# Closing Internal Timing Channels by Code Transformation

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Work-in-progress!

**FOSAD ’06**

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- Those kind of programs are called non-interferent!

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- Number of created threads, internal timing, etc.
- Our focus: **internal timing covert channel** (why?)
- Motivating example: mobile devices (Geo-localization)

# Internal Timing Leak: Example

$$c_1 : \quad \texttt{if}\ h\ \texttt{then}\ \texttt{skip}; \texttt{skip}\ \texttt{else}\ \texttt{skip};$$
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- The low race is affected by the secret! (how?)

# Internal Timing leak: Magnified

$p := 0;$

$\texttt{while}\ n \geq 0\ \texttt{do}$

$\quad k := 2^{n-1};$

$\quad \texttt{fork}(\texttt{skip}; \texttt{skip}; l := 0);$

$\quad \texttt{if}\ h \geq k\ \texttt{then}\ \texttt{skip}; \texttt{skip}\ \texttt{else}\ \texttt{skip};$

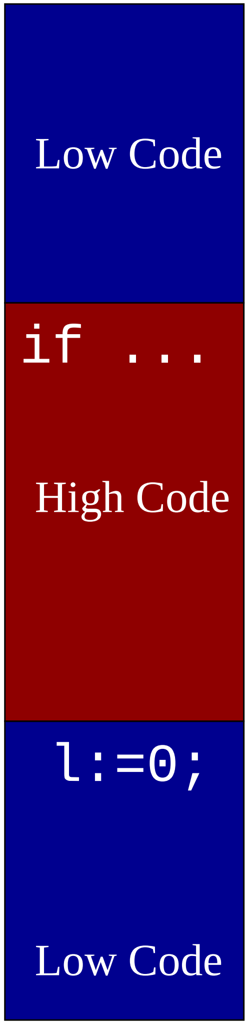
$\quad l := 1;$

$\quad \texttt{if}\ l = 1\ \texttt{then}\ h := h - k; p := p + k$

$\qquad\qquad \texttt{else}\ \texttt{skip};$

$\quad n := n - 1$

# Internal Timing Leak: Transformatio



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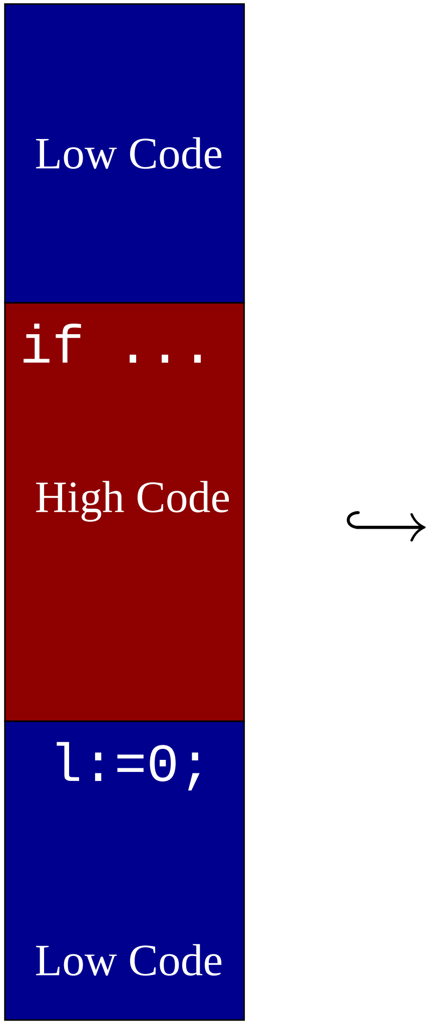

