SoSECIE Webinar

Welcome to the
2021 System of Systems Engineering Collaborators Information Exchange (SoSECIE)

We will start at 11AM Eastern Time

You can download today's presentation from the SoSECIE Website:

https://mitre.tahoe.appsembler.com/blog

To add/remove yourself from the email list or suggest a future topic or speaker, send an email to sosecie@mitre.org

NDIA System of Systems SE Committee

- **Mission**
  - To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
  - To identify successful strategies for applying systems engineering principles to systems engineering of SoS
- **Operating Practices**
  - Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August

NDIA SE Division SoS Committee Industry Chairs:
Mr. Rick Poel, Boeing
Ms. Jennie Horne, Raytheon
OSD Liaison:
Dr. Judith Dahmann, MITRE

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Teams.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

Disclaimer

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2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars

Sponsored by MITRE and NDIA SE Division

March 9, 2021
Distributed Architecture for Monitoring Urban Air Quality: A Systems Engineering Approach
Adrián Unger, Tom McDermott and Philip Dewire

April 6, 2021
Holistic architecture description for a future Global Health Assurance Systems of Systems
Adrián Unger

April 20, 2021
Leveraging Set-Based Practices to Enable Efficient Concurrency in Large Systems and Systems-of-Systems Engineering
Brian Kennedy

May 4, 2021
OUSD R&E: USD(R&E) Mission Engineering (ME) State of Practice
Elmer L. Roman

May 18, 2021
Application of Probabilistic Graph Models to Kill Chain and Multi-Domain Kill Web Analysis Problems
Jason Baker and Valerie Sitterle

https://www.mitre.org/capabilities/systems-engineering/collaborations/system-of-systems-engineering-collaborators

2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars

Sponsored by MITRE and NDIA SE Division

June 1, 2021
Applying an MBSE Approach for Evaluating Shipyard Operations
David Jurkiewicz

June 15, 2021
Implementing a Digital Engineering Environment for Mission Engineering
Jason Anderson and Jeffrey Boulware

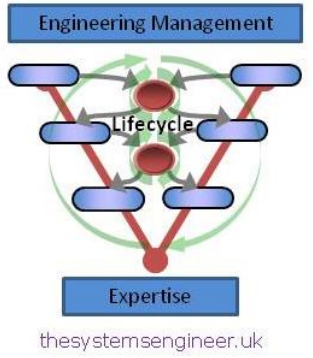
June 29, 2021
Digital Engineering: From Toolchain to Platform
Dr. Aleksandra Markina-Khusid

July 13, 2021
Developing Meta Systems Architectures for Leading Innovation with Complex Societal and Technical Challenges
Dr. Cihan Dagli

https://www.mitre.org/capabilities/systems-engineering/collaborations/system-of-systems-engineering-collaborators

30th Annual INCOSE international symposium

Virtual Event
July 20 - 22, 2020



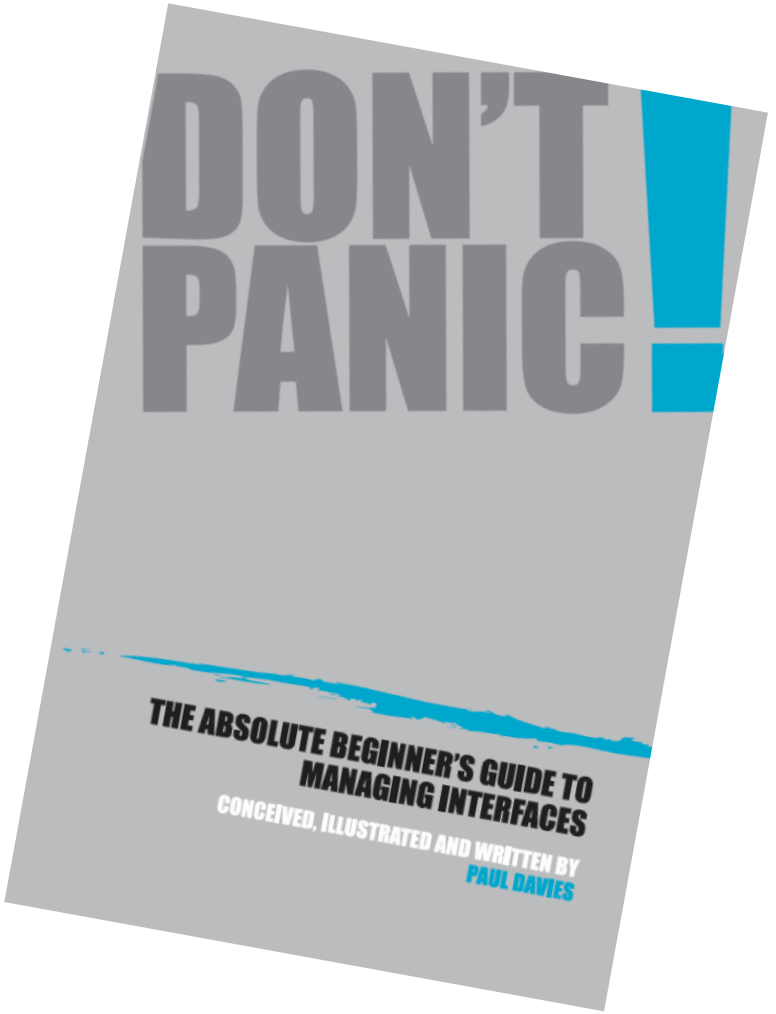
Interface Management – The Neglected Orphan of Systems Engineering

