# Engineering Interoperability to Accelerate Interdisciplinary Collaboration in the Automotive Industry

Towards the INCOSE Systems Engineering Vision 2025

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# Purpose and Content

**The Idea**

Leveraging Internet technologies, such as Linked Data, for Systems Engineering tools, to achieve integration of multi-disciplinary engineering workflows and data.

1. JLR's CHALLENGE OF PRODUCT COMPLEXITY
2. THE INTEROPERABILITY CHALLENGE
3. LINKED DATA AND OSLC

# JLR's CHALLENGE OF PRODUCT COMPLEXITY

http://www.jaguarlandrover.com/

# Our Company



We employ around 29,000 people globally and support around 190,000 more through our dealerships, suppliers and local businesses. 7,000 engineers and designers.

Jaguar Land over is the biggest UK investor in R&D in the manufacturing sector and is in the global top 100 for R&D spend.

Responsible Business of the Year Award 2013.

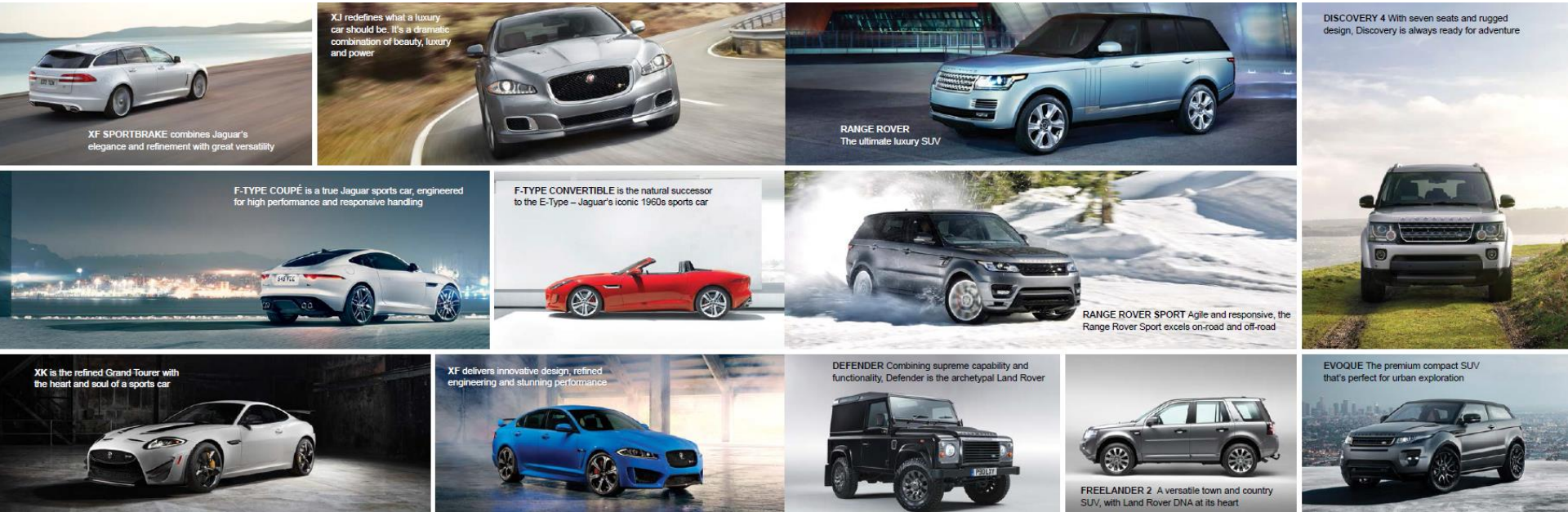


# Global Investment in Infrastructure

# Our Vehicles

THE COMPANY'S VEHICLE line-up consists of six Jaguar and six Land Rover models, ranging from elegant sports cars through to hugely capable SUVs.

2013 year Jaguar Land Rover sold 425,000 vehicles in more than 170 countries – up 19% from the previous year. These figures make Jaguar Land Rover one of the largest exporters by value in the UK, with 80% of our vehicles produced in the UK being sold abroad.