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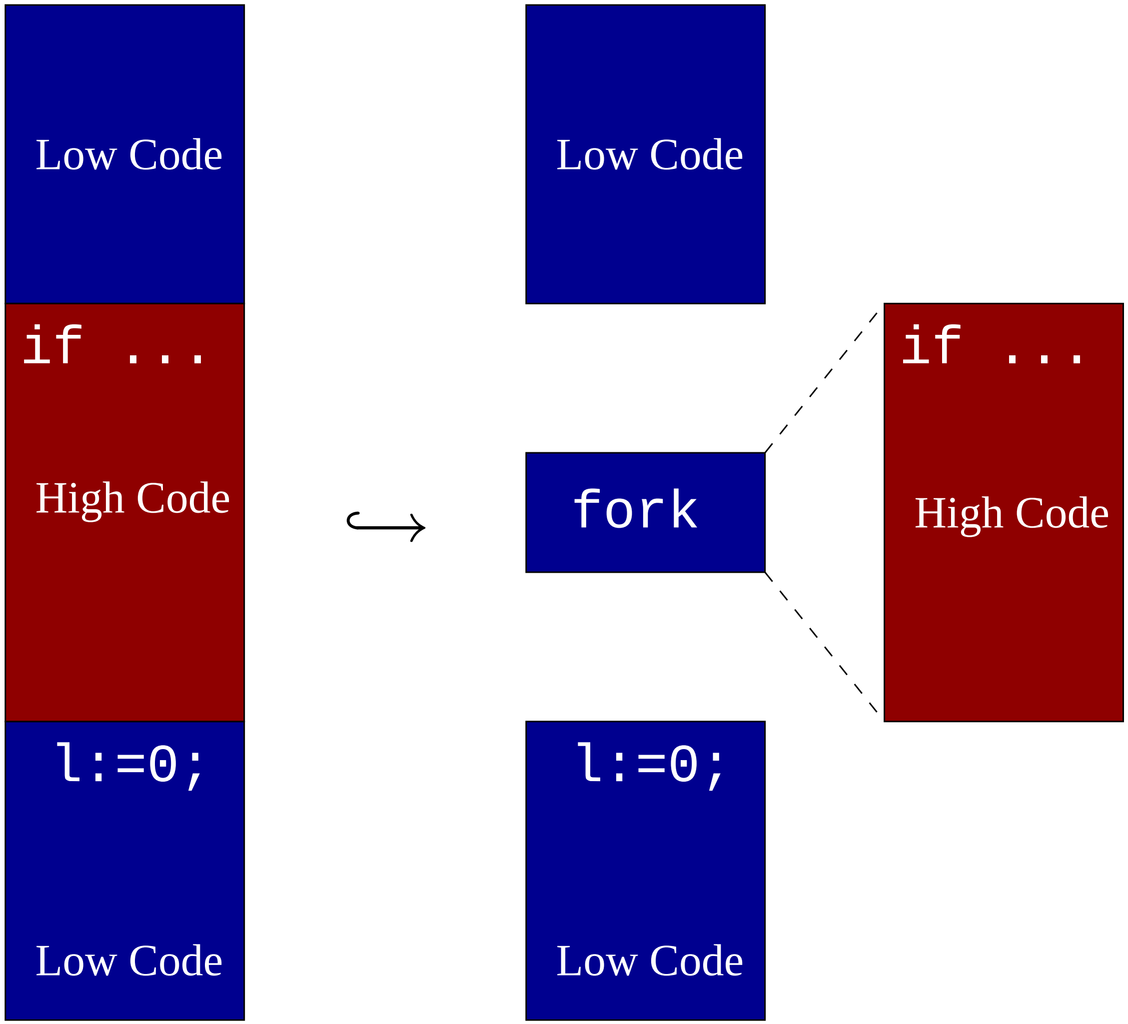

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- Spawn high computations in dedicated threads

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- Spawn high computations in dedicated threads
  - Good news: no internal timing leaks!
  - Bad news: it may introduce new races between variables!

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$\{h_2 = 0, l = 0\}$

$(\texttt{if}\ h_1\ \texttt{then}\ h_2 := 2 * h_2 + l; \texttt{skip}\ \texttt{else}\ \texttt{skip}); l := 1 \parallel c_2$

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$$\texttt{fork}((\lambda\hat{l}.\texttt{if}\ h_1\ \texttt{then}\ h_2 := 2 * h_2 + \hat{l}; \texttt{skip}\ \texttt{else}\ \texttt{skip})@l); l := 1$$

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$w := \texttt{newSem}(1); s := \texttt{newSem}(0);$

$\texttt{fork}((\lambda \hat{w}\hat{s}\hat{l}.\texttt{P}(\hat{w}); \texttt{if } h_1 \texttt{ then } h_2 := 2 * h_2 + \hat{l}; \texttt{skip else skip}; \texttt{V}(\hat{s}))@wsl);$

$w := s;\ l := 1;$

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- Final value of $h_2 \in \{1, 2\}$ (why?) (solution?)
- Synchronize the spawned dedicated threads

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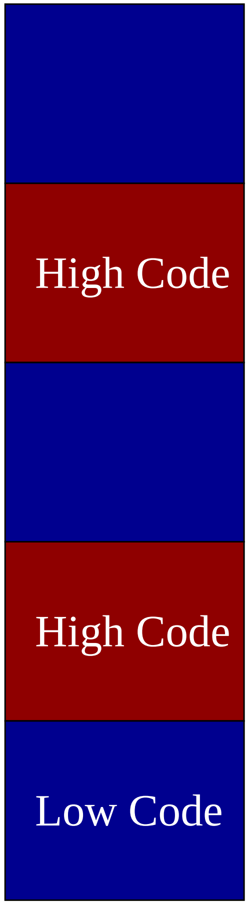

