Parameter-Aware Energy Models for Embedded-System Peripherals

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Energy Models

- Model energy behaviour of a system

→ Map workload to energy consumption

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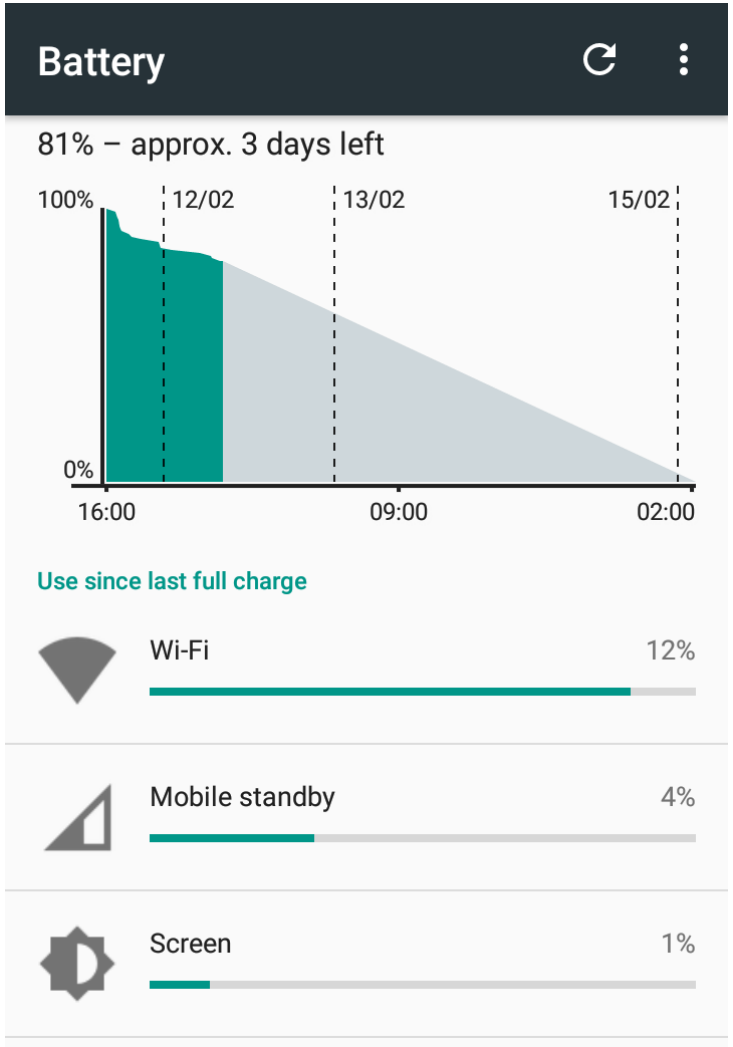
- Common in smartphones and laptops
  - Android, macOS, ...

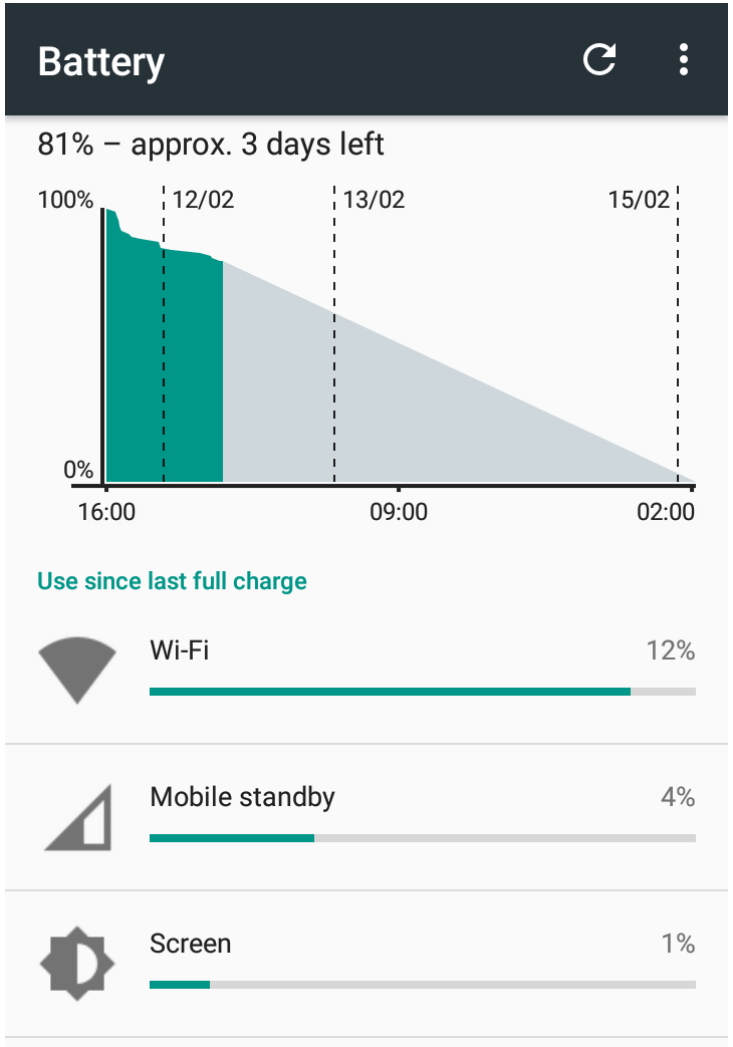


Energy Models

- Model energy behaviour of a system

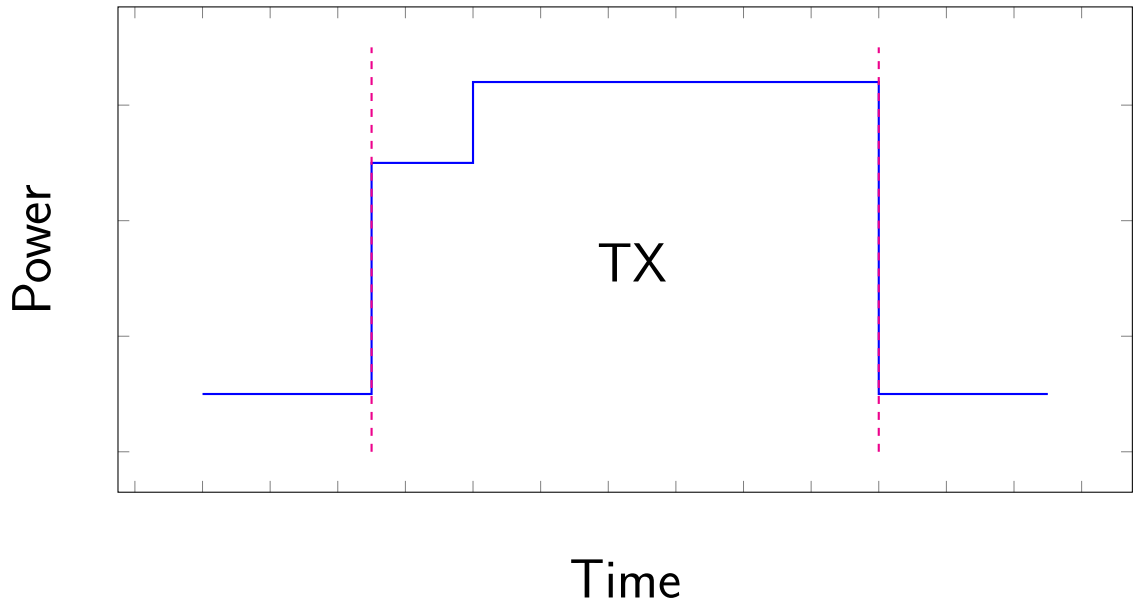
→ Map workload to energy consumption

- Common in smartphones and laptops
  - Android, macOS, ...
- Not as much in IoT/WSN applications
  - Solutions are use-case-specific
  - Often assume static hardware configuration



