H-DROID CLUSTER

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HPPS Project at Polimi
March - June 2014

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CONTEXT DEFINITION

Nowadays… more mobile devices than humans[1]

Idle periods are quite common:
(e.g. night time)

Potential huge amount of distributed computational power

How to exploit it ?

PROJECT GOAL

to build an **heterogeneous cluster**:

distributed computation

which performance ?

previous attempt:

2012-droidCluster, homogeneous smartphone cluster[2]

limitation: all equal devices

TECHNOLOGIES

Computer networks:

MPICH2, message passing interface devices communication

Measuring performance:

HPL, High Performance Linpack benchmark specifically written for clusters

HPL ALGORITHM

Resolution of a linear algebraic system of N linear equations

Matrix divided into blocks

A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}	A_{18}
A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{26}	A_{27}	A_{28}
A_{31}	A_{32}	A_{33}	A_{34}	A_{35}	A_{36}	A_{37}	A_{38}
A_{41}	A_{42}	A_{43}	A_{44}	A_{45}	A_{46}	A_{47}	A_{48}
A_{51}	A_{52}	A_{53}	A_{54}	A_{55}	A_{56}	A_{57}	A_{58}
A_{61}	A_{62}	A_{63}	A_{64}	A_{65}	A_{66}	A_{67}	A_{68}
A_{71}	A_{72}	A_{73}	A_{74}	A_{75}	A_{76}	A_{77}	A_{78}
A_{81}	A_{82}	A_{83}	A_{84}	A_{85}	A_{86}	A_{87}	A_{88}

Grid of processes

A_{11}	A_{14}	A_{17}	A_{12}	A_{15}	A_{18}	A_{13}	A_{16}
A_{31}	A_{34}	A_{37}	A_{32}	A_{35}	A_{38}	A_{33}	A_{36}
A_{51}	A_{54}	A_{57}	A_{52}	A_{55}	A_{58}	A_{53}	A_{56}
A_{71}	A_{74}	A_{77}	A_{72}	A_{75}	A_{78}	A_{73}	A_{76}
A_{21}	A_{24}	A_{27}	A_{22}	A_{25}	A_{28}	A_{23}	A_{26}
A_{41}	A_{44}	A_{47}	A_{42}	A_{45}	A_{48}	A_{43}	A_{46}
A_{61}	A_{64}	A_{67}	A_{62}	A_{65}	A_{68}	A_{63}	A_{66}
A_{81}	A_{84}	A_{87}	A_{82}	A_{85}	A_{88}	A_{83}	A_{86}

Matrix order and block size choices

WHY ANDROID

How to run MPI and HPL on Android ?

Debian on Android !

Chroot into Debian: same kernel of Android

INTO DEBIAN

Bash script to chroot into Debian

root@phone# **sh boot.sh**

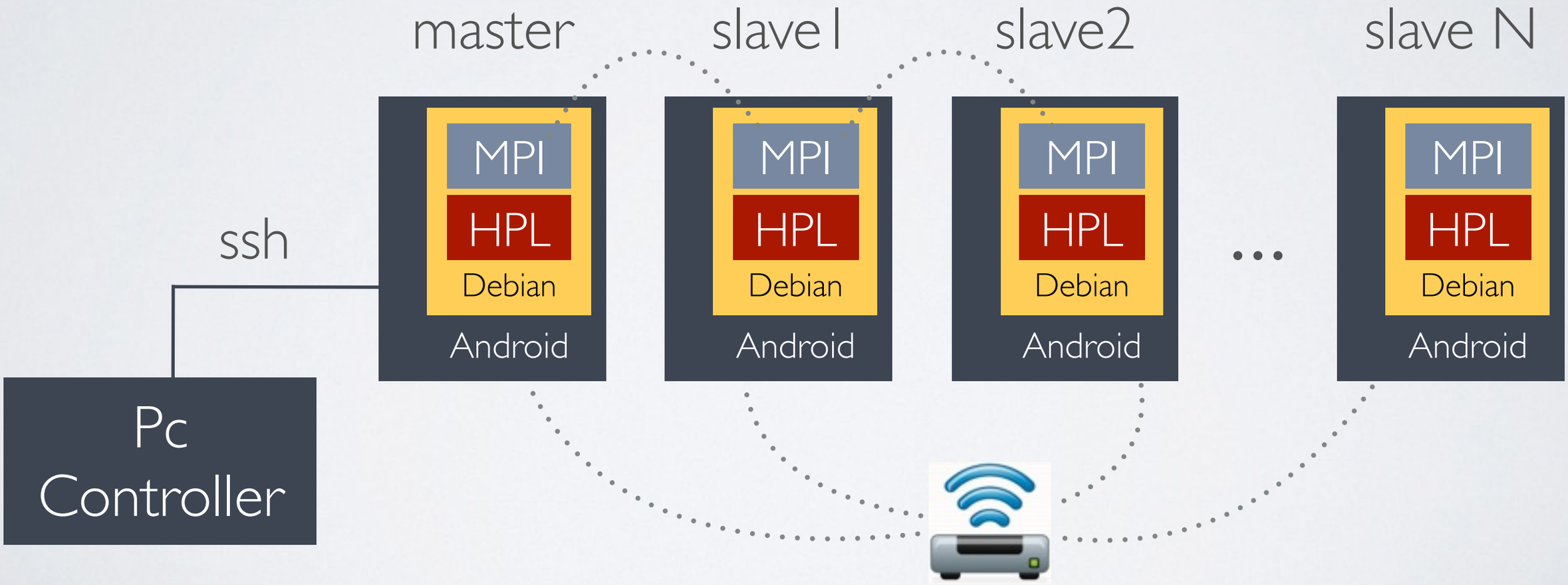
C program to launch the MPI cluster ring

