# FRESH ideas

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FRESH
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Event Sponsor: Maxeler Technologies

# Why FRESH?

- most conferences
  - major: past achievements
  - minor: future work

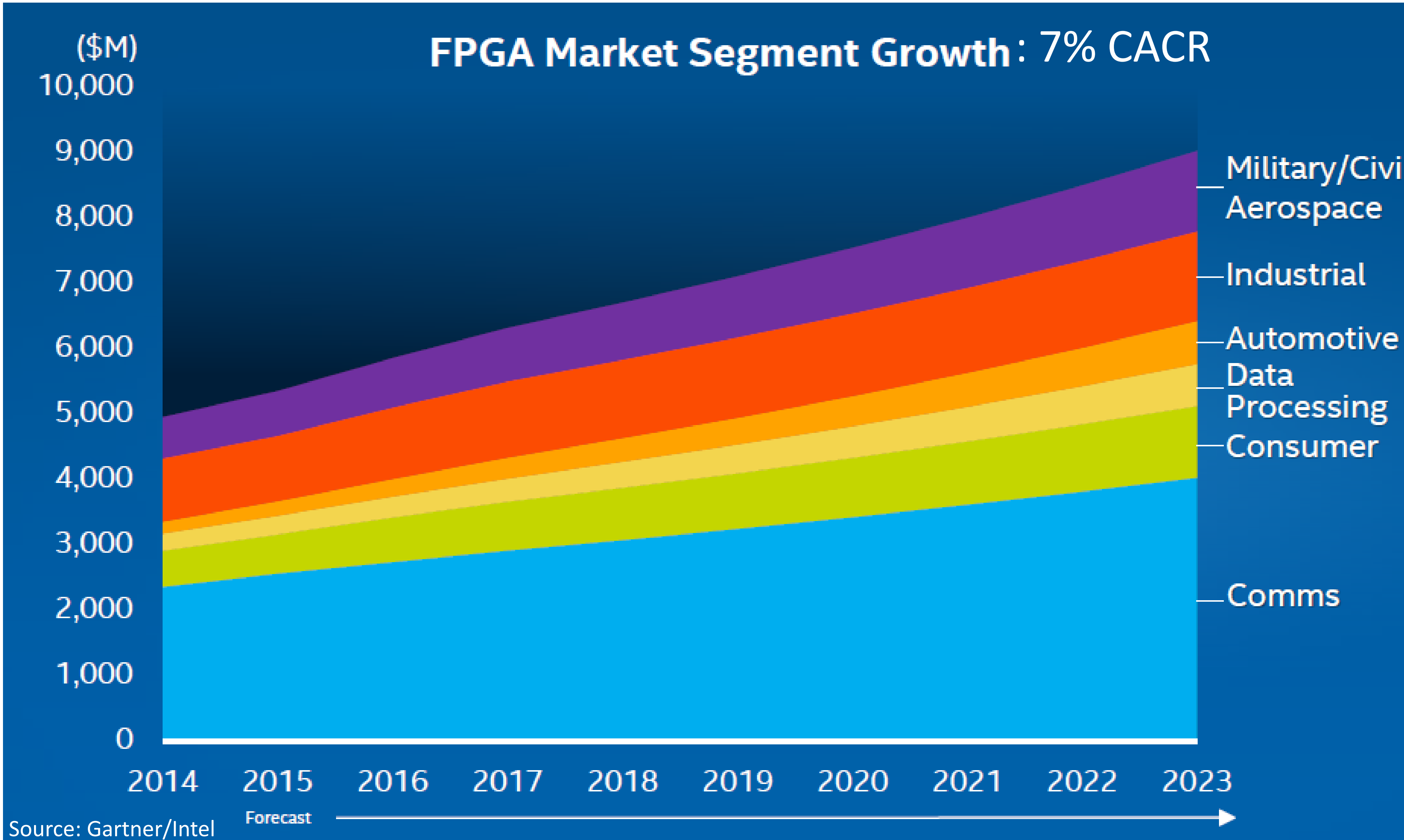
- FRESH
  - minor: past achievements
  - major: future work

- why now?