Paul Davies
paul@thesystemsengineer.uk

www.incose.org/symp2020

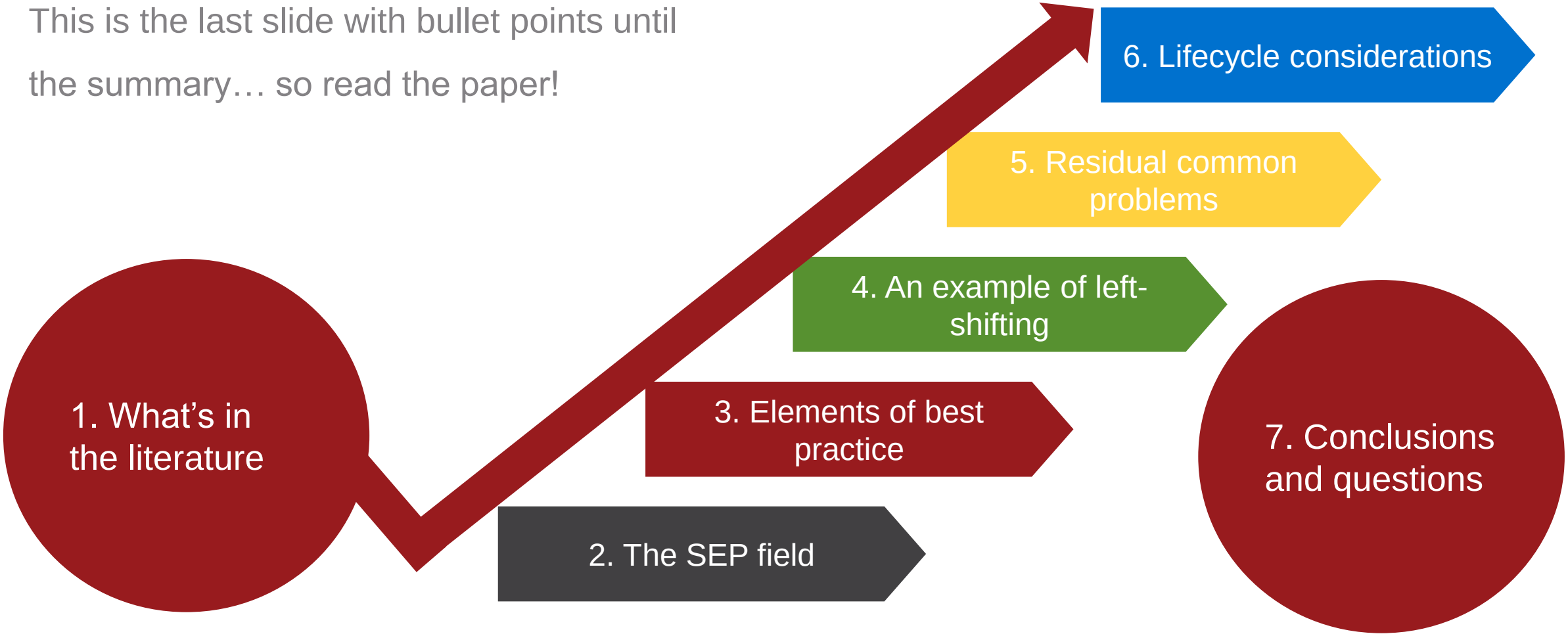
Aims of the paper

- To challenge the perception of an engineer as someone who ignores the world outside their System Element
- To remove the excuse “There’s no training or guidance on interfaces”
- To promote a whole-lifecycle view of interfaces, and left-shift their consideration in architecting

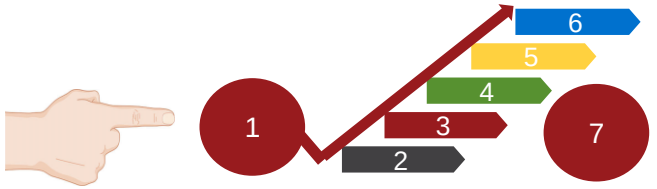


Outline

This is the last slide with bullet points until the summary… so read the paper!



What's in the Literature



IEEE Standards

IEEE Std 1220™-2005
(Revision of
IEEE Std 1220-1998)

