver Schedule]

	Model_name	Rise_on_dly	Rise_off_dly	Fall_on_dly	Fall_off_dly
1	3P3V_DRI-NSN-1+3_OUT	0.000ns	NA	0.000ns	NA
2	3P3V_DRI-NSN-1+4_OUT	NA	0.800ns	NA	0.800ns

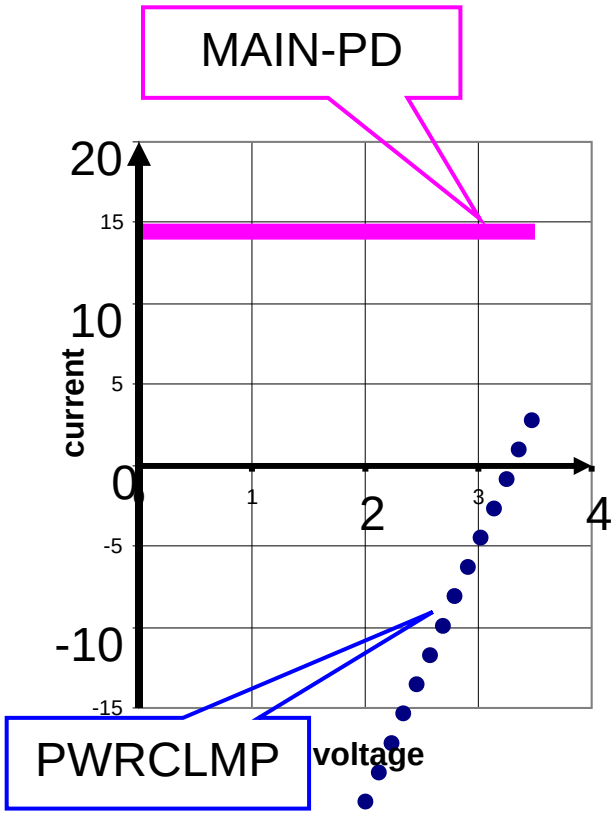


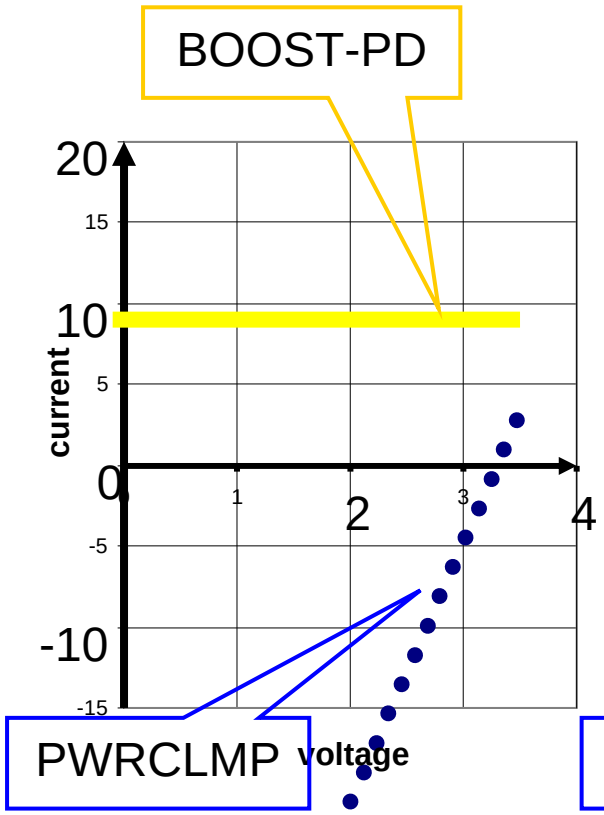
Don‘t forget the clamp currents from the top level model, if any

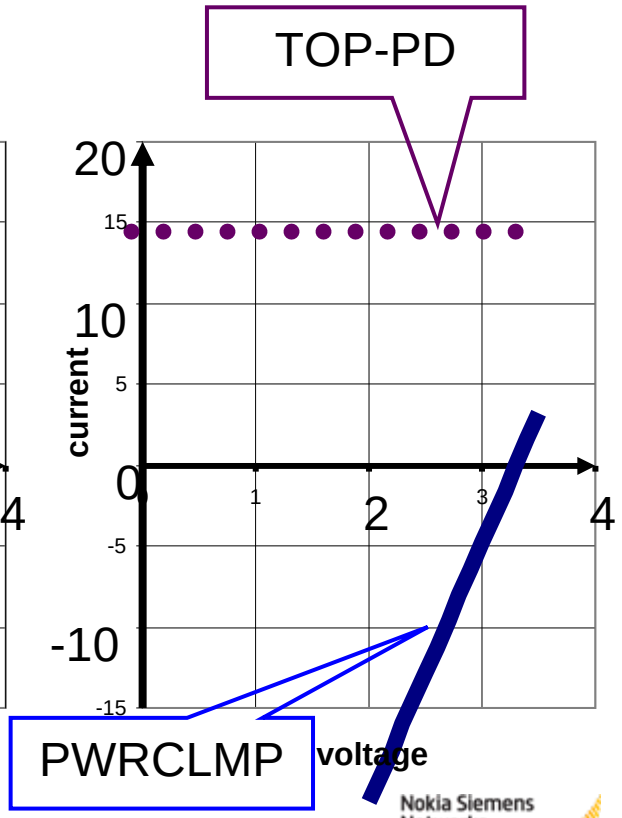
Example 1 static curves



- Main Model open-sink
- Boost-1 Model open-sink
- Toplevel Model open-sink







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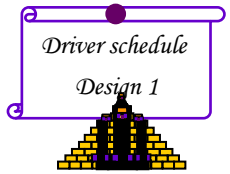
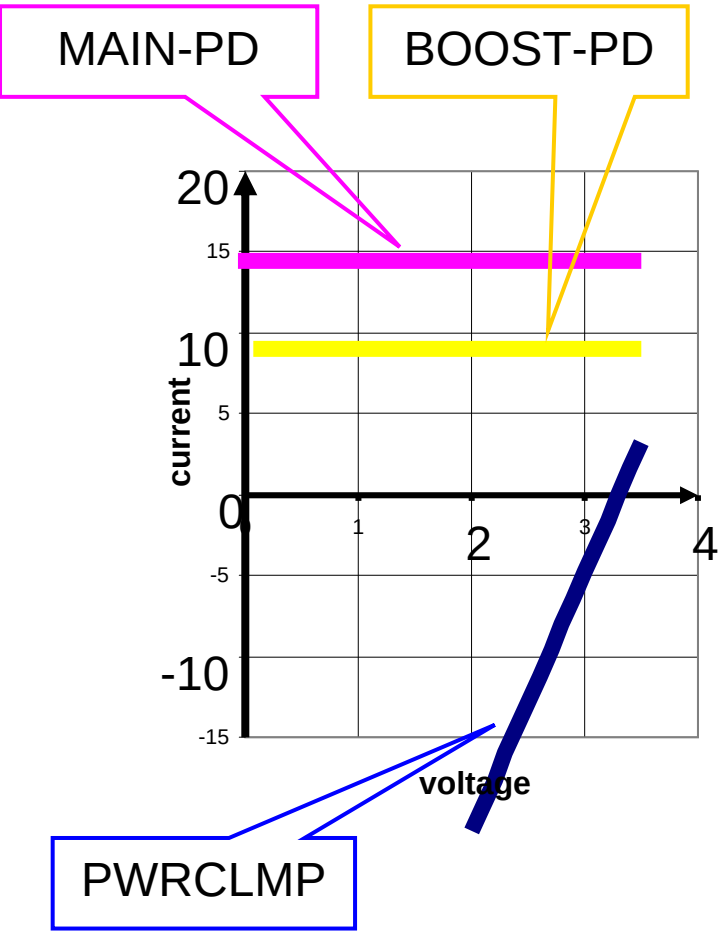
Example 1 combined static curves

