



Requirement Engineering Revisited

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Contents



- Introduction
- The Questionable Quest for a Unique Requirement Language
- Requirements for Communication
- Requirements for Expressing Commitments
- Conclusions



Engineering Information with Requirement Character

All engineering information preceding implementation has requirement character, e.g.

- design information
- information guiding the demonstration of compliance

Textual Requirements

- Versatile
- Adaptable
- Suitable for multiple narrative perspectives
- Translatable between various domain specific languages
- Varying level of precision

Mathematical Equations and Algorithms

- Definitive
- Explicit for simplifying correct implementation
- Widely inaccessible for validation from multiple stakeholder perspectives

Graphical Models expressing Functionality and Architecture

- High level of abstraction
- Powerful communication means, if people share common interpretation and level of knowledge
- If not, constant source of irritation and misinterpretation

Executable Models exercising Functions

- All stakeholder needs have to be solved upfront
- Enabling powerful validation per system
- Generally applicable methodology for virtual product integration across a system architecture missing

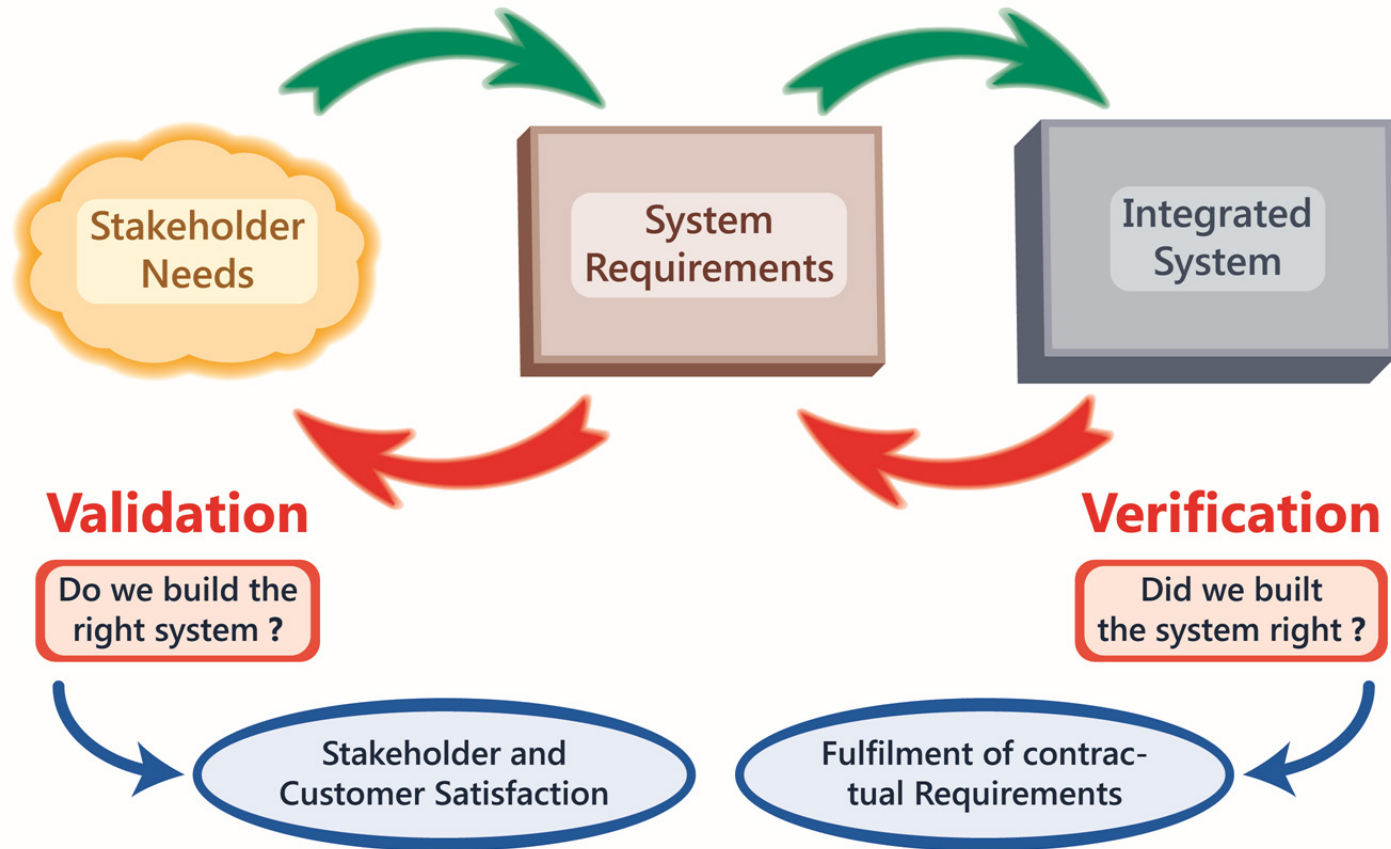
Definitions according to ISO 9000 und ISO 15288