# Time for FRESH ideas!

- it has been a while
  - Estrin 1960
  - 2015: 25 years of FPL
  - 2017: 25 years of FPGA/FCCM
  - 2016: 30 years of ASAP
- recent industrial developments
  - JP Morgan, CME, Juniper… adopted Maxeler systems
  - Microsoft adopted FPGAs in datacentres
  - Intel bought Altera

# Why Intel bought Altera



# Why Intel bought Altera

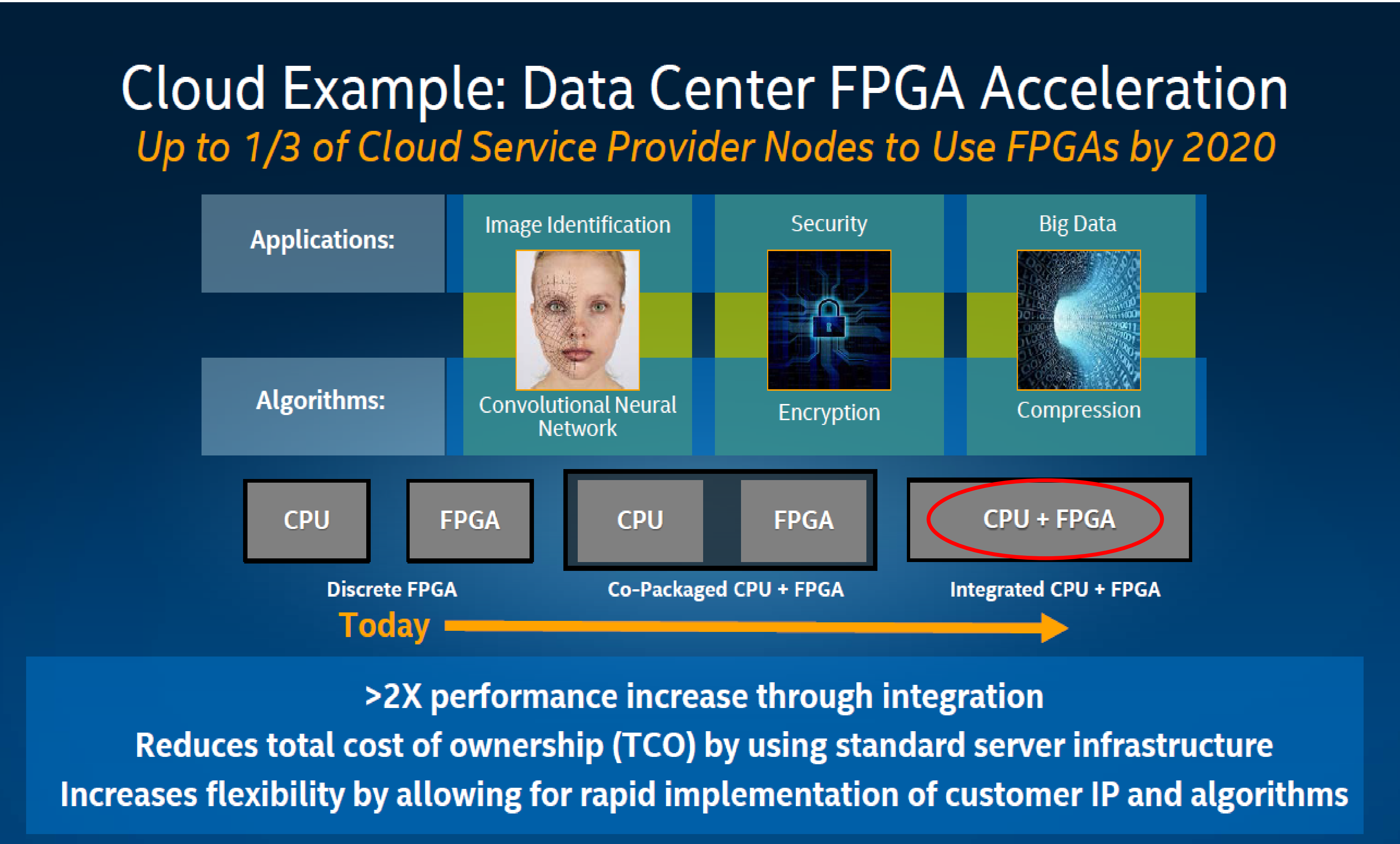
## Strategic Combination Creates Significant Value

| | |
|---|---|
| **Product Synergies** | • Addresses emerging customer workloads in the ~$37B data center logic market segment<br>• New IoT products expected to expand serviceable market by ~$11B<br>• Expected to be ~60% of total value created |
| **Cost & Manufacturing Synergies** | • OpEx reductions which increase over time<br>• Manufacturing leadership which is expected to improve existing Altera product portfolio and market segment share<br>• Expected to be ~40% of total value created |