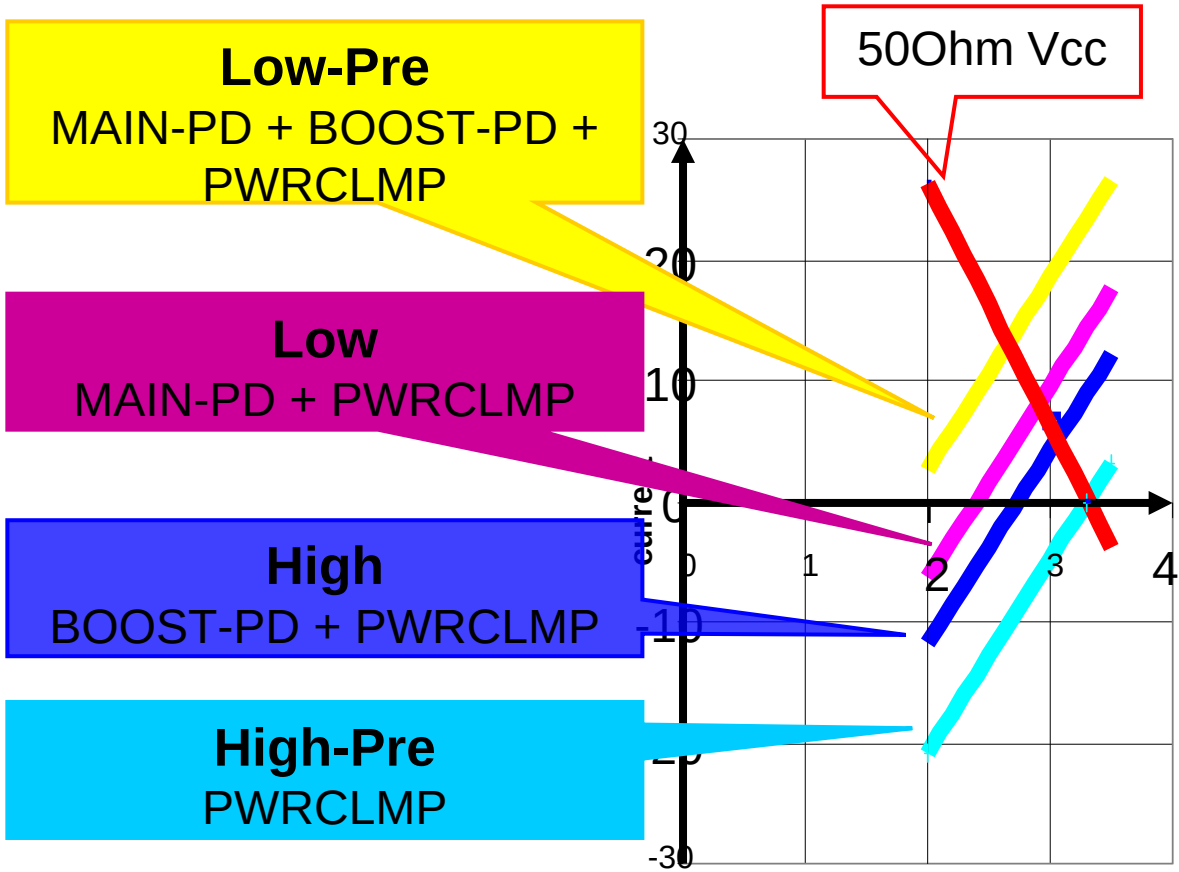


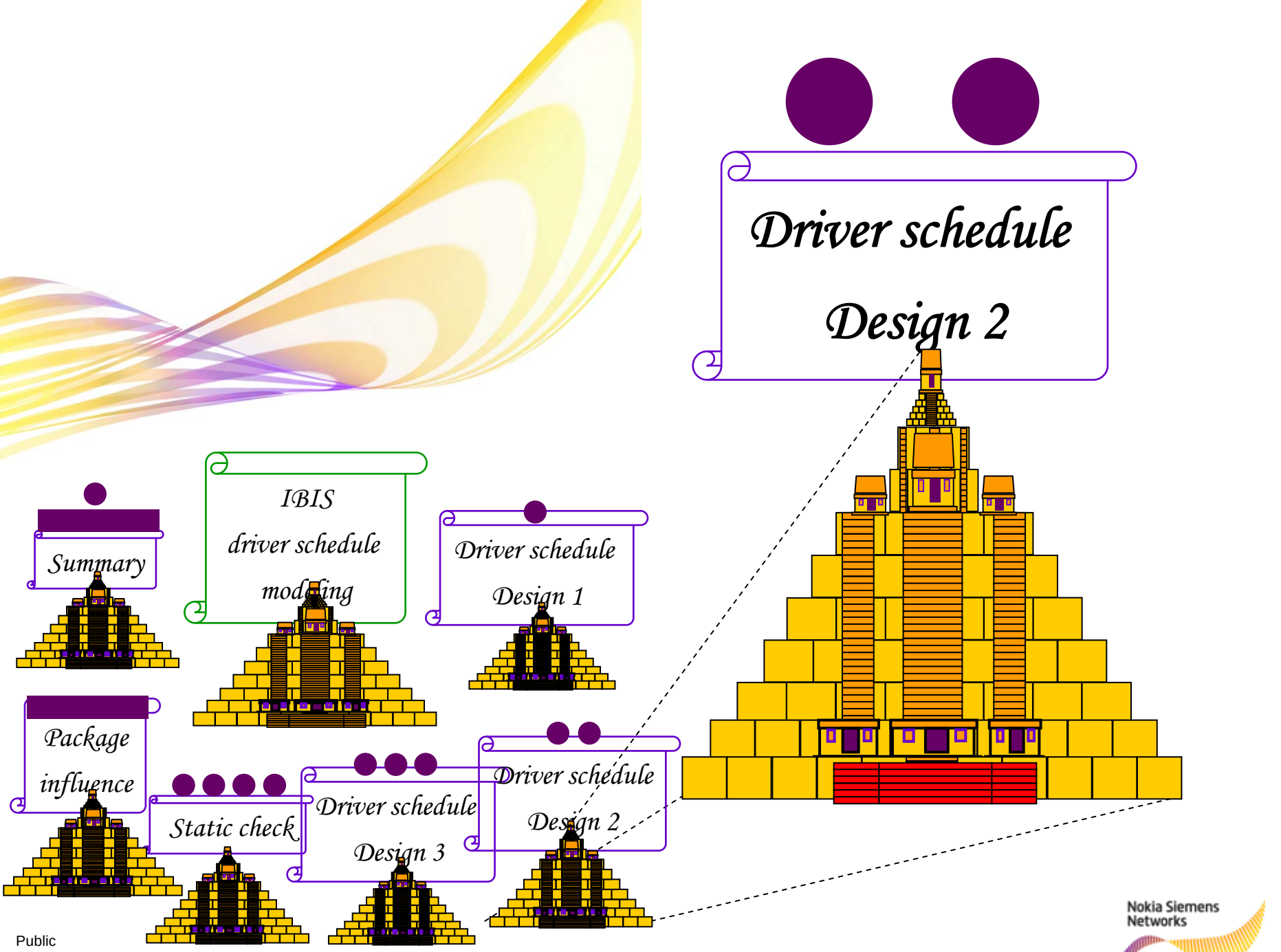
- static curves

In one diagram

- combined curves
- HIGH-Pre / HIGH / LOW / LOW-Pre






Driver schedule
Design 2
Summary
IBIS
driver schedule
modeling
Driver schedule
Design 1
Package
influence
Static check
Driver schedule
Design 3
Driver schedule
Design 2

Example 2 timing schedule pu pd plus opsink & opsource

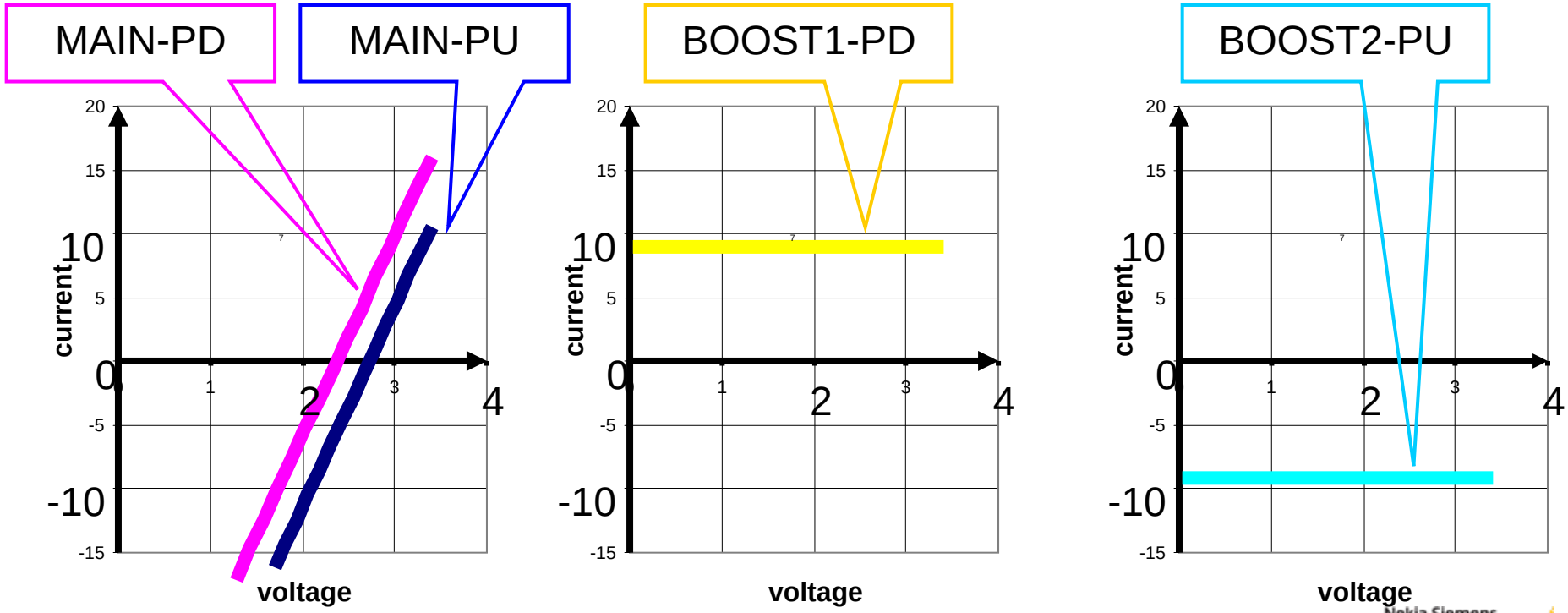
[Driver Schedule]