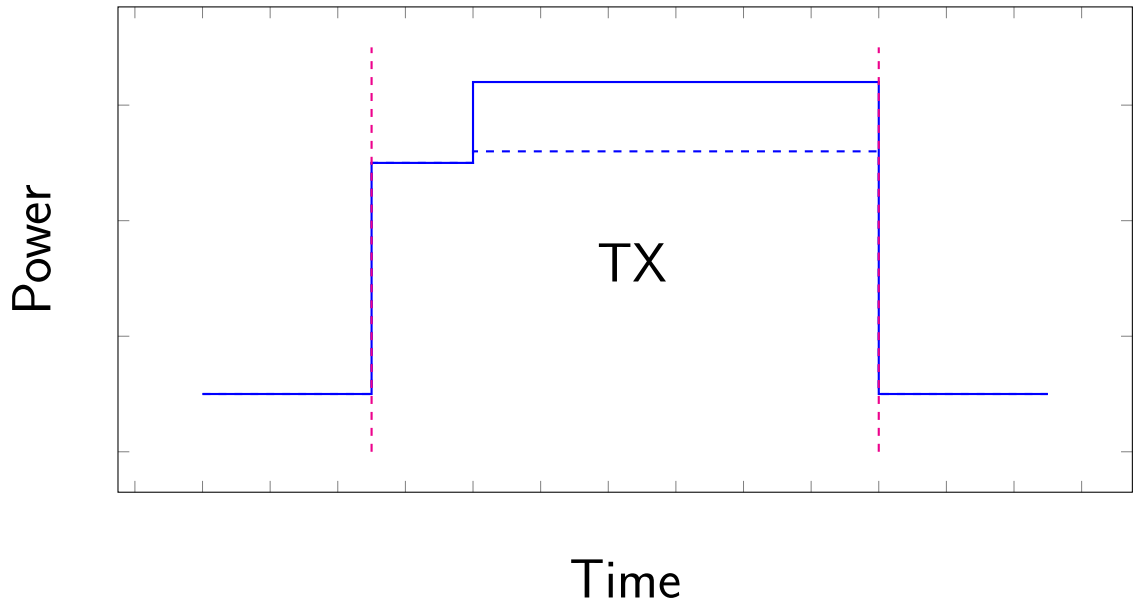
Parameter-Aware Energy Models

- Hardware behaviour may depend on configuration and function arguments



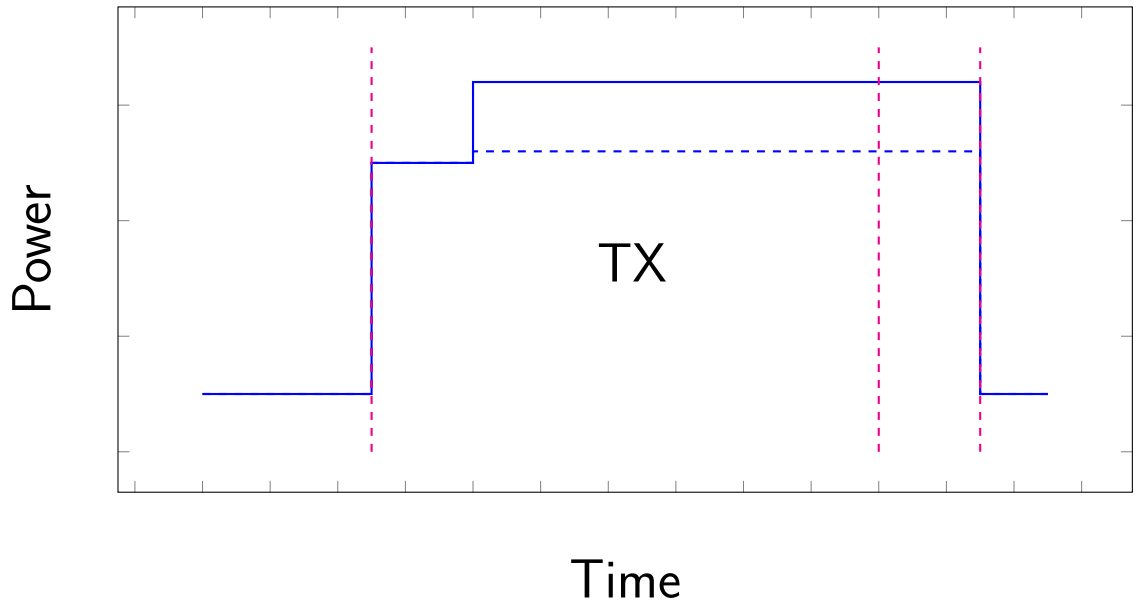
Parameter-Aware Energy Models

- Hardware behaviour may depend on configuration and function arguments
  - TX power



Parameter-Aware Energy Models

- Hardware behaviour may depend on configuration and function arguments
  - TX power, bitrate, data length, ...



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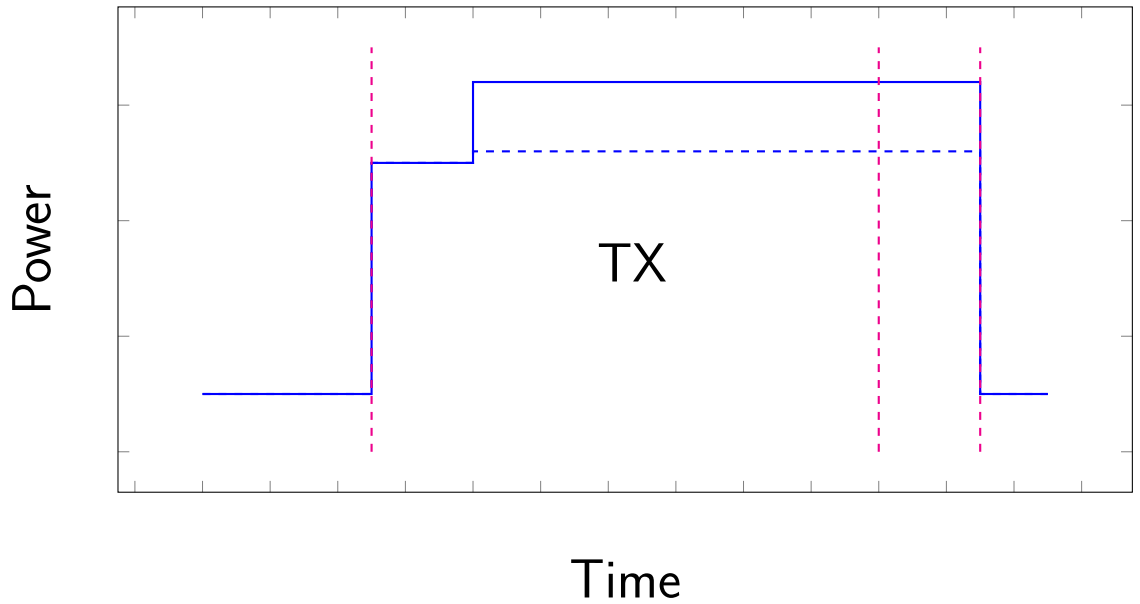

→ Parameter-aware energy models

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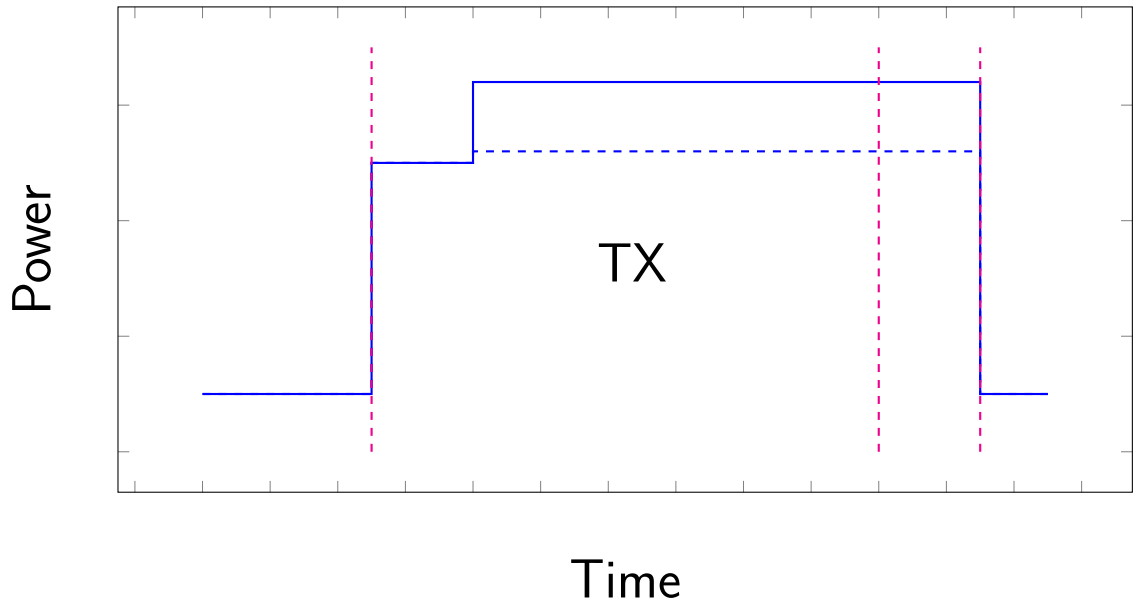
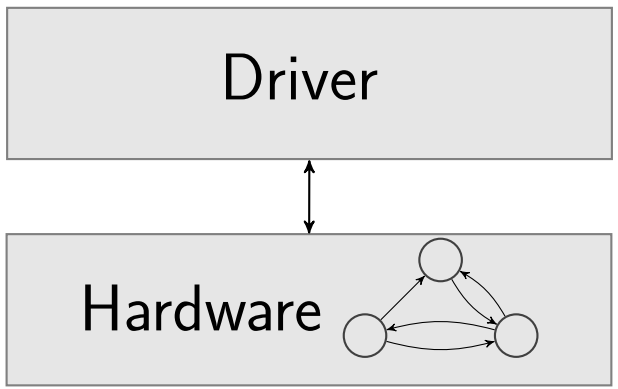


