Work-in-Progress: Towards a fine-grain thermal model for uniform multi-core processors

CISTER – Research Centre in Real-Time & Embedded Computing Systems

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Motivation

Thermal models

Rao et al. model
- \+ Has very low complexity
- – Neglects the heat transfer between neighboring cores

Matrix model
- \+ Has low complexity
- – Models only steady state temperatures

HotSpot model
- \+ Is a fine-grain model
- – Has very high complexity
- – Models a high number of thermal layers
- – Requires detailed information of the platform

Goal

To design **an efficient and simple thermal model for multi-core platforms** to be coupled with a large variety of existing schedulers. This model must **exhibit** both **transient** and **steady temperatures** at run-time.

Concluding Remarks

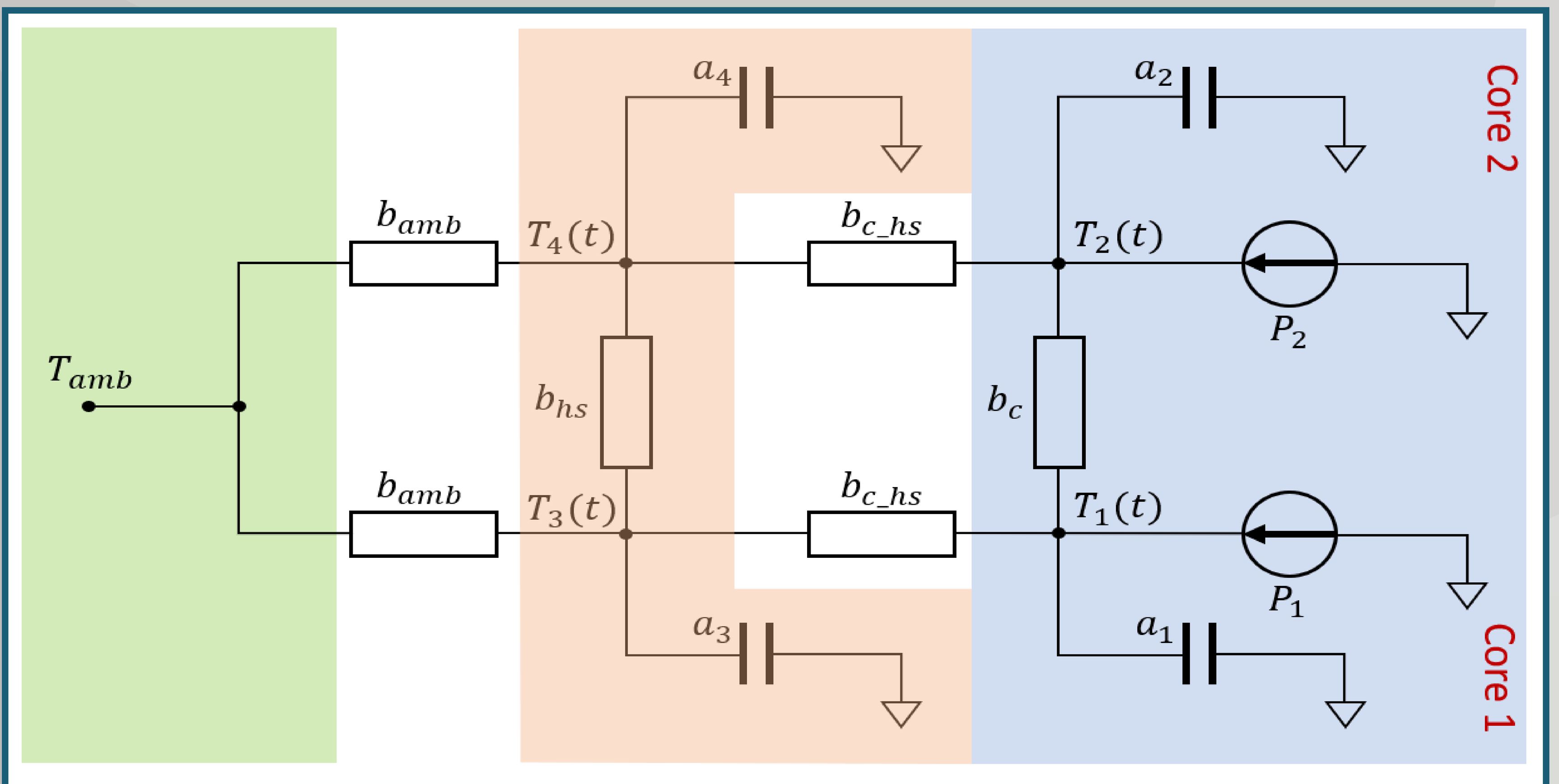
We provided a set of parameters; properties and a simple architectural/functional description of the hardware and software used to model the application and the platform.

