

# Energy Consumption and Performance Analysis Between ARM and Intel

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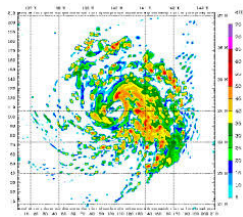
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# HPC

- HPC is used in:

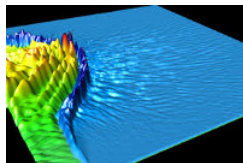
# HPC

- HPC is used in:
  - Weather forecasts



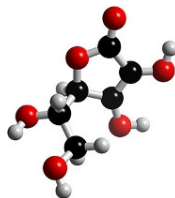
# HPC

- HPC is used in:
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  - Physics simulations



# HPC

- HPC is used in:
  - Weather forecasts
  - Physics simulations
  - Molecular models



# HPC Community Aims

- Accuracy and Reliability
- Performance, consequently, increase the power demand

# Power demand

- DARPA report
  - Limit of **20 MW** to reach **exascale** (KOGGE et al., 2008)
  - Increase the energy efficiency of supercomputers

# Advanced Risc Machine (ARM)

- Manufactured aiming low power consumption
- Compatible with Linux operating systems
- Recent improvements:
  - Floating-point single-precision and double-precision
  - Clock frequency

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- A detailed analysis of contemporary ARM and x86 architectures (BLEM et al., 2013)
- Towards green data centers: A comparison of x86 and ARM architectures power efficiency (AROCA AND GONÇALVES, 2012)
- The low power architecture approach towards exascale computing (RAJOVIC et al., 2013)
- Energy efficiency vs. performance of the numerical solution of PDEs: An application study on a low-power ARM-based cluster (GÖDDEKE et al., 2013)

Our work is different to these:

- MPSoC with ARM processor vs. Intel Xeon server processor
- Analysis:
  - Runtime
  - Energy consumption

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Analyze the feasibility of using low-power processors in HPC

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# Execution Environment

|                           | <b>Cubietruck</b>        | <b>Server</b>              |
|---------------------------|--------------------------|----------------------------|
| Processor                 | ARM Cortex A7            | Intel Xeon                 |
| Processor Model           | AllWinnerTech SoC A20    | E5-2640v2                  |
| Processor Technology (nm) | 40                       | 22                         |
| Clock Frequency (GHz)     | 1                        | 2                          |
| Cores/Processor(#)        | 2                        | 8                          |
| Memory (GB)               | 2                        | 32                         |
| Cache L1/Core(KB)         | 64                       | 512                        |
| Cache L2 (KB)             | 256                      | 2048                       |
| Cache L3 (MB)             | -                        | 20                         |
| Operating System          | GNU/Linux kernel 3.4.106 | Ubuntu 14.04 kernel 3.16.0 |
| gcc                       | 4.9.2                    | 4.8.4                      |

# Benchmarks

## NAS Parallel Benchmarks

- Pseudo Applications
  - BT (block tri-diagonal)
  - LU (Lower-Upper Gaus-Seidel)
- Kernels
  - IS (Integer Sort)
  - FT (Fast Fourier Transform)
  - MG (Multi Grid)

# Metrics

- Runtime  $\longrightarrow$  SpeedUp (times)

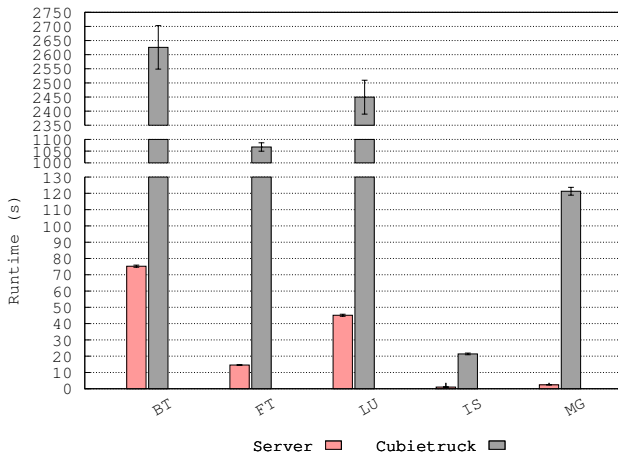
$$S(p) = \frac{t(1)}{t(p)}$$

- Energy Consumption (J)