→ Parameter-aware energy models

→ Automatic model generation from annotated measurements

The Big Picture: Automatic Model Generation



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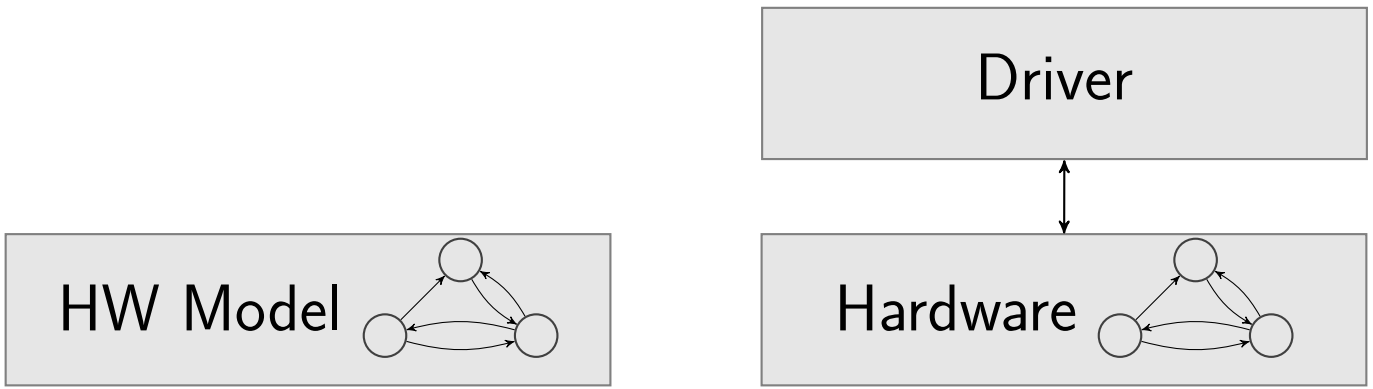

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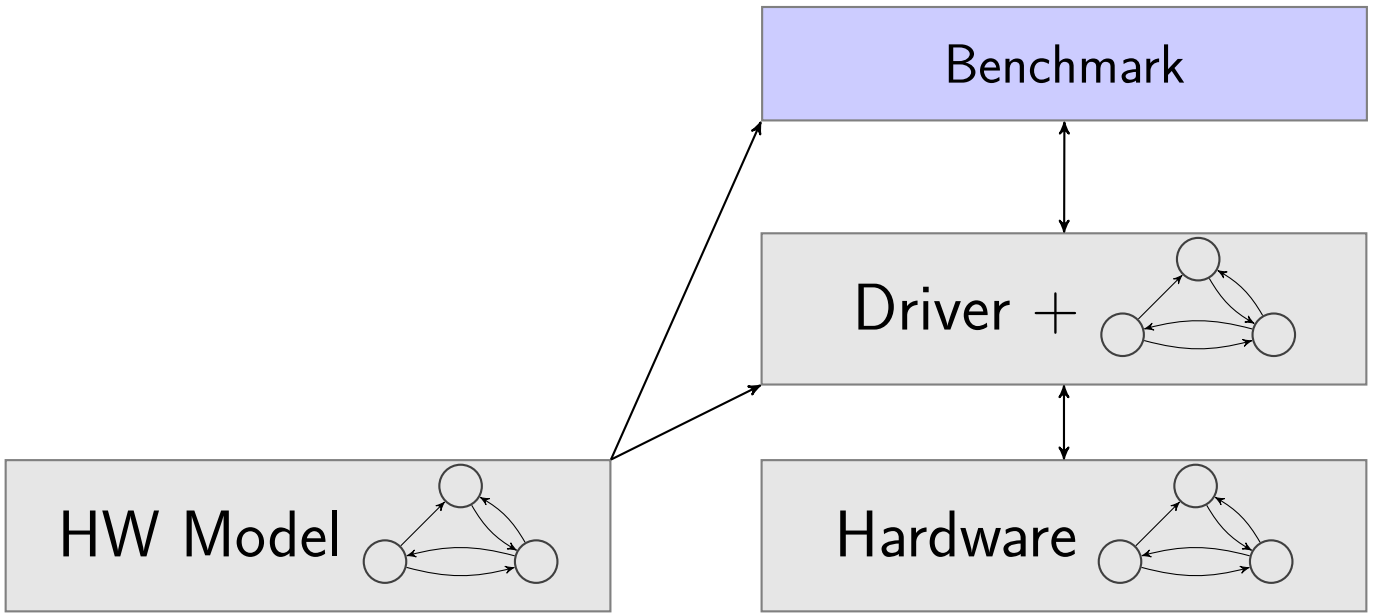

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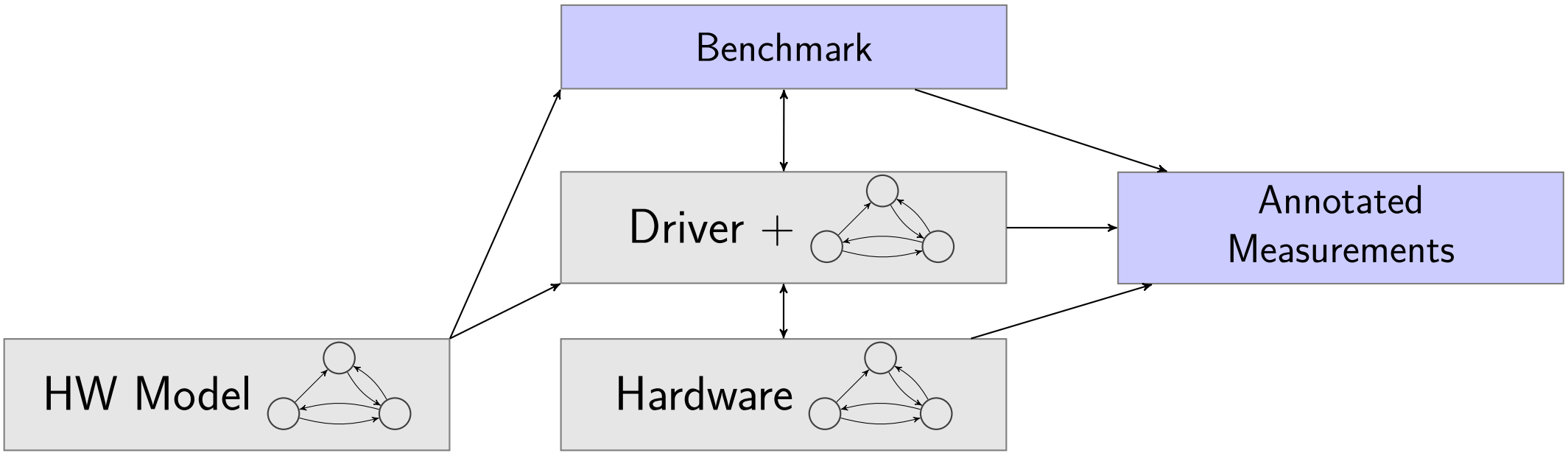

