



D3.2 Applications Challenges and D4.2 Enabling Technologies (combined) Synthesis Workshop Outcomes

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Change Log

Version	Description of Change
v1.0	Initial release to the European Commission

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1 Executive Summary

Europe's strengths in the area of the processing and analysis of Big Data **do not** cover all of the elements of the Value Chain, which is dominated by players from other regions. Europe could invest in the further development of its current strengths and thus adopt an aggressive 'niche' market strategy, but it is unclear whether this approach will bring the Return on Investment desired due to the position of the competition and their potential response. The other option for Europe is to propose a '**paradigm shift**', which bears more risk but, if executed correctly, would ensure a stable leading position in market segments that are opened by the emerging solutions.

2 Objective

On 18 March 2015¹, an Industry-focused representative group from the RETHINK big Project team carried out a detailed SWOT (Strengths, Weaknesses, Threats and Opportunities) analysis on European competitiveness in the processing and analysis of Big Data over the next 10 years (which is the project's objective). In other words, the team was asked the following question:

What Strengths, Weaknesses, Threats and Opportunities are there for Big Data in the area of Hardware and Networking Europe (with a view toward making the Big Data Value Chain / eco-system more competitive globally)?

2.1 Methodology

The analysis was divided into the 8 areas corresponding to the Working Groups of the project (i.e. 4 Technology areas and 4 Application areas – below):

Enabling Technologies

- Conventional and Unconventional Hardware Architectures, Process Technology
- Distributed Architectures, Devices and Sensors, Memory and Storage Systems
- Networks
- Frameworks, Software Models, Algorithms and Data Structures, Visualization

Applications

- Fundamental Sciences and Engineering Applications
- Business, Finance and Information Marketplaces
- Life Sciences
- Future Internet and Social Networking

The process applied was based on the Language Processing method developed by the Center for Quality Management (U.S.), www.cqm.org. In the first round of the exercise, the participants were required to contribute low-level, detailed examples and facts as either Strengths, Weaknesses, Opportunities or Threats, which then were

¹ Note that the RETHINK Project held an initial Synthesis Meeting on 11 December 2014 during which an initial SWOT was performed. The outcomes largely mirror the results of the meeting on 18 March; however, the meeting struggled to uncover a sufficient number of Opportunities due to Industry under-representation. Hence, the team agreed to hold a follow-up meeting.

grouped according to their similarity in order to arrive at high-level Strengths, Weaknesses, Opportunities or Threats. The core elements of the strategy (i.e. Critical Success Factors) to be adopted combine those Strengths that may help take advantage of an Opportunity, or those Weaknesses where the ecosystem's position may be Threatened by the competition.