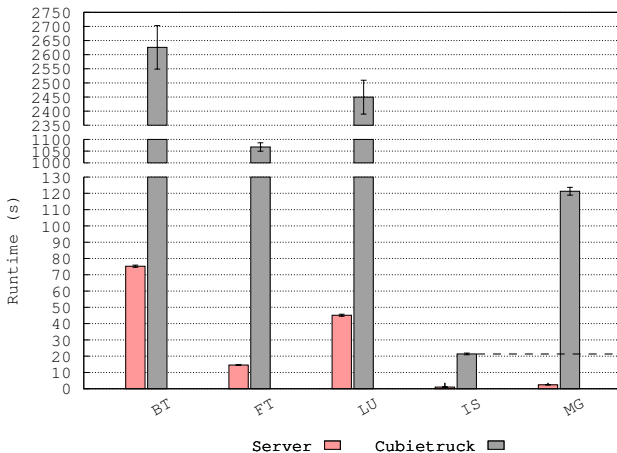
$$E = P_{(avg)} * t$$

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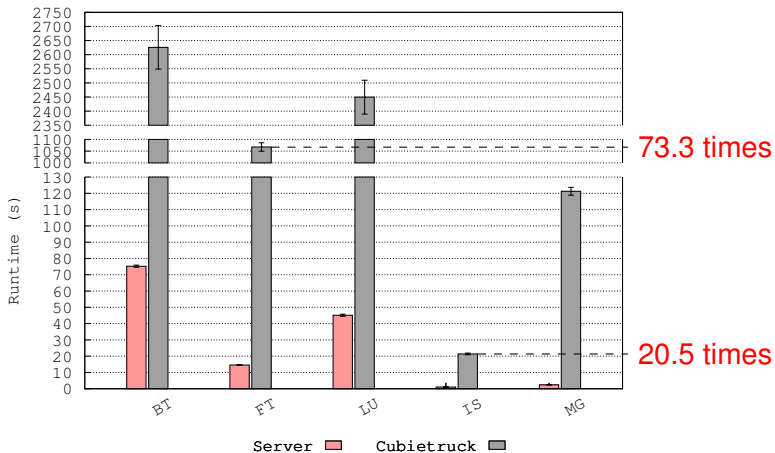
## MPSoC / Server



