

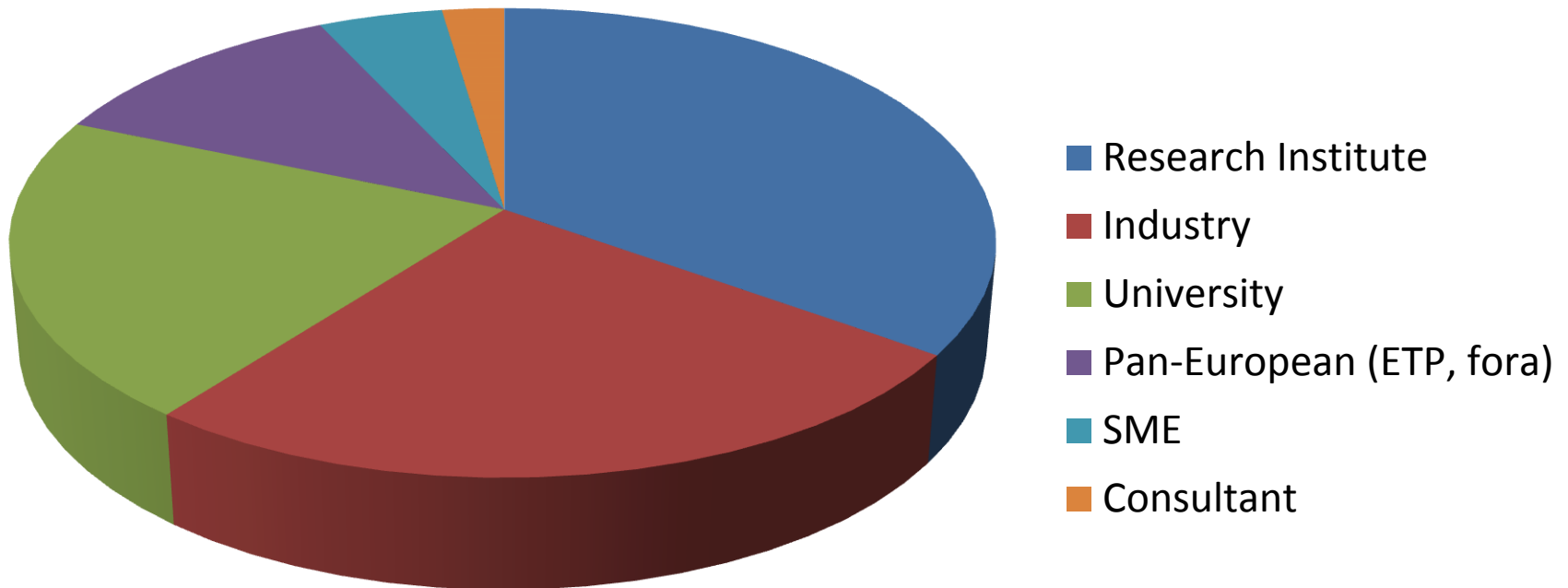
# Report on the public consultation for H2020 work programme 2014-15: Cloud Computing, Software and Services