1220™

IEEE Standard for Application and Management of the Systems Engineering Process

IEEE Computer Society

Sponsored by the
Software and Systems Engineering Standards Committee

IEEE

3 Park Avenue, New York, NY 10016-5997, USA

9 September 2005
Print: SH95334
PDF: SS95334

ANSI/EIA Standard

Processes for Engineering a System

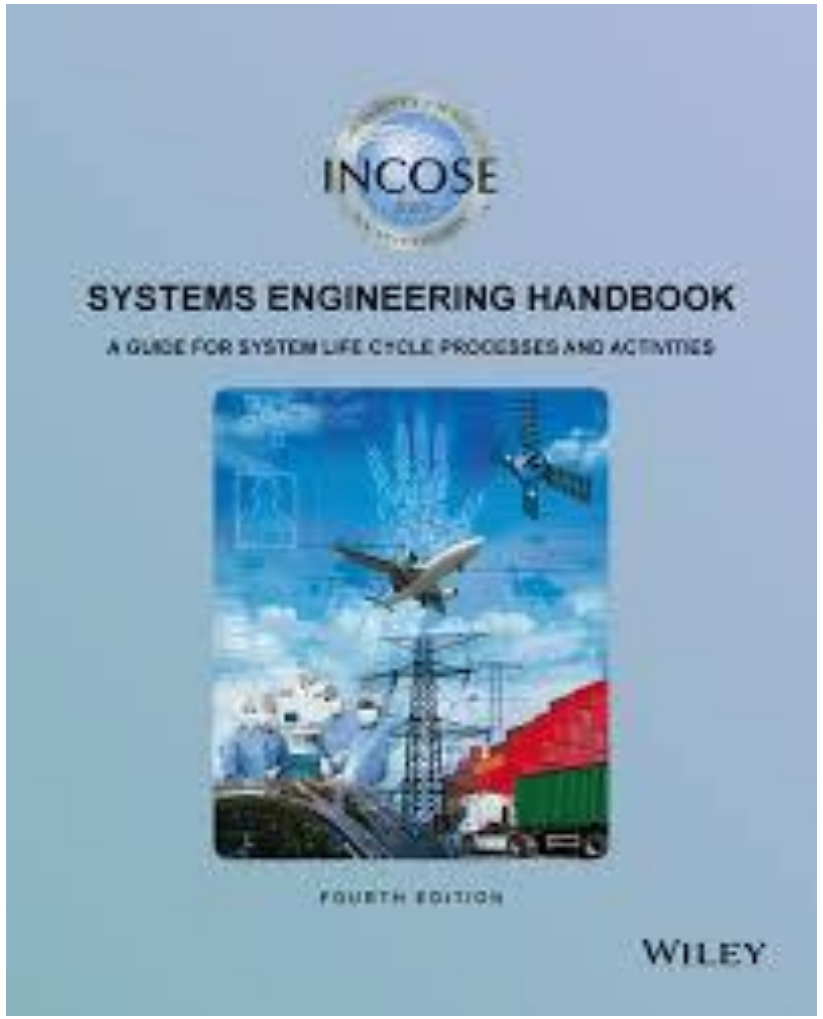
ANSI/EIA 632

NASA Reference Publication 1370

1997

Training Manual for Elements of Interface Definition and Control

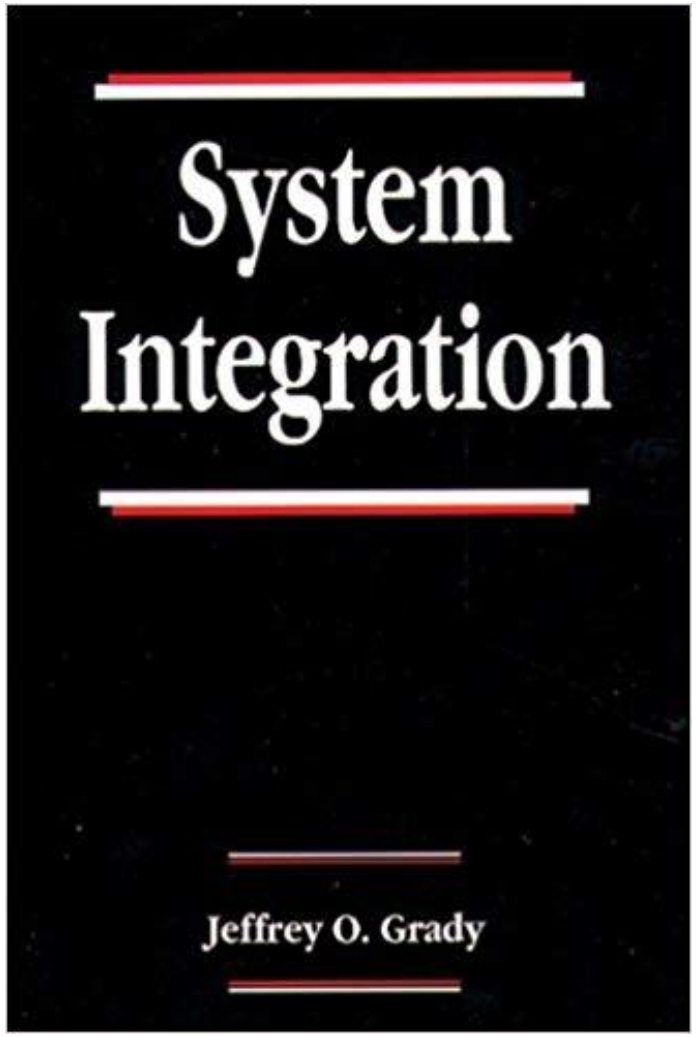
What's in the Literature

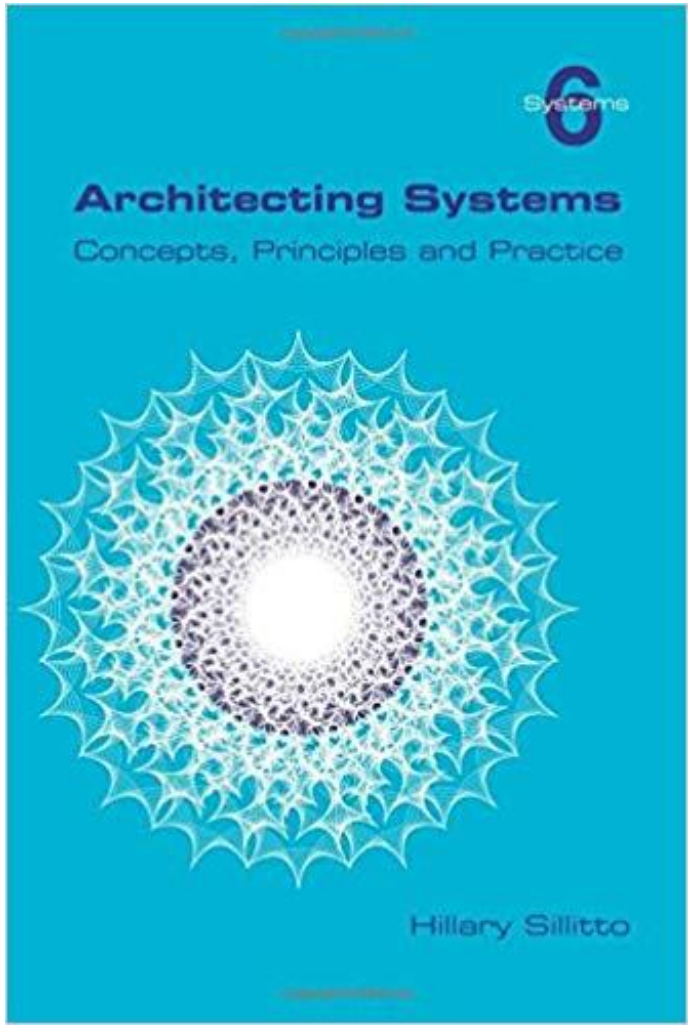


BKCASE SEBoK

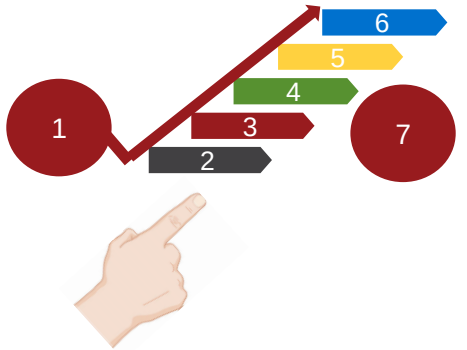
Guide to the
Systems Engineering Body of
Knowledge (SEBoK) version 1.9.1