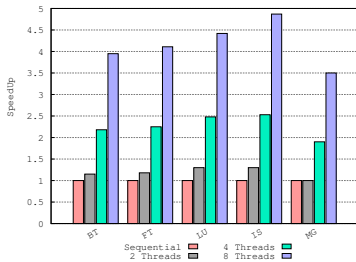
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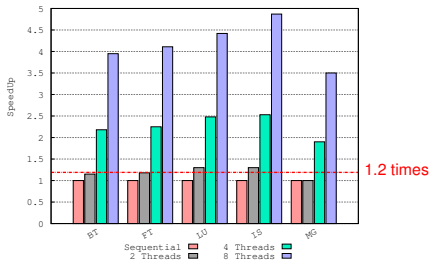
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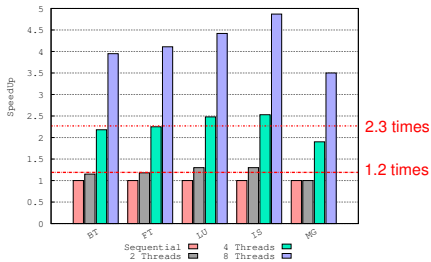
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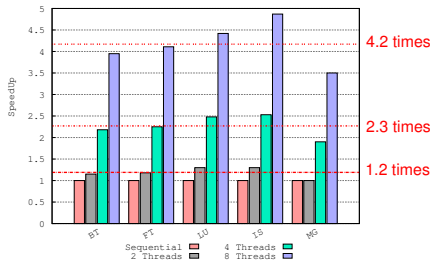
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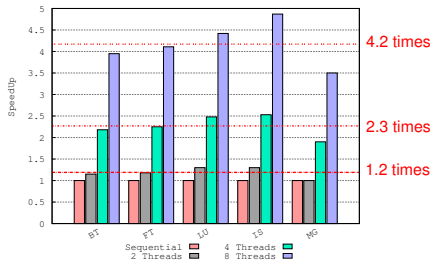
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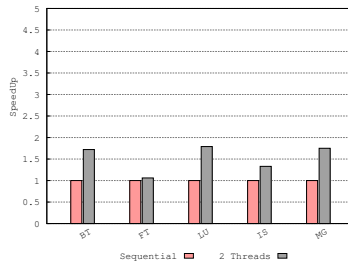
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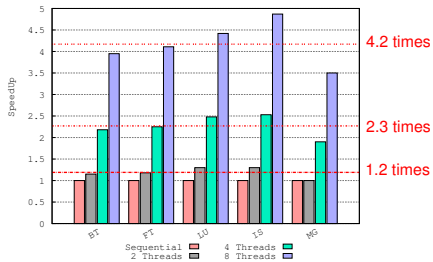
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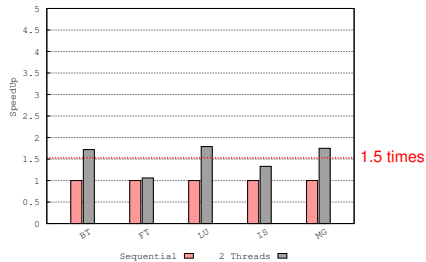
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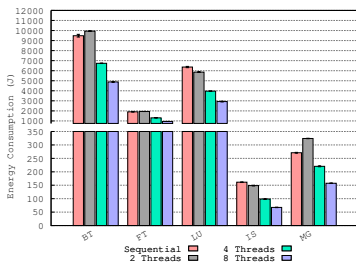
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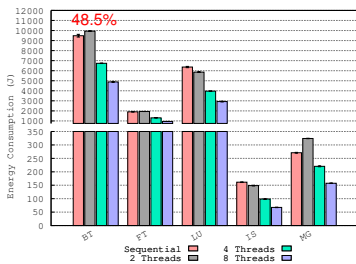
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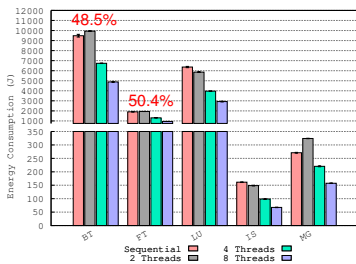
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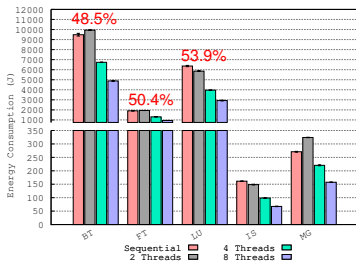
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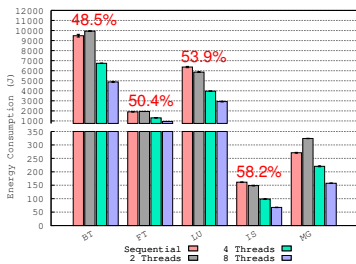
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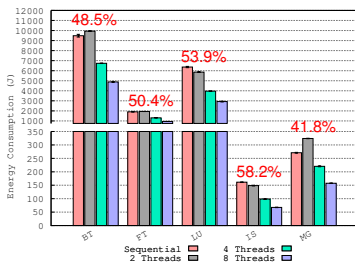
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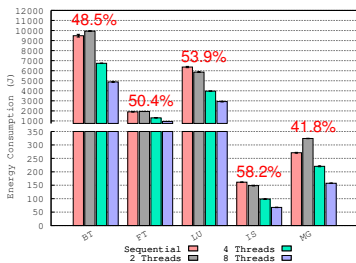
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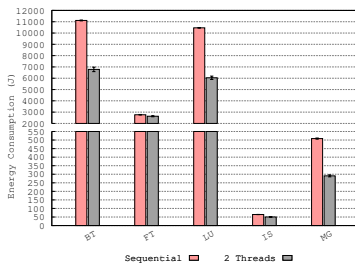
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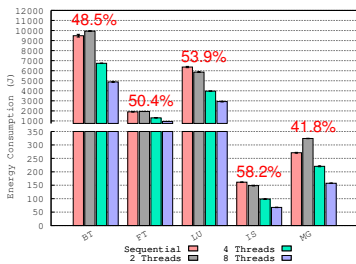
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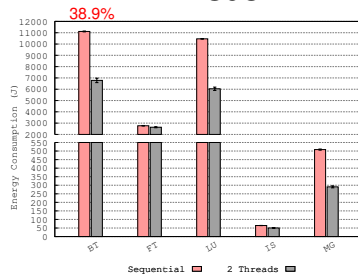
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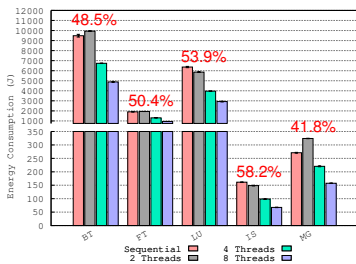
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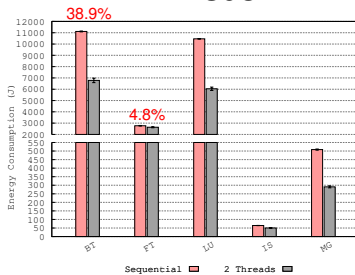
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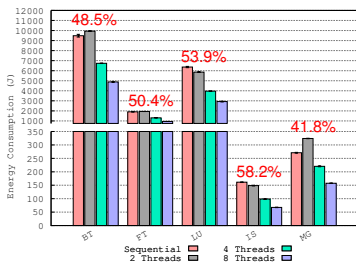
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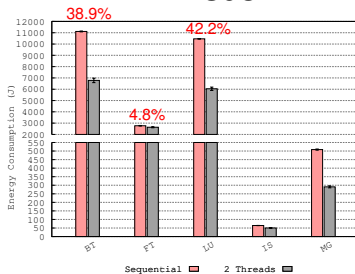
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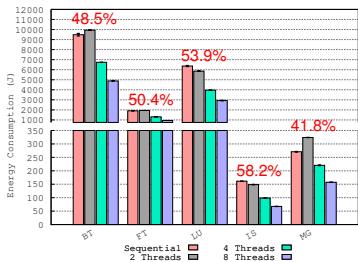
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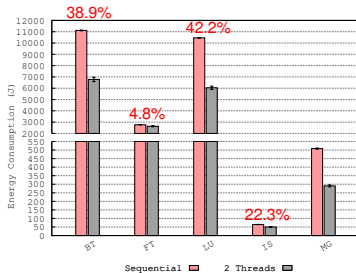
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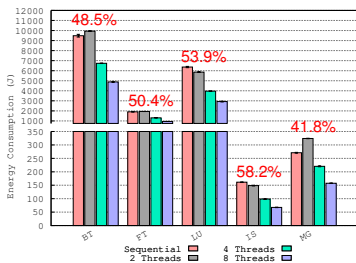
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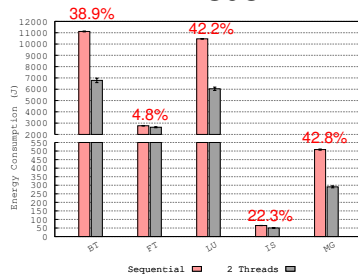
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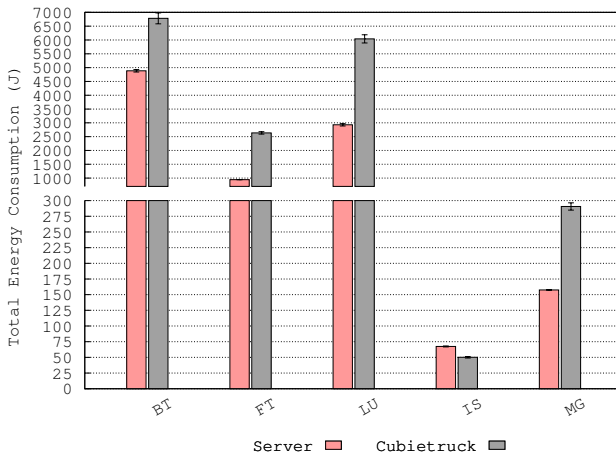