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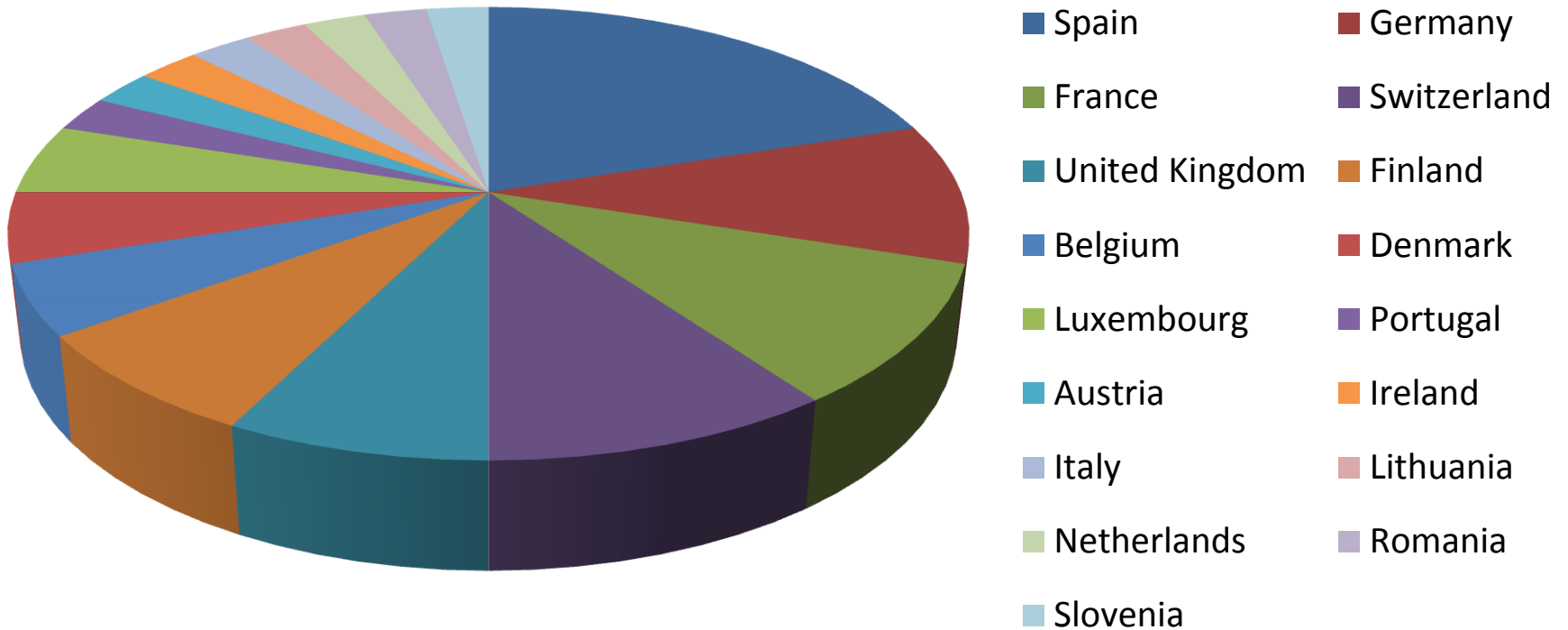
# Consultation process

- Consultation on research priorities in the Cloud Computing, Software and Services sector for H2020
- Consultation process opened early 2013
  - EC discussion document based on research priorities defined by:
    - ISTAG, July 2012
    - Cloud Computing Expert Group, December 2012
    - NESSI ETP position papers
    - Cloud Select Industry Group
  - Open invitation for input from interested sector actors/stakeholders (industry, academia, research institutes, SMEs, user communities...)
  - 43 written contributions
  - Post-consultation workshop held on 17 April 2013

