# Trace or Die

**Ad Sparrius**

**27 March 2014**

**provenance the history of ownership of a valued object, or work of art, or literature**

**Documented evidence of provenance for an object can help to establish that it has not been altered and is not a forgery, a reproduction, stolen or looted art.**

**1434 Painted and signed by Jan van Eck; paid for by Arnolfini**

**Owned by Don Diego de Guevara**

**1516 Guevara gave it to Margaret of Austria, the Habsburg Regent of the Netherlands**

**1530 Inherited by Mary of Hungary, who in 1556 went to live in Spain**

**1588 Inherited by King Philip II of Spain**

**1599 A German visitor saw it in the Alcazar Palace in Madrid, and wrote a letter about it**

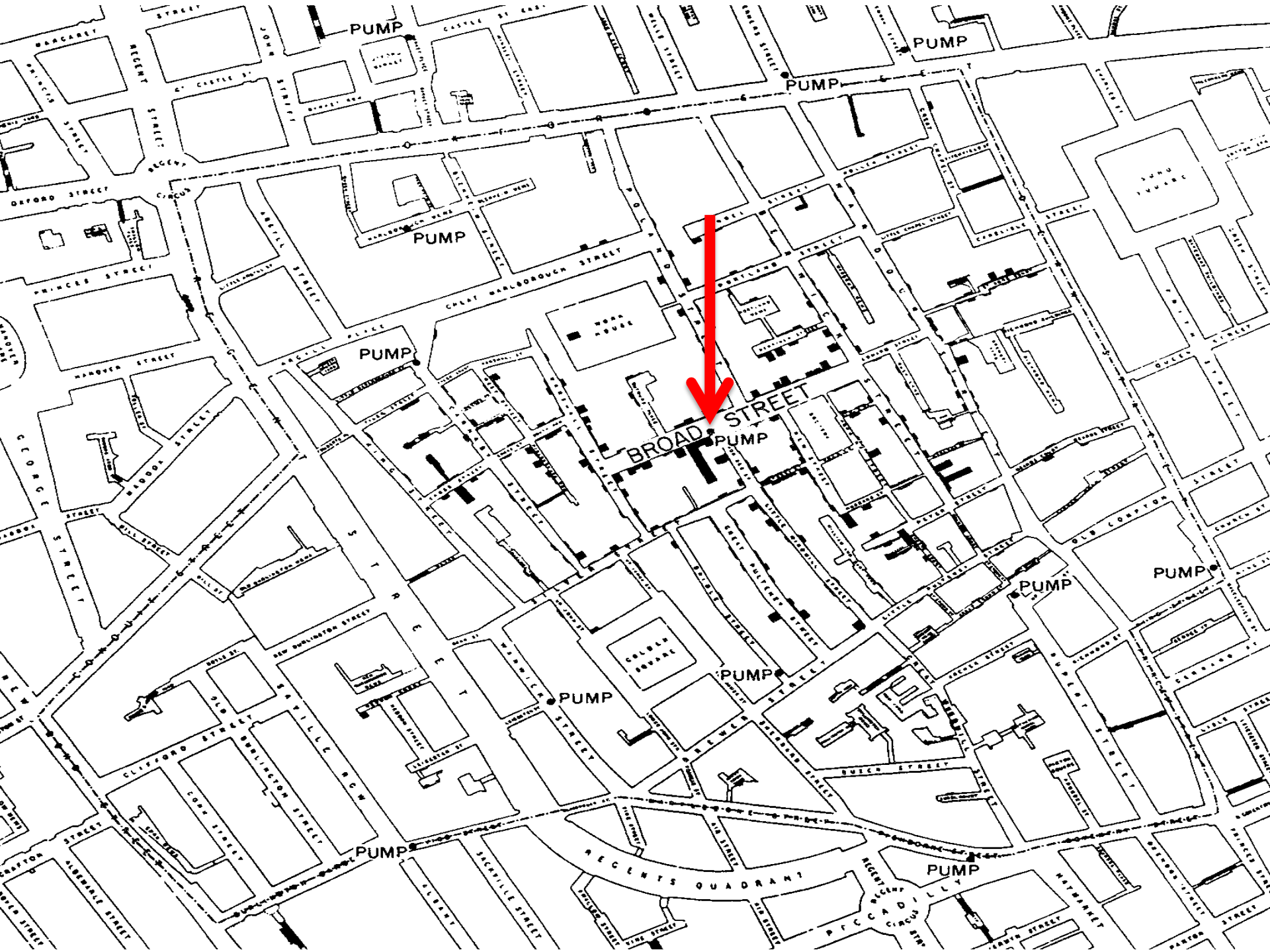
**1700 Listed in the estate of King Carlos II**

**1794 The painting was in the so-called New Palace in Madrid**

**1813 Napoleonic Wars: During the battle of Vittoria King Bonaparte fled with treasure of the Spanish royal court; looted by a Col Hay**

**1842 On public exhibition in London**

**1842 Sold by Col Hay to National Portrait Gallery in London for £600; inventory item 186**


PUMP
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OXFORD STREET
GEORGE STREET
REGENT STREET
BROAD STREET

**“3.7 Traceability is the capability to track system requirements from**

**(a) a system function to all elements of the system which collectively or individually perform that function;**

**(b) an element of the system to all functions which it performs; and**

**(c) a specific requirement to the source analysis or contractual constraint which originated that requirement.**

**MIL-STD-499 (1969); *System Engineering Management***

**Traceability includes tracking allocated design and technical program requirements through the breakdown structure between the system level and the lowest level of assembly requiring logistic or maintenance consideration."**

**"3.6 Correlation is the maintenance of the integrity of design parameters of interrelated system elements according to valid functional, physical, and environmental dependency relationships as system definition progresses.**

**MIL-STD-499 (1969); *System Engineering Management***

**Typical examples are:**

- **the integrity of reliability values between configuration items and subordinate system elements,**
- **maintenance of a valid weight budget, or**
- **the assignment of accuracy values to test equipment that correspond to the tolerances to which the mission equipment must be calibrated."**

**MIL-STD-499 (1969); *System Engineering Management***

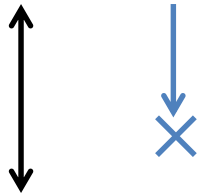
*Requirement Verification Index*

*Verification Method*
N/A Not applicable
1 Inspection
2 Demonstration
3 Analysis
4 Test