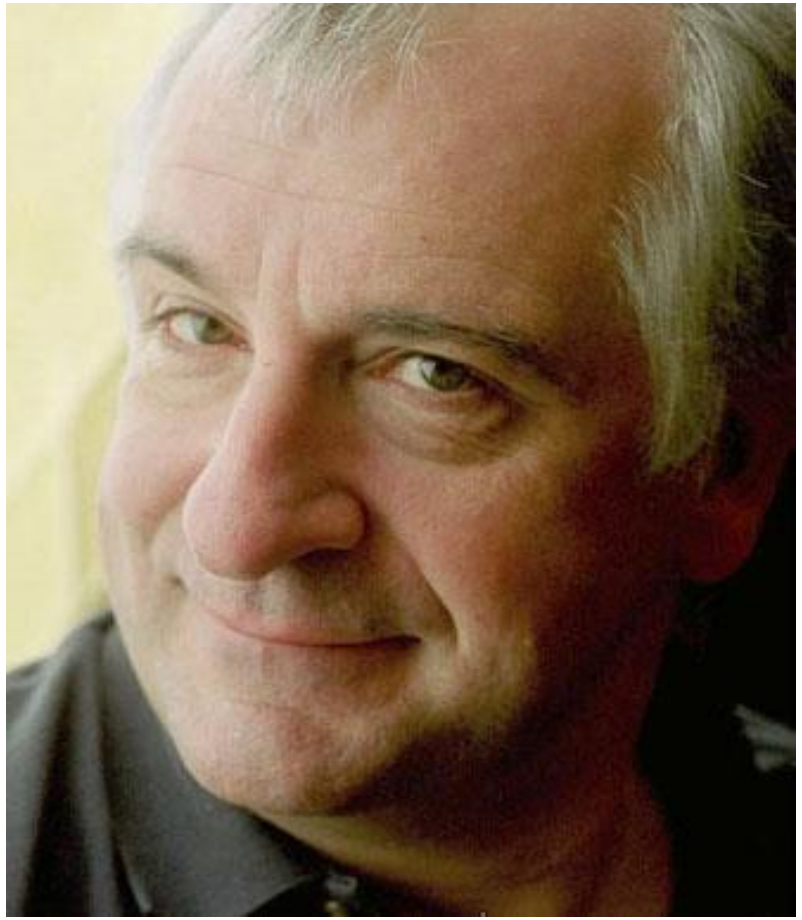
What's in the Literature



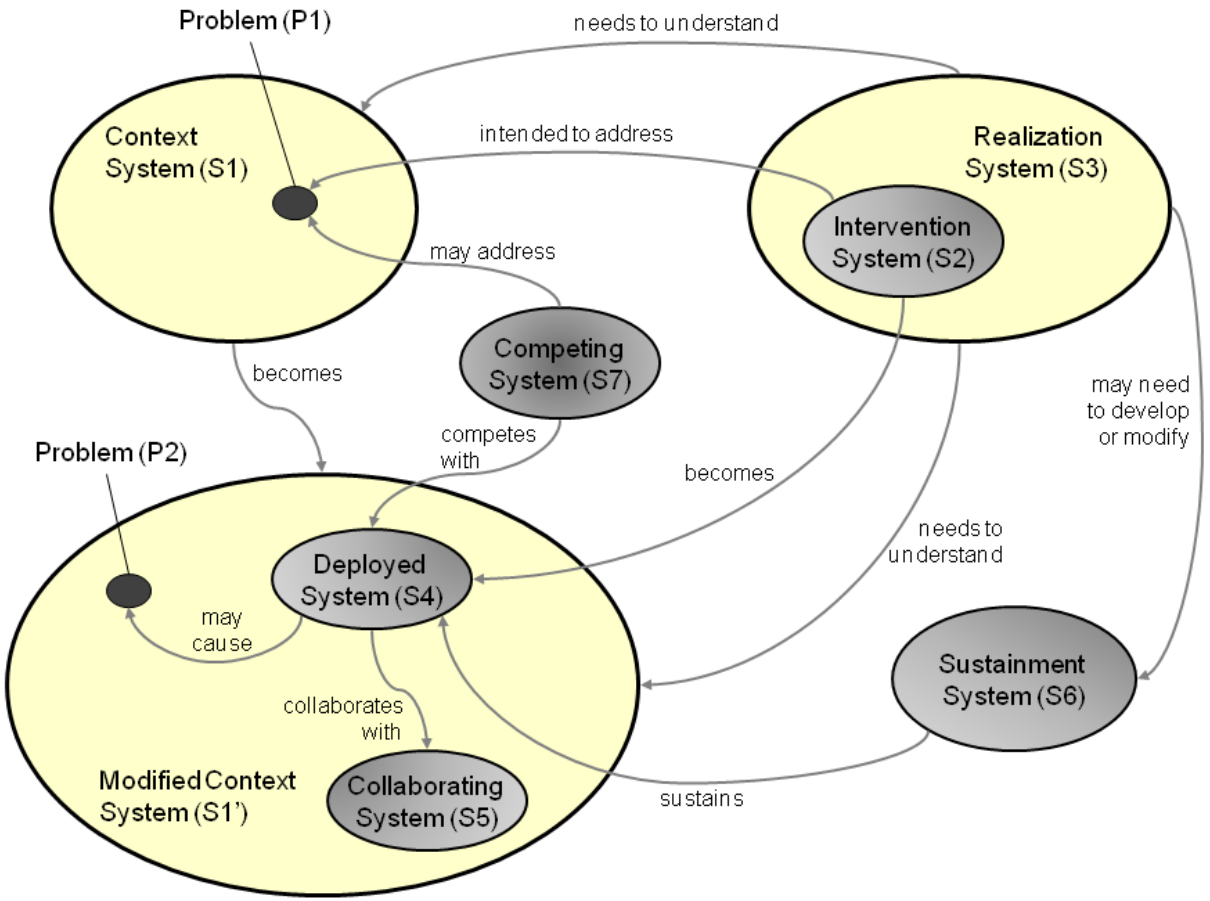


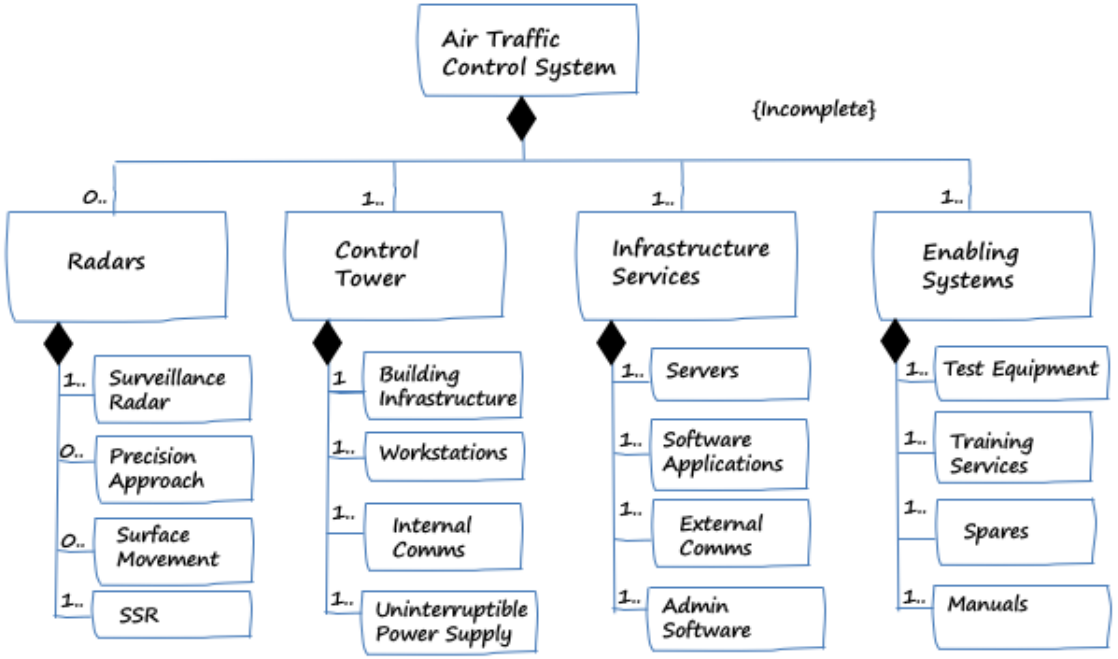
The “Somebody Else’s Problem” field