	ISO 9000:2005	ISO 15288:2015
Requirement	Need or expectation that is stated, generally implied or obligatory	Statement which translates or expresses a need and its associated constraints and conditions
Validation	Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled	
Verification	Confirmation, through the provision of objective evidence, that specified requirements have been fulfilled	

- Consequently, organisations with a certified Quality Management System according 9001 may use two quite different definitions in the same enterprise context
- The definition for Requirement has become restricted in Systems Engineering
 - The definition for Verification remains understandable
 - The definition for Validation loses its meaning, and is not anymore distinguishable from Verification

Validation and Verification



- Due to the definition problem, systems engineering predominantly focusses on the fulfilment of contractual requirements with far less considerations on stakeholder and customer satisfaction



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The Claim for the Unity of Science



- Relativity theory and quantum mechanics provided a new boost for advancing the philosophy of science around 1930
 - Vienna Circle and Berlin Group
- Rudolf Carnap (1891 – 1970) took an exposed position claiming the unity of science based on a universal language capable to express everything consistently in a single language based on physics
- There is more evidence that such a language may be out of reach for humans
 - Kurt Gödel demonstrated for the Principia Mathematica that some theorems remain undecidable
 - Experience of translators between natural languages

References:

Rudolf Carnap: Die physikalische Sprache als Universalsprache der Wissenschaft. 1932.

Rudolph Carnap: The Unity of Science. 1934.

Kurt Gödel: Über formal unentscheidbarer Sätze der Principia Mathematica und verwandter Systems. 1931.

Juri Lotman: On the Semiosphere. 1984. English translation 2005.

Conscious Perception



- EEG and brain imaging technology have been supportive to translate conscious perception into neuronal activity
- Basic stages of perception are running in parallel
- Conscious perception is characterized by
 - Synchronized activity of wide areas of the cerebral cortex
 - Some areas of the cerebral cortex are activated while other areas are inhibited
- Conscious perception is always one third of a second behind the fact
- Even if our world is consistent in fact, our perception of the world is context dependent allowing the seamless integration of multiple rather inconsistent world views
- Consequently, neuroscience provides the evidence why a universal language expressing everything in a consistent manner understood by everybody in the same way may be out of human reach

References:

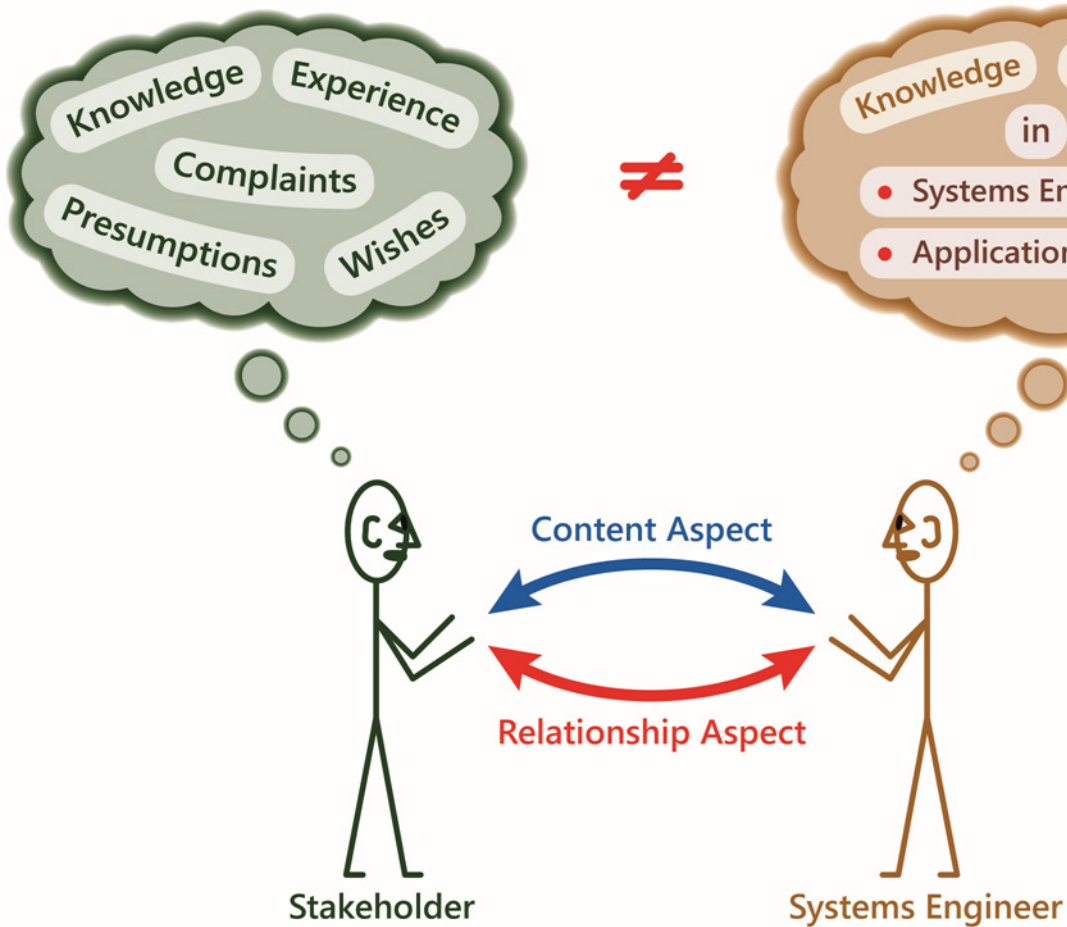
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Contents