# Contributions by organisation type



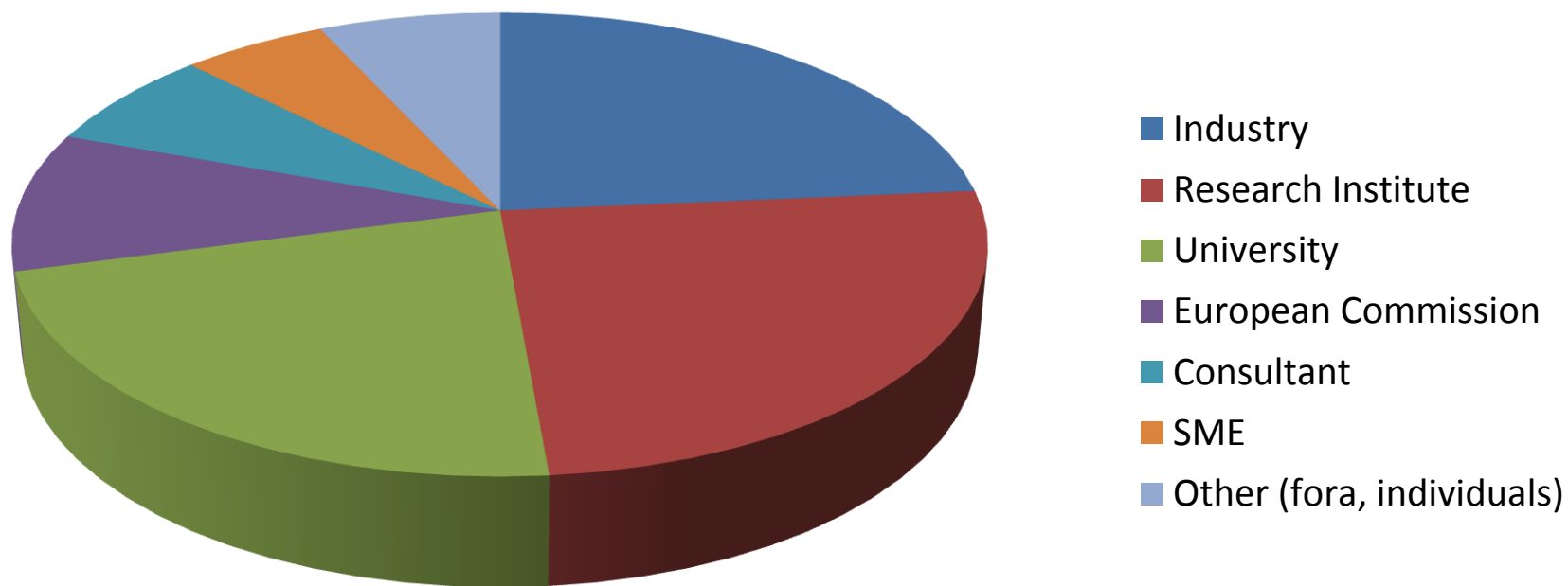
# Contributions by country



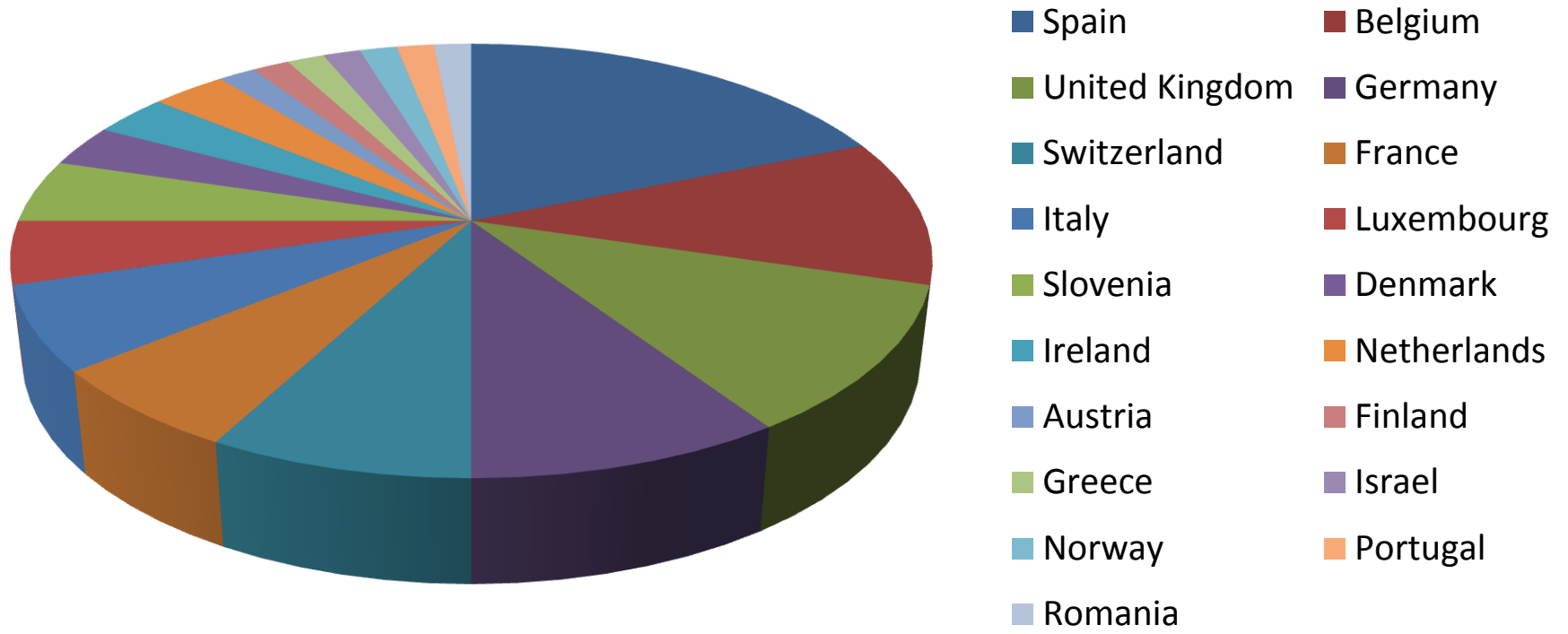
# Post-consultation workshop

- 26 contributions selected for presentation and discussion:
  - General Research Challenges in Cloud Infrastructures and Services (6 presentations)
  - Software Engineering Tools and Methods (7 presentations)
  - Cloud Architectures, Interoperability and Usability (6 presentations)
  - Cloud Networks, Localisation and Performance Issues (5 presentations)
  - Security and Trust in Cloud Computing (2 presentations)
- 72 participants

# Workshop participants (by organisation type)



# External workshop participants (by country)



# Topics emerging from consultation

- Increased cloud performance (scalability, reliability, latency, etc.)
  - In general and for challenging new applications for big data
  - Performance for data uploaded/downloaded from the cloud
- Increase cloud networking performance
  - Including use of SDN for greater control of inter-data-centre networking
- Quality/performance monitoring and independent performance verification
- Decentralised (and infrastructure-less) clouds
  - Processing capabilities and data positioned closer to users
  - Migration of servers to follow mobile users
- Access to advanced resources/specialised hardware, including GPUs, sensors, etc.



# Topics emerging from consultation (II)

- Hybrid private/public clouds
  - EC should foster hybrid clouds, promote federated private clouds, expand public research and scientific clouds
- Management/monitoring of large scale DCs/clouds (millions of CPUs)
- Improved interworking/interoperability/openness for services, apps and data
  - Standards, measurement metrics, migration techniques to avoid lock-in
- Dynamic configuration/automated provisioning/orchestration
