# COMPASS

COMPREHENSIVE MODELLING FOR ADVANCED SYSTEMS OF SYSTEMS

System-of-Systems (SoS) technology promises to support the networking of previously independent ICT systems so that they collaborate in a more responsive, efficient and greener way. However, SoS design is hampered by the complexity, heterogeneity and independence of constituent systems, and stakeholders. SoS engineering lacks models and tools to help developers make trade-off decisions, and define precise contracts between constituents. This leads to sub-optimal design and expensive rework.

COMPASS augments industry tools and practice with a modelling language in which SoS architectures and contracts can be expressed. A formal semantic foundation – the first to be developed specifically for SoS engineering – will enable analysis of global SoS properties. It will be supported by an open tools platform with prototype plug-ins for model construction and analysis, and links to an established architectural modelling language (SysML). These foundations and tools will support methods guidelines that help SoS developers to take advantage of this new technology in practice.
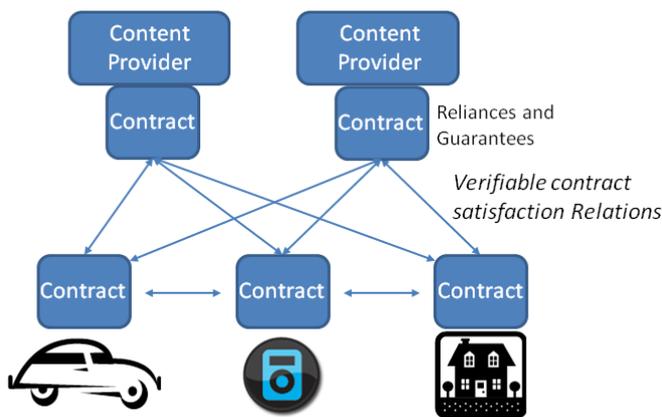
Audio/Video & home automation as a SoS, needs to deliver a consistent "SoS experience" to the user as content, digital rights etc. change

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Technical approach

COMPASS will combine and extend existing modelling techniques for SoSs. The core is a new purpose-built modelling formalism for SoS (COMPASS Modelling Language – CML) with formal semantic foundations, and methods and tools that take advantage of these. CML will allow developers to choose different levels of description, starting from a graphical architectural view in SysML that is easy for most stakeholders to understand. SysML will be linked to CML, and extended with SoS-specific features to describe the assumptions and guarantees of constituent systems.

SysML, with CML extensions will have semantics in pure CML, in a form that can be readily processed by static analysis tools including theorem provers and model checkers, allowing automated detection of inconsistencies, and potential deviation from contract conformance. The CML representation can also form the basis of test generation and management, and can be subjected to simulation in demanding operational scenarios. The underlying semantics of CML will be given in the Unifying Theories of Programming (UTP), which helps to guarantee consistency between diverse models and analyses. CML will be open, so that extensions may be developed for other modelling languages besides SysML.

Project partners	Country
Newcastle University	UK
Aarhus University	DK
University of York	UK
Bremen University	DE
Universidade Federal de Pernambuco	BR
Bang & Olufsen A/S	DK
Insiel S.p.A.	IT
Atego	UK

Demonstration and Use

The COMPASS tools will allow users to operate at the SysML level, or at the CML level, or both. The tool set can be extended with CML plug-ins for static fault analysis, model-checking, theorem-proving, test automation, and support for run-time checking of contract conformance. The platform is open, and links to a range of architectural modelling tools can be developed.

Industrial Case Studies are used to evaluate the emerging formalism and tools. In each case, a SoS development problem is addressed first using current best practice and then using SysML+CML, as a basis for evaluation. The main studies are:

- **Accident Response:** a SoS for dynamic coordination of diverse healthcare services in an acute emergency (ward, ambulance management, triage, hospital management systems etc.)

- **Audio/Video/Home Automation Ecosystem:** a SoS that aggregates AV and home automation systems in multiple spaces (house, car, office etc.), managing content and applications from diverse sources.

- **Challenge Problems**, which stretch the formalism in a wider range of sectors, will be solicited via the **COMPASS Interest Group** (CIG) and tackled by the consortium.

Impact

With major European SoS designers (Bang & Olufsen and Insiel) in the consortium, a leading supplier of system modelling technology (Atego), and an industrial interest group of influential SoS developers, COMPASS will have an impact on:

- **SoS engineering** by giving improved methods for trade-off analysis, managing evolution and gaining assurance of global SoS properties. Ability to innovate new SoS-based products/services rapidly.

- **SoS stakeholders** by giving the ability to offer new services on SoS structures; assurance of SoS-level properties; ability to model/verify end-user "SoS experience" early in design.

- **The SoS research community** by giving the ability to contribute new SoS-specific analysis tools, formalisms, and an advanced semantic basis for further research.

- **Standards:** inclusion of methods guidelines, architectural patterns/styles.

The COMPASS Interest Group

The COMPASS Interest Group (CIG) consists of SoS stakeholders, with membership. including providers of constituent systems, systems integrators, and those with a stake in the performance of SoSs.

The CIG will provide a range of guidance to the COMPASS project consortium, such as evaluating emerging COMPASS technology and defining challenge problems. Members receive a regular e-Newsletter and invitation to a number of CIG workshops throughout the project.

For further details and information on joining the COMPASS Interest Group, contact Steve.Riddle@ncl.ac.uk or see the COMPASS website, *www.compass-research.eu*