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Identifying Top Challenges for International Research on Requirements Engineering for SOS Engineering

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My situation

- Systems Engineering within a global prime contractor
- Leadership role within INCOSE

- My focus is on Systems Engineering
- Requirements Engineering is a key system lifecycle process

- Systems of Systems are my reality, and that of many of us
 - Deliver goods and services into customer SOS
 - Deliver outcomes from a company SOS

- Nature of SOS calls for new approaches & mindsets

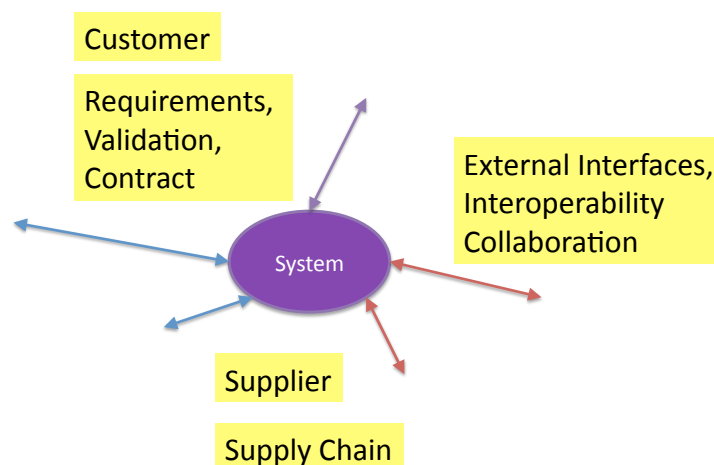
Example complex products

- Delivering goods and services into customer SOS
 - Integration and Interoperability
 - Delivery of value, changing situation, etc.
- Platform SOS such as a warship
 - Large complex system
 - Common sensors, weapons, C2 across the fleet
 - Crew “sub-system” developed and managed by customer
- Complex service such as aircrew training
 - Contract for outcomes – trained pilots, engineers
 - Source and integrate contributions across people, equipment, facilities, procedures, etc.



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Typical Requirements/SE situation



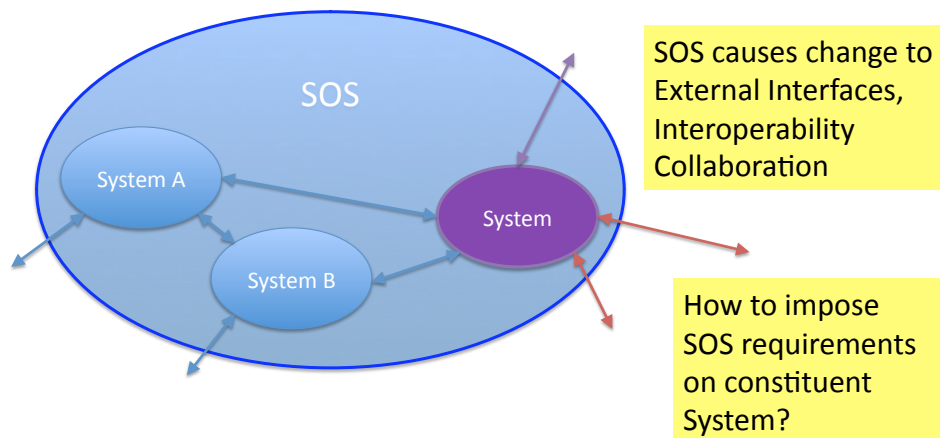
Complicated but achievable, many years of practice experience