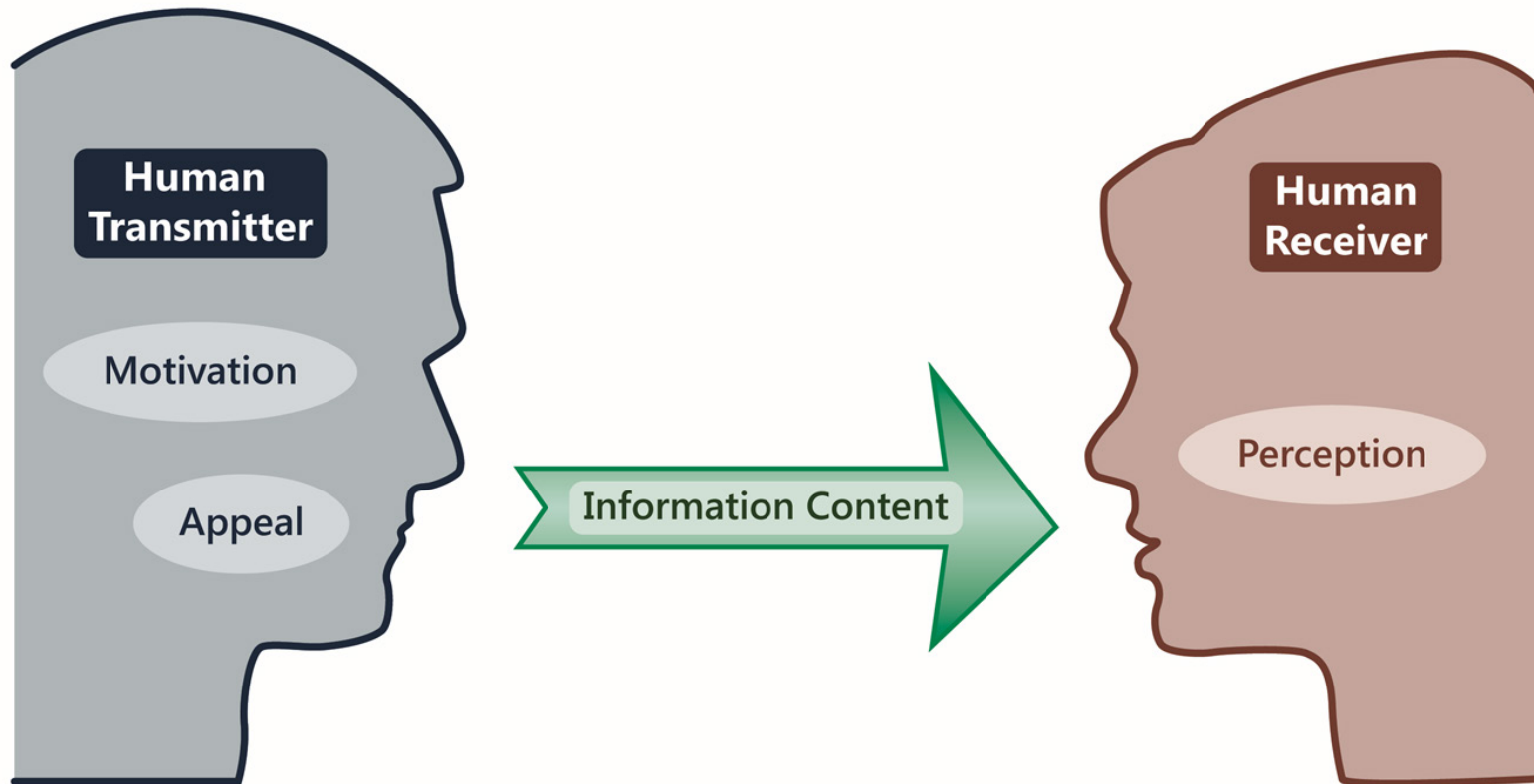


- Introduction
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Communication with Stakeholders



- Stakeholder Requirements serve for communicating stakeholder needs to be understood by systems engineers
- Similarly, Allocated Requirements are the means to communicate needs between engineering teams downwards in a hierarchical system architecture
- Every communication process includes a translation step between different world views



- Information flow is only one aspect of human communication
- Human communication follows a pattern
 - Motivation > Appeal > Information Transmission > Perception



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The Three Essential Views on a System



- Complete system definition by three complementary and consistent views
 - System Requirements,
 - Functional Definition, and
 - Architecture Definition