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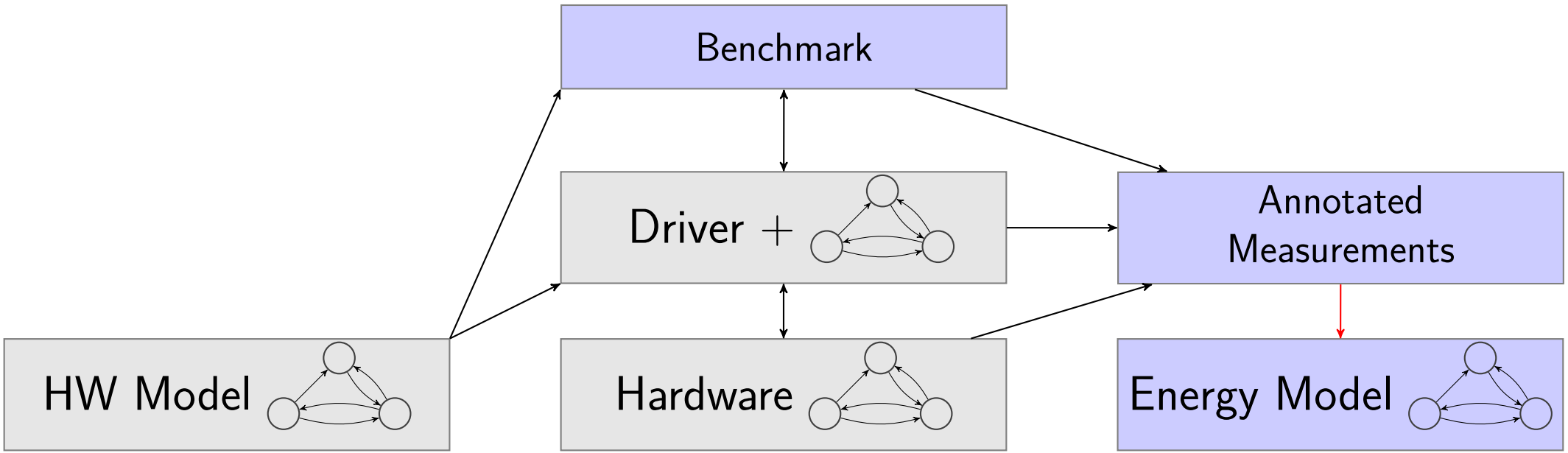
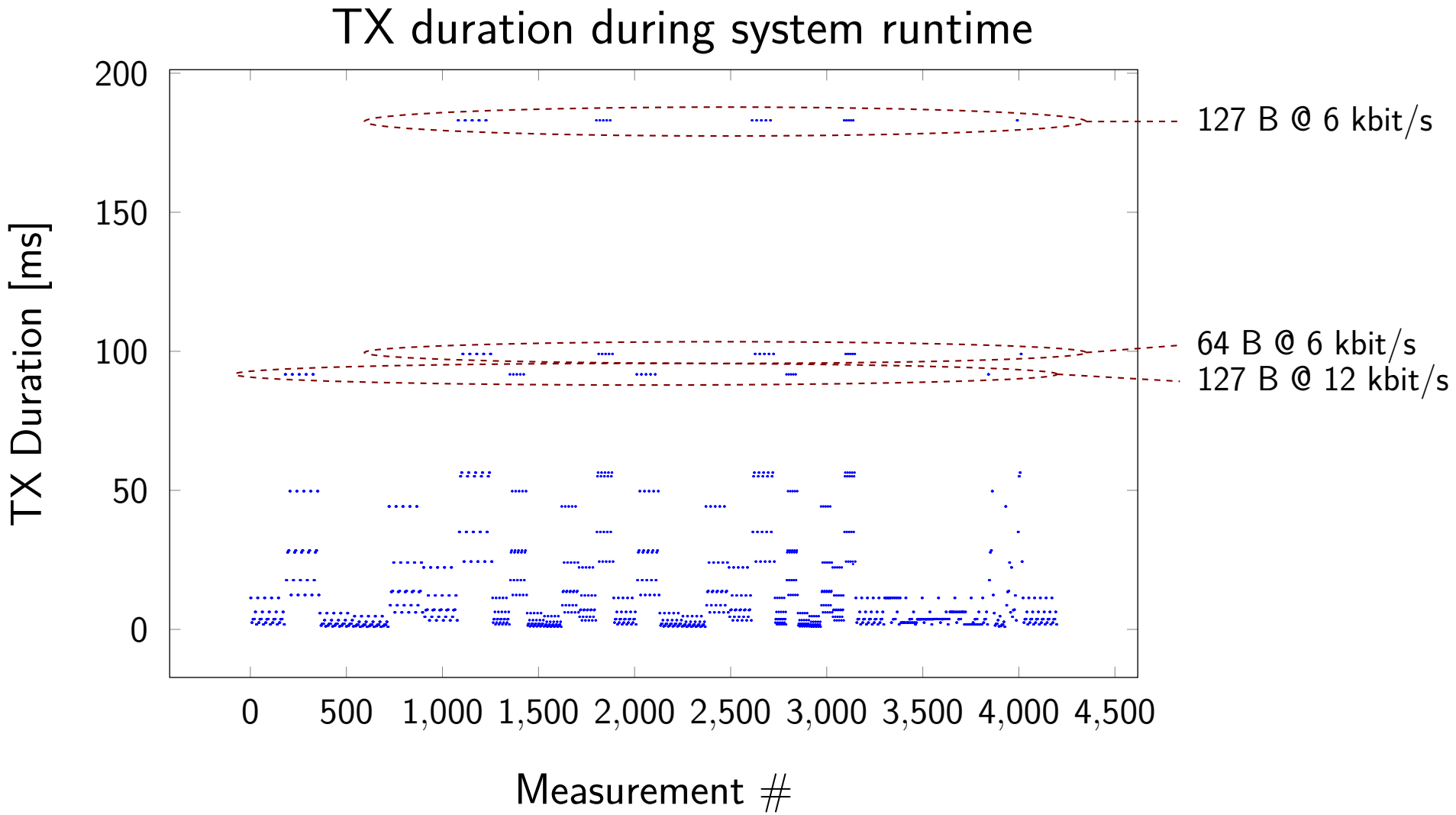
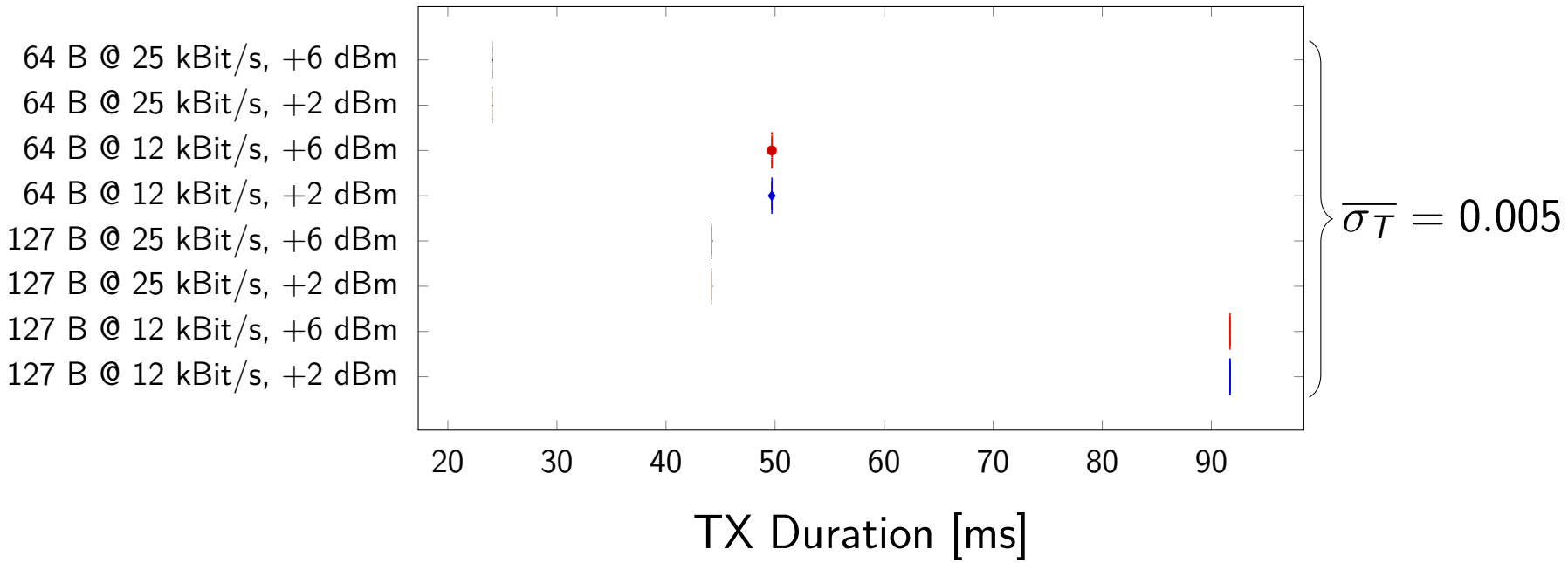


Annotated Measurements



Parameter Detection

- Comparison of static model quality for various parameter sets
- Parameter is relevant $\Leftrightarrow$ ignoring it increases model error
  - Static model $\Rightarrow$ model error $\approx$ data standard deviation



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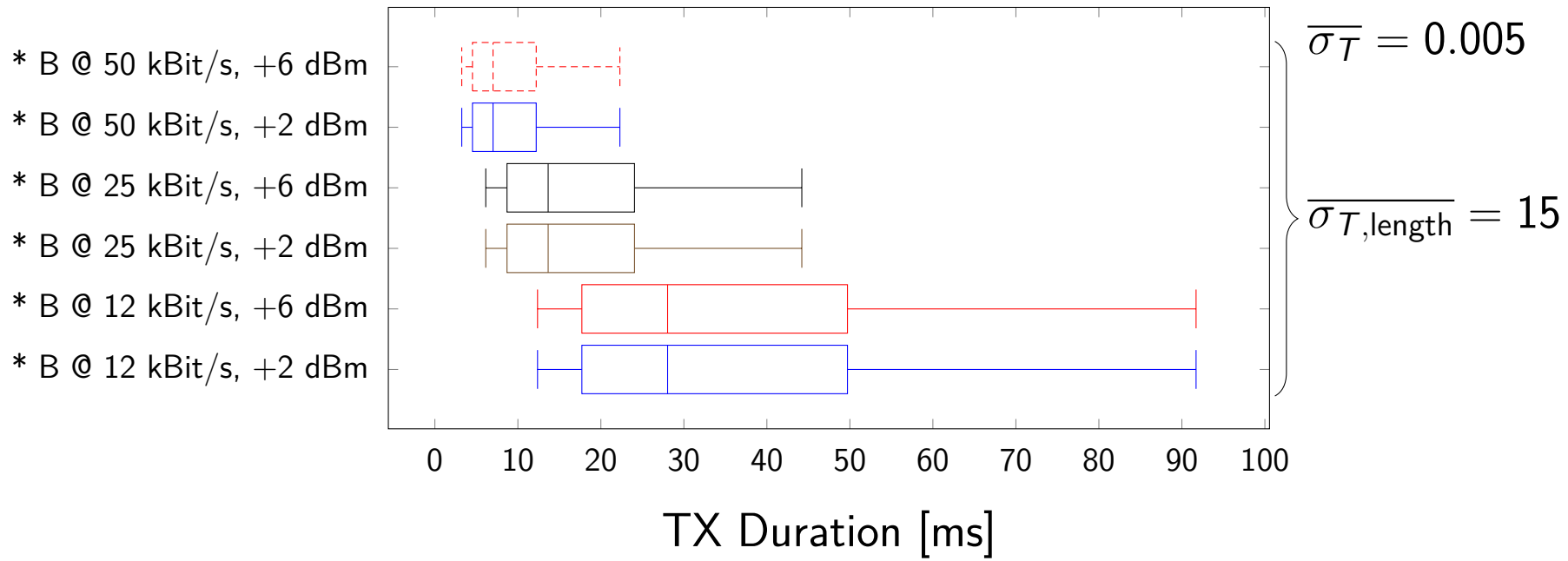