Next Step

To design efficient thermal-aware task-to-core mapping and scheduling strategies together with the associated analyses to reduce the average platform temperature.

Inputs

Dual core thermal model



$$b_{amb}(m) = \frac{A_{hs} - A_{chip}}{R_{conv} \cdot A_{m_{hs}}}$$

$$b_{c\_hs}(m) = \frac{A_m}{R_{chip} \cdot A_{chip}}$$

$$b_c(m,n) = \frac{w_{mn} \cdot th_{si} \cdot K_{si}}{L_{mn}}$$

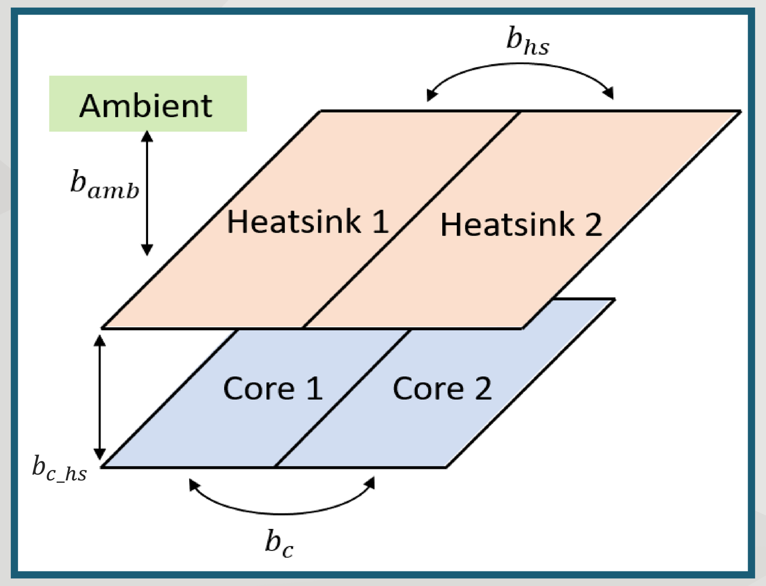
$$b_{hs}(h,g) = \frac{w_{hg} \cdot th_{cu} \cdot K_{cu}}{L_{hg}}$$

$$a_{hs}(m) = A_{m_{hs}} \cdot th_{cu} \cdot \mu_{cu} \cdot c_{p_{cu}} \cdot C_{factor\,cu}$$

$$a_{core}(m) = A_m \cdot th_{si} \cdot \mu_{si} \cdot c_{p_{si}} \cdot C_{factor\,si}$$

$$P_j = \beta_0 \cdot s_j^{\alpha} + \beta_1 \cdot s_j \cdot \beta_2 \quad (j = 1, 2)$$