*Verification event**
A Preliminary qualification tests
B Formal qualification tests
C System acceptance tests

| *Section 3 and Section 5 Requirement* | *Verification method* | | | | | *Verification event* | | | *Section 4 Verification* |
|---|---|---|---|---|---|---|---|---|---|
| | *N/A* | *1* | *2* | *3* | *4* | *A* | *B* | *C* | |
| 3.1.3.1 | | | | | x | x | | | 4.3.2.1.1 |
| 3.1.3.2 | | x | | | | x | | | 4.3.2.2.3 |
| 3.1.3.2.1 | | | | | x | x | | | 4.3.2.5.1 |
| 3.1.3.3 | x | | | | | | | | |
| 3.1.3.3.1 | | | x | | | | x | | 4.3.2.3.2 |
| 3.1.3.3.2 | | | | | x | | | x | 4.3.2.3.5 |
| 3.1.3.3.3 | | x | | | | | | x | 4.3.2.3.6 |
| 3.1.3.3.4 | | | | | x | | x | | 4.3.2.1.5 |

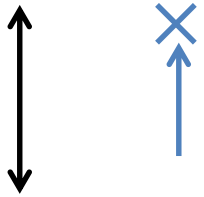
**Stakeholder requirement**



**Sterile: No child**

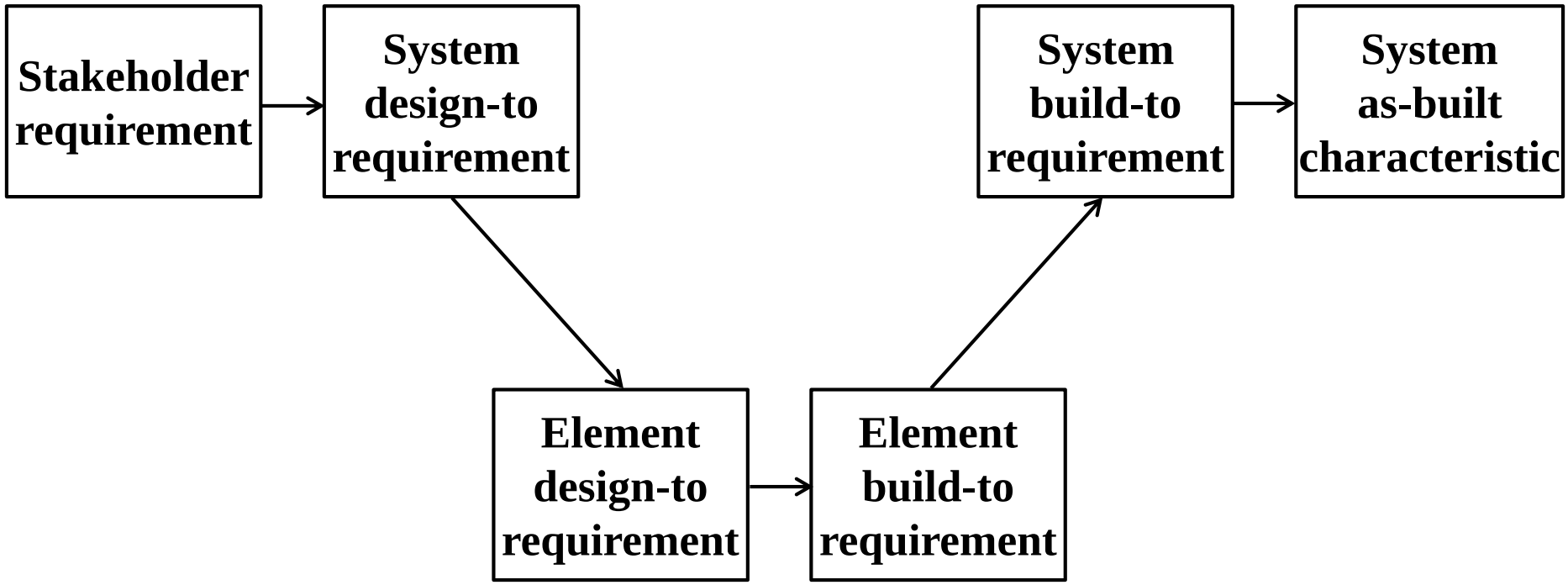
**System requirement**

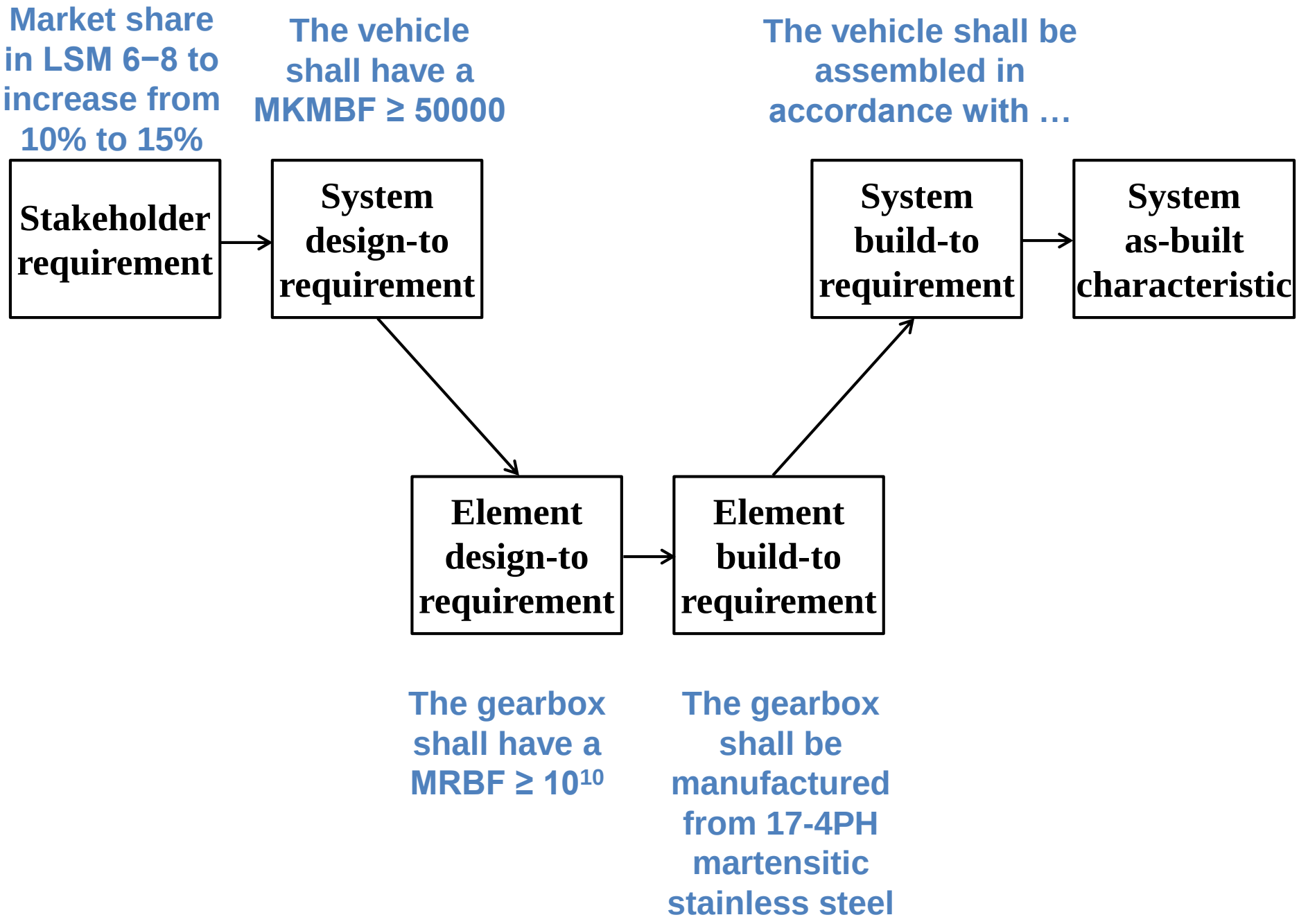
**Element requirement**



**Orphan: No parent**

**Element requirement**

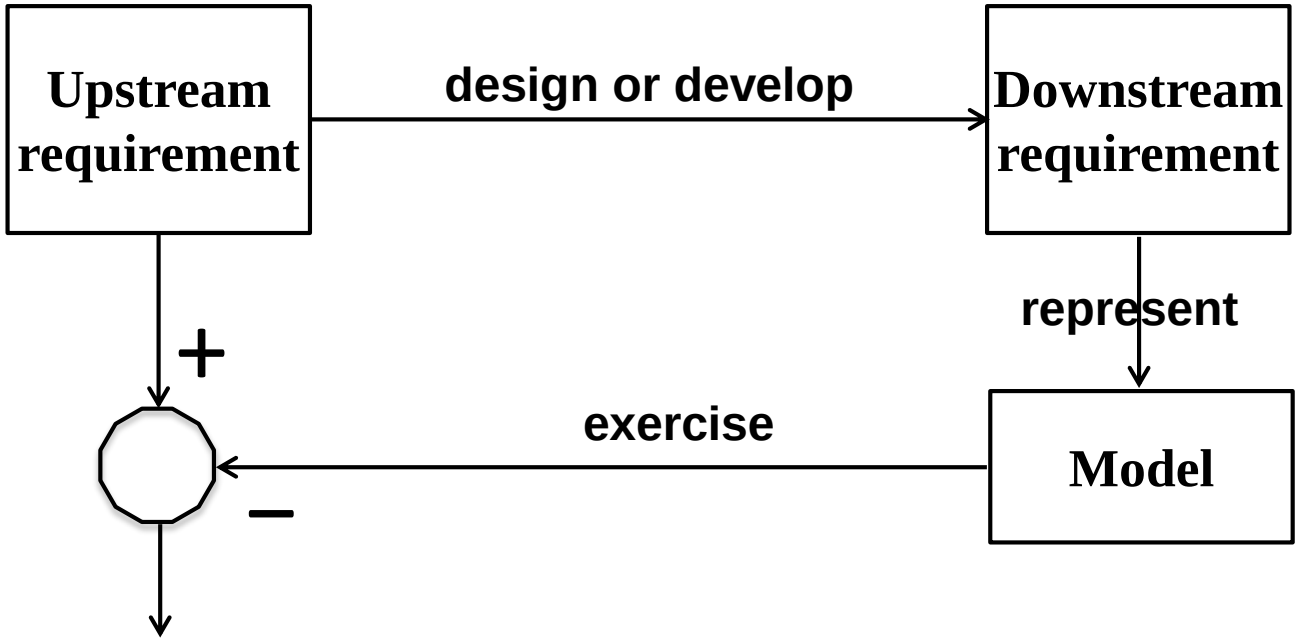

Stakeholder requirement
System design-to requirement
Element design-to requirement
Element build-to requirement
System build-to requirement
System as-built characteristic


Market share in LSM 6−8 to increase from 10% to 15%
The vehicle shall have a MKMBF ≥ 50000
The vehicle shall be assembled in accordance with …
Stakeholder requirement
System design-to requirement
System build-to requirement
System as-built characteristic
Element design-to requirement
Element build-to requirement
The gearbox shall have a MRBF ≥ 10^10
The gearbox shall be manufactured from 17-4PH martensitic stainless steel

***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**

**ISO 9000 (2005), ISO 15288(2008)**




**The model is a representation of a requirement**

**A downstream requirement is verified once during its life cycle against an upstream requirement**

**An upstream requirement may be verified *against* by various downstream requirements, typically three times during its life cycle:**

- **Analysis during the downleg of the Vee-diagram,**
- **Qualification test during the upleg of the Vee-diagram, and**
- **Acceptance test during manufacturing.**