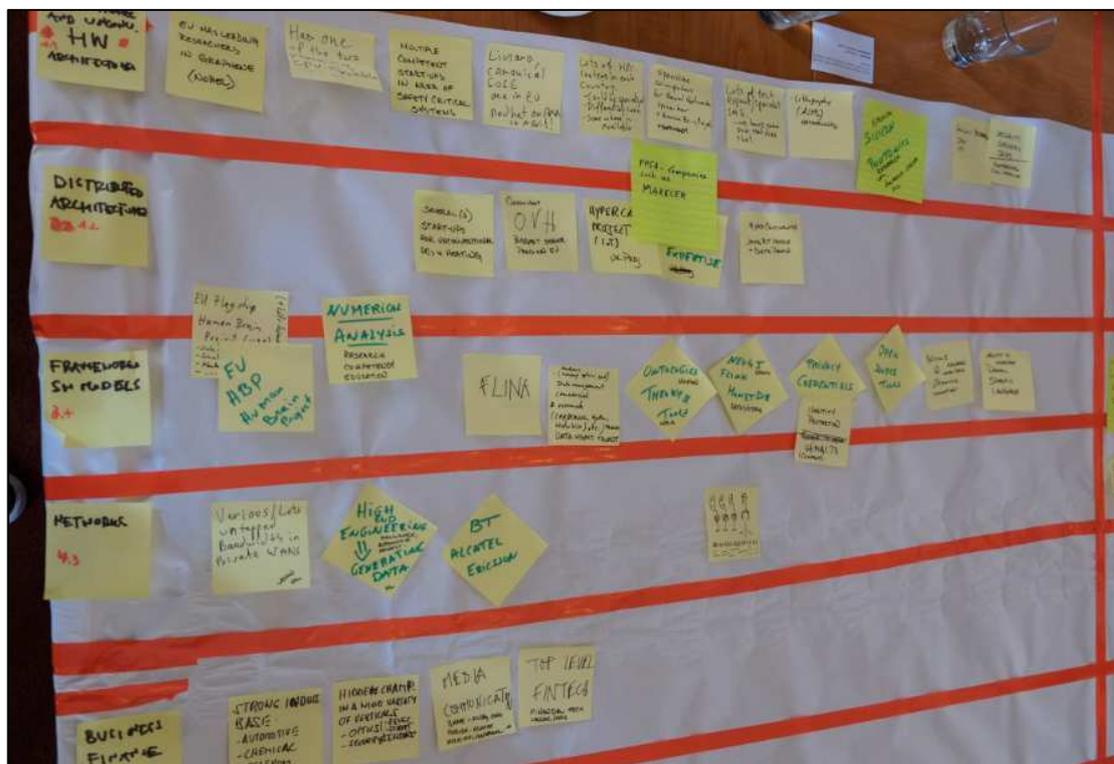


Figure 1 - Part of the SWOT analysis as developed during the first phase of the Workshop (the picture shows Strengths divided into various areas)

3 High Level Conclusions

The objective of this document is not to provide the details of the contributions made during the Workshop. Instead, we will focus on the high level conclusions. As some of the first level groupings span multiple project areas, the following SWOT components are not categorized according to the project areas (although the first contributions were made according to them).

3.1 Strengths

Europe has the following **Strengths**, which can be deployed to utilize the Opportunities offered by this environment:

- **Research and Scientific Competence and Expertise in key technological areas** – European researchers excel in important technological areas such as Silicon Photonics, Sensors, Real-time critical systems, Lithography, Security, Specialized hardware architecture design, Open Source Software, Ontologies, Numerical Analysis, Domain-Specific Languages.
- **Vertical market leadership** - Europe maintains leadership in select vertical markets such as the Optics and Security Sensors industries.

- **One of the two leading CPU architectures is European**, which can serve as a basis for developing novel and radical solutions, without reliance on other regions
- **European industrial leaders** – There are companies in Europe (e.g. multiple telecommunications, automotive and chemical companies) who, due to their size and competitive position, could lead in certain market segments in data processing and analytics due to their accumulated expertise and critical mass of resources.
- **Big ‘Media and Entertainment Players’** – Some of the leading media companies are European (e.g. Spotify, Ubisoft, Rovio, Vivendi and King); these companies are sophisticated and demanding consumers of advanced technology.
- **Flourishing Start-Up and SME Culture** – While major parts of the Value Chain might be dominated by other regions, Europe has some start-ups or successful SMEs in all areas of the Value Chain.
- **Top-level Fin-tech** – Financial technology sector investment is growing faster than general venture capital with the fastest growth in European companies.
- **European ‘Big Science’** – Europe is home to some of the world’s largest and best research infrastructures and project, e.g. ITER, HPC Centers and PRACE, SKA, EBI, Human Brain Project. The knowledge accumulated within those organizations and projects can help develop competitive solutions.
- **Excellent support infrastructure** – In general, Europe has the necessary infrastructure, including fiber and electricity provisioning for the Datacenter in and across European cities.

3.2 Opportunities

The Strengths above should be deployed in order to develop solutions as a response to the Opportunities present in the Eco-system. The following Opportunities have been identified bases on detailed input submitted by end-users. What follows is a high level summary of those:

- Disruptive and non-Von Neumann computing architectures could change the configuration of industry.
 - Approximate, probabilistic, neuromorphic, optical and quantum computing architectures could be an opportunity for new champions to emerge and overtake current global industry leaders.
- The European predilection toward strong privacy protections in addition to security of data and services could drive “killer” security technologies.
 - The need for security in untrusting / untrusted world is growing beyond Europe.
 - Lack of data provenance and security techniques is essential for the larger economic transformation of data value chains.