  - Considering performance targets/constraints
  - Offloading from clients/hosts to cloud
    - At design and run time
    - Including mobile users/apps

# Topics emerging from consultation (III)

- Reduced energy footprint
- Data-intensive cloud-based applications
  - Considering data migration issues and avoiding lock-in
- Increase confidence/trust and security for private and sensitive data
  - Counter-espionage methods
  - Formal methods to improve trust/security
  - Measurable/auditable security metrics
  - Simple to understand metrics
- Common SLAs, with agreed terms
- New (and/or efficient/integrated) value chains/ecosystems/business models for cloud-based software and systems
  - Including new programming and licensing models

# Topics emerging from consultation (IV)

- Software complexity issues
  - Use of composition to avoid building large and complex systems
- Data-driven software, abstractions for distributed data management/sharing, better integration between software development and data management
- Software tools:
  - For cloud and data-centric programming models
  - To simulate and test data-driven software/services
  - UI testing in heterogeneous/federated environments

# Topics emerging from consultation (V)

- Software architectures for cloud-computing
- Architectures are more important than tools
- Software scalability
  - Currently limited to certain software architectures (load balancer and N instances)
  - Instance placement/localisation issues (close to users for example)
- Improved software lifecycle and management of change
  - Change/flexibility at the heart of software
  - Evolution to be planned/built in
  - Narrower line between development and maintenance
- Software for critical systems
  - Secure, commercially-sensitive, etc.
  - High reliability software under evolution/change