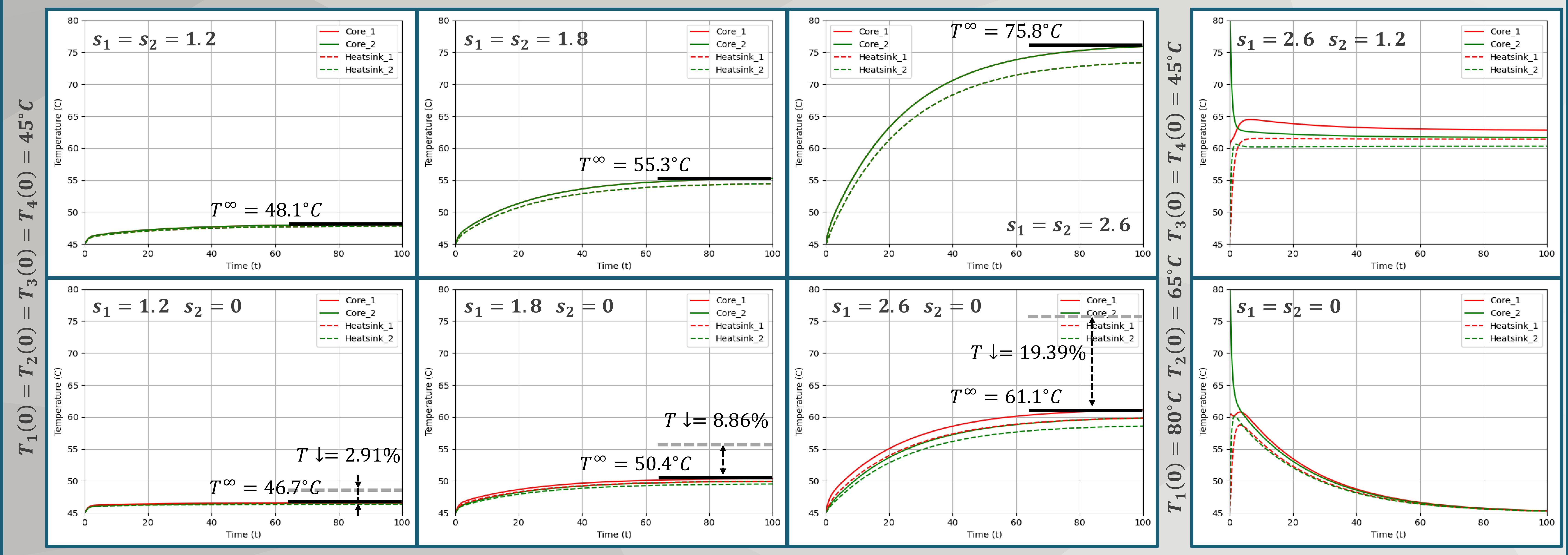
Dual core floorplan



$$\begin{bmatrix} a_1 & 0 & 0 & 0 \\ 0 & a_2 & 0 & 0 \\ 0 & 0 & a_3 & 0 \\ 0 & 0 & 0 & a_4 \end{bmatrix} \begin{bmatrix} T_1'(t) \\ T_2'(t) \\ T_3'(t) \\ T_4'(t) \end{bmatrix} + \begin{bmatrix} (b_{c\_hs} + b_c) & -b_c & -b_{c\_hs} & 0 \\ -b_c & (b_{c\_hs} + b_c) & 0 & -b_{c\_hs} \\ -b_{c\_hs} & 0 & (b_{c\_hs} + b_{hs} + G_{amb}) & -b_{hs} \\ 0 & -b_{c\_hs} & -b_{hs} & (b_{c\_hs} + b_{hs} + G_{amb}) \end{bmatrix} \begin{bmatrix} T_1(t) \\ T_2(t) \\ T_3(t) \\ T_4(t) \end{bmatrix} = \begin{bmatrix} P_1 \\ P_2 \\ 0 \\ 0 \end{bmatrix} + T_{amb} \begin{bmatrix} 0 \\ 0 \\ b_{amb} \\ b_{amb} \end{bmatrix}$$

One-dimensional Laplace transform: $\check{f}(t) \overset{\text{def}}{=} \int_0^{\infty} f(t) e^{-st} dt$

Results



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