- The need for standardization and interoperability is an opportunity to influence industry development
 - Lack of tools for data wrangling / taming / herding
 - Need for standardizes data format transfer standardization
 - Need for definitions for standards/protocols/solutions for Industry 4.0 and IoT (Internet of Things)
- There is a need for new algorithms and for smart abstractions
 - Lack of Big Data specific algorithms
 - Lack of efficient data sharing techniques
 - No algorithmic solution to the global store v. partitioned address space problem
- I/O communication between systems is becoming the new challenge for large scale applications.
 - I/O is a bottleneck at the chip, system, data center (node) and multiple data center level
 - Lack of network awareness
 - Need for interface technology for communication
- We do not yet know what life after Moore's Law will look like, but we have the chance to shape it.
 - Lack of energy proportionality
 - Need for techniques for efficient ingress of data
- The complexity of new systems will require smart runtimes in order to use resources in the most efficient manner possible.
 - Need for application specific architectures
 - Need for smart software frameworks
- The current trend of one-size-fits-all architecture solutions cannot be sustained. There is an opportunity to better balance hardware architecture form versus software function.
 - Current software / hardware abstractions are inefficient
 - Fitting generalized solutions to specific problems doesn't work
 - It is difficult to engineer 'forward' compatibility
 - We do not yet develop solutions across technology silos (e.g. Non-volatile HDD + processor solutions)
- Europe's current embedded and sensor industry advantages provide a strong start toward leadership in emerging IoT-related markets.
 - Data set filtering techniques
 - Smart Software networks
 - Improved edge computing at both system and network level

3.3 Weaknesses

The following Weaknesses characterize the European Eco-system:

- **Lack of control over major parts of the industrial Value Chain**

- Lack of SOC design implementation (it is done outside of Europe)
- Lack of silicon manufacturers
- **Lack of strategic focus**
 - Increasing asymmetry of data between EU and other actors is not seen as a major threat (but it should be seen as a threat)
 - Few European players can see beyond immediate product / service delivery revenue streams; they do not have a global vision that takes into consideration the end-to-end technology.
 - European players do not see disruptive technology drivers as a strategic asset for the future.
 - There is a general lack of platform solution building
 - There is also a lack planning for future revenue streams in terms of business model (e.g. i-Tunes, NetFlix)
- Lack of large project budgets (unlike in better integrated economies)
- Lack of experience with the needs of large-scale organizations (due to the small number of large pan-European organizations)

3.4 Threats

The external environment affects Europe's position in the following way:

- **Other regions dominate the major parts of the Value Chain.**
 - Lack of control of chip manufacturing
- Brain drain from Europe to other regions
- Lack of venture capital to compete with U.S. funding
- Exodus of most successful SMEs to U.S. and beyond
- Project and research funding schemes of other regions are better able to support larger and / or long-term projects
- Europe maintains higher labor costs in certain manufacturing bases
- Not enough of a concentration of large organizations that can drive hardware business needs and not enough interest from remaining large organizations.
- Foreign trade barriers impede European development

4 Critical Success Factors (CSF)

The following key conclusions appear at the intersections of the key Strengths (S) and Opportunities (O) as well as Weaknesses (W) and Threats (T):

1. **CSF – WT (Defensive): Change the dominant position of other regions in the major areas of the Value Chain by developing own solutions.**
2. **CSF – SO (Aggressive): Use the skills in the areas (still) in Europe's control to address the growing opportunities generate by end-user needs**
3. **CSF – SO/WT (Cautious): Target niche use markets but without gaining control over parts of the Value Chain**

5 Conclusions

The three strategies bear different levels of Risk and are able to generate different levels of Return on Investment (ROI).

CSF	Risk	ROI
1	High – Achieving a dominant position is unlikely	Low – Huge investment is needed
2	High – Changing paradigm bears a lot of uncertainty	High – Potential revenues are high
3	High – The competitions will respond and close off those opportunities	Low – We do not have a critical mass of skills to generate enough revenue

Conclusion: The Strategy that most likely to be successful is:

- 2. CSF – SO (Aggressive): Use the skills in the areas (still) in Europe’s control to address the growing opportunities generate by end-user needs**

This strategy should be based on a paradigm shift, i.e. changing the way of thinking (e.g. shift in overall compute paradigm) starting with the area of Big Data. . This will be developed further in the Roadmap.