	Model_name	Rise_on_dly	Rise_off_dly	Fall_on_dly	Fall_off_dly
1	3P3V_DRI-NSN-CML-PREOFF_OUT	0.000ns	NA	0.000ns	NA
2	3P3V_DRI-NSN-CML-PRELO_OUT	NA	NA	0.000ns	2.000ns
3	3P3V_DRI-NSN-CML-PREHI_OUT	0.000ns	2.000ns	NA	NA

1	turn on PU turn off PD	turn off PU turn on PD	turn on PD turn off PU	turn off PD turn on PU
2	~~turn on PU~~ turn off PD	~~turn off PU~~ turn on PD	turn on PD ~~turn off PU~~	turn off PD ~~turn on PU~~
3	turn on PU ~~turn off PD~~	turn off PU ~~turn on PD~~	~~turn on PD~~ turn off PU	~~turn off PD~~ turn on PU

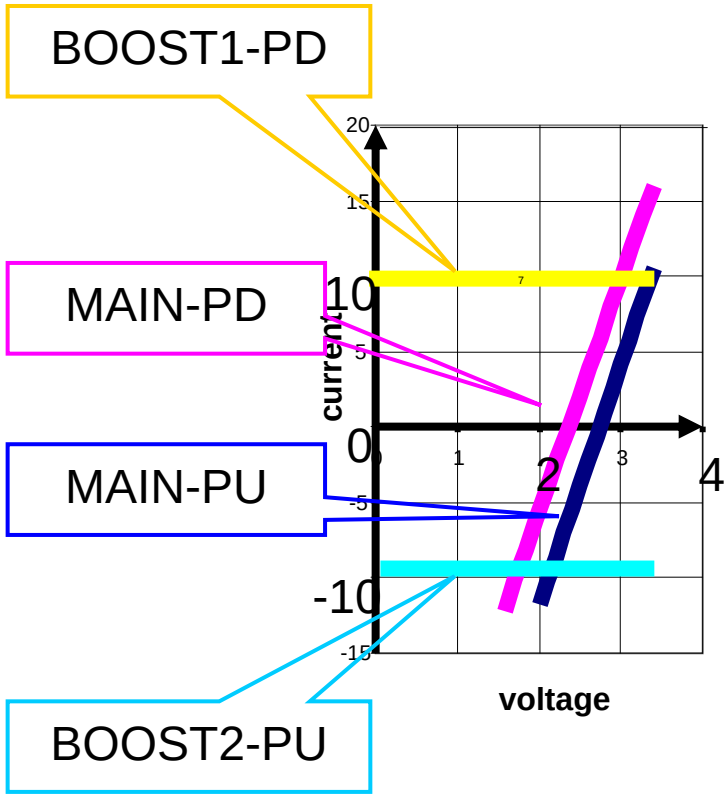
Example 2 static curves

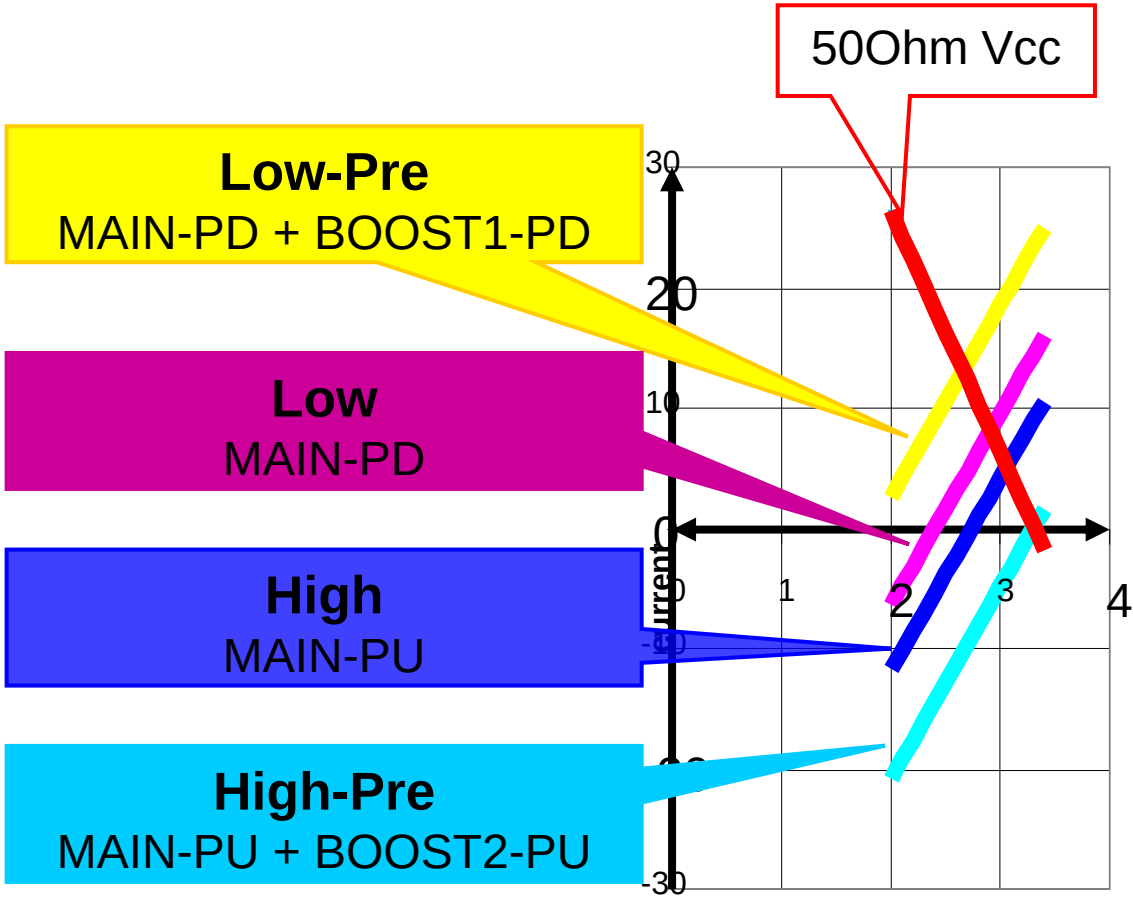
- Main Model
  with pullup and pulldown
  (*also Toplevel model*)
- Boost-1 Model
  open-sink
- Boost-2 Model
  open-source