How to tune the benchmark ?

CASE STUDY

Heterogeneous cluster of Android Devices :

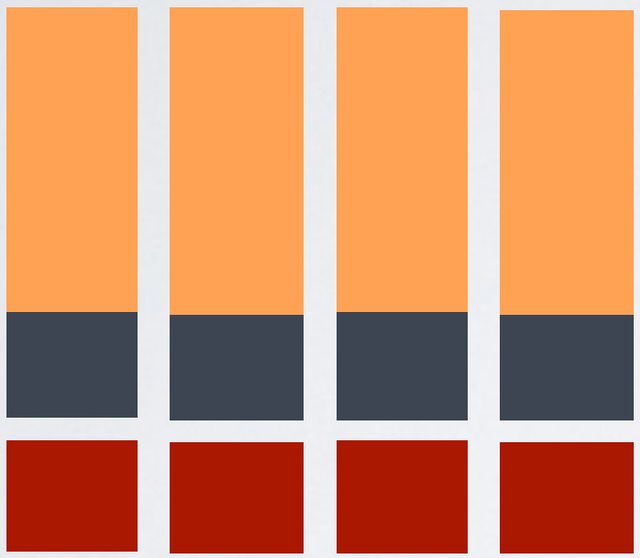
- Master distributes workloads
- Wireless connection