**Expected to be Accretive to Non-GAAP EPS & Free Cash Flow in the First Year After Close**

Source: Intel estimates

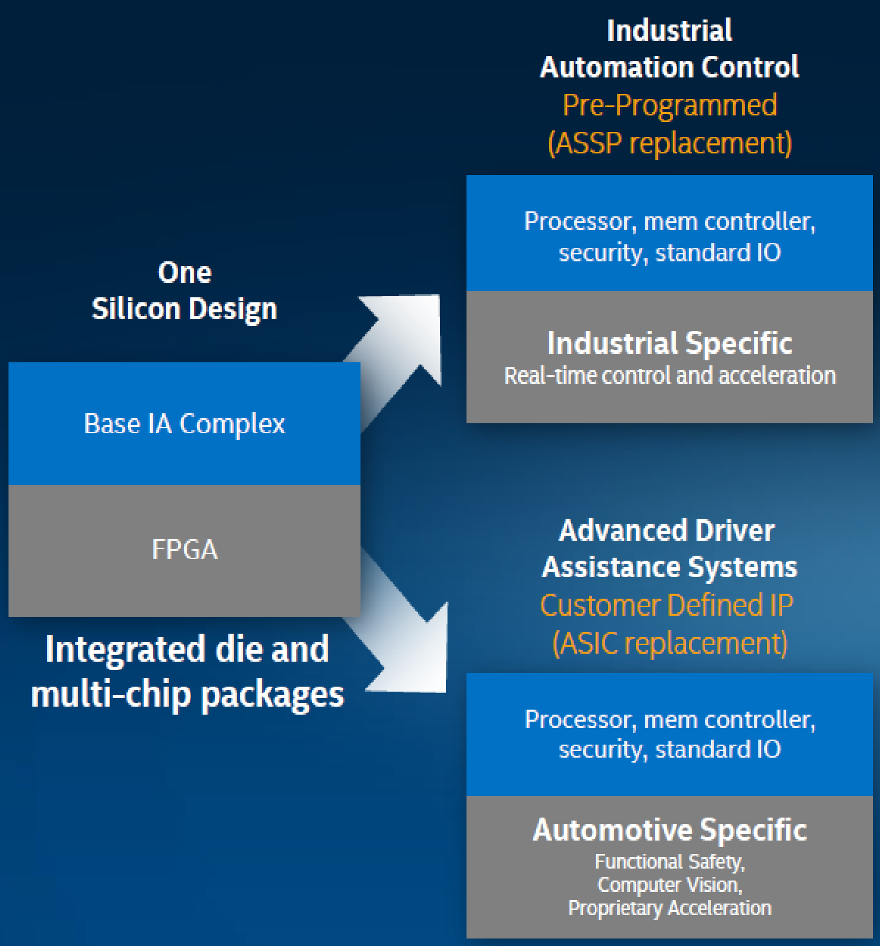
# Why Intel bought Altera




https://gigaom.com/2015/02/23/microsoft-is-building-fast-low-power-neural-networks-with-fpgas/

Source: Intel

# Why Intel bought Altera




## IoT Application Examples

- Integrated solutions accelerate growth in key IoT segments by adding new functionality, improving performance, and lowering cost
- ~$11B incremental SAM by 2020 as integrated FPGAs become cost competitive with ASICs & ASSPs
- Customers can program their own IP, replacing ASICs
- Intel can pre-program industry-specific IP, replacing ASSPs
- Expected to reduce time-to-market by more than 50%

Source: Intel

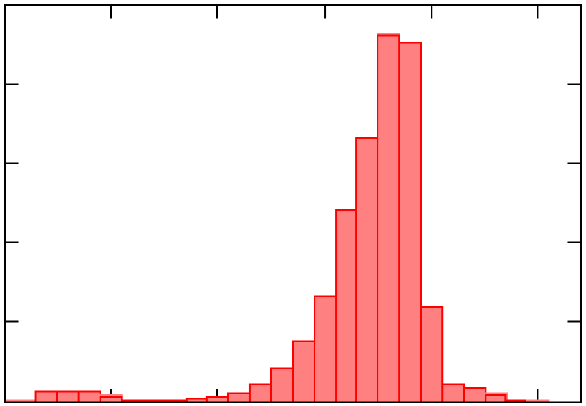
# Why fundamental?