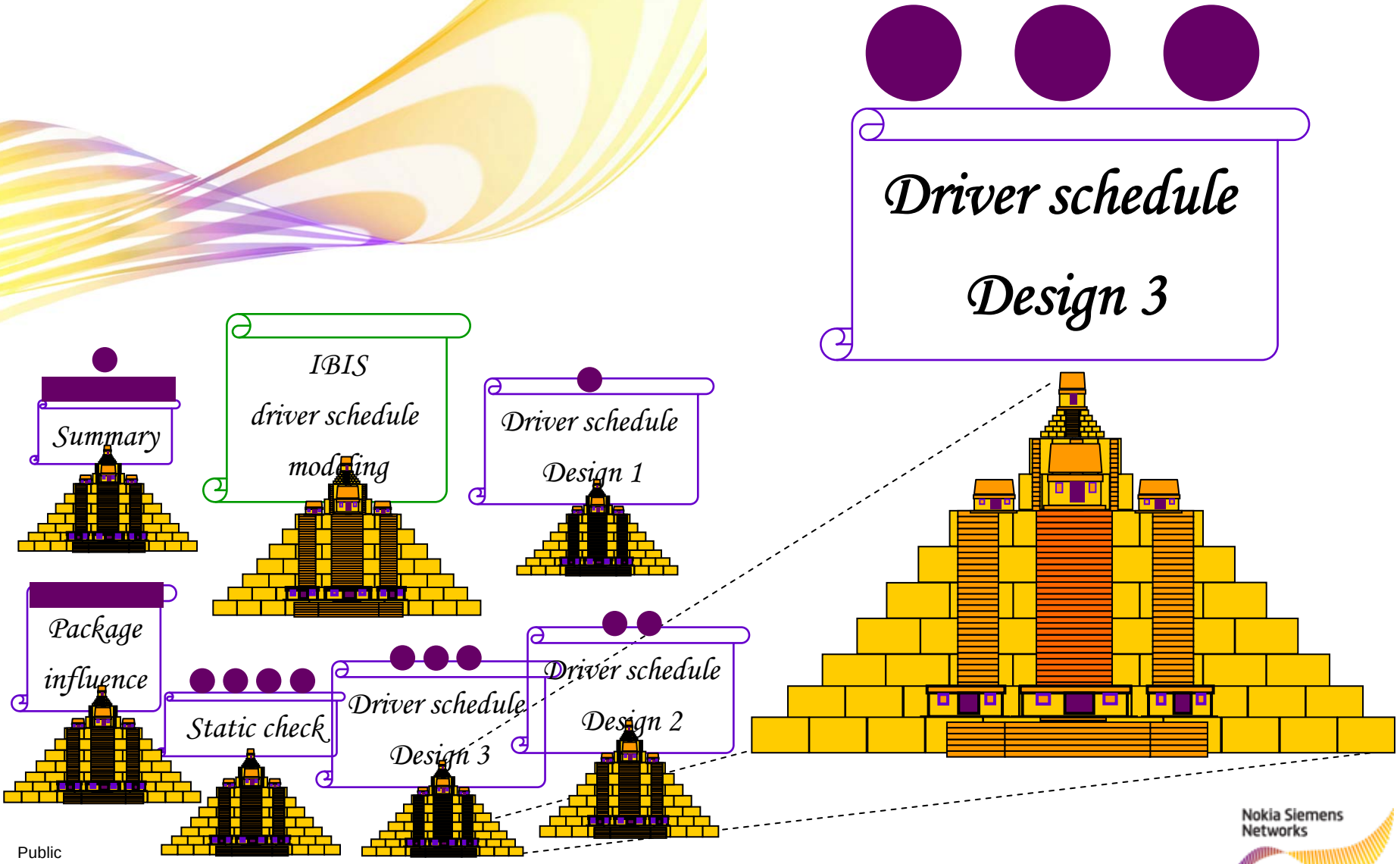


Example 2 combined static curves

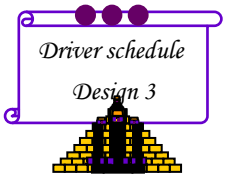
- static curves in one diagram
- combined curves
- HIGH-Pre / HIGH / LOW / LOW-Pre






Driver schedule
Design 3
Summary
IBIS
driver schedule
modeling
Driver schedule
Design 1
Package
influence
Static check
Driver schedule
Design 3
Driver schedule
Design 2

Example 3 timing schedule pu pd plus pu pd



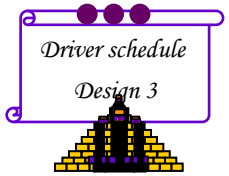
[Driver Schedule]

|Model_name Rise_on_dly Rise_off_dly Fall_on_dly Fall_off_dly

1	3P3V_DRI-NSN+MAIN_OUT	0.000ns	NA	0.000ns	NA
2	3P3V_DRI-NSN+BOOST_OUT	0.400ns	NA	0.400ns	NA

1	turn on PU turn off PD	turn off PU turn on PD	turn on PD turn off PU	turn off PD turn on PU
2	turn on PU turn off PD	turn off PU turn on PD	turn on PD turn off PU	turn off PD turn on PU

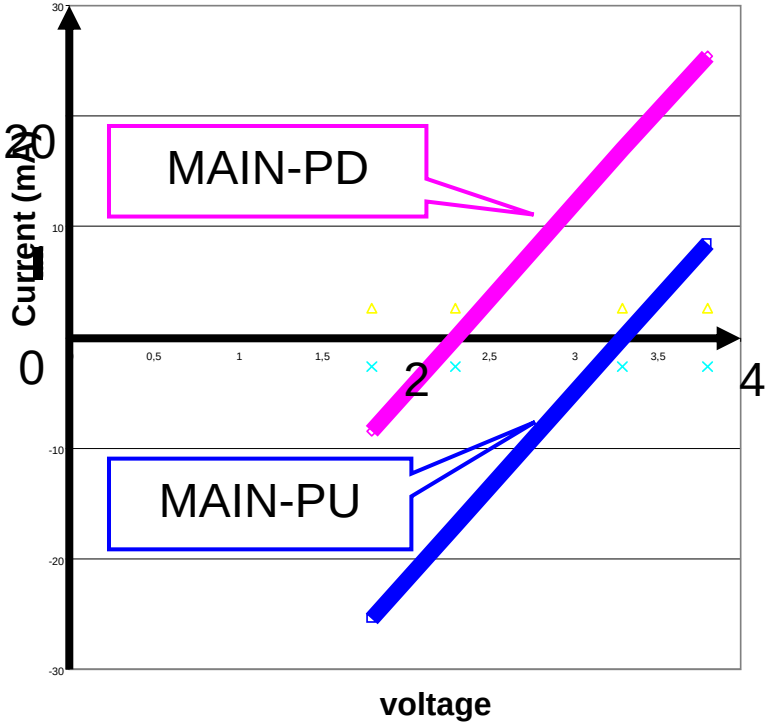
Example 3 static curves

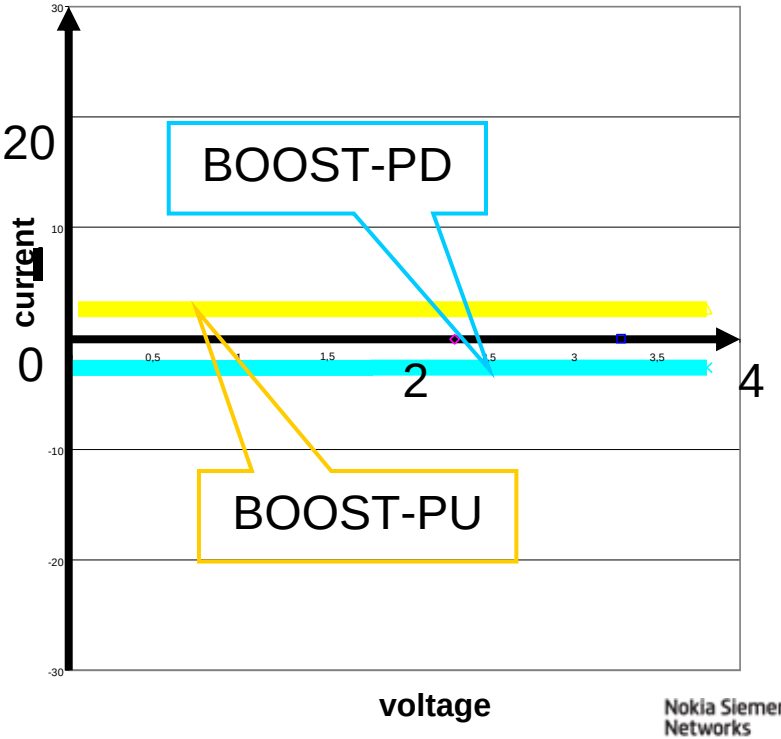


- Main Model
  with pullup and pulldown
  (also Toplevel model)

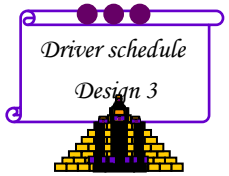
- Boost Model
  with pullup and pulldown