**Each of these verification occasions uses increasingly-strong verification methods to further improve confidence**

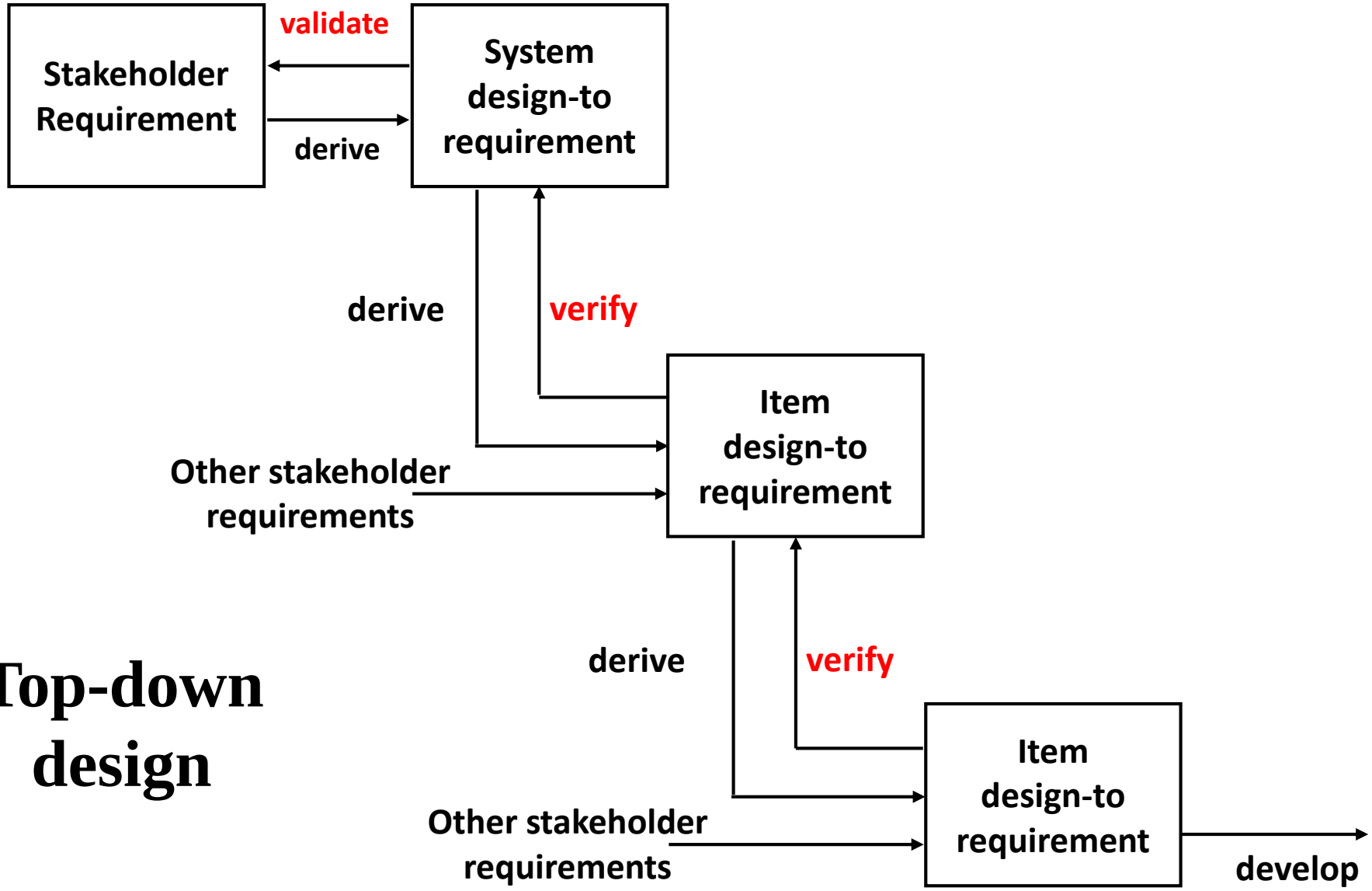
***Validation*** **is the process of determining the fitness or worth of a software product for its operational mission; and evaluating software at the end of the software development process to ensure compliance with software requirements. Validation answers the question "Are we building the right product?"**

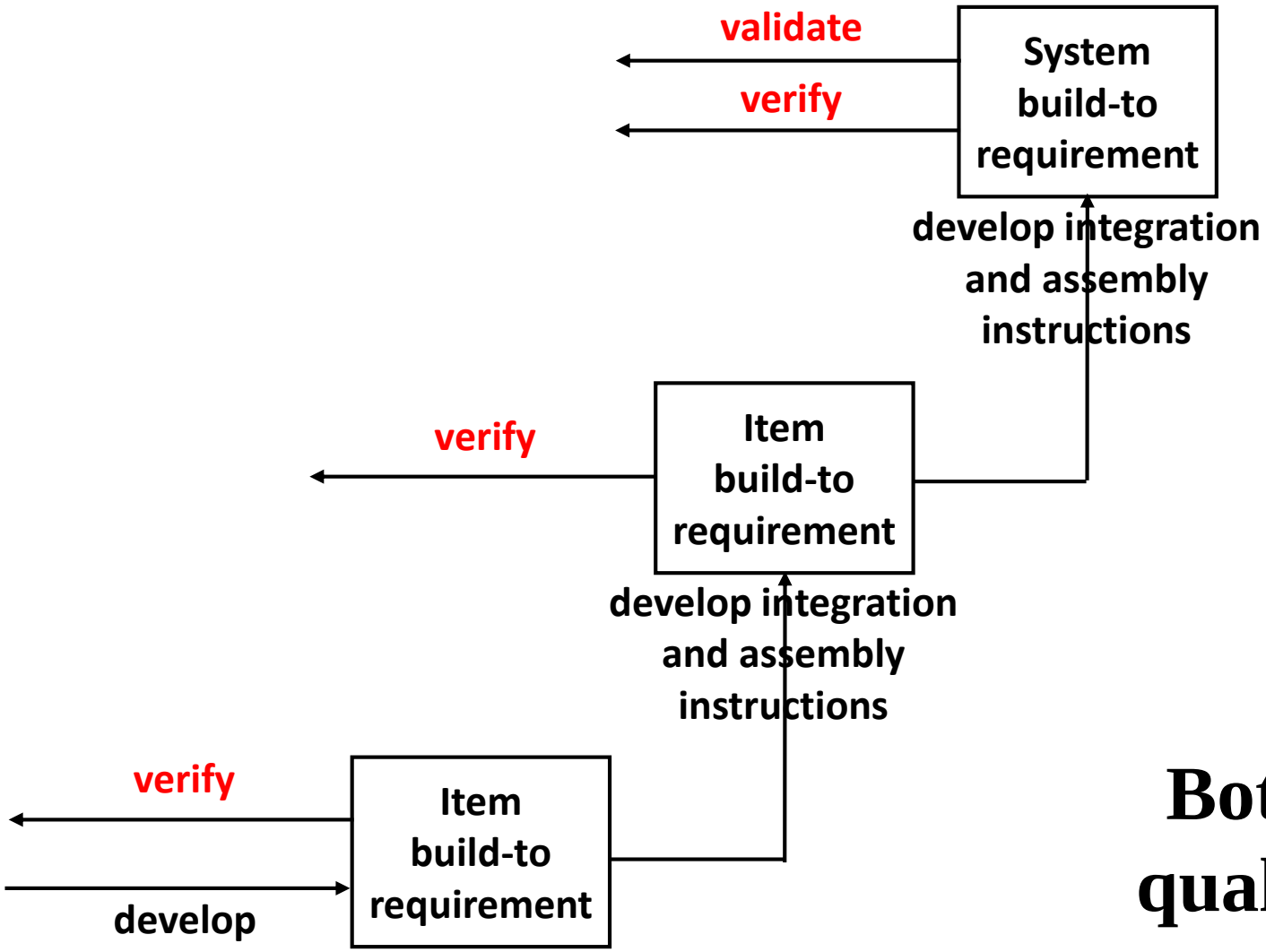
**IEEE Std-729 (1983)**

***Verification*** **is the process of determining whether or not the products of a given software development cycle fulfill the requirements established during the previous phase. Verification answers the question "Are we building the product right?"**