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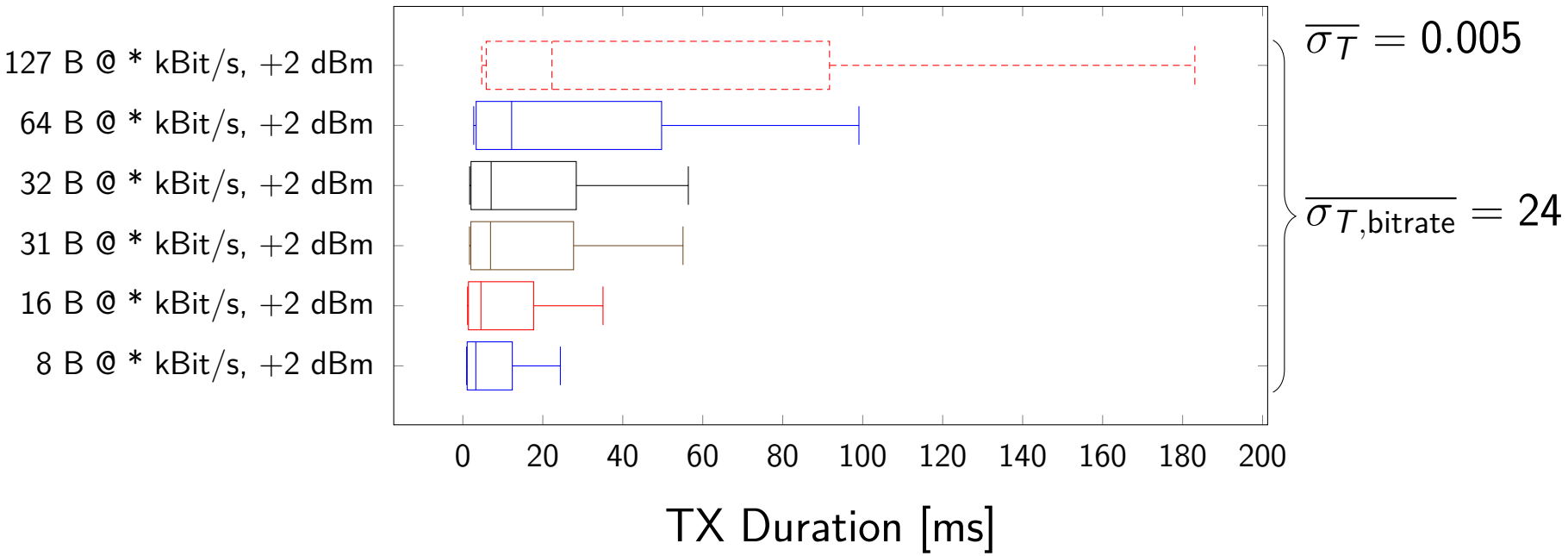

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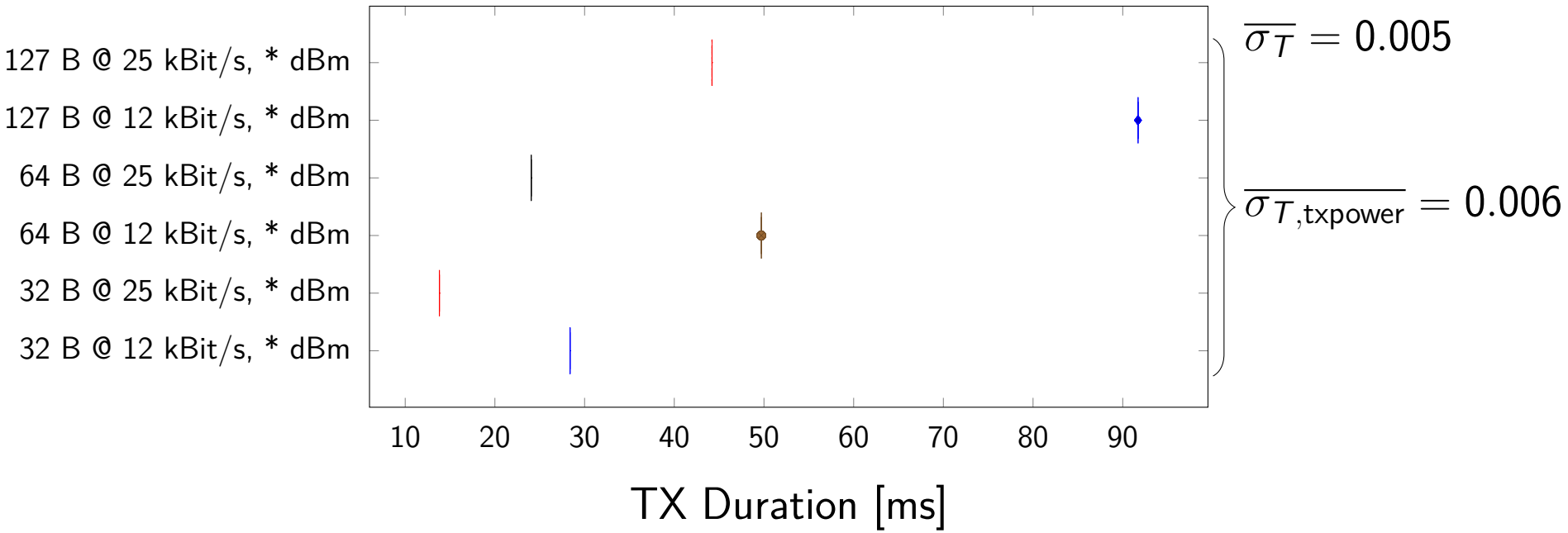

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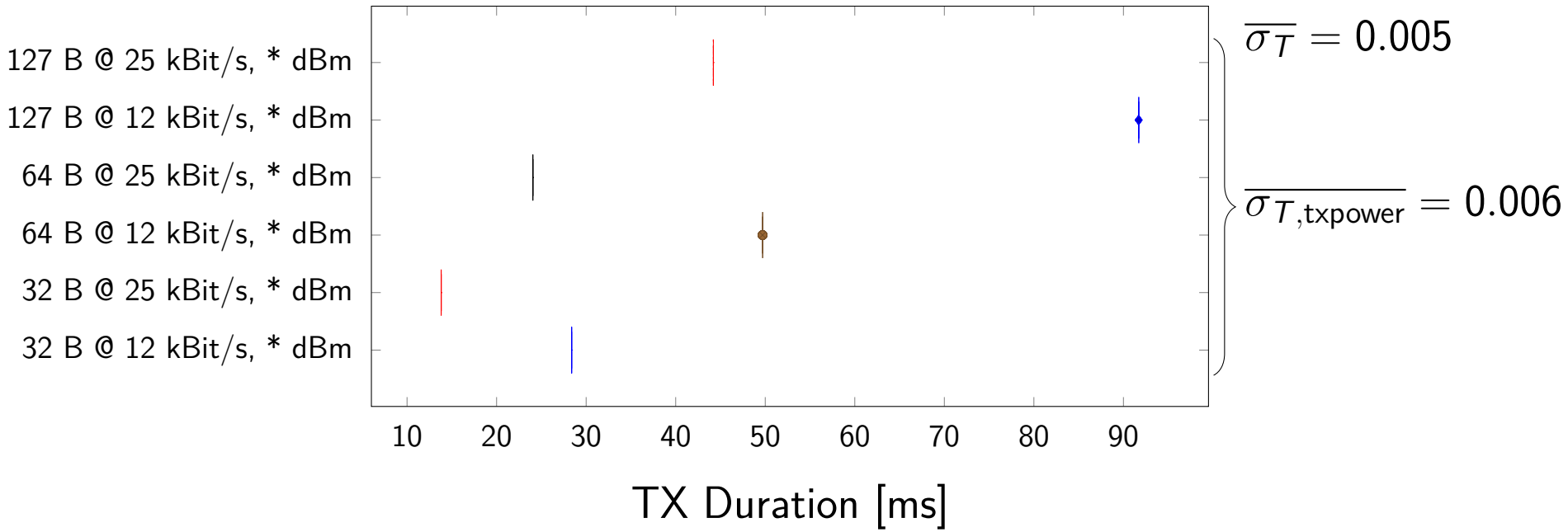
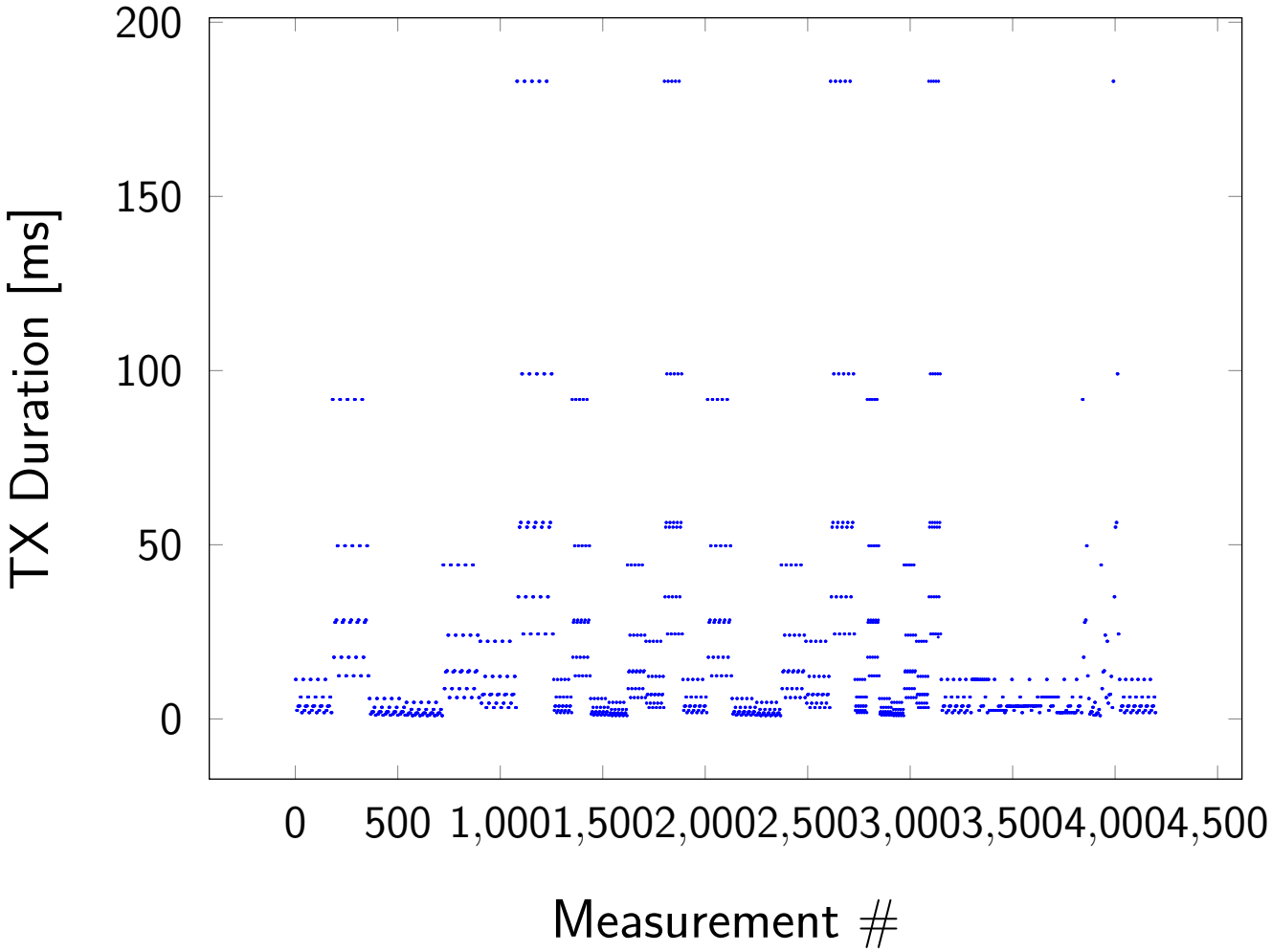