TYPES OF CLUSTERS

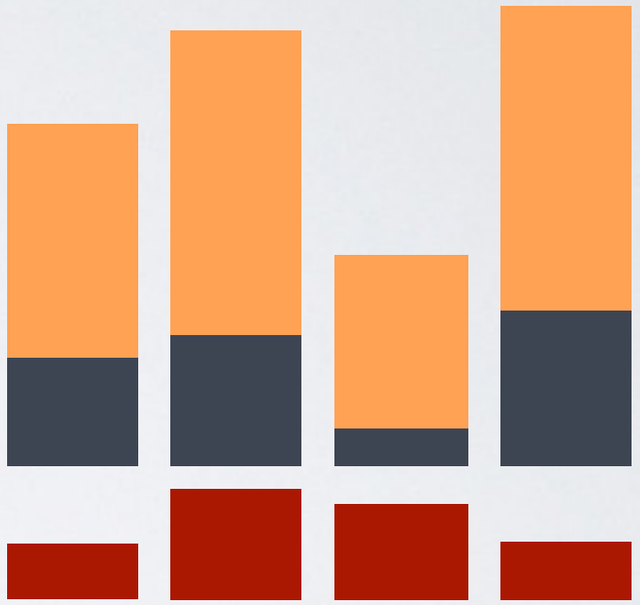
Homogeneous

all equal devices



Heterogeneous

our case



Free memory

OS memory

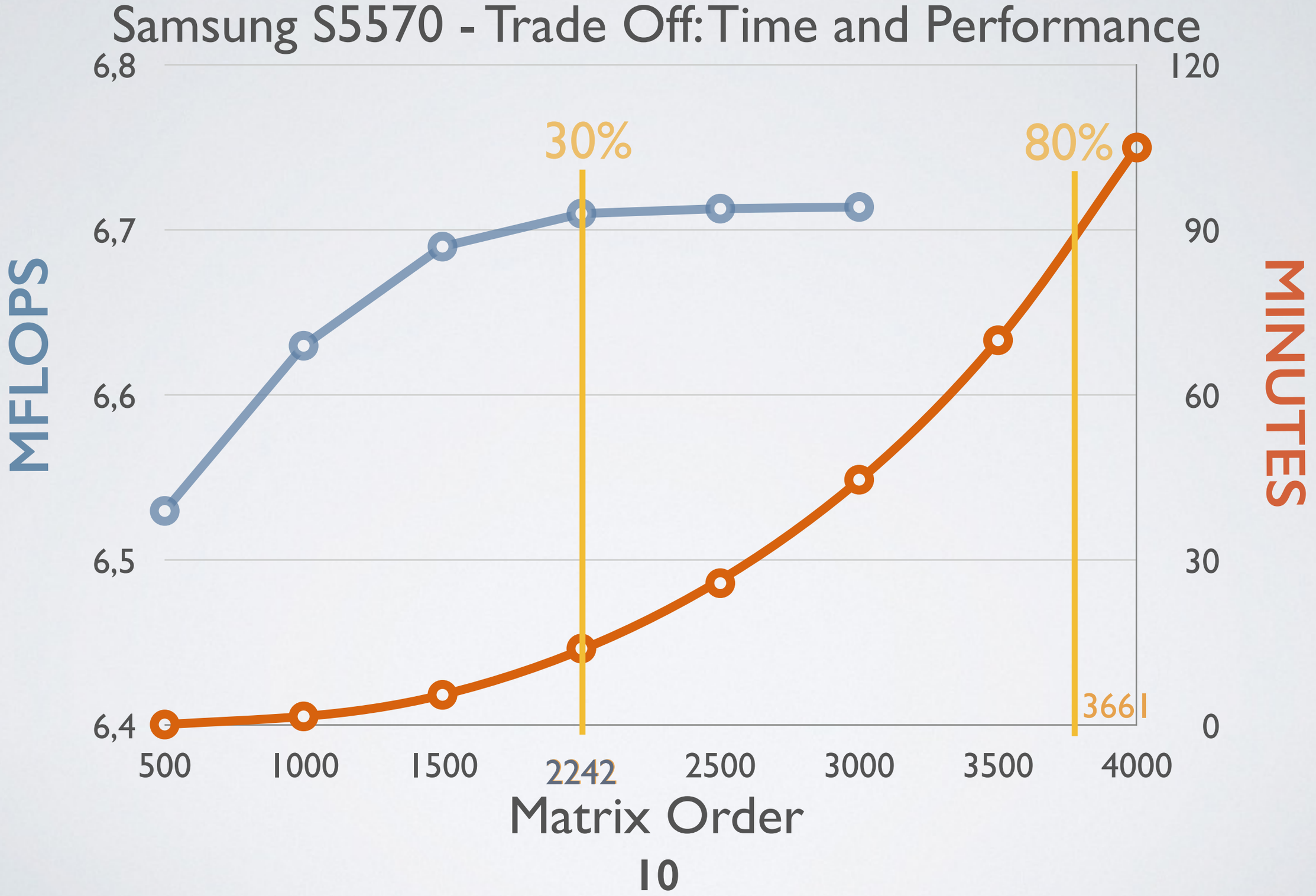
CPU

Trivial benchmark tuning

Hard benchmark tuning

Choice of MATRIX ORDER ?

