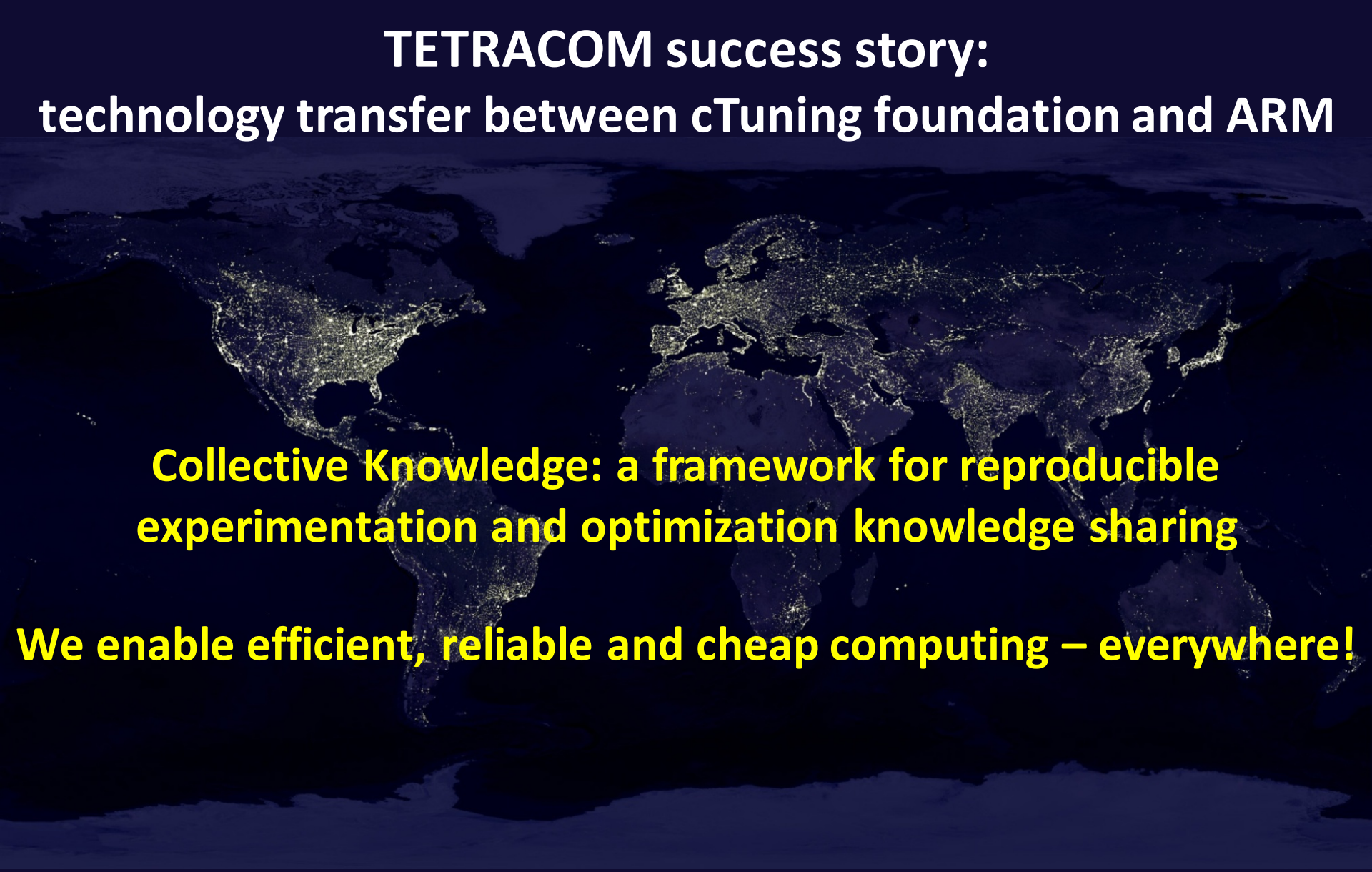
TETRACOM success story: technology transfer between cTuning foundation and ARM



Collective Knowledge: a framework for reproducible experimentation and optimization knowledge sharing

We enable efficient, reliable and cheap computing – everywhere!

Dr. Grigori Fursin
dividiti (UK) / cTuning (France)

cTuning Foundation

ARM®

tetracom

We need cheaper, faster, more energy efficient & more reliable computing!

Computing is critical to innovation & wellbeing everywhere: from tiny computers in "smart things" to supercomputers.

Hence the perpetual need for faster, cheaper, smaller, more energy efficient and reliable computer systems.

Many actors contribute to computer systems

Software developers and service providers

Hardware providers

How to perform a given computation
in the most efficient way given available resources,
user requirements and constraints
(performance, energy, accuracy, network utilization,
resource usage, price, etc)?

Academia

Tool developers

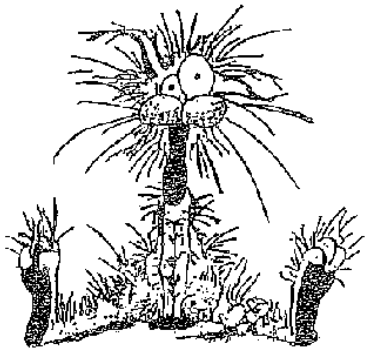
End-users

Problem: ever growing complexity and poor understanding of trade-offs

- ever changing software and hardware ;
- raising number of design and optimization choices ;
- non-representative benchmarks and data sets ;
- highly stochastic behavior ;
- no knowledge sharing and no common experimental methodology

Technological chaos!