$\rightarrow$ TX Duration depends on packet length and bitrate, but not TX power

Parameter Modeling

- Linear Regression on a predefined set of function templates



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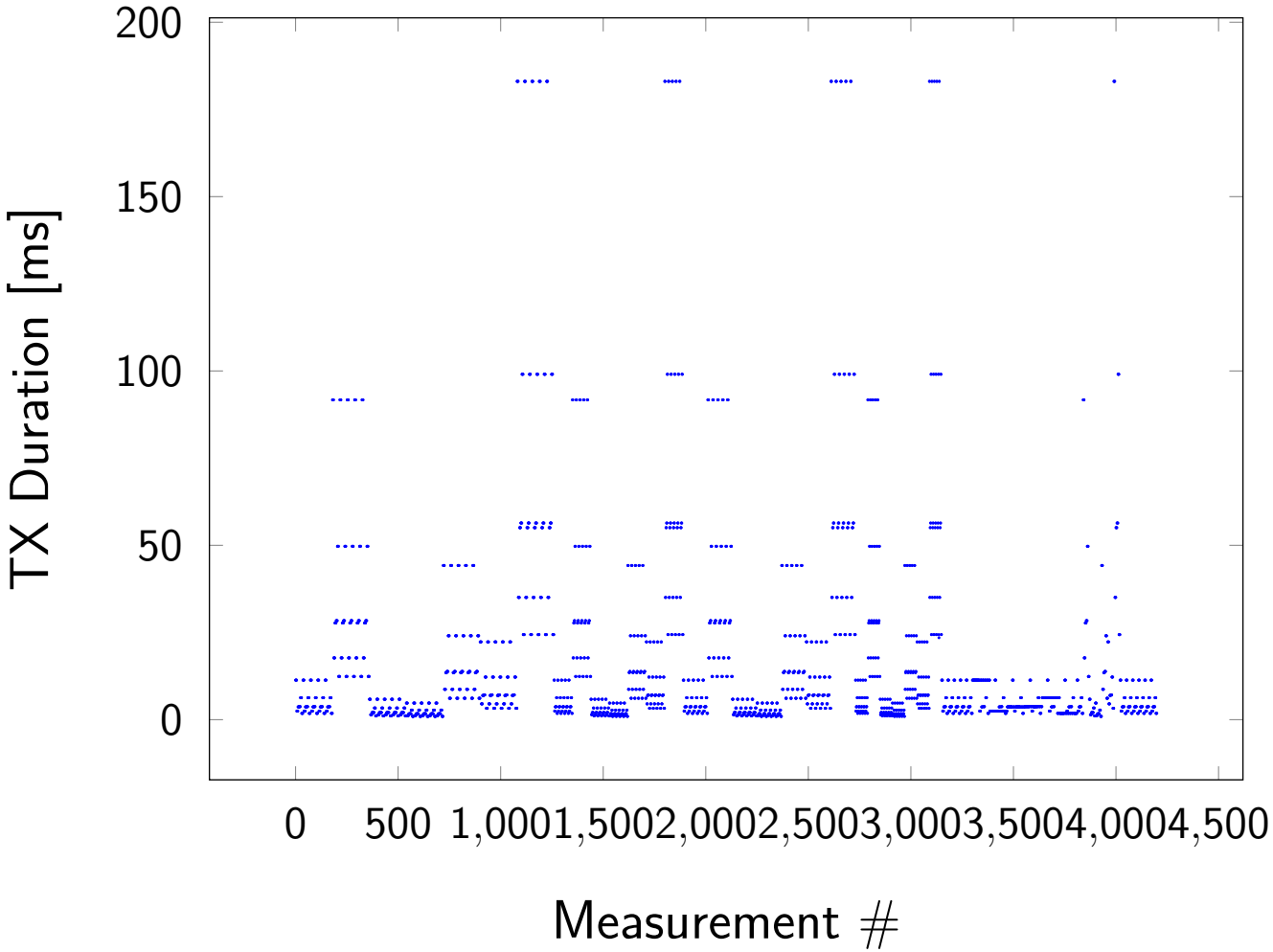