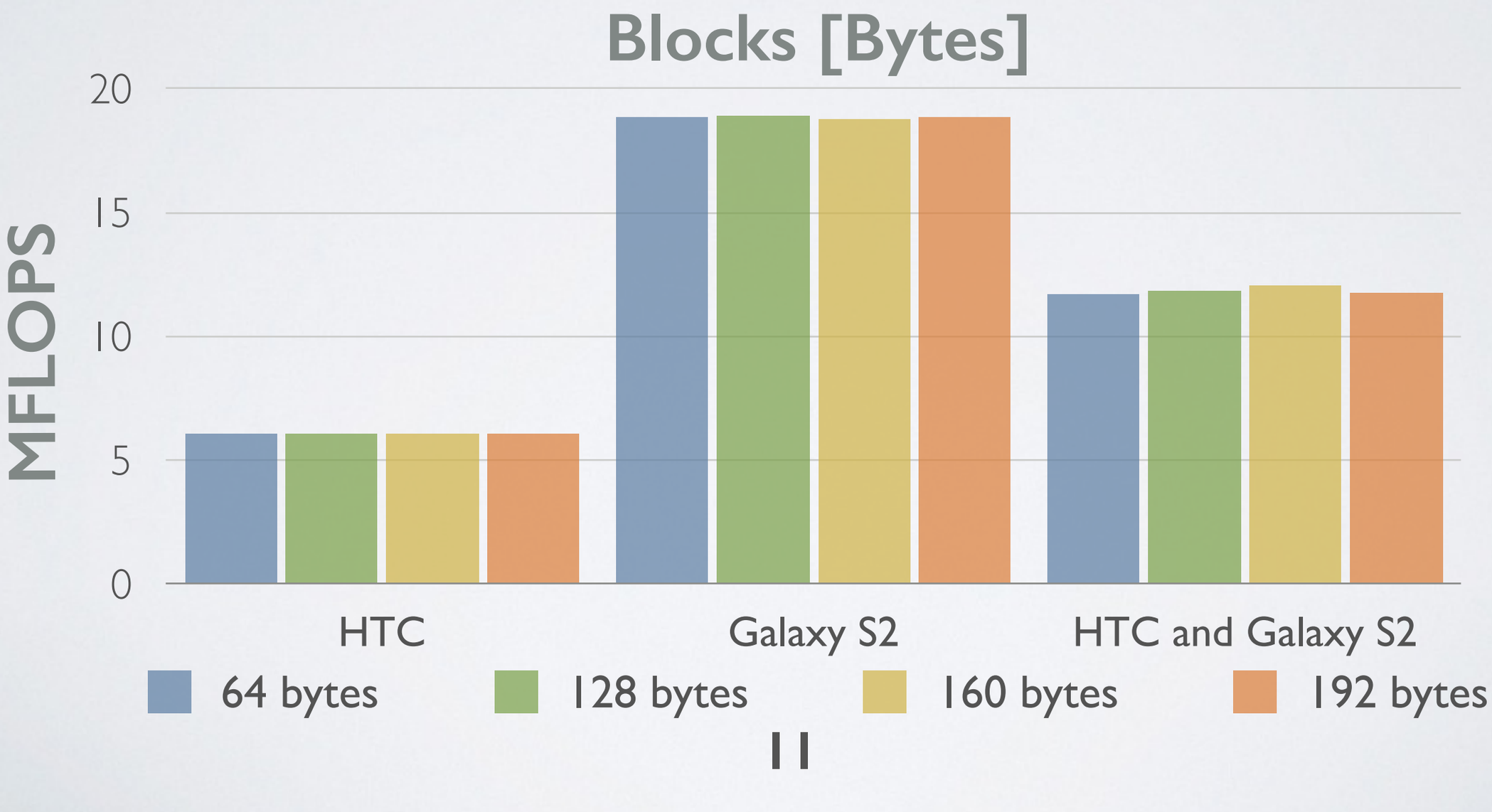
TUNING: MATRIX ORDER



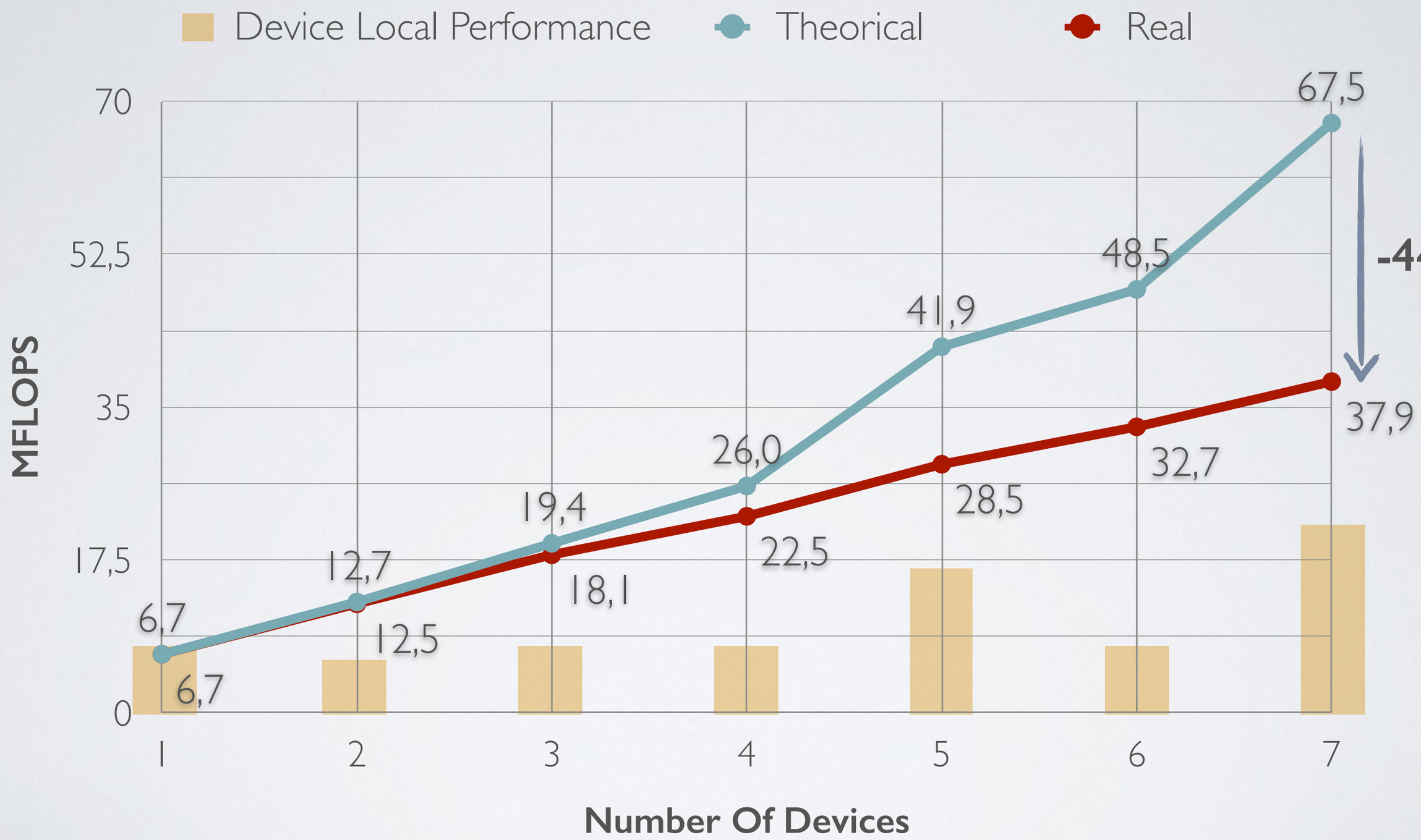
TUNING: BLOCK SIZE