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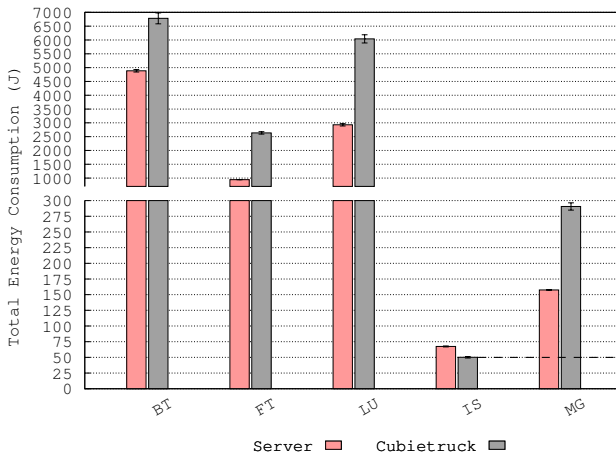
ARM processors have:

- Higher runtime
- Lower power demand

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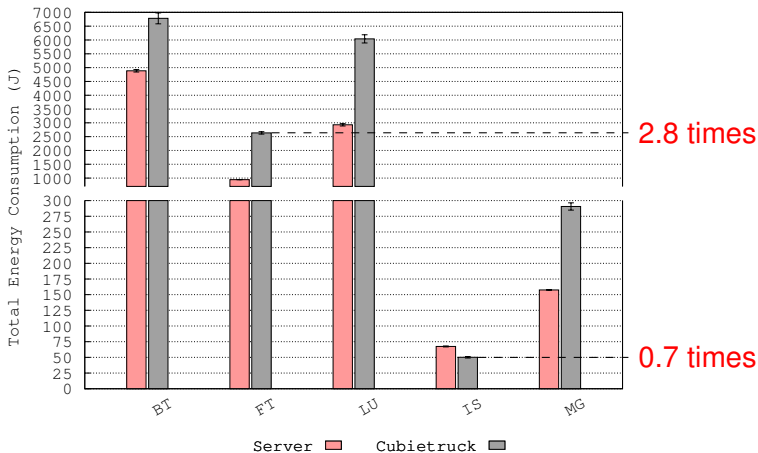


## MPSoC / Server



0.7 times

## MPSoC / Server



## Future Works

- Evaluate the energy efficiency using other MPSoCs

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# References



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Thanks!!

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