# Highly Complex and Interconnected Features

A customer experience initiated for example by an idea or need which leads to a solution. There may be multiple variances of a feature.

Example: Driver lead highway pilot
A vehicle equipped with a highway pilot feature to perform driving tasks, which is still controlled and lead by the driver.

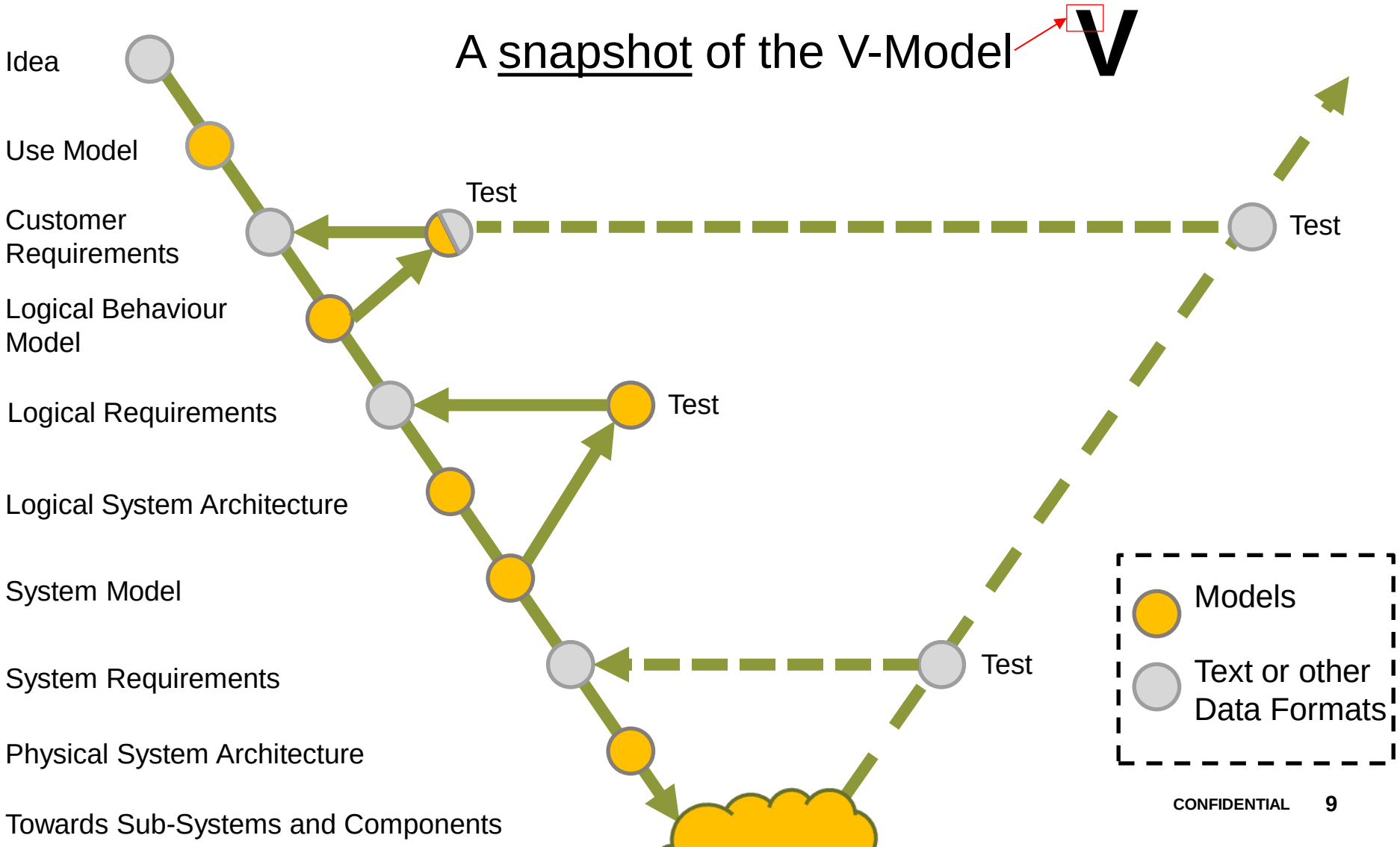
# Application Examples of Model-Driven Engineering