**IEEE Std-729 (1983)**

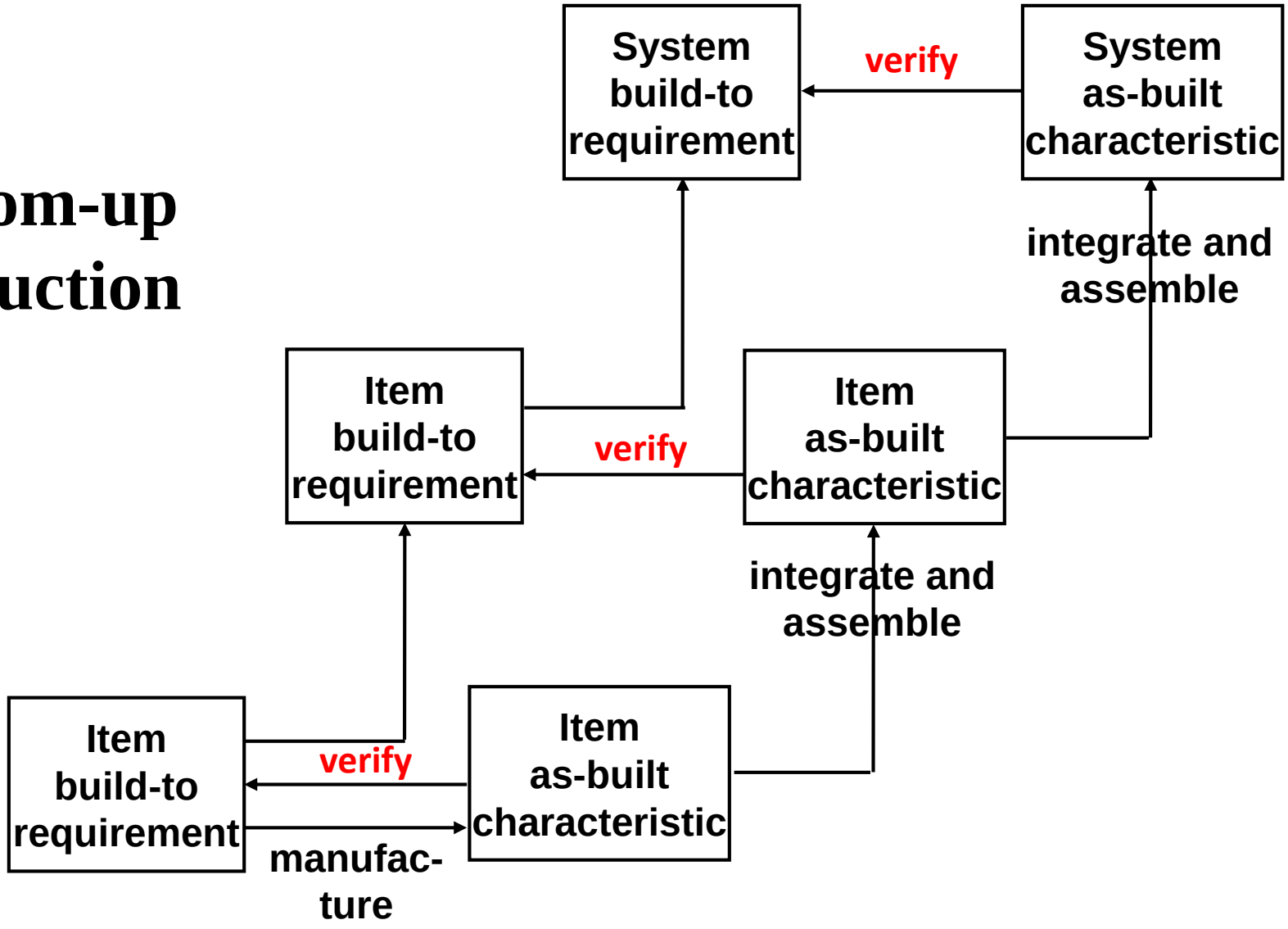
# Top-down design






# Bottom-up qualification

# Bottom-up production

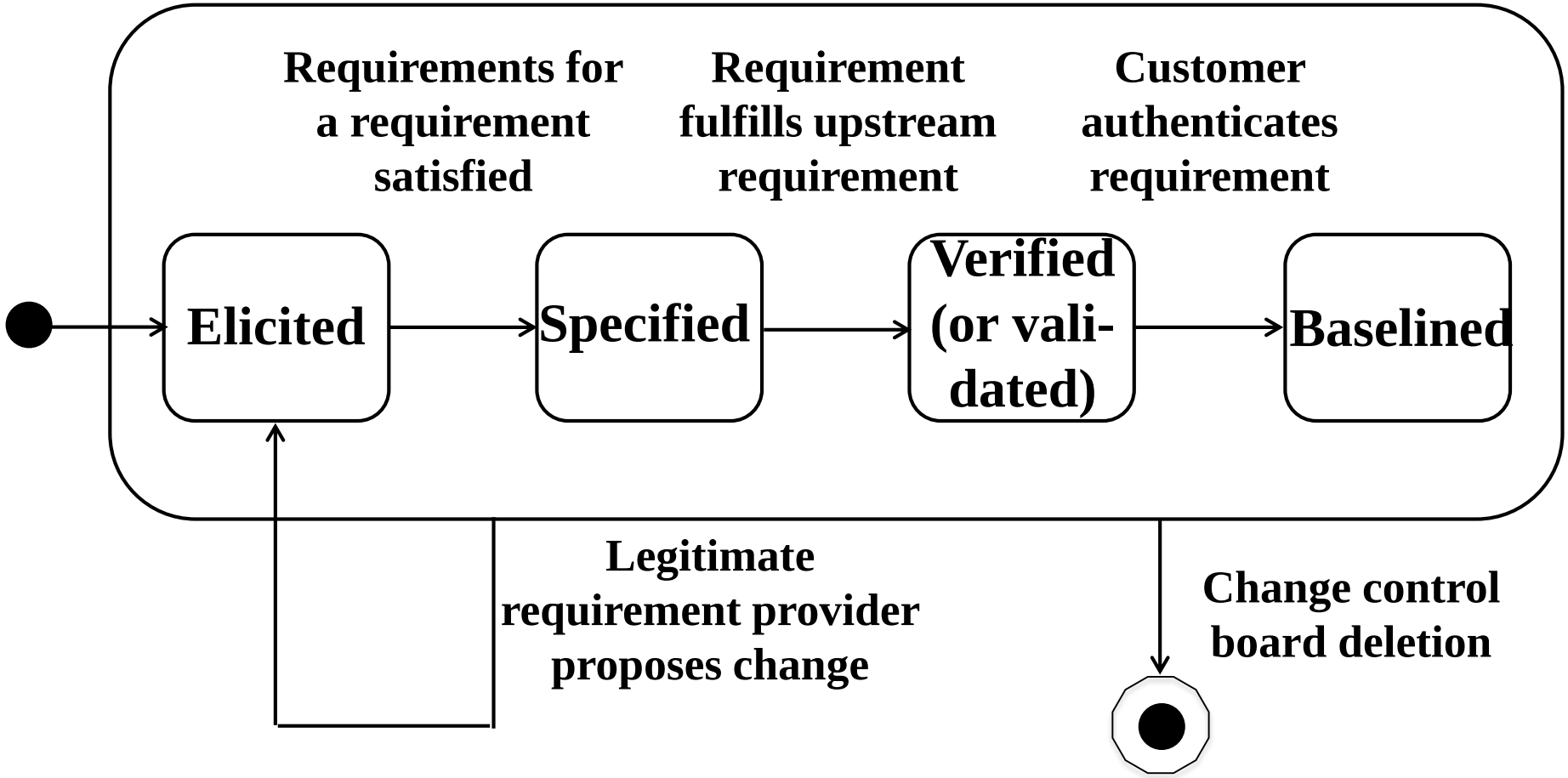


**To verify a stakeholder requirement or a system requirement is to check the application of syntactic and grammatical rules, and characteristics defined in the stakeholder requirements definition process, and the system requirements definition process such as; necessity, implementation free, unambiguous, consistent, complete, singular, feasible, traceable, and verifiable.**

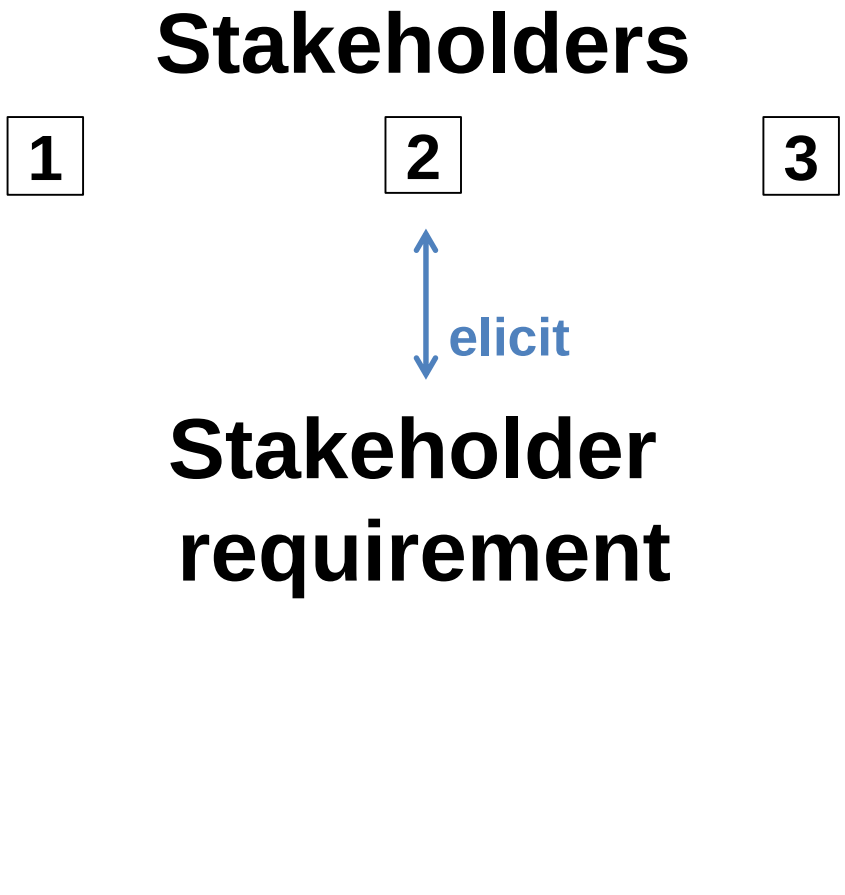