No precise rules, test different measures

Devices return same performance with different sizes

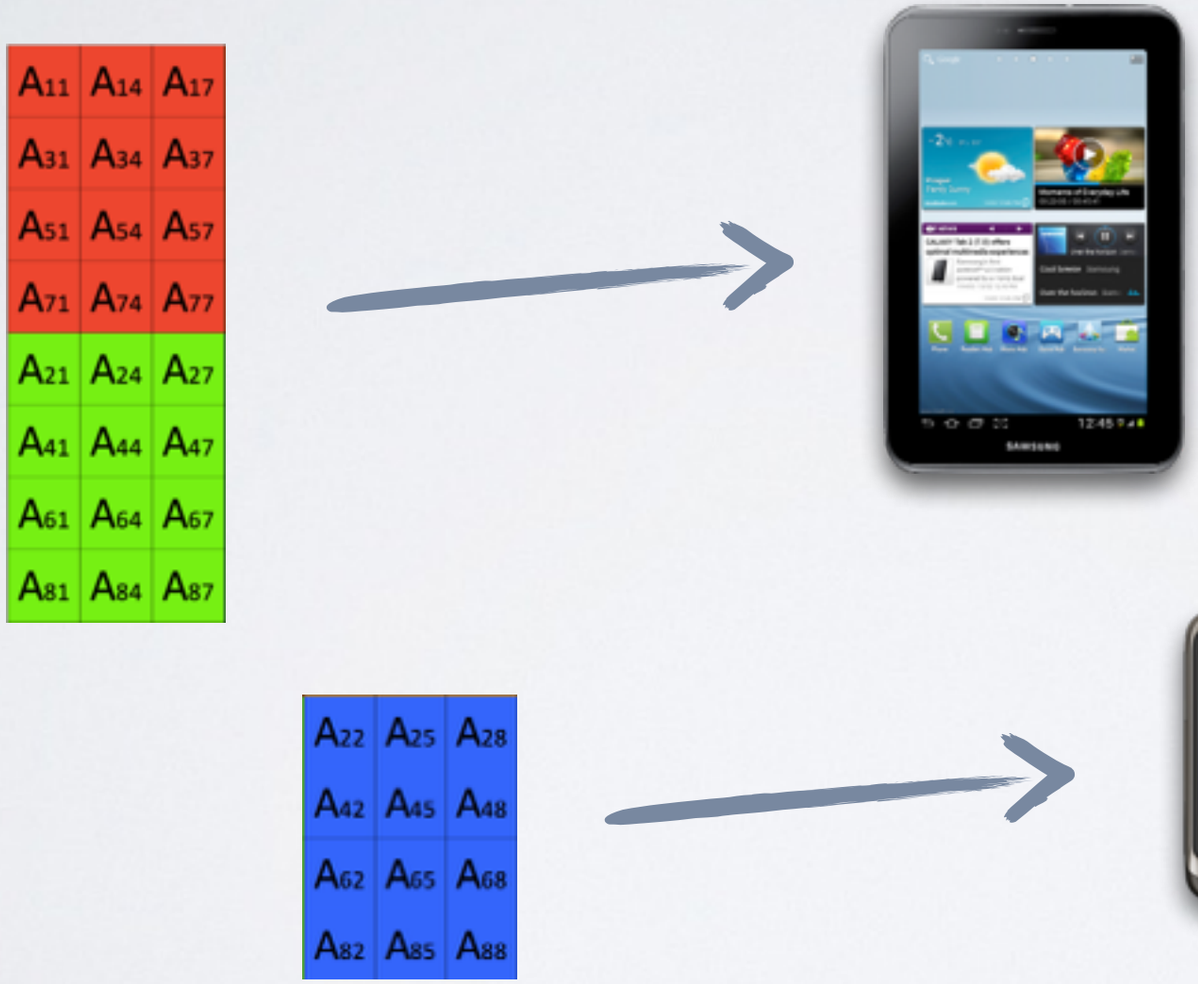


CLUSTER PERFORMANCE

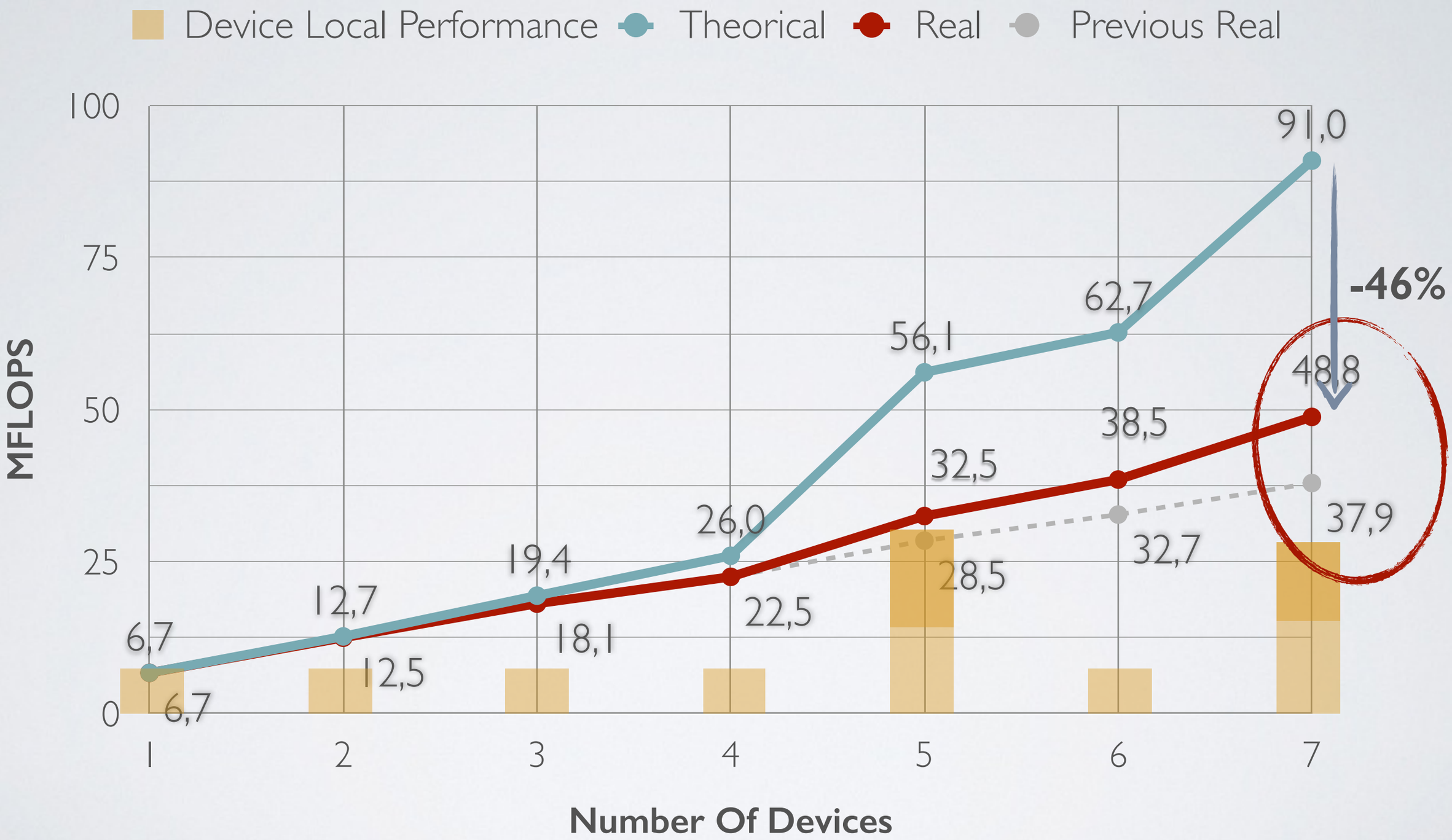


PROCESSES ALLOCATION