Model-Driven Engineering is key to ensure management and delivery of complex products. Some application areas are:

- Improve Communication and Collaboration
- Manage Complexity of modern Features
- Harmonise Features across Car Lines and their Functions
- Complement understanding of Requirements
- Support and Accelerate Design of Solution
- Support and Accelerate Verification and Validation

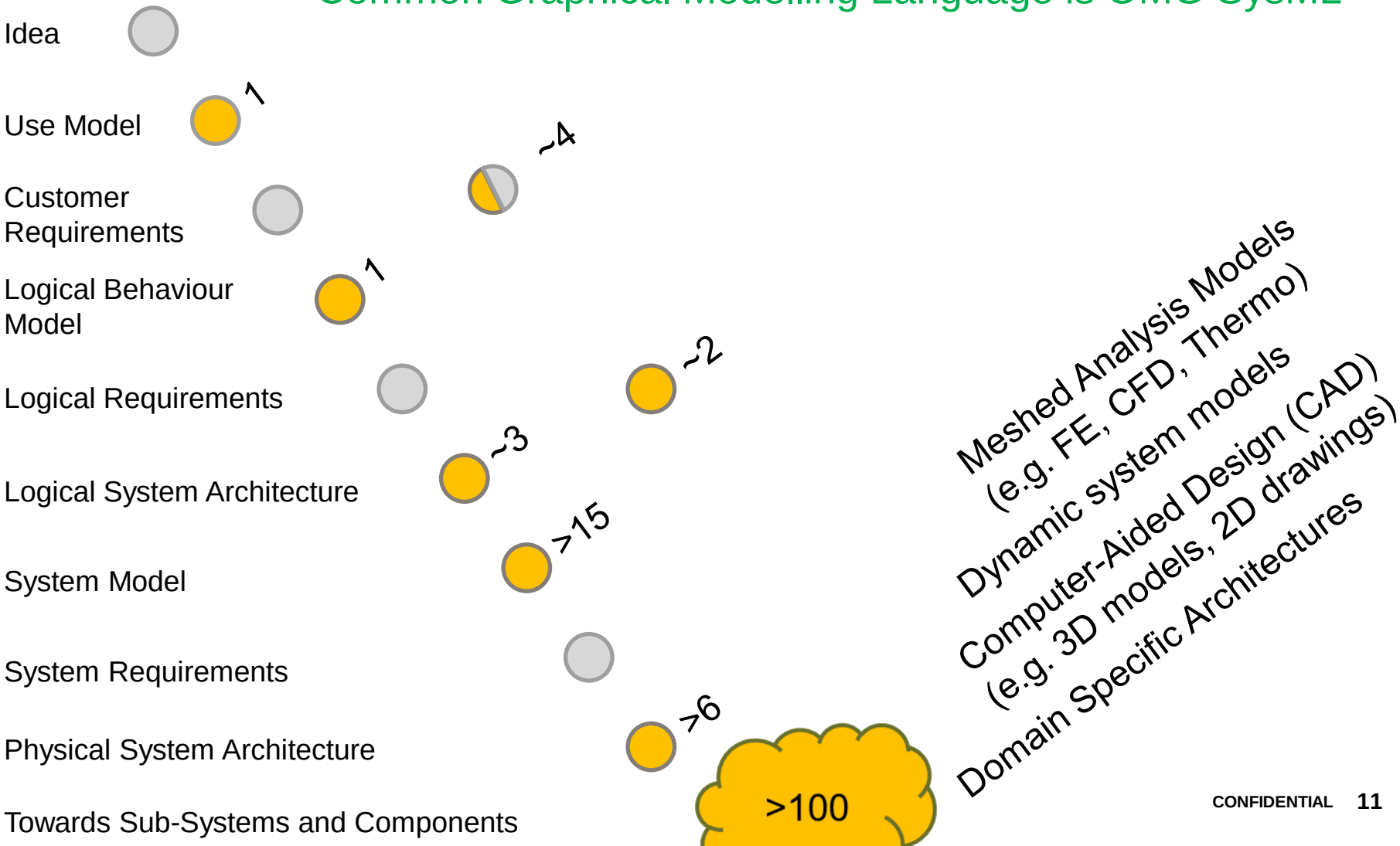
# Application of Models during Feature Development