  but with „inverse currents“

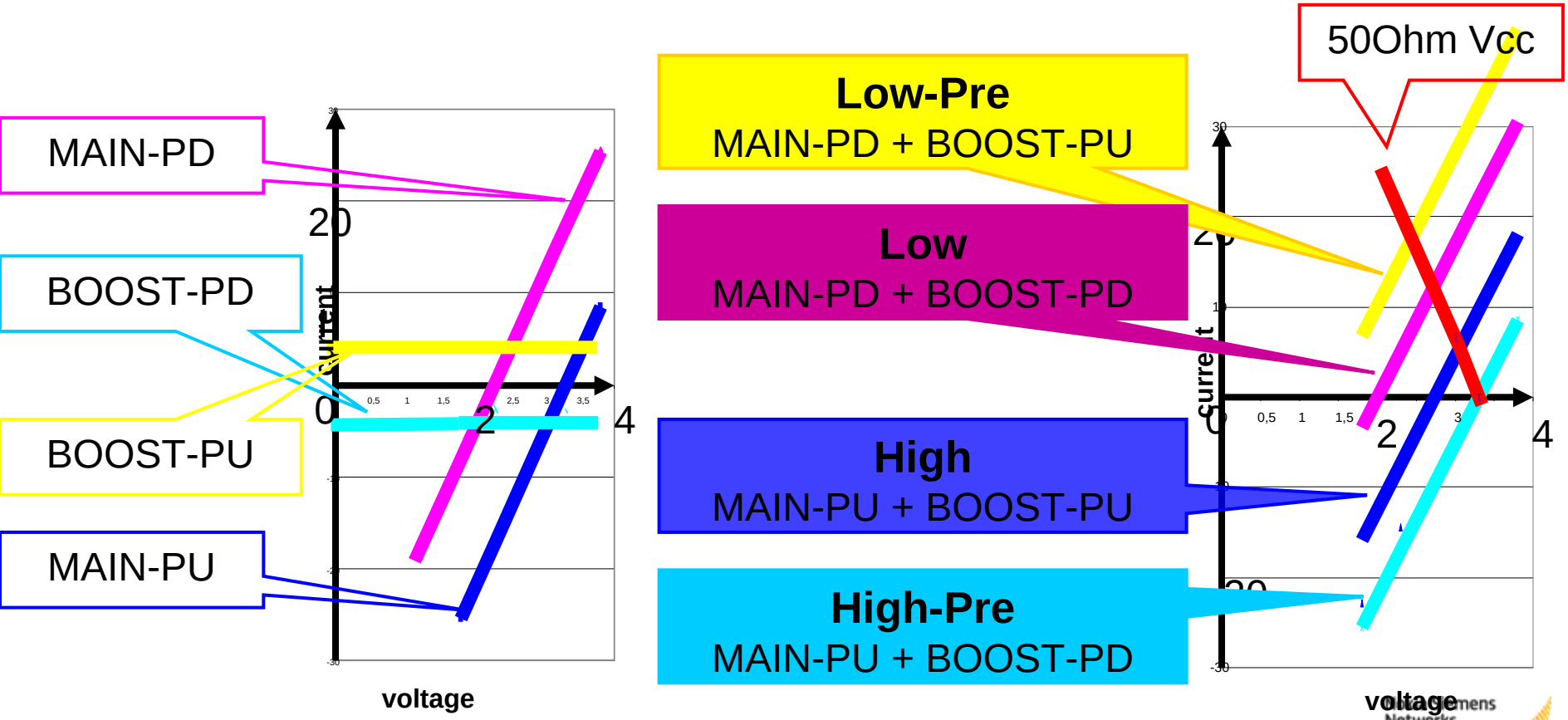


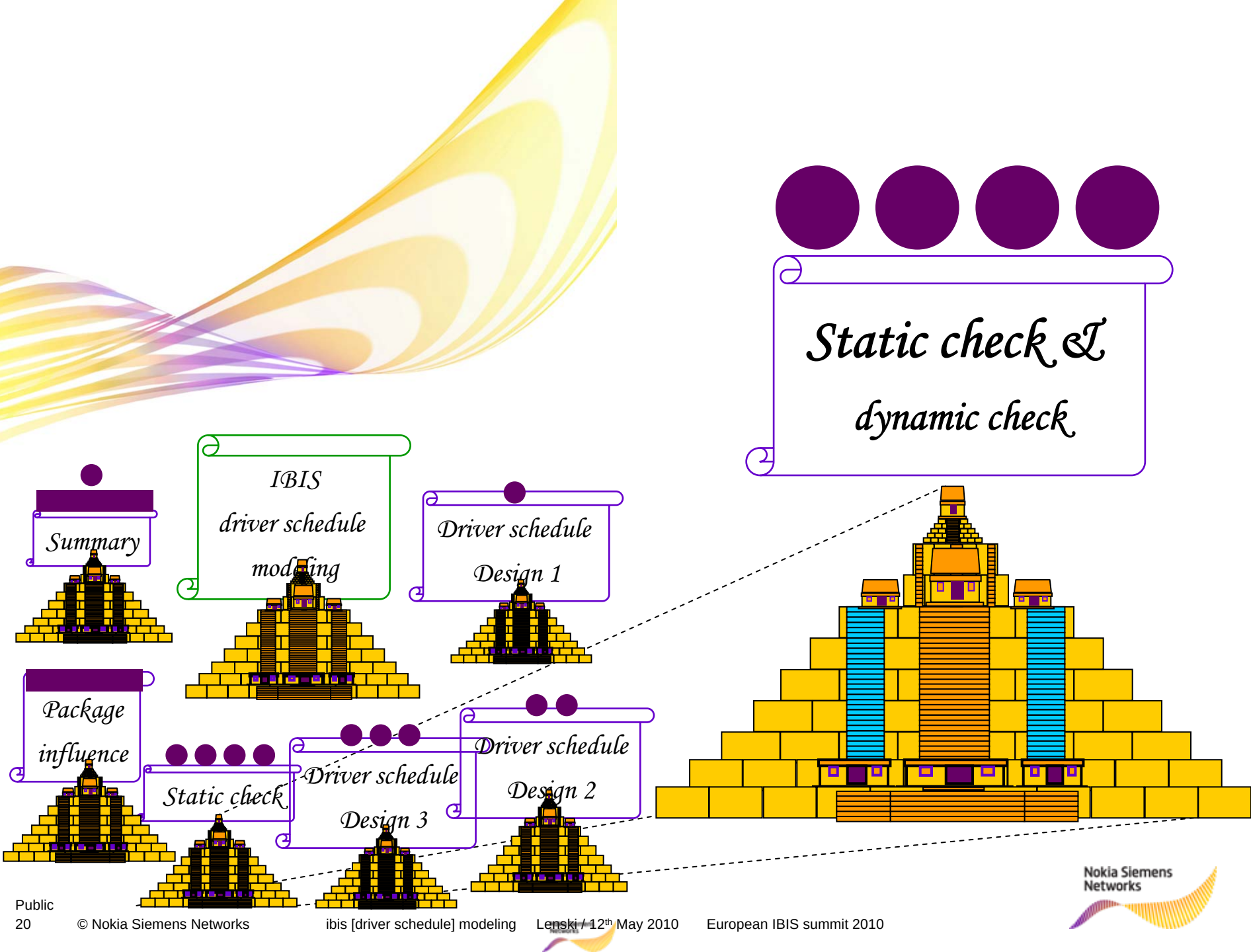


Example 3 combined static curves

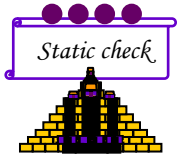


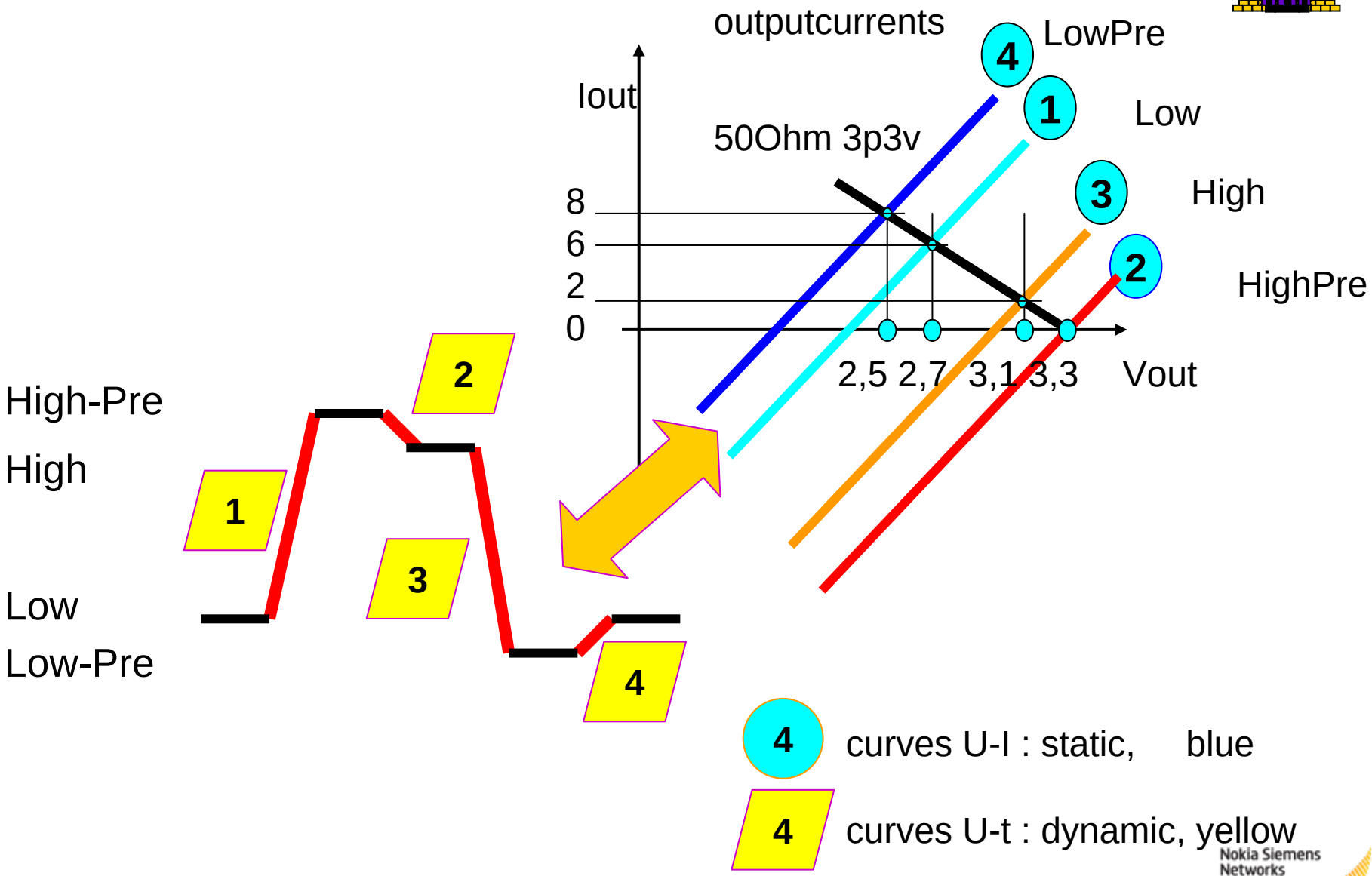
- static curves in one diagram
- combined curves :
- HIGH-Pre / HIGH / LOW / LOW-Pre