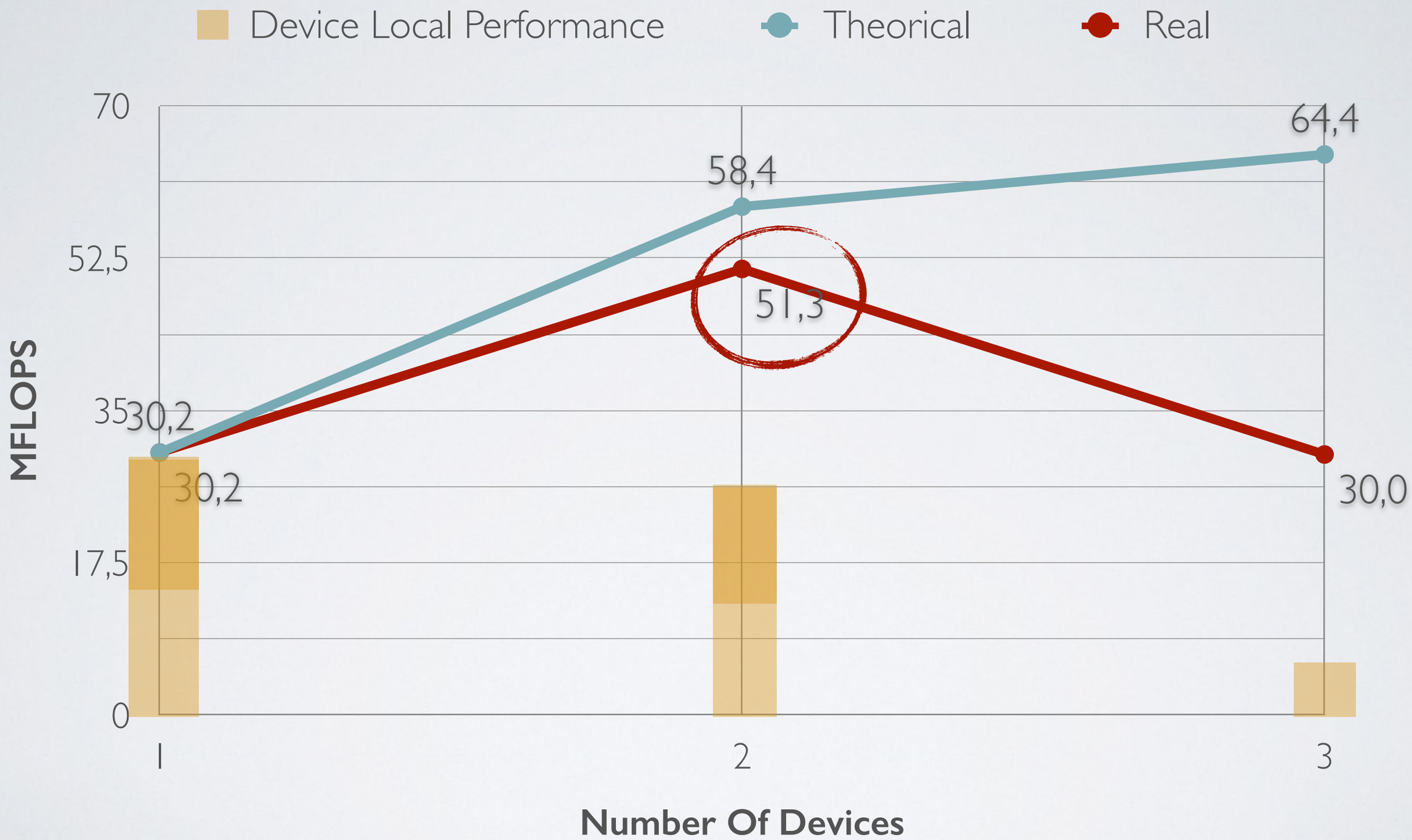
Some devices are more powerful, why not to give them more work to do?