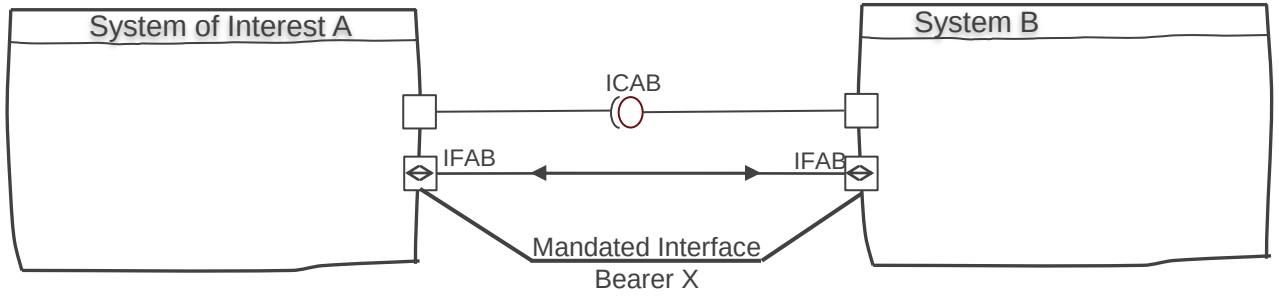


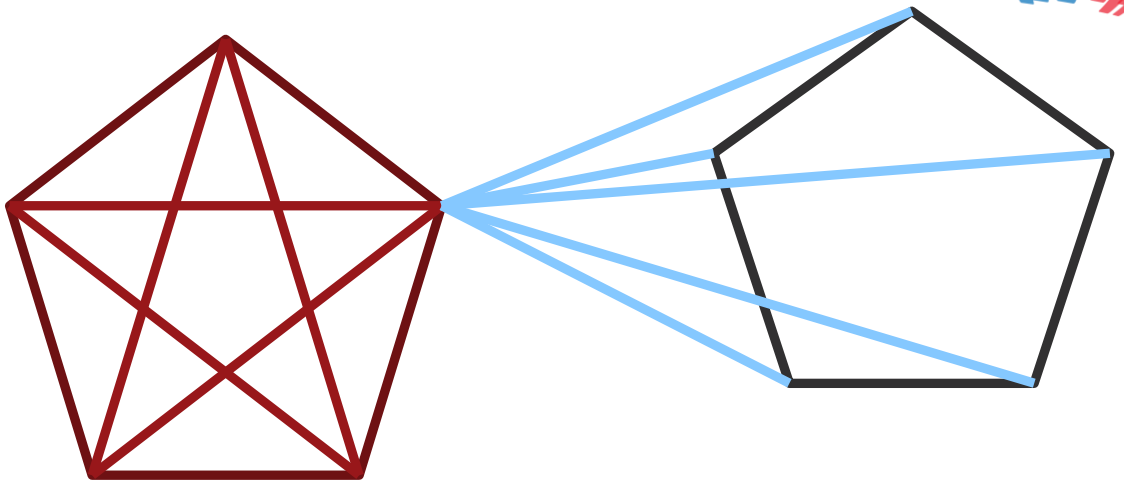
7 Samurai battle the SBS



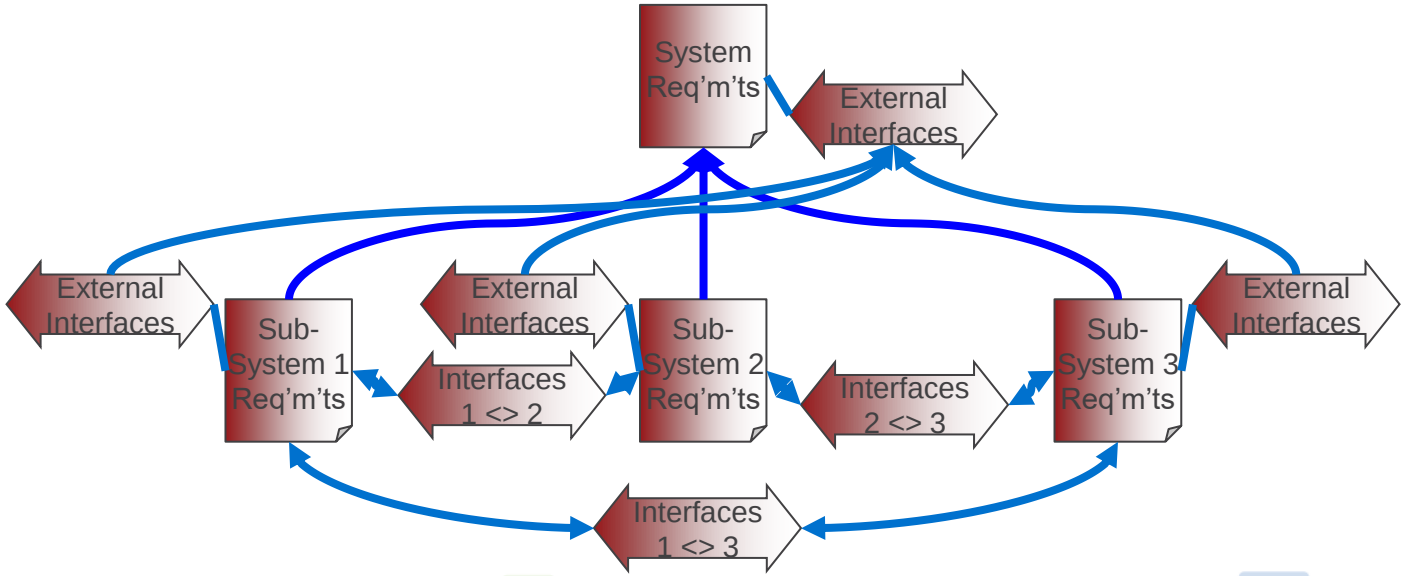


Why does it matter?