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System viewed within a SOS

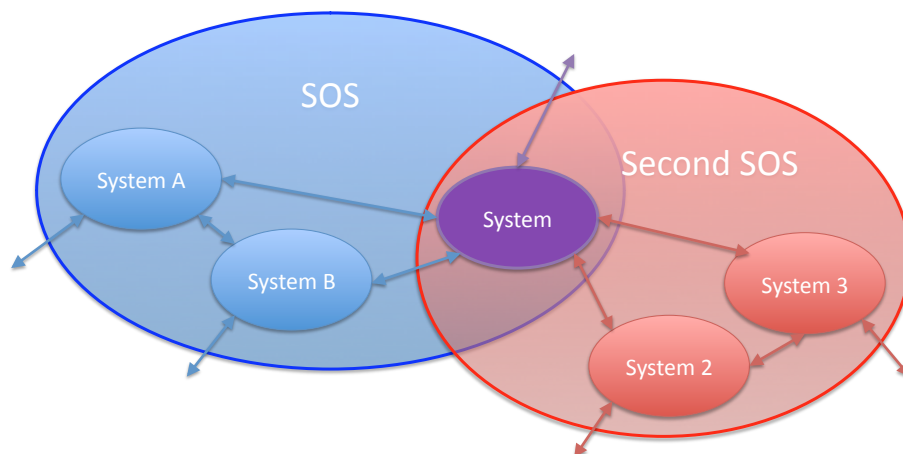
SOS Customer

SOS Objectives/Needs



Complex stakeholder context, often influence rather than contract ⁵

Be careful – a system can participate in multiple SOS

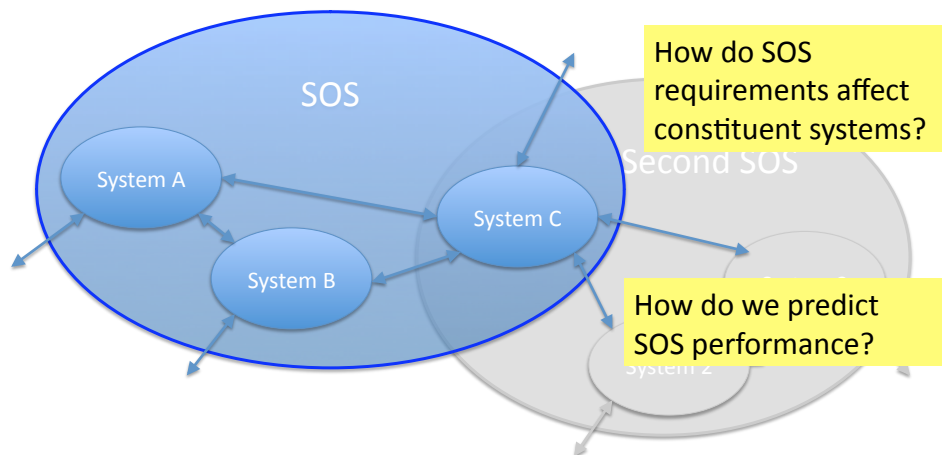


Even more complexity, more sources of requirements and change ⁶

Flip perspective to the SOS

Who is the SOS customer?

How do we set SOS reqts?



How to ensure the SOS achieves its purpose within this context?

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Key Challenge - Change

- SOS context is more complex than traditional case
 - More actors and relationships
 - Lacks the clarity of the single contractual relationship
 - More sources of change
 - Wide variety in rates of change – from decades to real-time
- Traditional techniques
 - Assume relative stability
 - Handle change in linear fashion
 - Impact assessment can be laborious (some good examples)
- Drivers for change:
 - Purpose of the SOS
 - External Context
 - Availability and configuration of the constituent systems

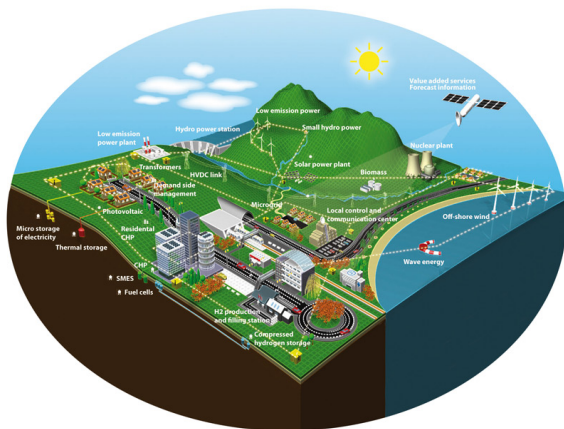
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Drivers of Change

SOS Purpose	External Context	Availability/Configuration of Constituent Systems
<ul style="list-style-type: none"> Stakeholders and Values Intended Outcomes Relative Priorities between Outcomes 	<ul style="list-style-type: none"> PESTLE factors (political, economic, social, technological, legislative, environmental) Legal framework – national and international Social norms/behaviour Emerging cyber-physical threats 	<ul style="list-style-type: none"> May be subject to binding “contract” or not Exist in the “free market” Driven by the individual customer priorities May change without notice to SOS Changes in previously unimportant area may matter in the future Obsolescence and update drive changes

Many of these are outside our control, but need to be understood.
Significantly different time-constants – from decades to real-time ⁹

Change Examples - Energy



- Priorities between energy sources
 - Obsolescence
 - renewables
- Legislation & financial incentives
- Company creation, merger, closure
- Differing consumer take-up patterns
- Real-time demand and supply changes
- Algorithms e.g. electric car re-charge rate

<http://desismartgrid.com>

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Methods, tools and techniques to address change

- Systems Thinking
 - Mind-set and structured methods to understand the SOS big picture and to reason about what is really needed
- Systems Modelling
 - Many separate areas of modelling expertise
 - If used more coherently could help predict SOS response to change
 - Hence to predict SOS emergent properties
 - Inform achievable requirements-setting

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In Summary

- SOS are increasingly prevalent and are an uncertain context for most systems
- SOS environment has many change triggers
 - Affect both SOS and its constituent systems
- Existing techniques are probably too simple to cope
- More coherent use of modelling may help in setting achievable requirements for SOS and constituent systems

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Thank-you

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My published position

- The principal challenge for Requirements Engineering for Systems of Systems (SOS) is Change – whether that is change to the purpose of the SOS, its external context, or the availability and configuration of the constituent systems within the SOS.
- Traditional Requirements Management (and SE) is based on tacit assumptions regarding the relative stability of the external context, and of the customer's requirements. Change, when identified, is handled by fairly traditional processes, and variable degrees of impact assessment.
- When working in the SOS paradigm there are clearly more sources of change than for the traditional case, and the stakeholder context is much more complicated. I believe that this represents a gap in current practice, an important opportunity for discussion between the requirements and systems communities, and potentially an area where research may be beneficial.

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