1 PROCESS PER CORE

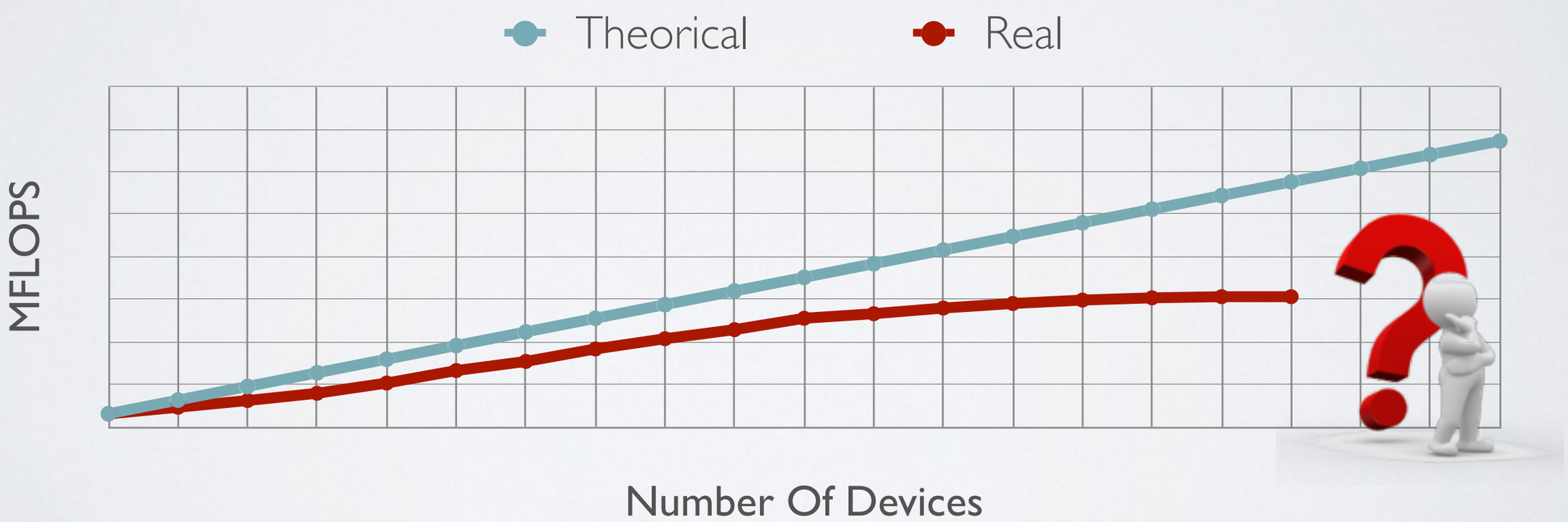


THE BOTTLENECK



FUTURE WORK

What happens with tens / hundreds of devices ?



QUESTIONS ?

REFERENCES

1. digitaltrends.com: Number of mobile phones to exceed world population by 2014

2. Büsching, Schildt, Wolf: "DroidCluster: Towards Smartphone Cluster Computing";2012, Technische Universität Braunschweig

3. J. Dongarra, P. Luszczek, A. Petitet, "The linpack benchmark: Past, present and future." 2003

4. Daniel Loreto, Erik Nordlander, Adam Oliner, "Benchmarking a Large-Scale Heterogeneous Cluster", MIT, 2005

5. netlib.org: /benchmark/hpl/tuning.html