OpenBLAS CNN ICC 2015 GCC 4.5.x MVS 2013 Jikes CAFFE
GCC 6.x GCC 5.x GCC 4.1.x ATLAS OpenACC memory size
LLVM 3.x polyhedral
cuDNN frequency LLVM 3.9 hardware execution time transformations Open64
genetic CUDA 7.x function counters perf
ICC 11.1 GCC 4.3.x ICC 12.0 Scalasca
algorithms threads level pass predictive ICC 11.0
LTO SSE4 TAU
big/little ARM v8 reordering scheduling
MPI OpenCL MKL bandwidth GCC 4.4.x GCC 4.6.x
OpenMP cuFFT
cache size LLVM 2.6 PAPI
algorithm precision SimpleScalar OpenCV

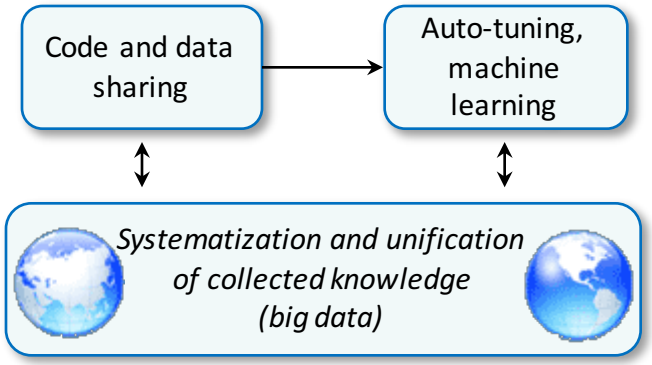


Only **incremental** advances lead to overly-expensive, under-performing and energy-hungry computer systems!

Must stop wasting expensive resources and energy!
It's time to revisit computer engineering!

Our solution: Collective Knowledge framework and repository

cKnowledge.org/repo



Interdisciplinary community

Collective Knowledge, a **disruptive** approach to designing and optimising computer systems in a collaborative way:

Similar to Wikipedia, invites a broad **community** to share representative programs, data sets, tools, predictive models, as **reusable** components.

Allows the community to **crowdsource** and **reproduce** experiments across **diverse** computer systems.

Applies **predictive analytics** (machine learning, data mining) to continuously **grow** knowledge about optimising computer systems.

How did the SAE project TETRACOM help us?

Provided know-how and funding (**€50K**) to the cTuning foundation (non-profit research organization – an outcome of the EU FP6 MILEPOST) to mature the Collective Knowledge (CK) technology, and release it under **a permissive license** (cknowledge.org)

Allowed to validate our approach at ARM, the world-leading supplier of microprocessor technology (arm.com) :

- ✓ CK provided valuable insights into performance of ARM products in a fraction of time required by conventional analysis...
- ✓ ...which demonstrated the potential of CK to spur the design of next generation, high performance and energy efficient systems.

Industrial and academic impact

- ✓ dividiti, a UK startup co-founded by Dr Grigori Fursin (cTuning, ex-INRIA, ex-Intel) and Dr Anton Lokhmotov (ex-ARM).

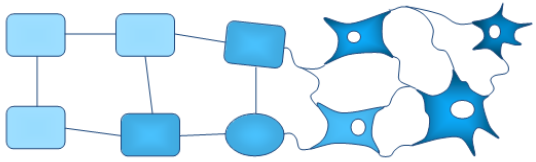
optimizing computing; reinventing computer engineering;
accelerating knowledge discovery;
crusading for reproducible and collaborative R&D
(including w/ ACM SIGs and artifact evaluation)

- ✓ Customers already include a cloud company and a car manufacturer on the Fortune 50 list.
- ✓ 2016 estimates: revenue of €300K; headcount of 4.
- ✓ 2017+ year-over-year growth: 4x revenue; 2x headcount.
- ✓ Customer savings: €1-10M in 2 yrs; €10-100M+ in 5 yrs.
- ✓ 2..3x faster time to market for new products

$$\frac{d\vec{v}}{dt}$$

Acknowledgments and suggestions

TETRACOM (FP7)
HiPEAC
CARP (FP7)
MILEPOST (FP6)



cTuning
Foundation

Provide extra funding (6-12 months) to help create startups after successful TTP or EU projects?

Discussion?

Any comments and questions?
Please get in touch!

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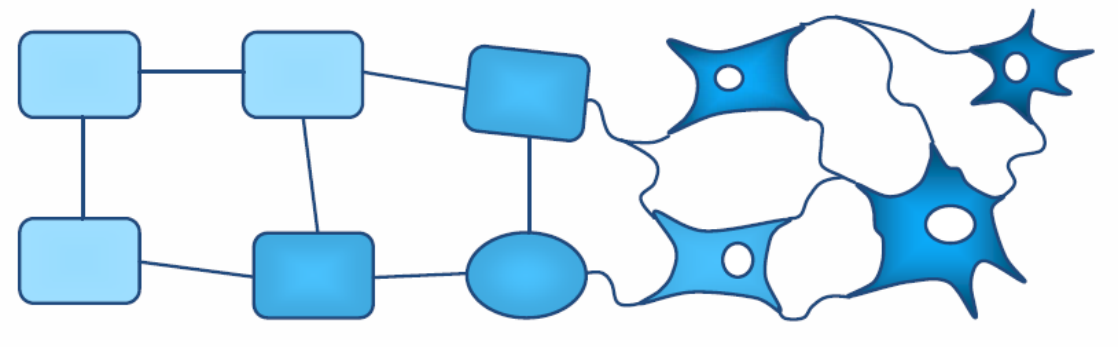

Further info:

dividiti.com **cTuning.org** **cKnowledge.org**