"System A shall interface to System B via bearer X"



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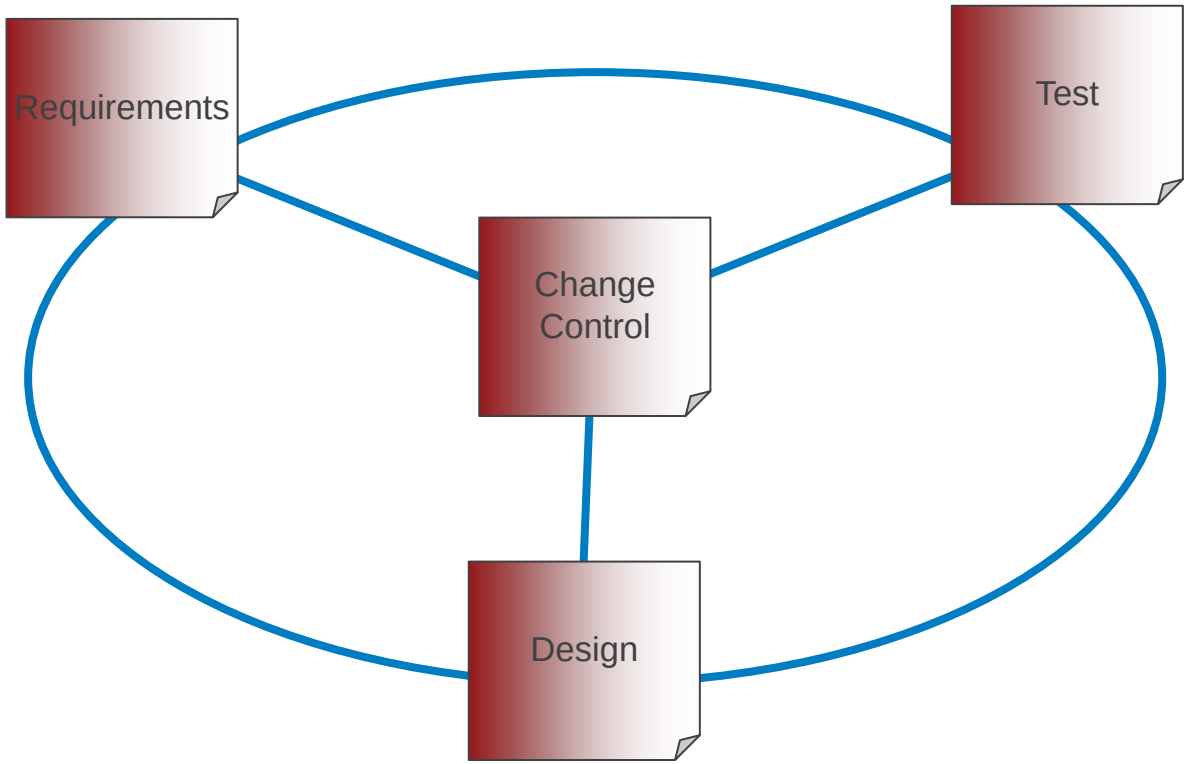
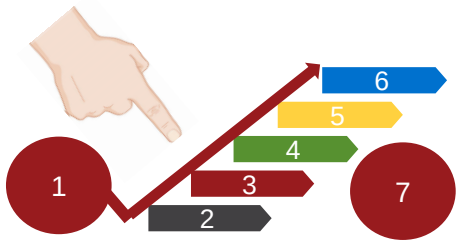