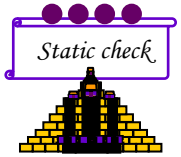

Static check &
dynamic check
Summary
IBIS
driver schedule
modeling
Driver schedule
Design 1
Package
influence
Static check
Driver schedule
Design 3
Driver schedule
Design 2

compare dyn. levels – stat. levels

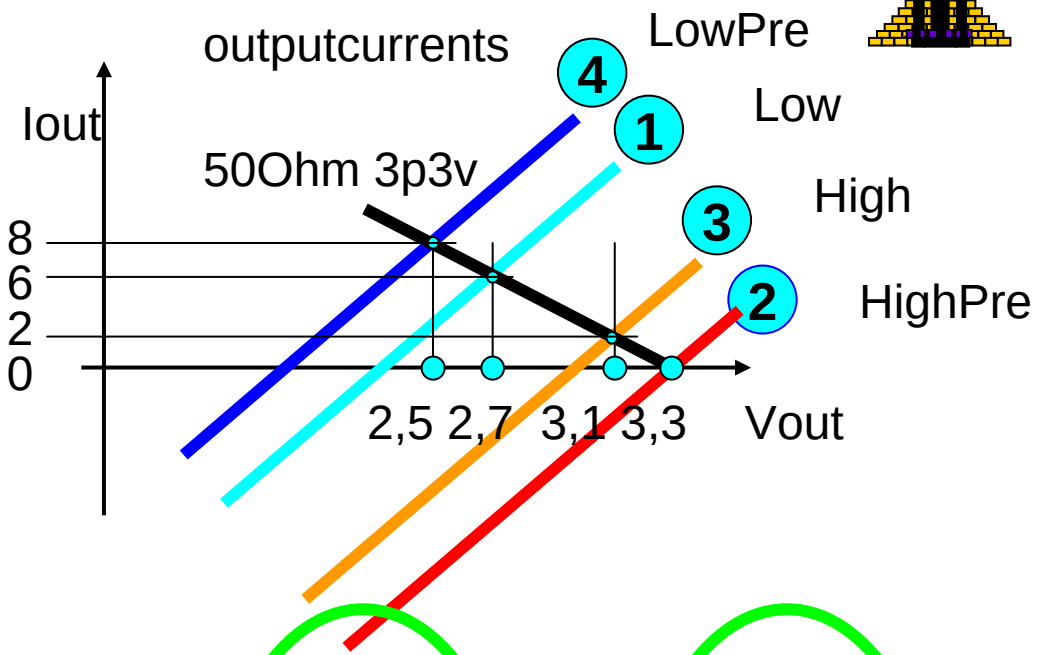




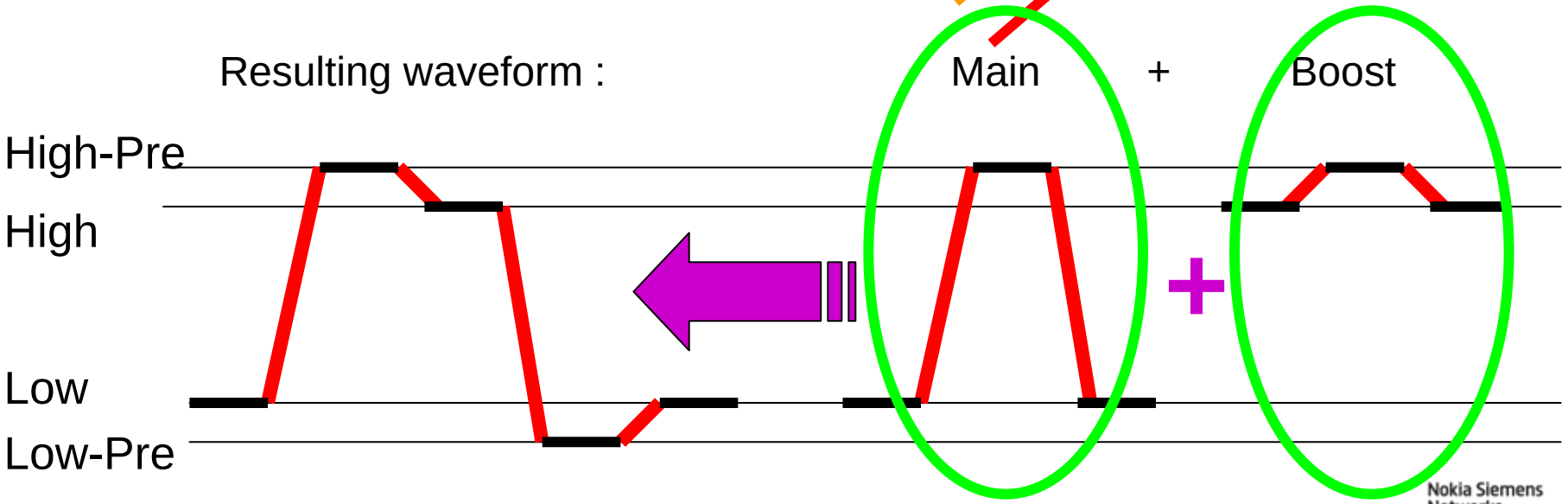
stat. Levels of scheduled models



Each scheduled model
will/can be checked
as a single model with ibischk5



Resulting waveform :



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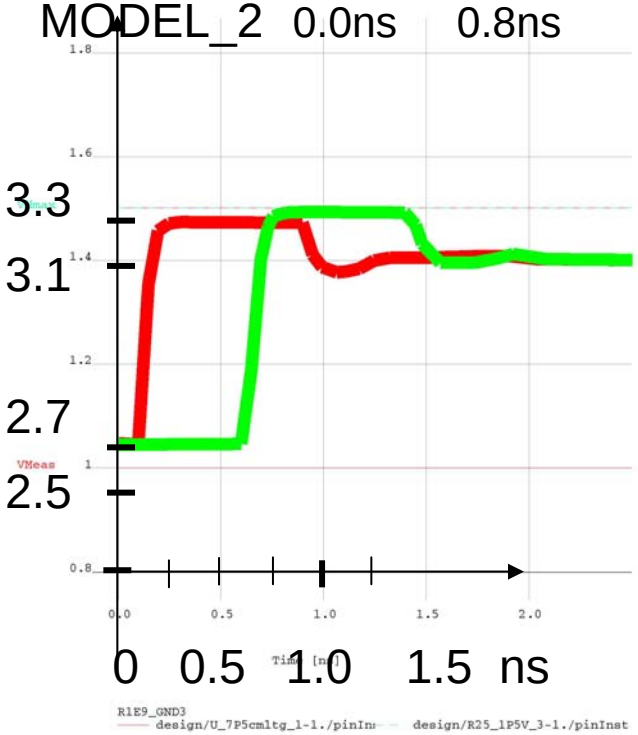
compare golden waveform vs. stat. levels

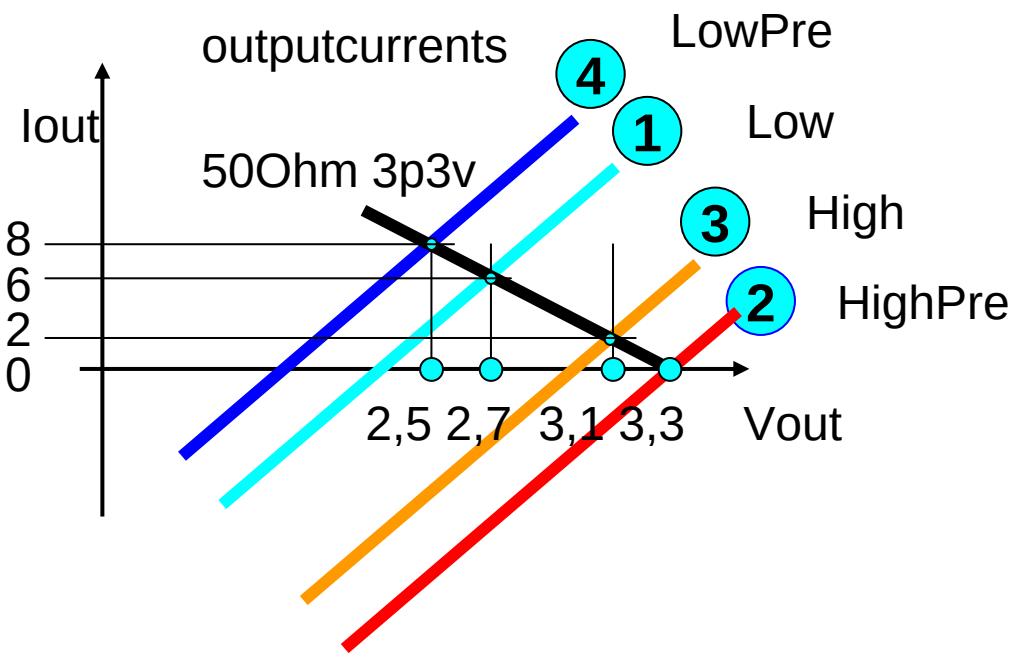
Prinzip Pre-/De-emphasis

|Model_name Rise_on_dly Rise_off_dly

MODEL_1 0.0ns NA

MODEL_2 0.0ns 0.8ns





Checks for driver schedule models

➢ Scheduled models :