- conventional computing: fit program to processor

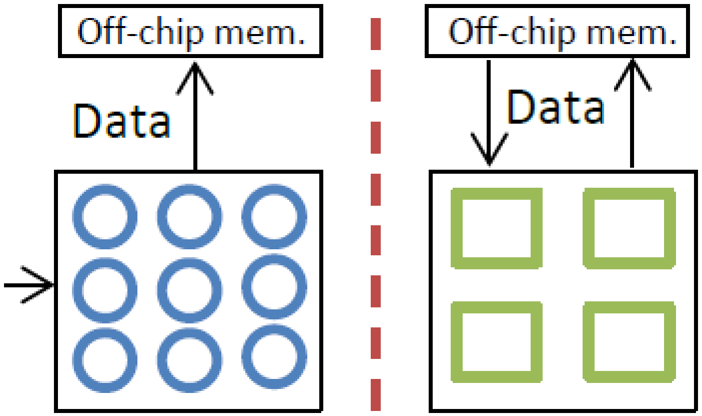

- reconfigurable/custom computing: fit processor to program


- reconfigurable fabric: heterogeneous programmable resources

# Reconfigurable acceleration: examples

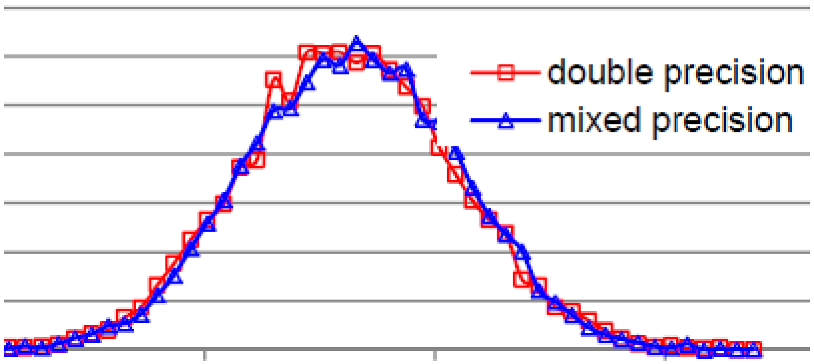


Climate modelling:
13 times faster, 24 times less energy

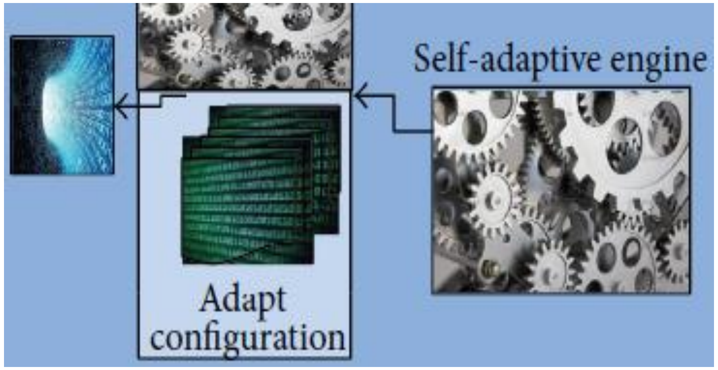



Genomic data analysis:
88 times faster, 3 times less energy

a snapshot of current FPGA vs multicore processor




Financial simulation:
163 times faster, 170 times less energy




Avionics monitoring:
10 times faster

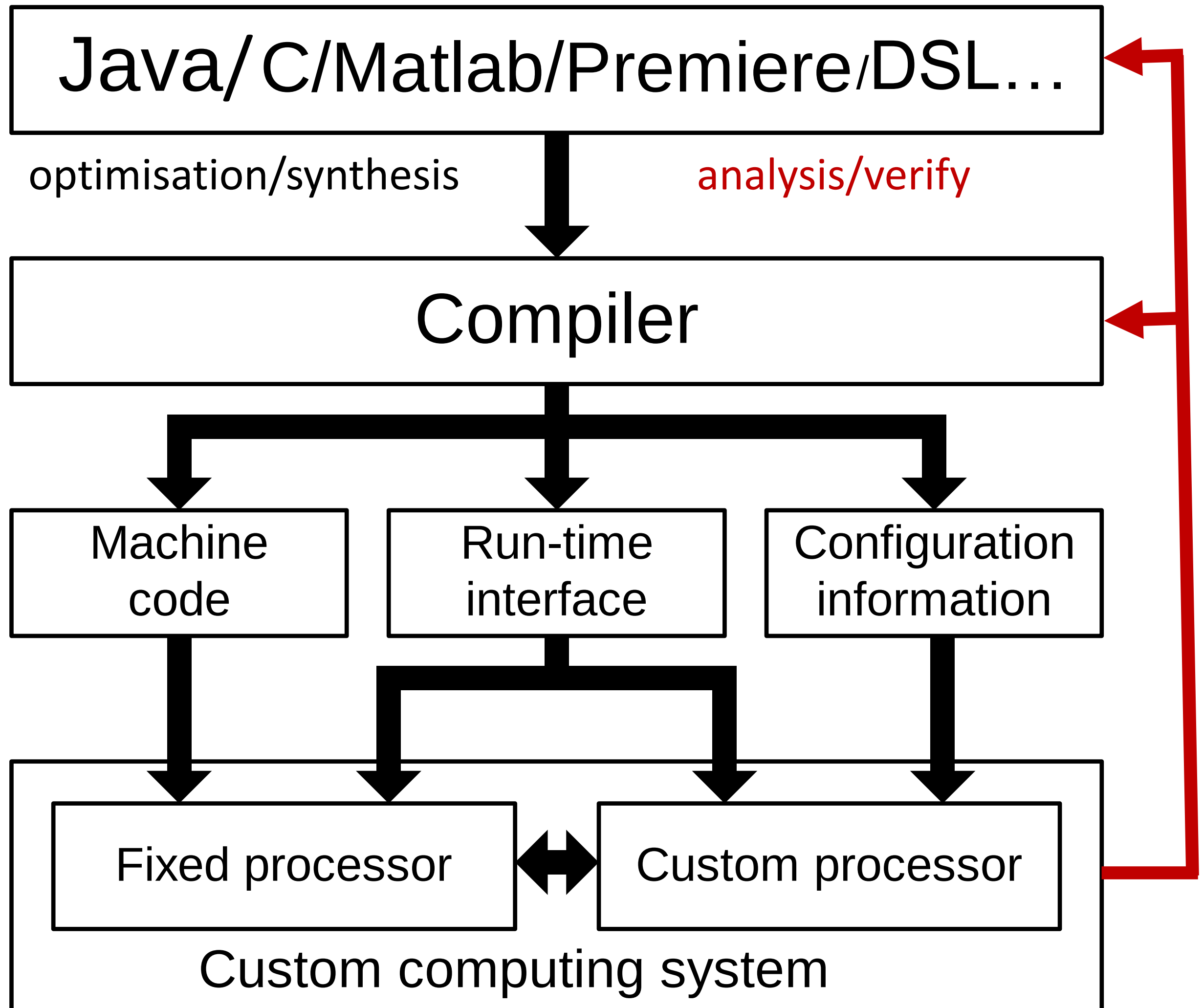
# Vision: customise synthesis + analysis

application description

partition, compile, analysis, verify

system-specific programming interface

system-specific adaptation: clouds to devices



# Future: short term

- accelerators for cloud computing
  - virtualisation + elastic resource model + event-triggering

POETS project

- automate compilation and run-time reconfiguration
  - mixed precision + type/aspect-driven + exa-scale systems

TYTRA project EXTRA project

- reconfigurable fabric: memory + Sys/Net-OC architecture
  - optimised: dynamic data access, heterogeneous resources…
- machine learning and reconfigurable design
  - reconfigurable design accelerates machine learning + vice versa
- self-adaptive design and auto-tuning
  - functional/temporal/statistical assertions, on-line optimisation

# Future: long term

- fundamental, timeless principles
  - models: fabric + systems
  - mapping from high-level: correct + efficient
  - automation: specialisation + generalisation
  - limits: how far away from ideal
- understanding trade-offs
  - automation: quality vs tool runtime/resources/user guide (overlay)