***Guide to the Systems Engineering Body of Knowledge (SEBoK)*, version 1.2, 2013**

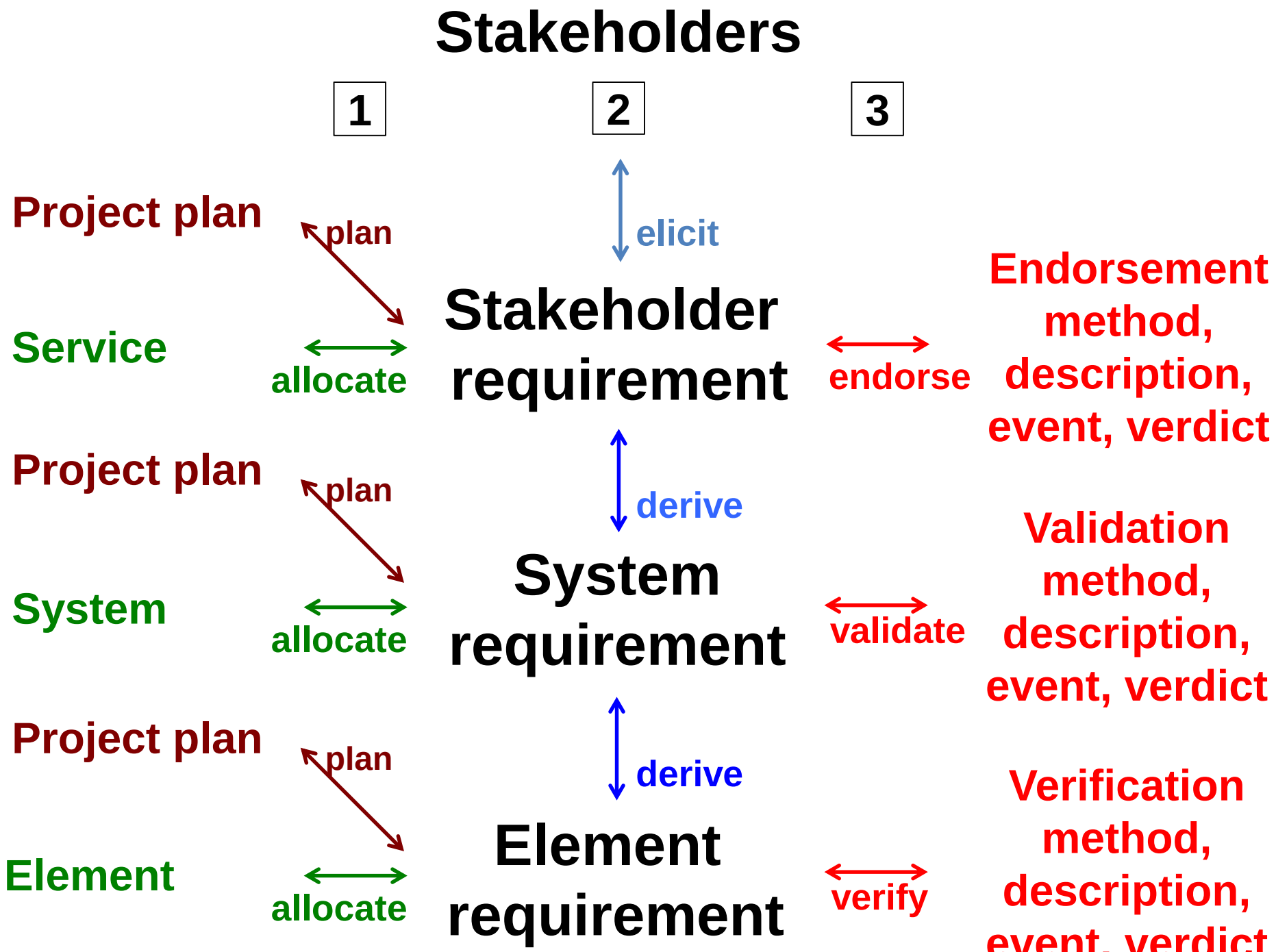
***Requirements traceability*** **refers to the ability to describe and follow the life of a requirement, in both forwards and backwards direction, in other words from its origins, through its development and specification, to its subsequent deployment and use, and through all periods of on-going refinement and iteration in any of these life cycle phases.**