- Check each model by itself for static vs. dynamic consistency (works with ibischk5)

➢ Driver schedule :

- Create combined static curves corresponding timing schedule switching behavior
- Crossover with loadline should give corresponding voltage levels
- Compare with golden waveforms or by using the model in a simulator
- User has to take care that the „frequency“ corresponds to UI

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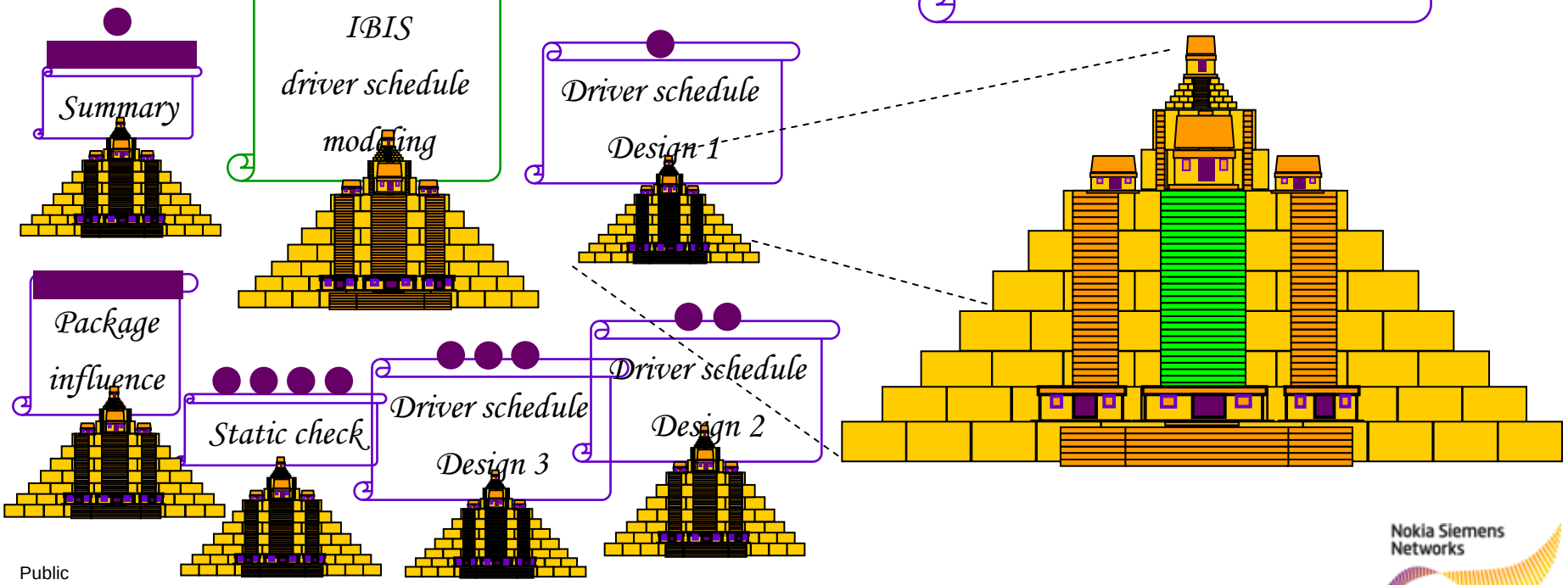
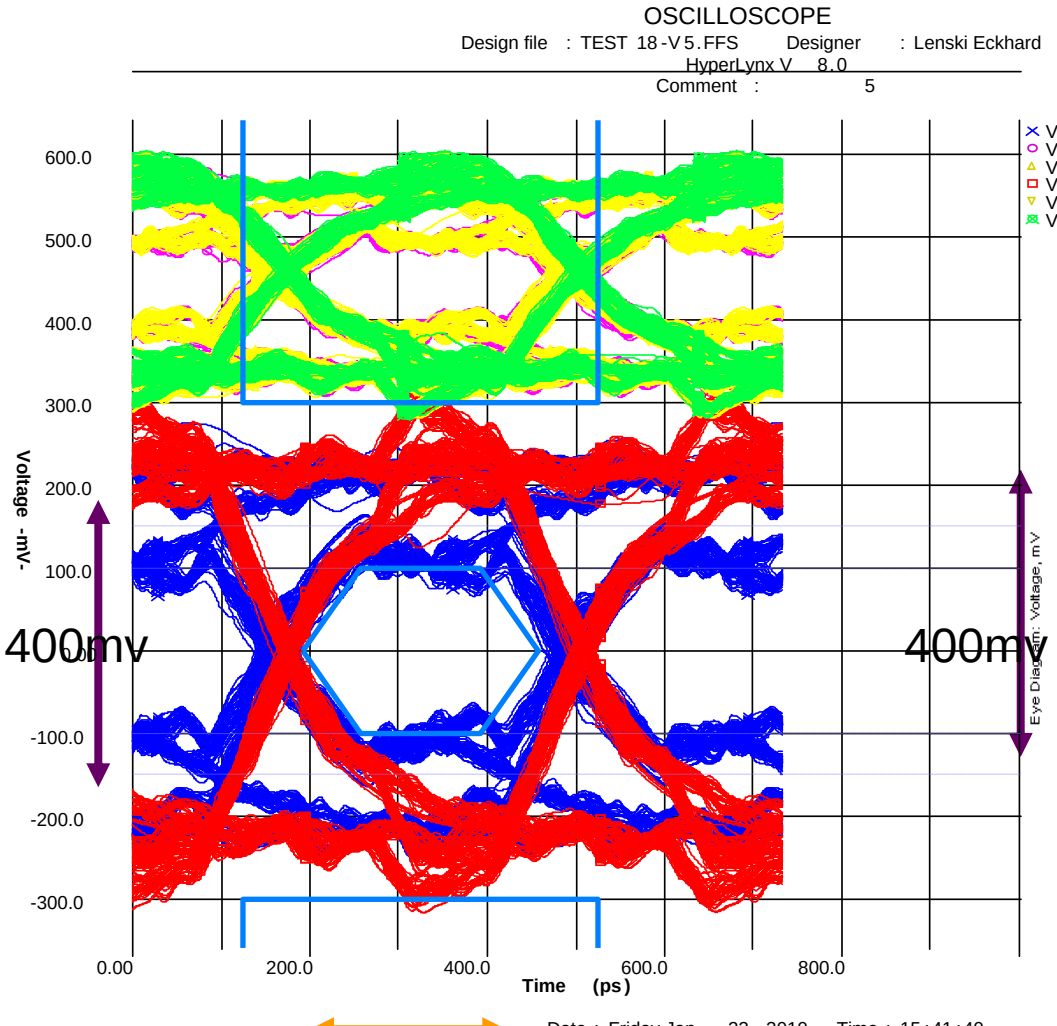
Package influence