  - speed vs resources vs energy vs accuracy vs security… (privacy, resilience)
  - optimisation: compile-time vs run-time
  - technologies: silicon vs molecular vs quantum vs optic…
- grand challenges for the next industrial revolution?

# FRESH: why here

- most UK research teams on reconfigurable systems
  - industry: Maxeler
  - rest of the world: Toronto
  - audience: Europe + Asia
- research areas
  - cover most areas
  - complementary
  - mutual respect
- opportunity and challenge: cross fertilisation
  - what can we do together?
  - what can we share?

# Discussions

- how to accelerate advances in
  - reconfigurable systems
  - related technologies
- how to promote sharing of resources for
  - research and teaching
  - hardware, software, application data…
- how to improve interactions between
  - universities
  - industry
  - funding agencies

# Next

- The Future of Reconfigurable Systems: an Industrial Perspective
- Overlays: a Solution Paradigm for FPGA High-Level Design?
- Architecture Centric Overlays for Abstraction and Performance
- break
- New Vistas in High Level Synthesis
- FPGA Virtualization for Enabling General Purpose Reconfigurable Computing
- Reconfigurable Market-on-Chip

* lunch

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- FPGA Virtualization for Enabling General Purpose Reconfigurable Computing
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- Heterogeneous Dataflow for Heterogeneous MPSoC FPGA
- Communication as a first class design constraint for reconfigurable systems
- Computing to the Energy and Performance Limits in Heterogeneous CPU-FPGA Devices
- High-Level Programming of FPGAs using Type-Driven Program Transformations and Cost-Modelling

* Break; Discussion + Wrap-Up