DEDISYS

Scope

Distributed systems are at the core of the information society, ranging from everyday's applications such as banking or health care to highly specialised systems used in automation, transportation, and air traffic control. The key element for achieving scalable and maintainable distributed software systems is **balanced dependability**, because systems might otherwise become brittle, vulnerable, and uncontrollable at the end. Dedisys provides concepts for balanced dependability for two classes of distributed systems: Traditional data-centric information systems and emerging service-oriented systems such as Web service based Grid systems or peer-to-peer systems.

Advances

The mismatch between increasing demand for dependability on one hand and a degradation of dependability caused by complexity, scale, and dynamics has recently been coined as the "dependability gap". Dedisys advances the state of the art by providing means to **support dependability** while maintaining scalability and mastering complexity. Moreover, Dedisys enables the partial re-design of running software, in order to adapt to changes.

Positioning in global context

The mismatch between increasing demand for dependability on one hand and a degradation of dependability caused by complexity, scale, and dynamics on the other hand has recently been termed by Laprie as the "dependability gap". Dependability is not independent from other system properties and a **welldefined balancing** of dependability with other nonfunctional requirements is required. While generic approaches can never provide optimal solutions, the "end-to-end" argument (i.e. let the application do the work) is not appropriate either, as most of the infrastructure tasks are very similar throughout a wide range of applications. The **Dedisys** project consequently made its major research contributions on balancing dependability in distributed software systems via run-time **cooperation between middleware and application** (or end user).

The achievements contribute to the state of the art of several research communities: Dependable systems, distributed systems and middleware, software engineering, as well as service-oriented and peer to peer systems, as proven by a number of high-quality publications. Overall, **two major contributions** have been identified: First, the explicit run-time representation, management, and negotiation of integrity constraints or capabilities. Second, adaptive replication protocols and dependable discovery services. This will help to overcome the common industry practices either of first building the system and deriving the non-functional properties only ex-ante or of massive over-provisioning of the system architecture to assure the non-functional properties (especially dependability) in all situations. Consequently, the outcome of Dedisys can help to **efficiently and effectively** design distributed systems with particular **dependability** requirements **without surprise or massive overprovisioning**, leading to increased dependability at lower cost for design and implementation.

Contribution to standardization and interoperability issues

Dedisys has not contributed to any formal standardization process. However, Dedisys has contributed to interoperability issues as one of the major findings was that the differences between the distributed component technologies (CORBA, .NET, EJB) are not as significant as expected with respect to dependability requirements. This is important for software engineers, as it allows for technology selection based on other (perhaps non-technical) criteria.

Target users / sectors in business and society

The following sectors will benefit from increased dependability:

- Air traffic control and public safety
- Control systems in experimental physics
- Grid and scientific computing
- Health care
- Fleet management systems for road traffic, trucks, emergency vehicles

Overall benefits for business and society

Primarily, software engineers can benefit from the results of Dedisys: The overall Dedisys framework to be delivered to **software engineers** (developers, integrators, etc.), comprise a system architecture, adaptive replication protocols, required platform services to build upon, and methods for run-time configuration of adaptive dependability. This framework has the potential to **significantly ease building complex dependable distributed systems** in combination with well-established or innovative software engineering techniques such as aspect-oriented programming (AOP), model driven architecture (MDA), component-based software engineering (CBSE), and service engineering. This will, in turn, reduce development, maintenance and opportunity cost of 24*7 applications and services.

Examples of use

Dedisys already has significant impact on the existing product families of the industrial partners. For instance,

Cosylab introduced core Dedisys concepts into their EPICS Directory Service and the Advanced Control System frameworks. Dedisys concepts are likely to play integral parts in Frequentis' information systems for safety critical decision support and control systems as well as their process engineering and workflow systems. XLAB has already introduced concepts of the loosely coupled Dedisys track in their online collaboration solution (ISL Light) and their online auctioning system for electrical power markets.

ISL Light

XLAB's ISL Light enables an operator to connect with a remote client's computer anywhere in the world in less than 30 seconds. Neither installations nor configurations are needed in this firewall-friendly remote support tool. The new version of ISL Light, enhanced in the course of Dedisys, switched from a centralized star topology to using a peer-to-peer infrastructure. The algorithms for discovery of sufficiently capable services in a peer-to-peer based system that were developed within the Dedisys project, were modified and are being used to discover relay nodes providing the desired capabilities for the performed tasks.

EPICS Directory Service

EPICS (Experimental Physics and Industrial Control System) is a control system widely used in particle accelerators and synchrotrons. The EPICS directory service developed by Cosylab in the course of Dedisys significantly improves manageability of EPICS-based deployments.

Advanced Control System

Cosylab intends to introduce Dedisys concepts into their ACS (Advanced Control System) infrastructure, which is being used for construction of the Atacama Large Millimeter Array radio-telescope in the Atacama desert, where system dependability is of prime importance. Also, ACS is being widely used in the astronomy instrumentation control community. Thus, many telescopes under construction today will benefit from increased availability.

Decisions support and control systems for air traffic control and public safety

Frequentis is operating in highly safety critical environments and supplies decision support systems and control systems that serve tactical and strategic decision makers in Public Transport including Air Traffic, Rail and Waterborne, and Public Safety. The results of Dedisys will be incorporated in the products of Frequentis in order to enhance the information quality and to improve availability and performance of the systems.

Achievements

Formalization of balanced dependability based on UML/OCL

The concept of balanced dependability has been formalized using UML (Unified Modelling Language) and OCL (Object Constraint Language). Several adaptive replication protocols have been designed that support the trading process. This provides for a sound basis for the application of the project's concepts.

System models and reference middleware architectures for balanced dependability

Platform-independent system models for enhanced dependability that comprise a system architecture and interaction and composition of main system elements. One of the models is targeted to data-centric systems and the other one is focused on service-oriented systems.

Platform-specific mappings and prototype implementations

The platform-independent system models have been mapped to and implemented on different commercial and open-source middleware platforms.

Comparison between the system models and guidelines for developers

The technologies have been compared and assessed in the context of industry scenarios. Generally, while the application scenarios of data-centric applications are very specific, the Dedisys framework will provide most benefits to service-oriented applications deployed in large, wide-area inter-organizational networks, where the environment can not be controlled and the ability to make a priori assumptions about the environment during development is severely limited, and other approaches prove impossible or prohibitively expensive.

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