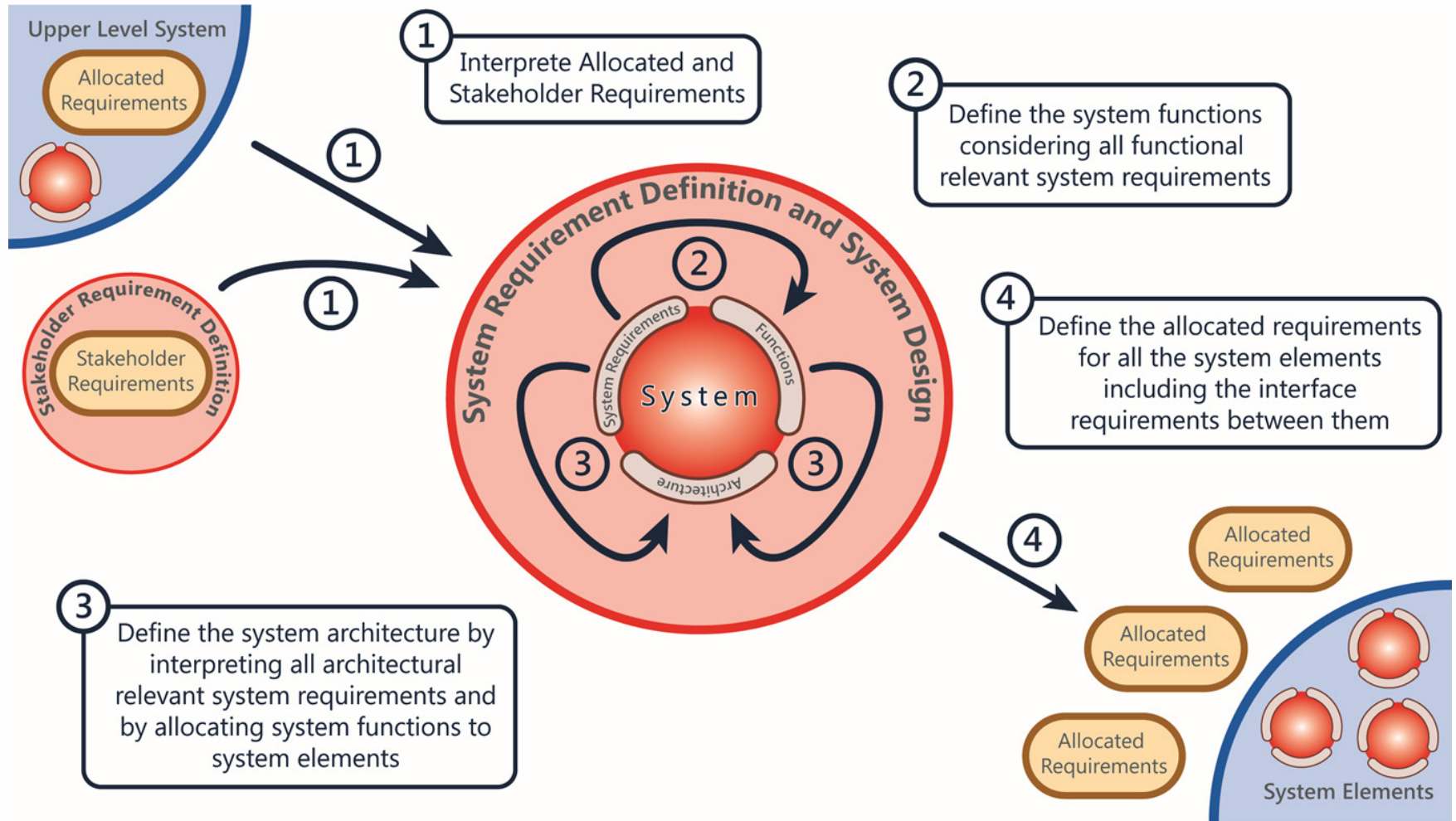
System requirements describe the commitment of the design team for which system features they take responsibility, and for which compliance will be demonstrated accordingly



Functional descriptions utilise the associative human cognitive capabilities for the fast perception of complex situations (Fast Thinking)

Architectural descriptions utilise the human cognitive capabilities for making distinctions and generating categories (Slow Thinking)