# THE INTEROPERABILITY CHALLENGE

# Mapping of Languages and Tools

## Common Graphical Modelling Language is OMG SysML



# Systems Engineering

Systems Engineering is an **interdisciplinary** approach to creating large, complex systems

It's both a Practice and a Process

- **As practice,** it's about the **holistic view**
- **As a process,** it promotes and provides a robust and structured approach to system development

Is supported by a **set of Processes, Methods and Tools** which enable engineers to first understand the needs, manage and develop a solution over it's **life cycle**.

# Systems Engineering and Interoperability

Multiple stakeholder viewpoints

**interdisciplinary**

Consistency and Integrity

**holistic view**

**set of Processes, Methods and Tools**

A lot… >200

over it's **life cycle**.

Traceability, Change Management

# INCOSE Vision 2025 and Interoperability

**“Collaborative Engineering: Integrating Teams and Organizations Across All Boundaries”**

## Today

- *“Little or no integration across disciplines”*

## Future

- *“Integration of multi-disciplinary engineering workflows and data across the life-cycle”*
- *“Collaboration across the supply chain”*

*Source: INCOSE Vision 2025*



# LINKED DATA AND OSLC

# INCOSE Vision 2025
## Transforming Systems Engineering

***"Leveraging Technology for Systems Engineering Tools"***

**Today**

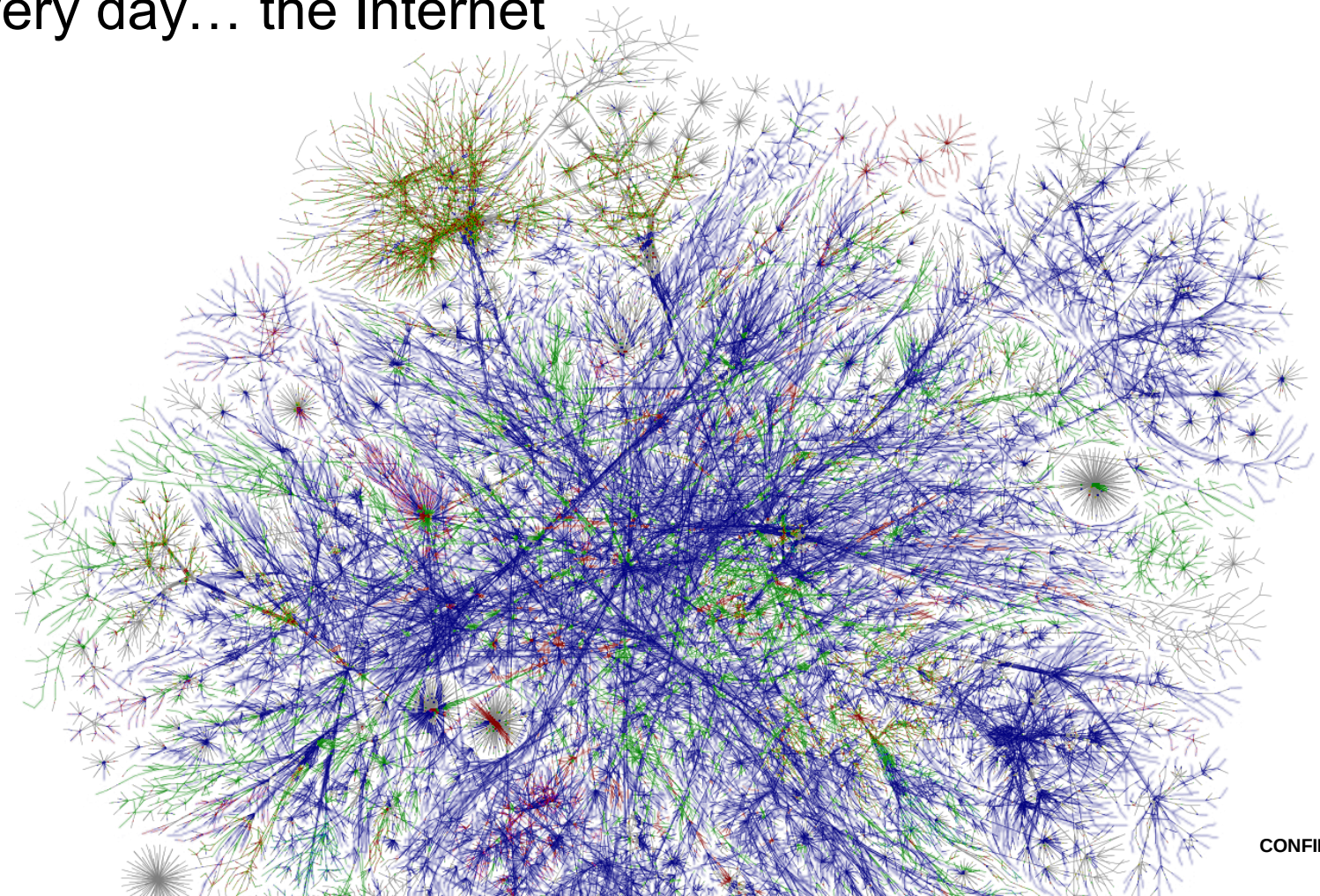
- *"Current SE tools leverage computing and information technologies to some degree. The tools have limited integration with other engineering tools"*