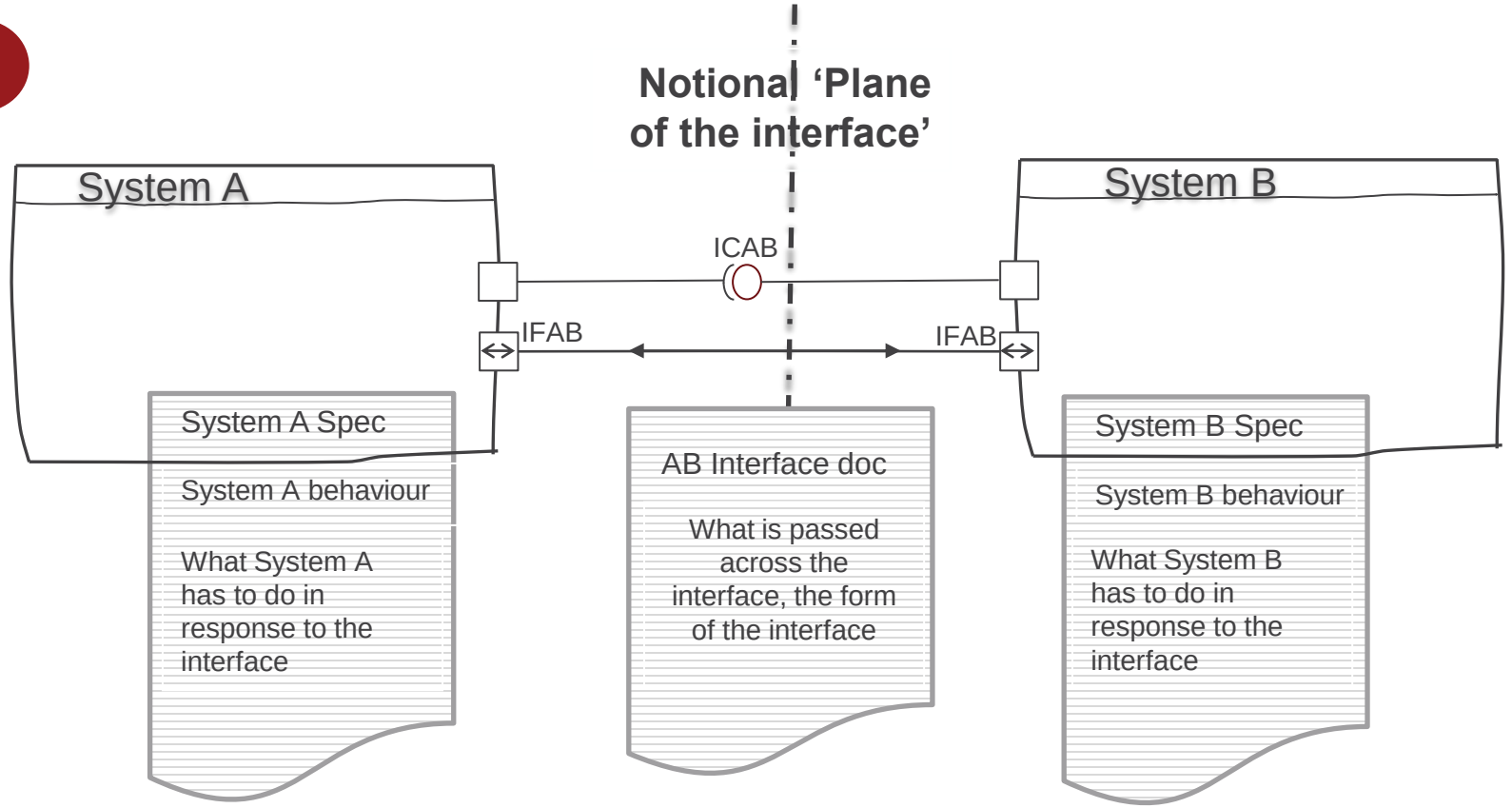
It’s not just software

- Electrical voltage + current (+ spikes)
- Vertical forces (time-varying)
- Longitudinal forces due to friction
- Heat
- Flash arcing
- Electromagnetic field flux (+RFI)
- Vibrational forces (resonance?)
- Shock (at joints)

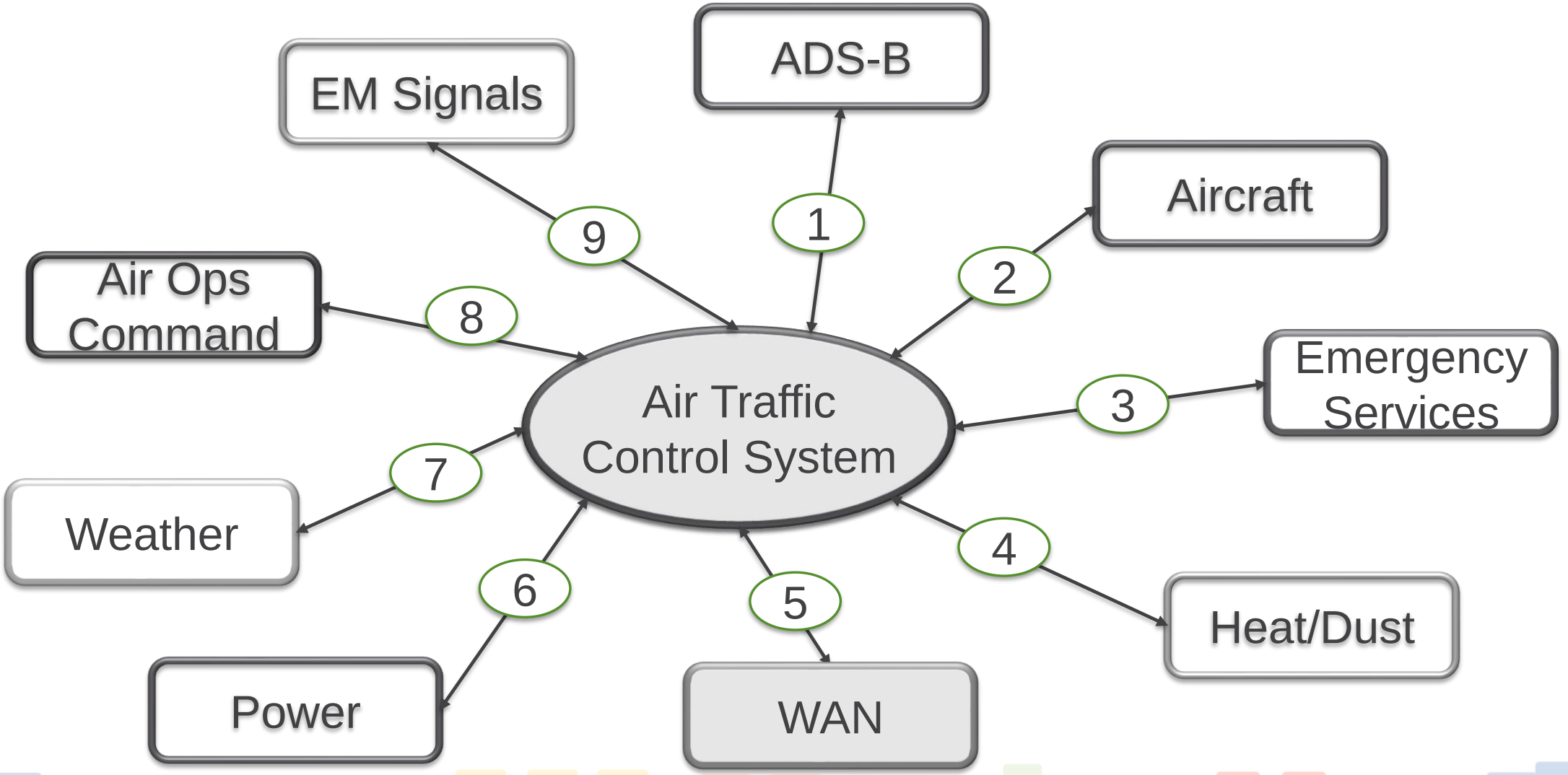
- Moisture & salt deposition
- Carbon deposits, rust, crud