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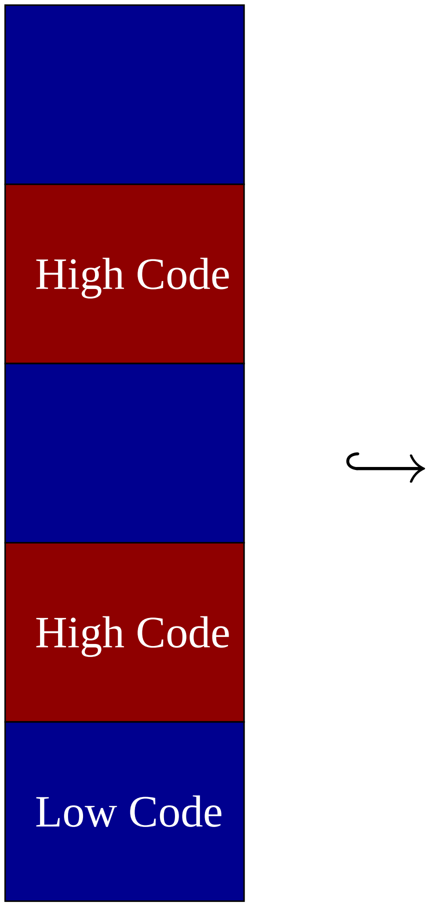

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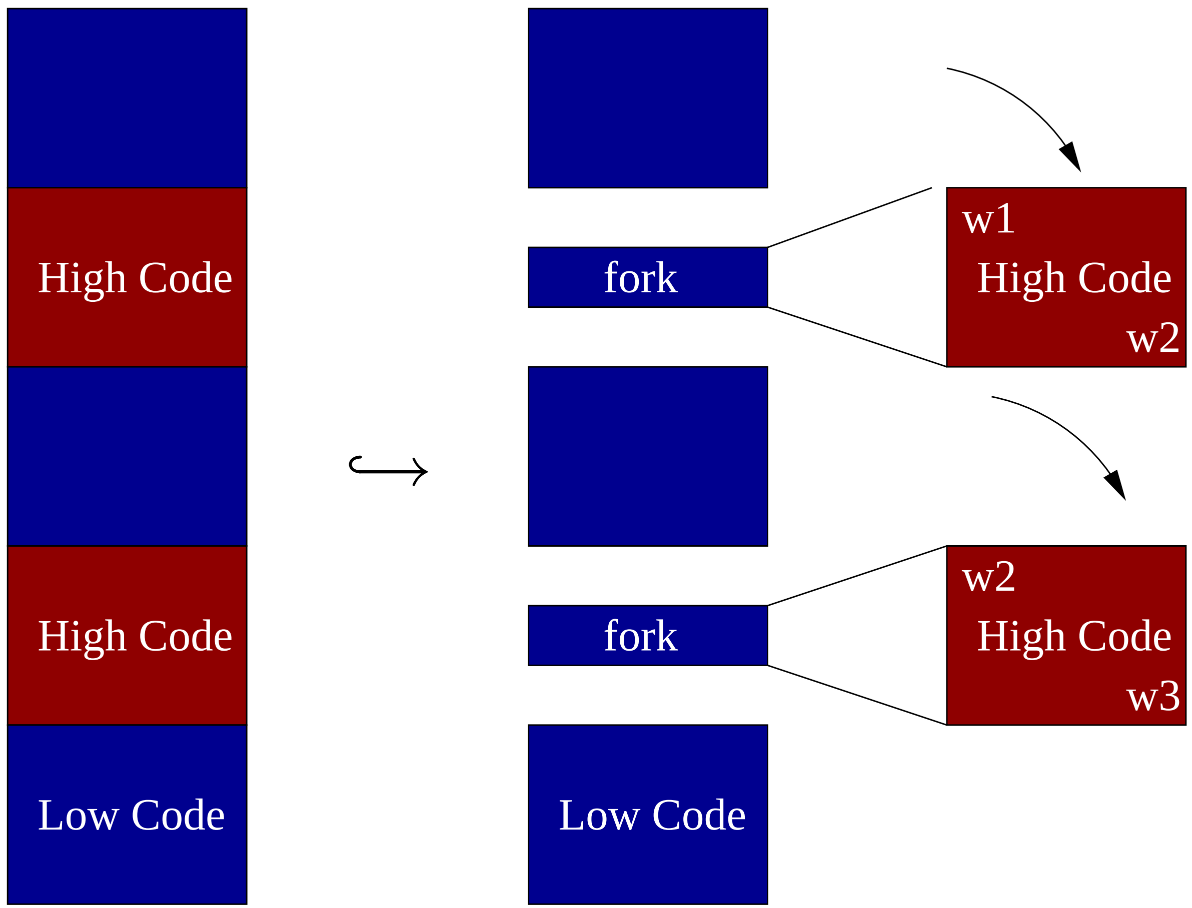

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- **Refinement**: Suppose $\Gamma \vdash c \hookrightarrow_t c'$ and $g'_1$ and $g'_2$ are global memories for $c'$ such that $(c', g'_1) \Downarrow g'_2$ using the nondeterministic scheduler $ND$. Let $g_1$ and $g_2$ be the restrictions of $g'_1$ and $g'_2$ to the globals of $c$. Then $(c, g_1) \Downarrow g_2$ using $ND$.

# To sum up...

- Transformation that closes internal timing channels
- Dynamic thread creation in the source language
- No need to change the environment (schedulers, etc)
- Transformation only reject programs with illegal flows inherent to sequential computations