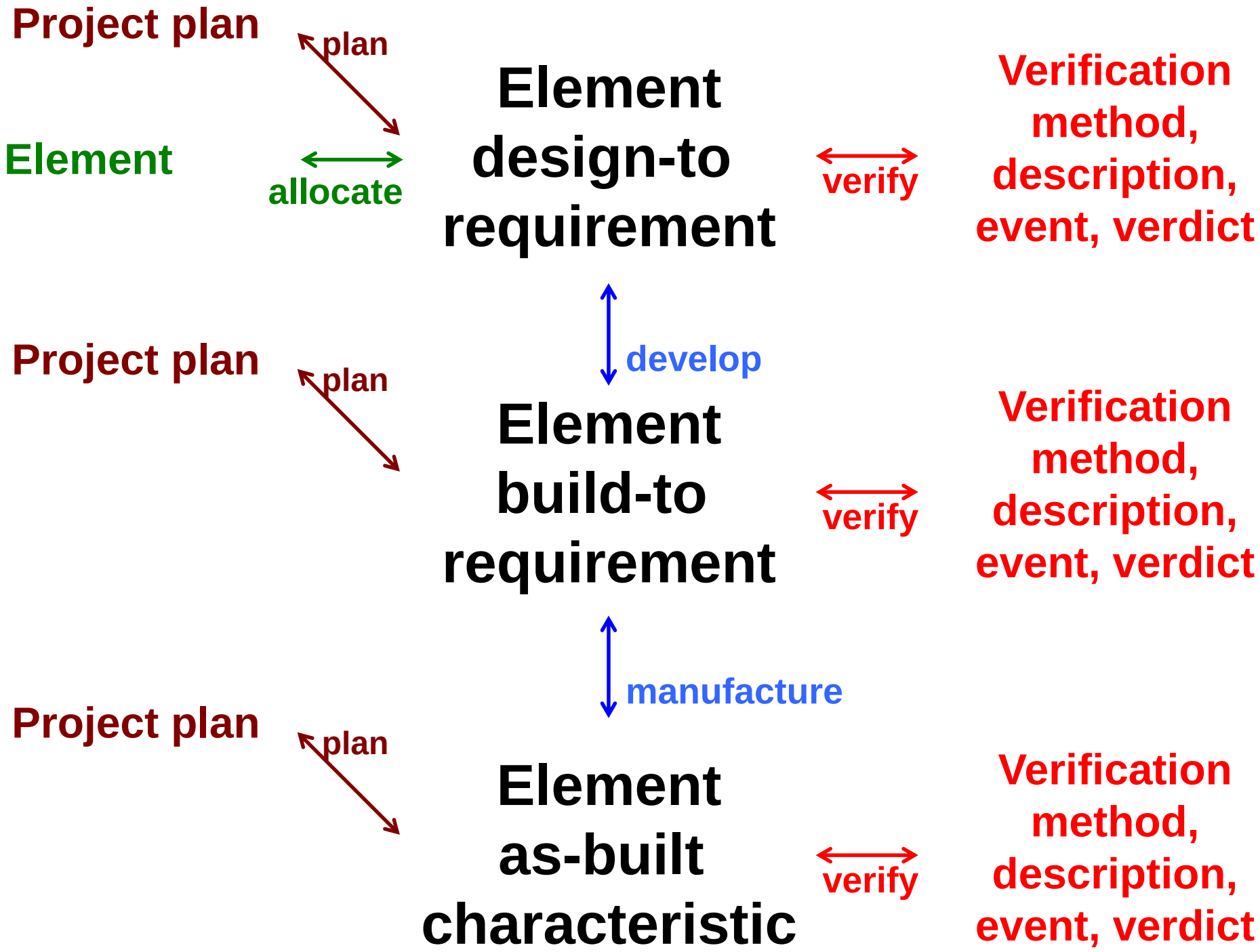
**Gotel, Finkelstein (1993);** ***An Analysis of the Requirements Traceability Problem*****, Technical Report TR-93-41, Department of Computing, Imperial College.**