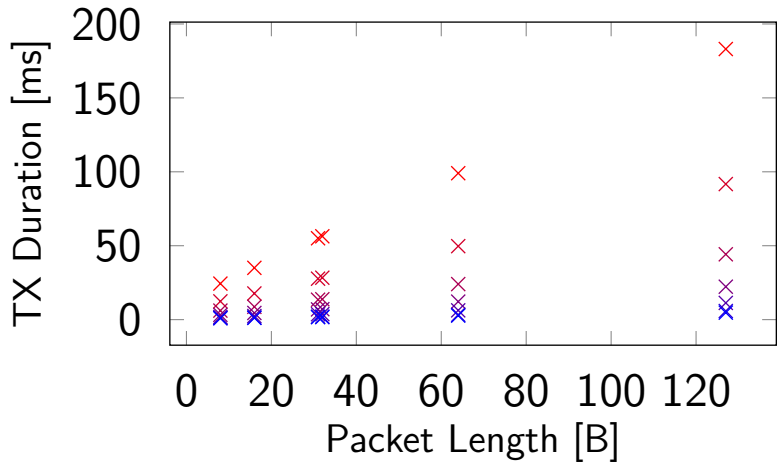

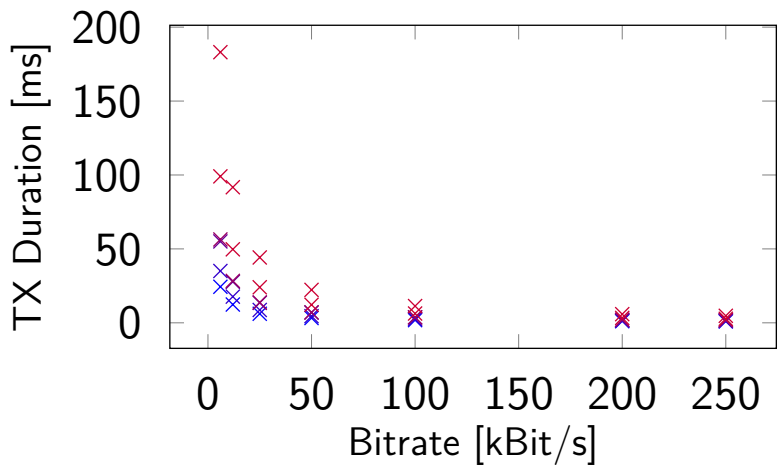

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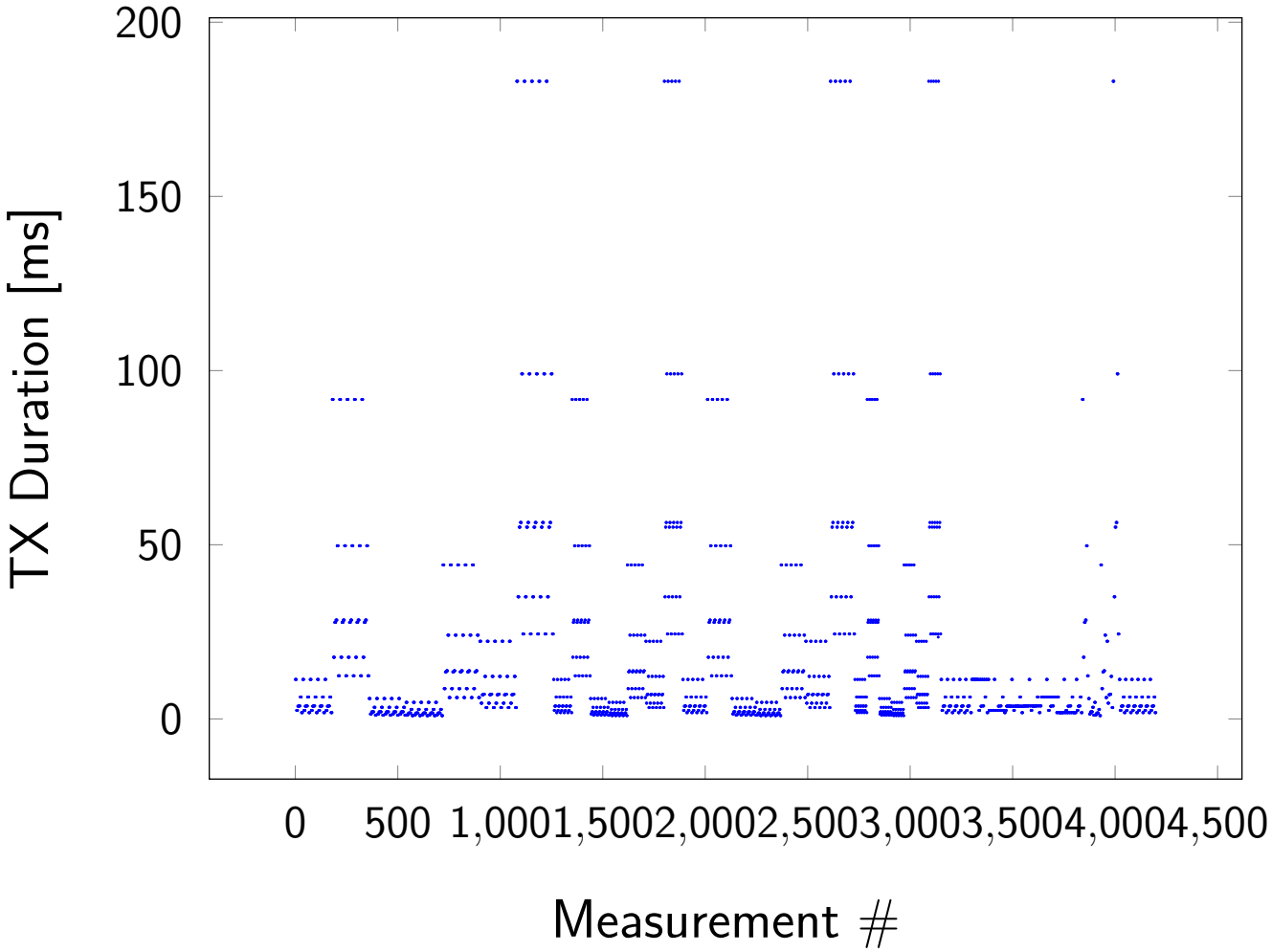
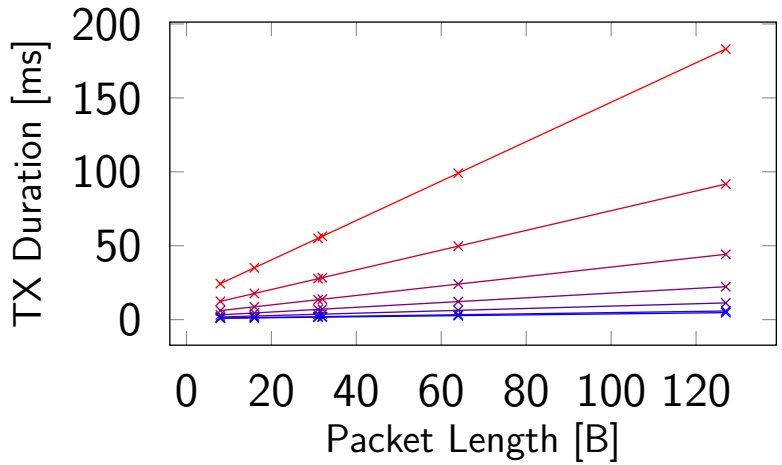
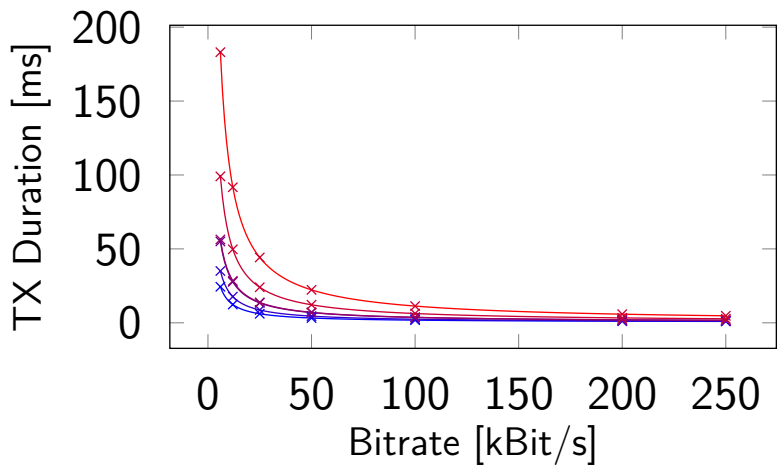
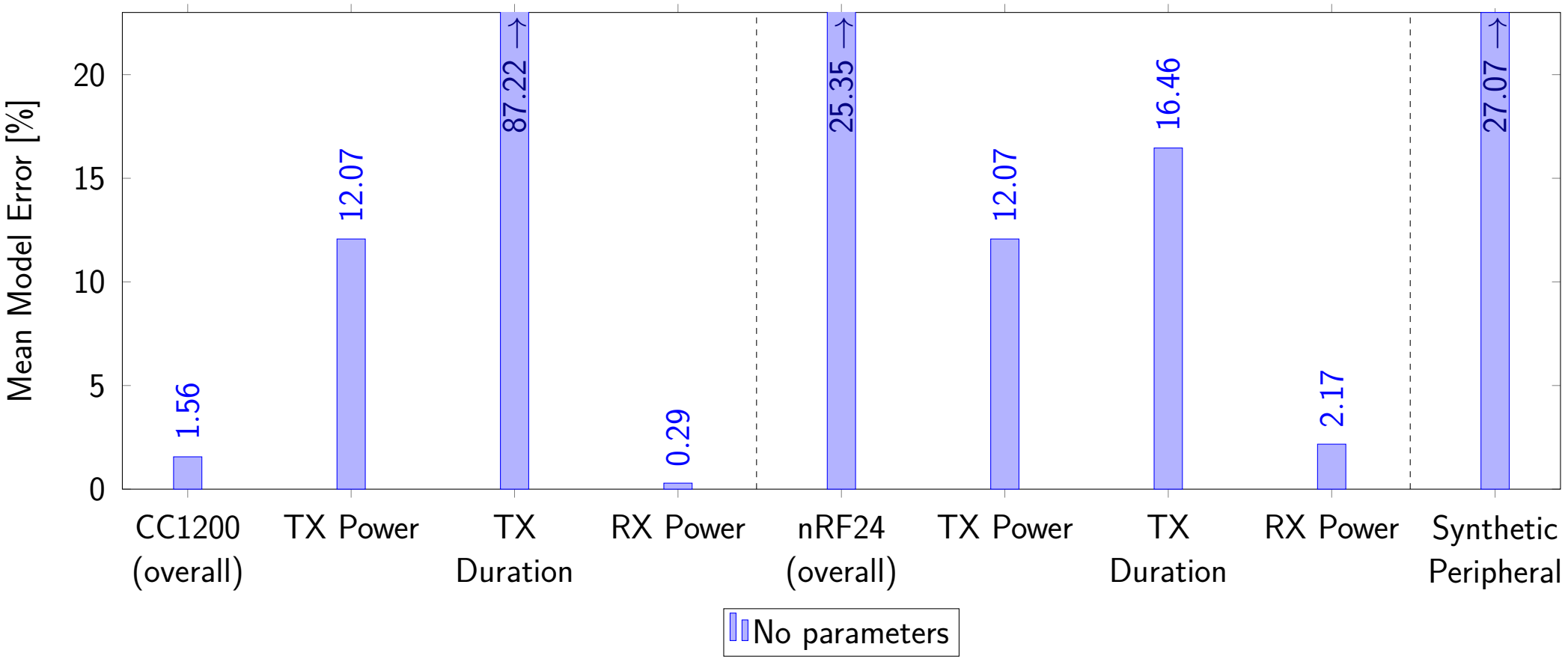