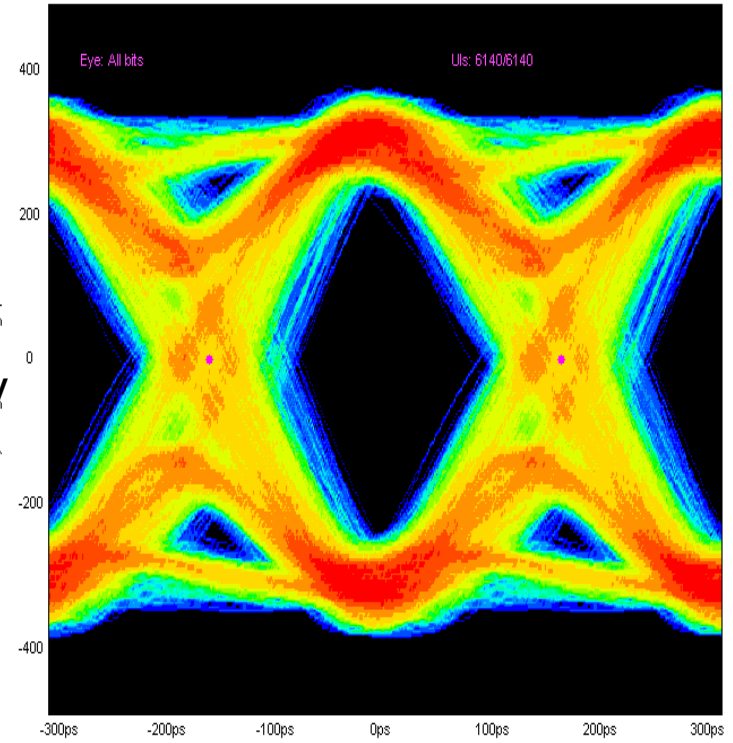


simulation max pkg at pin vs measurement



Diff driver

Diff receiver

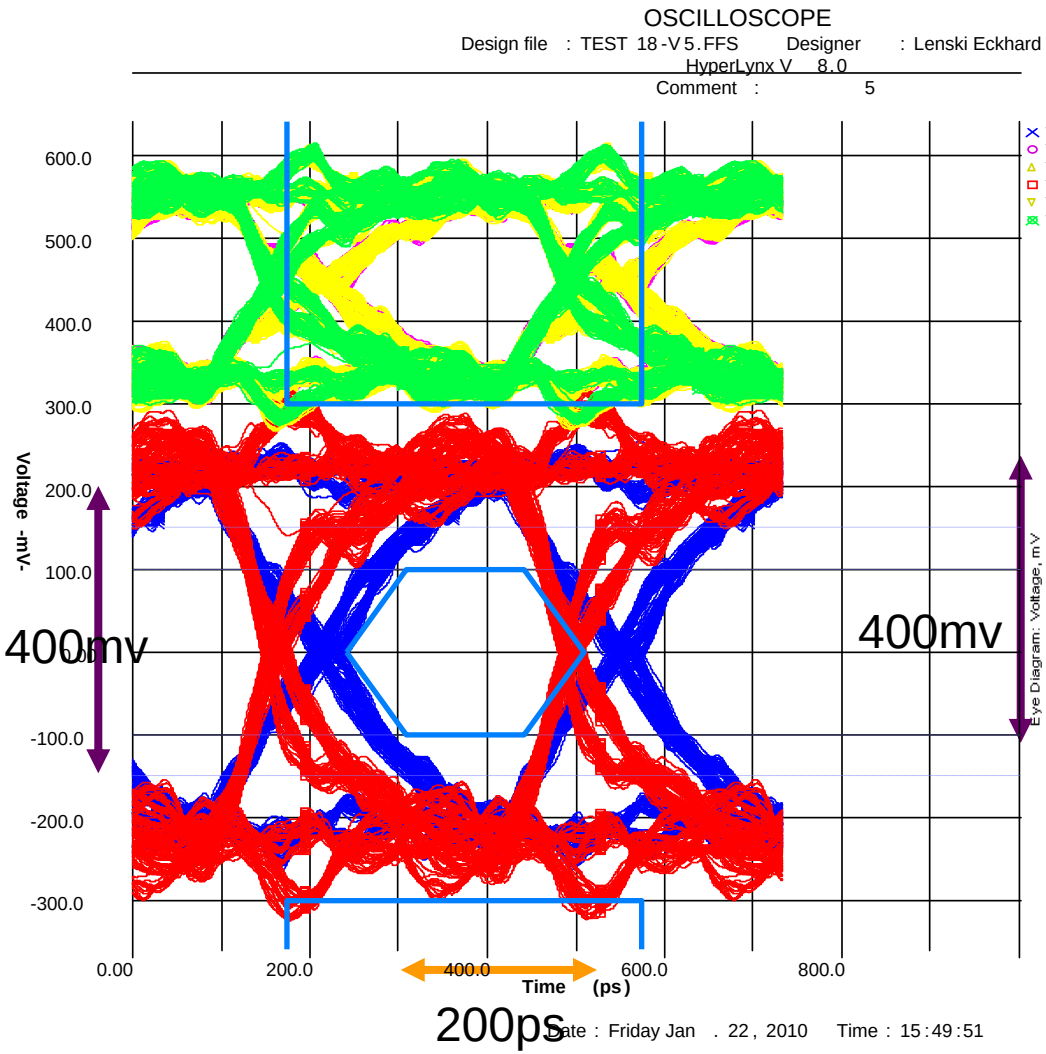


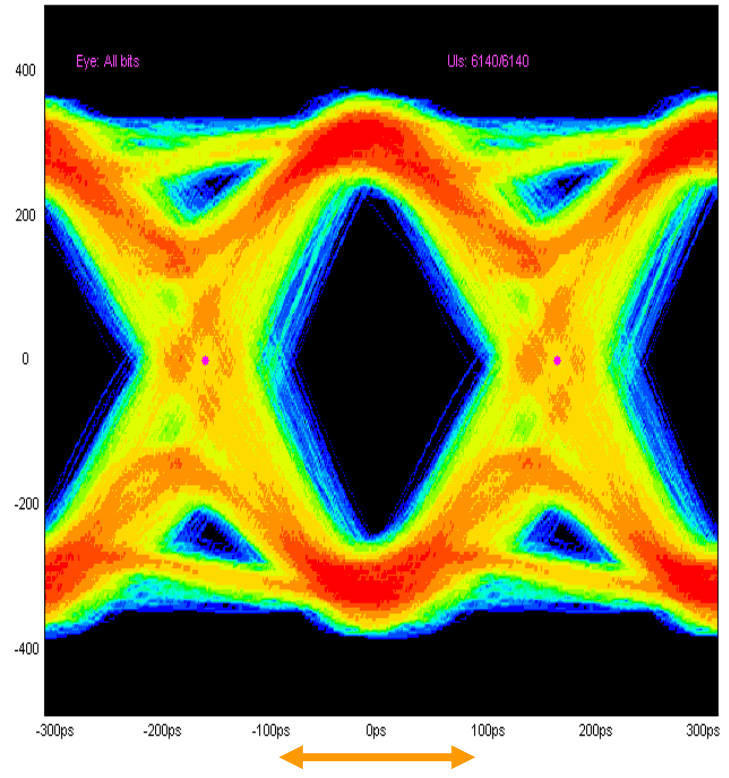
Simulation min pkg at pin vs measurement

Package influence

Diff driver

Diff receiver





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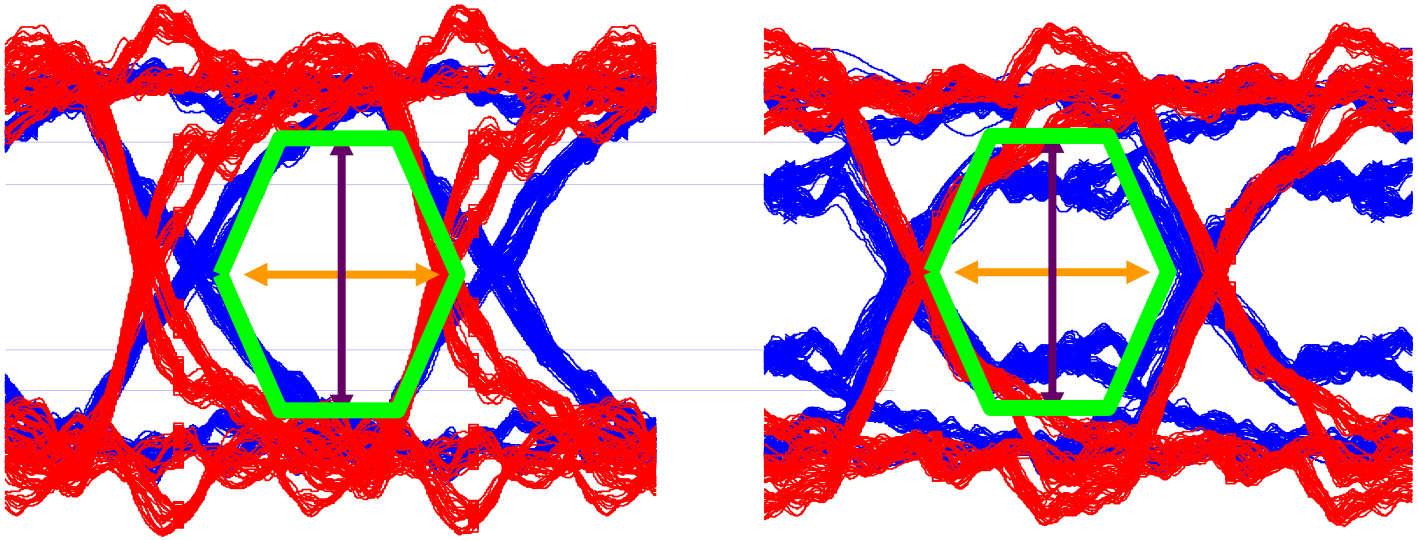
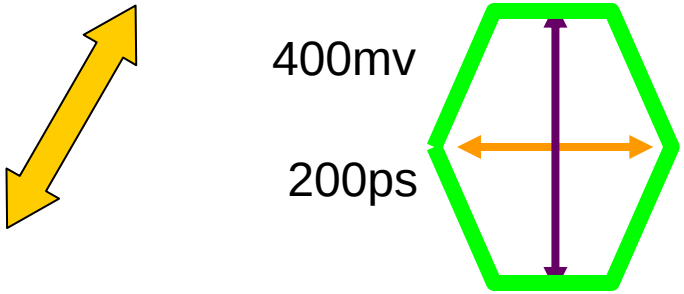
Comparison with min and max pkg at pin





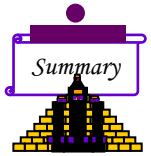
Min pkg
Cpkg 0.8pF
Lpkg 2.26nH

Diff driver

Diff receiver

Max pkg
Cpkg 1.3pF
Lpkg 3.69nH

Summary



- Driver schedule timing can be used to determine the datarate/frequency of the model
- There are many ways to create pre-emphasis behavior
- Static levels can be checked manually
- Golden waveform should exist
- The quality of the package model is extremly important
- How to use an s-param-file to include as package model ?

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Thank You

- **Questions ?**

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