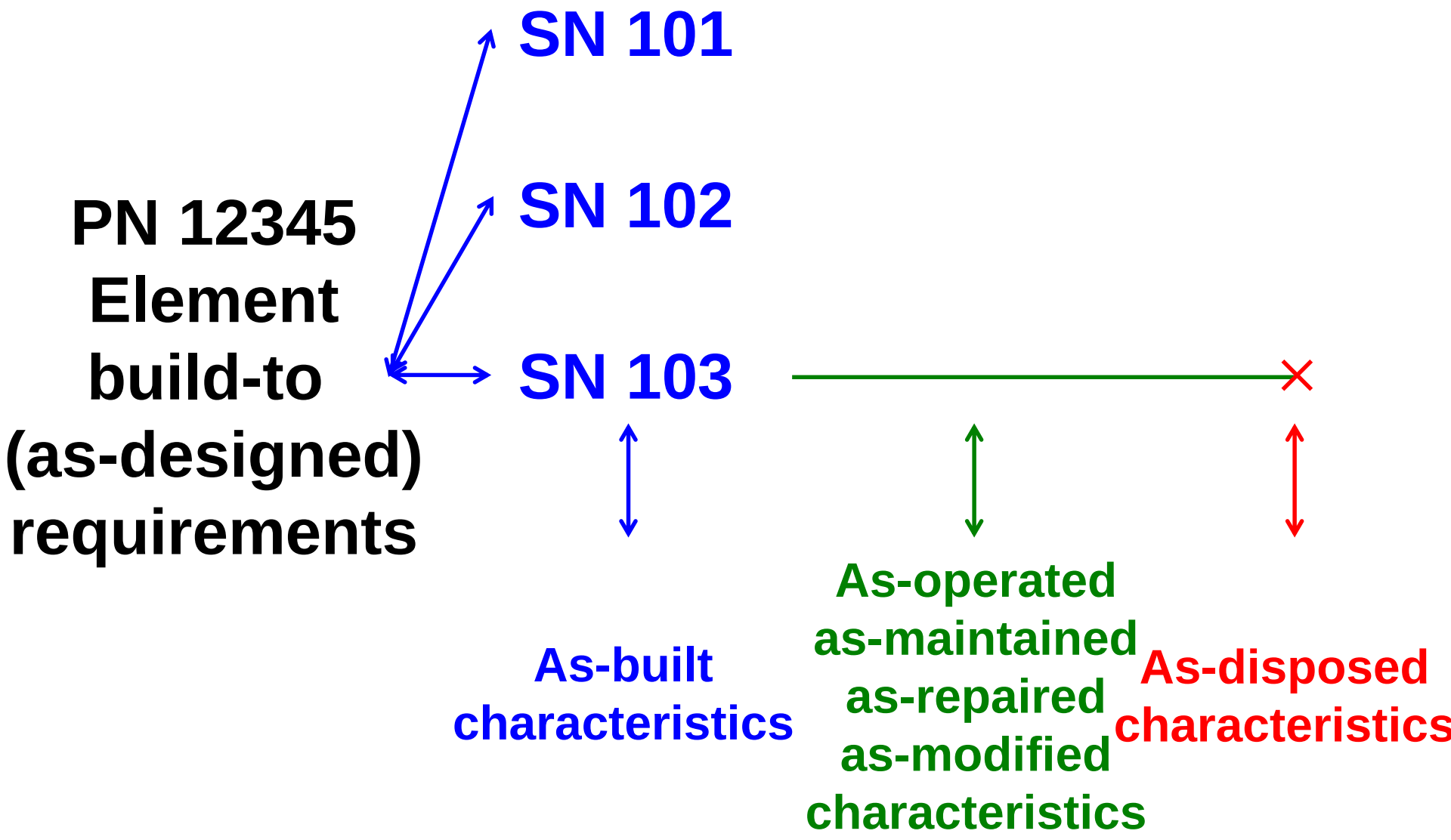



# State machine diagram for a requirement


Stakeholders
1
2
3
elicit
Stakeholder requirement


Stakeholders
1
2
3
Project plan
plan
elicit
Stakeholder requirement
Service
allocate
endorse
Endorsement method, description, event, verdict
Project plan
plan
derive
System requirement
System
allocate
validate
Validation method, description, event, verdict
Project plan
plan
derive
Element requirement
Element
allocate
verify
Verification method, description, event, verdict


Project plan
plan
Element
allocate
Element design-to requirement
verify
Verification method, description, event, verdict
develop
Project plan
plan
Element build-to requirement
verify
Verification method, description, event, verdict
manufacture
Project plan
plan
Element as-built characteristic
verify
Verification method, description, event, verdict




# Configuration status accounting

# Traceability:

- **Requirement trace: An explicit tree-up and tree-down bidirectional trace between requirements, using the validation/verification model as foundation**
- **Allocation trace: An explicit bidirectional trace between a requirement and the element that implements it**

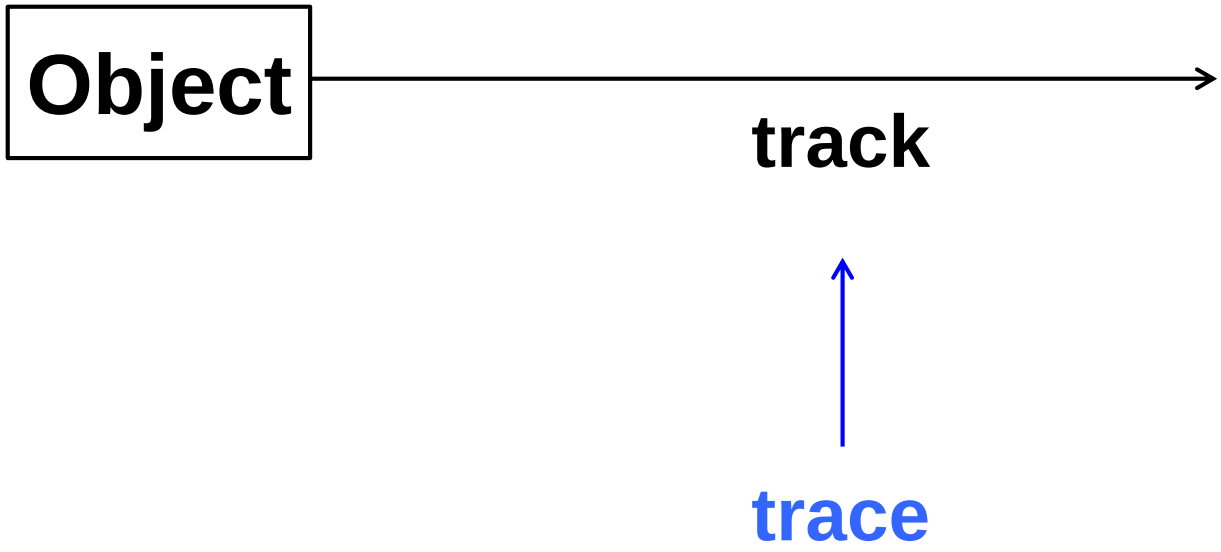
- **Verification trace: An explicit bidirectional trace between a requirement and the verification method, description, event, and verdict (ditto for validation and for endorsement)**

- **Configuration trace 1: An explicit bidirectional trace between an engineering change proposal and its implementing specification changes and resultant modifications**

- **Configuration trace 2: An explicit bidirectional trace between a particular version of the product baseline, the associated part number, and all serial numbers manufactured against it**

- **Configuration trace 3: An explicit bidirectional trace between a serial number and its as-built, as-operated, as-maintained, as-repaired, as-modified, and if applicable, as-disposed configuration status**

- **Project trace: An explicit bidirectional trace between a requirement and the work breakdown structure task that implements it, including its associated budget, schedule, deliverables, and responsibility assignment**


Object
track
trace