**Future**

- *"Facilitate systems engineering practices as part of a fully integrated engineering environment…"*
- *"Benefit from internet-based connectivity and knowledge representation to readily exchange information with related fields…"*

# Leveraging Internet Technologies

One of the most scalable and powerful technologies we use every day… the Internet



# Open Services for Lifecycle Collaboration (OSLC)

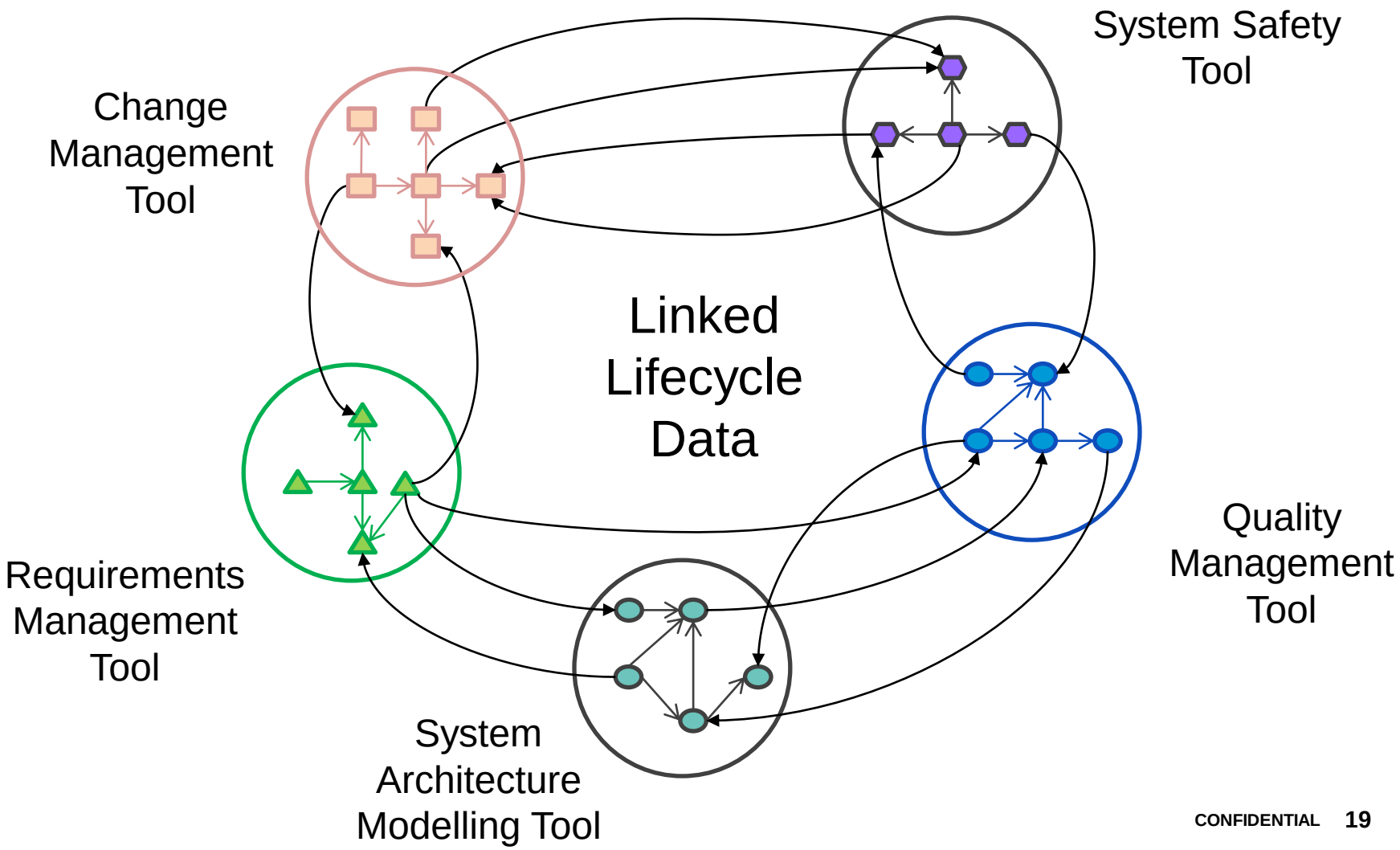
OSLC is an open community creating open specifications for integrating tools http://www.open-services.net

Approach based on standard Web Technologies

- HTTP
- Linked Data
- Resource Description Framework (RDF)

OSLC is part of the OASIS Open Standards Network

# Linked Lifecycle Data (OSLC)



# OMG OSLC4MBSE WORKING GROUP

Initiated in 2013 as a collaborative effort between members of the OMG Systems Engineering and OSLC community as part of the OMG SE DSIG.

**Main Objectives:**

- Investigate and develop an approach for multidisciplinary life-cycle integration in systems engineering
- Investigate how SysML concepts can be implemented using OSLC to achieve life-cycle integration.
- Define OSLC specifications for MBSE

**Scope:**

- Modelling-Based Engineering languages and tools

http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-oslc:oslc4mbse_working_group

# Summary

**Different domains select different modelling tools**

- Need to represent and analyse domain specific artefacts
- Different level of abstracting across multiple domains
- Specific modelling competency of engineers
- Cost and availability of different tools
- Amount of legacy models

**Leveraging Internet and Web Technology for Systems Engineering Tools**

**Integration for traceability and data management purposes can be achieved without huge interdisciplinary ontologies and specifications (e.g. OSLC)**

# Acknowledgements and References

Axel Reichwein, Koneksys is co-chair of the OSLC4MBSE WG and developed the scenarios and examples.

OSLC4MBSE, http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-oslc:oslc4mbse_working_group

Open Services for Lifecycle Collaboration (OSLC), http://open-services.net and http://www.oasis-oslc.org

Ford MBSE approach, Chris Davey, http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:03-2013_incose_mbse_workshop-ford_automotive_complexity_v4.0-davey.pdf

INCOSE Systems Engineering Vision 2025, http://www.incose.org/newsevents/announcements/docs/SystemsEngineeringVision_2025_June2014.pdf

W3C Linked Data and RDF, http://www.w3.org

CESAR Interoperability Specification, http://www.cesarproject.eu/fileadmin/user_upload/CESAR_D_SP1_R1.6_M4_v1.000_PU.pdf