# Topics emerging from consultation (VI)

- More applications deployed in the cloud
  - Tools for migration of legacy software
  - Modernisation of legacy, especially large software systems for public infrastructures and large corporations
- New services supporting a rapidly changing business world
  - B2B and not just end-user apps/social networks
  - Support real business services and involve all stakeholders, including SMEs
  - Involve application-domain stakeholders (from infrastructure to software/services)
- Less emphasis on infrastructure-research, more on software and services in the cloud
- Involve and encourage cloud-orientated ecosystems

# Discussion topics (I)

- Infrastructure, services, clouds are a reality now
  - Private, managed and public clouds currently offered commercially
  - Don't underestimate the amount of industry investment in this sector
- Need to leapfrog, need new challenges
- Need more challenging research objectives
  - E.g. real-time data stream management, algorithms for machine learning, real-time presentation of data to end users
  - More ideas are sought
  - To be explicitly mentioned in the workprogramme text?

# Discussion topics (II)

- Need less ambition and a more realistic approach otherwise we spent too much on new technology and the market will have moved on
- SaaS is where money is – shift from infrastructure research to more commercially-focussed application-centric topics
- Support for new business opportunities...
  - Rapid/agile development lifecycle (3 months) is incompatible with research funding cycle
  - Lots of support for alternative instruments to assist rapid application and service development and commercial roll-out
  - Cloud computing is a tool to serve other areas – If we are not making products, what will be the legacy of the research?

# Discussion topics (III)

- Are SLAs and performance metric definitions a suitable topic for research projects or is this the role of standards?
- Open source
  - Some controversy...
  - Open source can increase trust
  - Model for collaborative development but how can EU instruments contribute or dent current initiatives?
  - Use open source and standards to commoditise areas where EU is behind, to allow innovation on top
- Security challenges:
  - Data outside of host organisations
  - Cloud storage proves resilience for data back-ups, etc. but potentially makes confidential data more accessible
  - Trust is the main issue preventing more widespread adoption of cloud-based applications (for banks, etc.)



# Possible re-emphasis of objectives (I)

- Objective 3: Advanced Cloud Infrastructures and Services, including innovation oriented initiatives
  - High performance heterogeneous cloud infrastructures
    - More emphasis on high performance and QoS, heterogeneity, large quantities of data, dynamic environments, SLAs/monitoring
  - Federated cloud networking
    - Openness/interoperability for interworking and migration, hybrid public-private clouds, distributed clouds, software-defined DC and cloud networking to improve performance
  - Cloud security
    - Increased trust and security transparency, security metrics and auditing, overcome issues of sensitive data in 3<sup>rd</sup> party resources
  - Automated service composition
    - More emphasis on heterogeneity and distributed environments, include performance concerns, offloading of client/host processing to the cloud (incl. mobile), support realistic business process/applications
  - “Mobile Cloud service development environments” could be dropped as a separate sub-objective
    - Little support from consultation, mobility to be mentioned in other sub-objectives

# Possible re-emphasis of objectives (II)

- Objective 4: Innovative tools and methods for software development
  - Tools and methods for complex software and data-intensive systems
    - Increased robustness/reliability in software development lifecycle, critical systems, closer link between development and maintenance, composition as a means to manage complexity, management of emergent complexity, data-driven software (architectures and data abstractions)
  - Software architectures and methods for system deployment in distributed environments
    - Possible new sub-objective to reflect emphasis on software for clouds rather than software in general
    - Architectures for scalability/elasticity, adapting to hardware resources in heterogeneous environments, managing data locality in distributed elastic systems, migration of legacy software to cloud infrastructures, open abstractions/schemas for large-scale data-driven cloud-based systems
  - Flexible and scalable tools for collaborative software development
    - Little support from consultation
    - Explicit mention of *open source* raised some controversy in discussions
  - Identity of stand-alone objective on software is an issue