System Requirement Definition and System Design

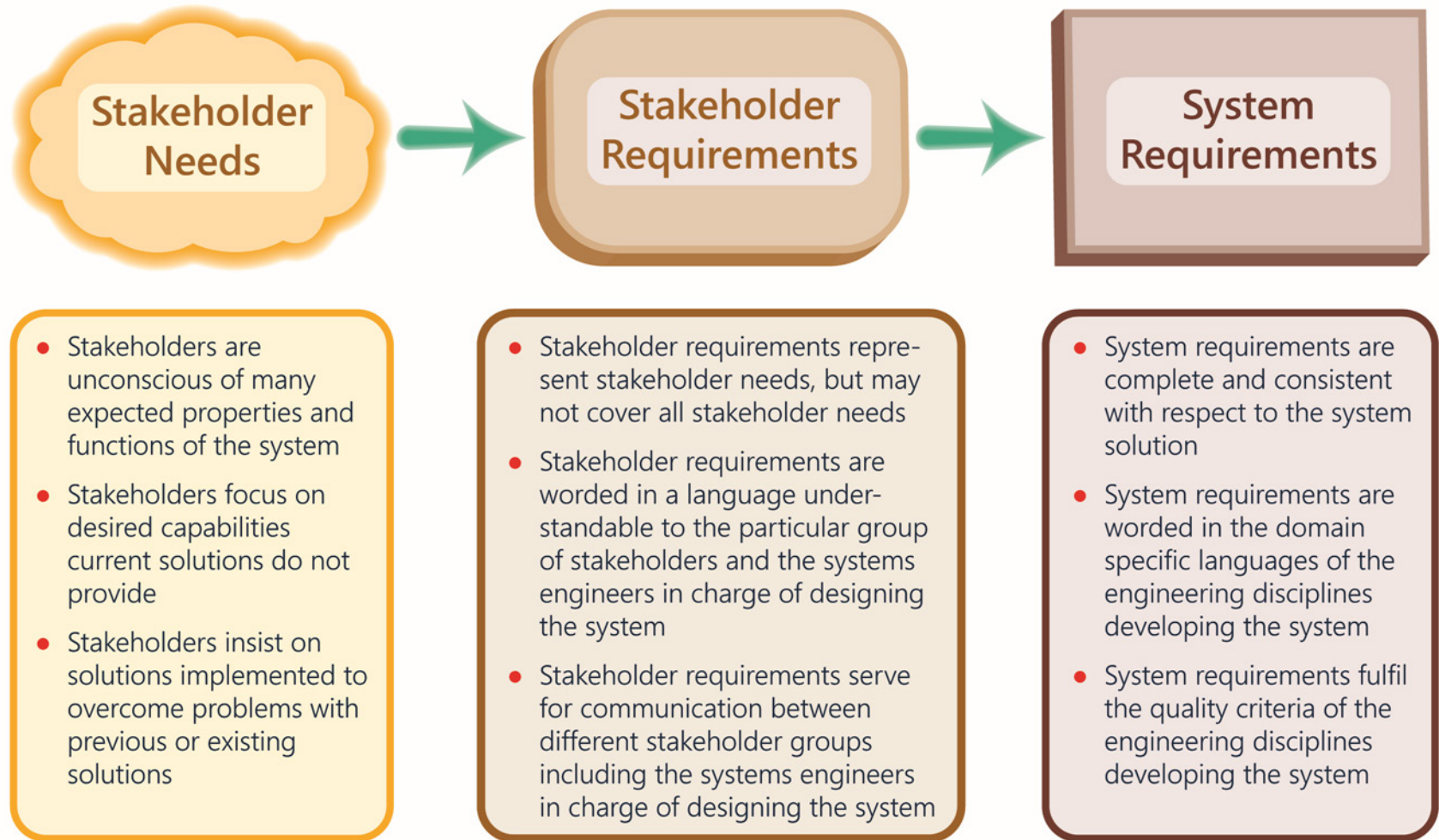


Contents



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From Stakeholder Needs to System Requirements





Thank You
for your attention

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