Preliminary Results



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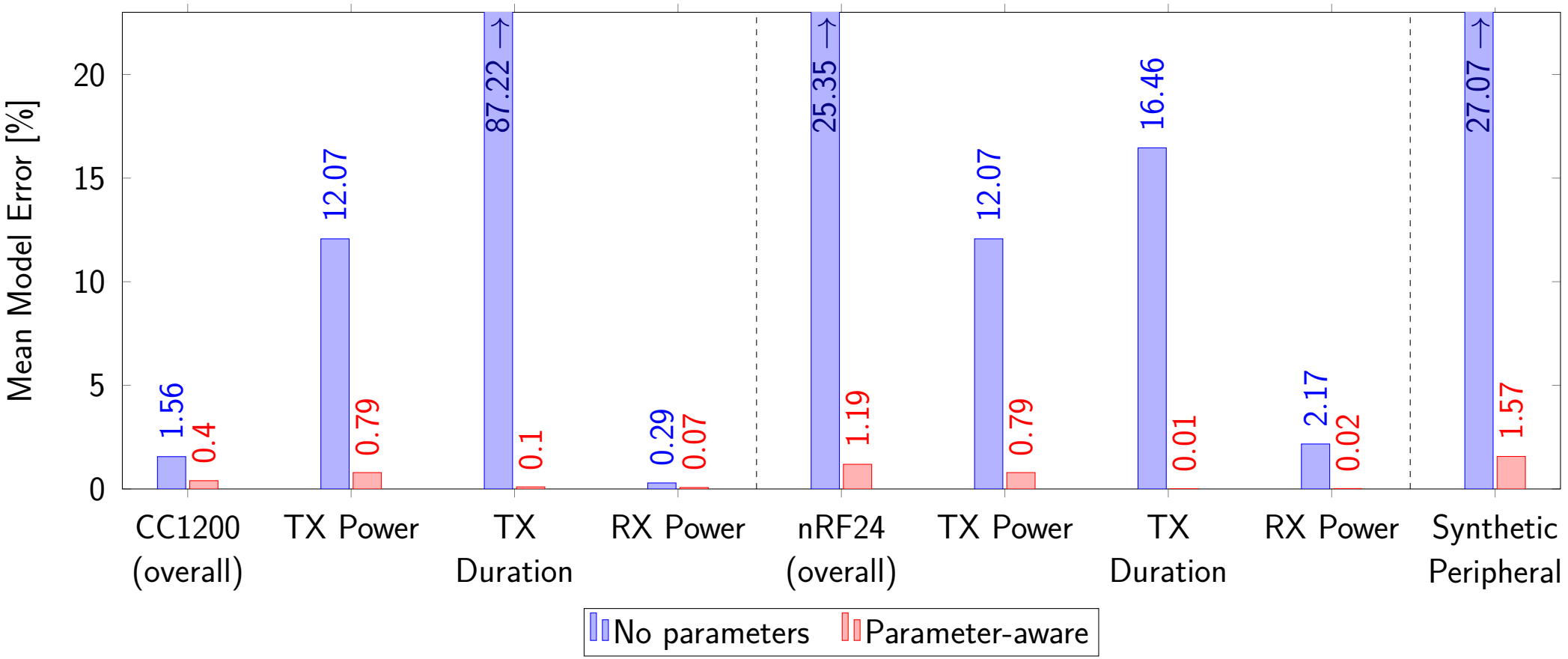

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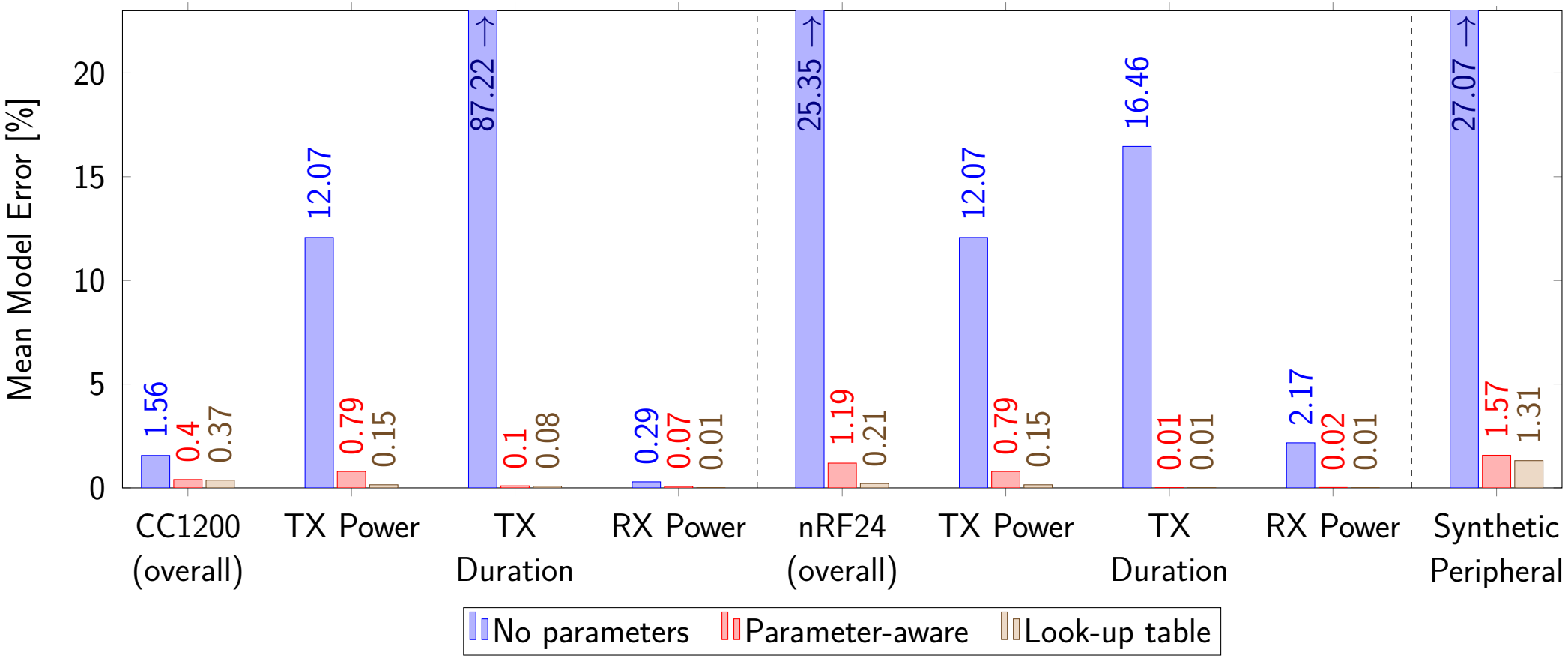

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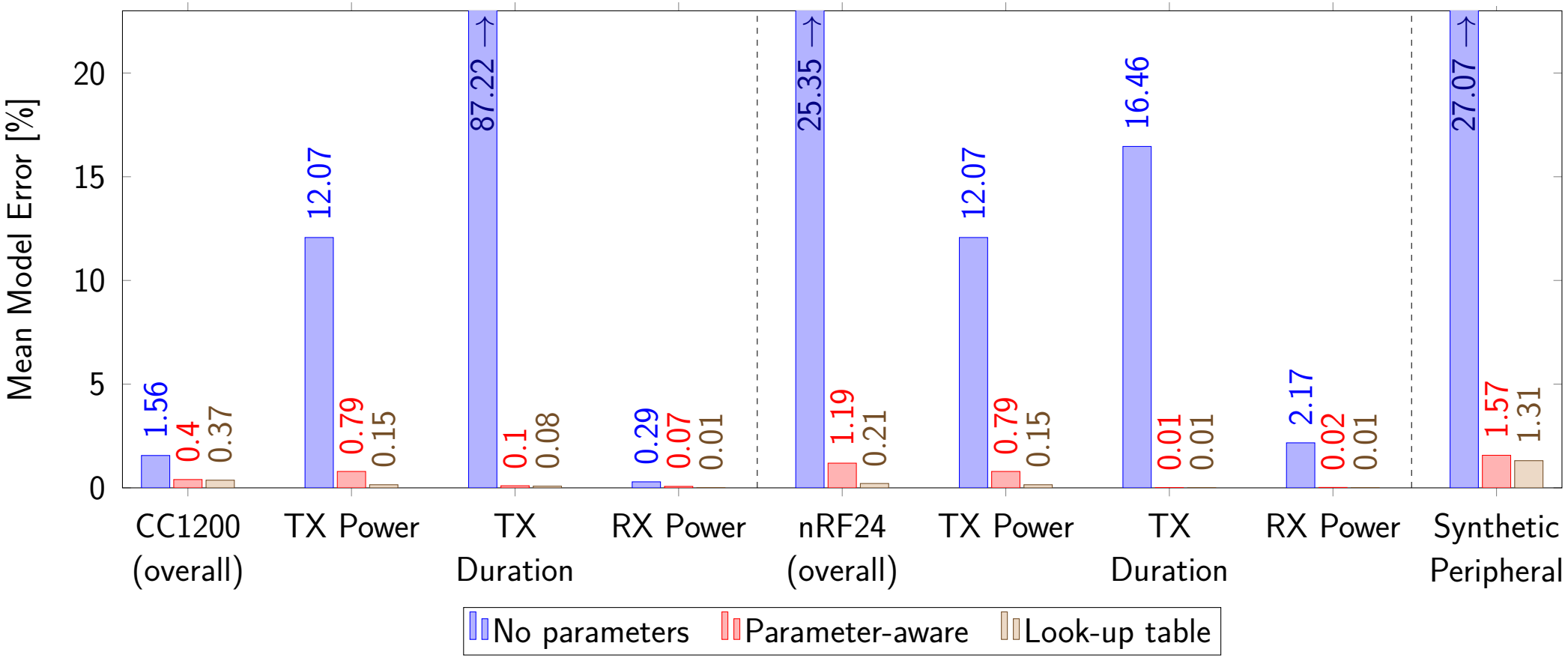

- Overall model error $< 1.6\,\%$
  - Lower than model without parameters, close to optimum