Best Practice 1: the Separation Principle

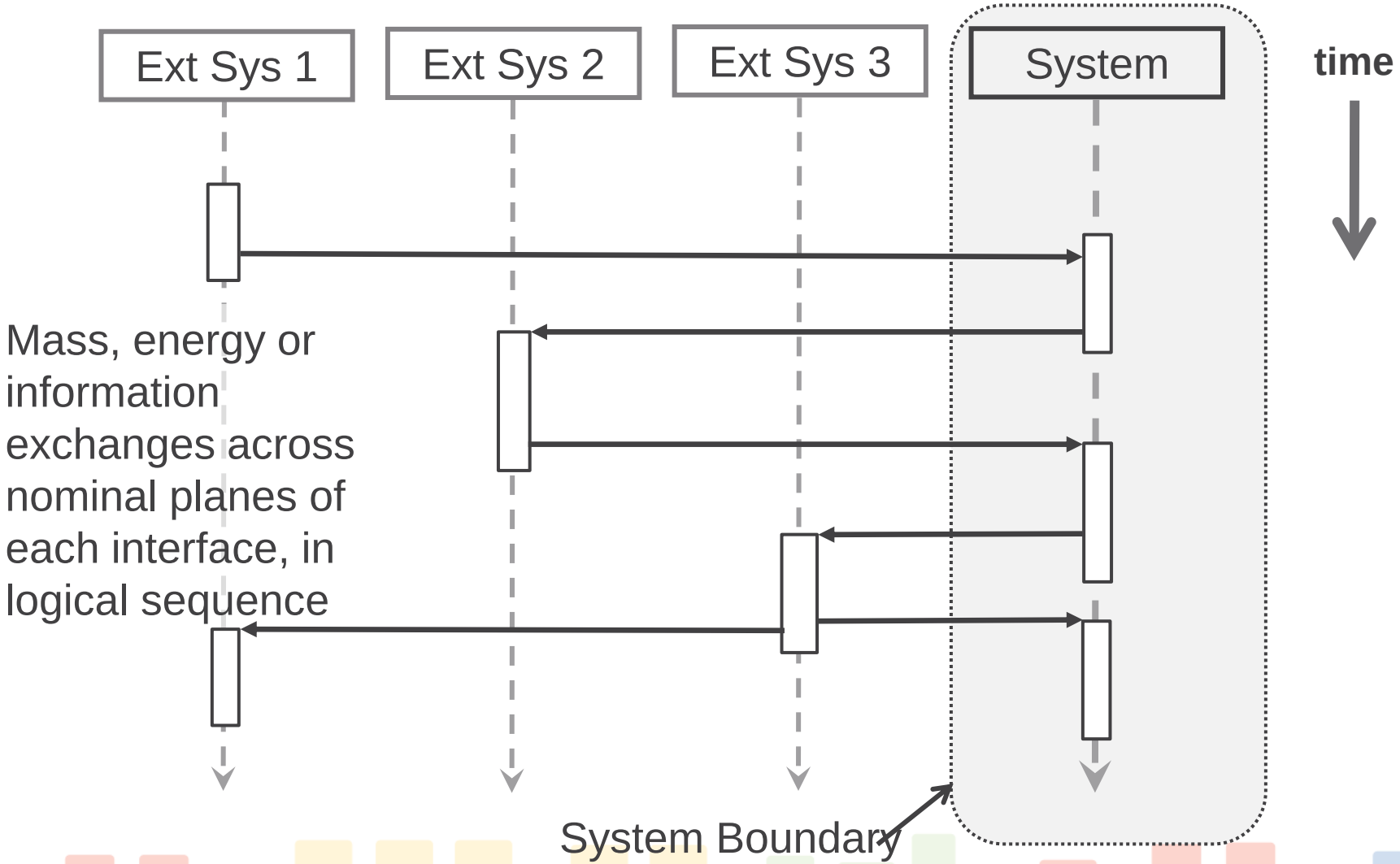




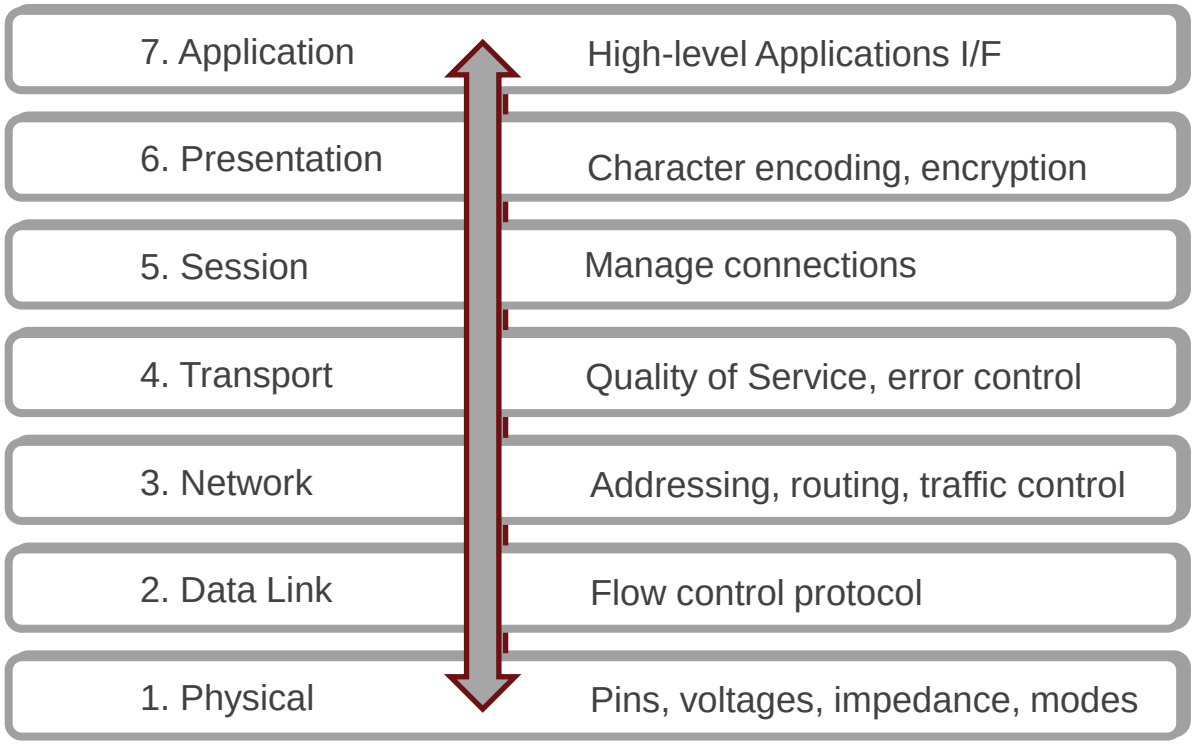
Best Practice 2: the Context Diagram



Best Practice 3: the Sequence Diagram



Best Practice 4: layered models as patterns



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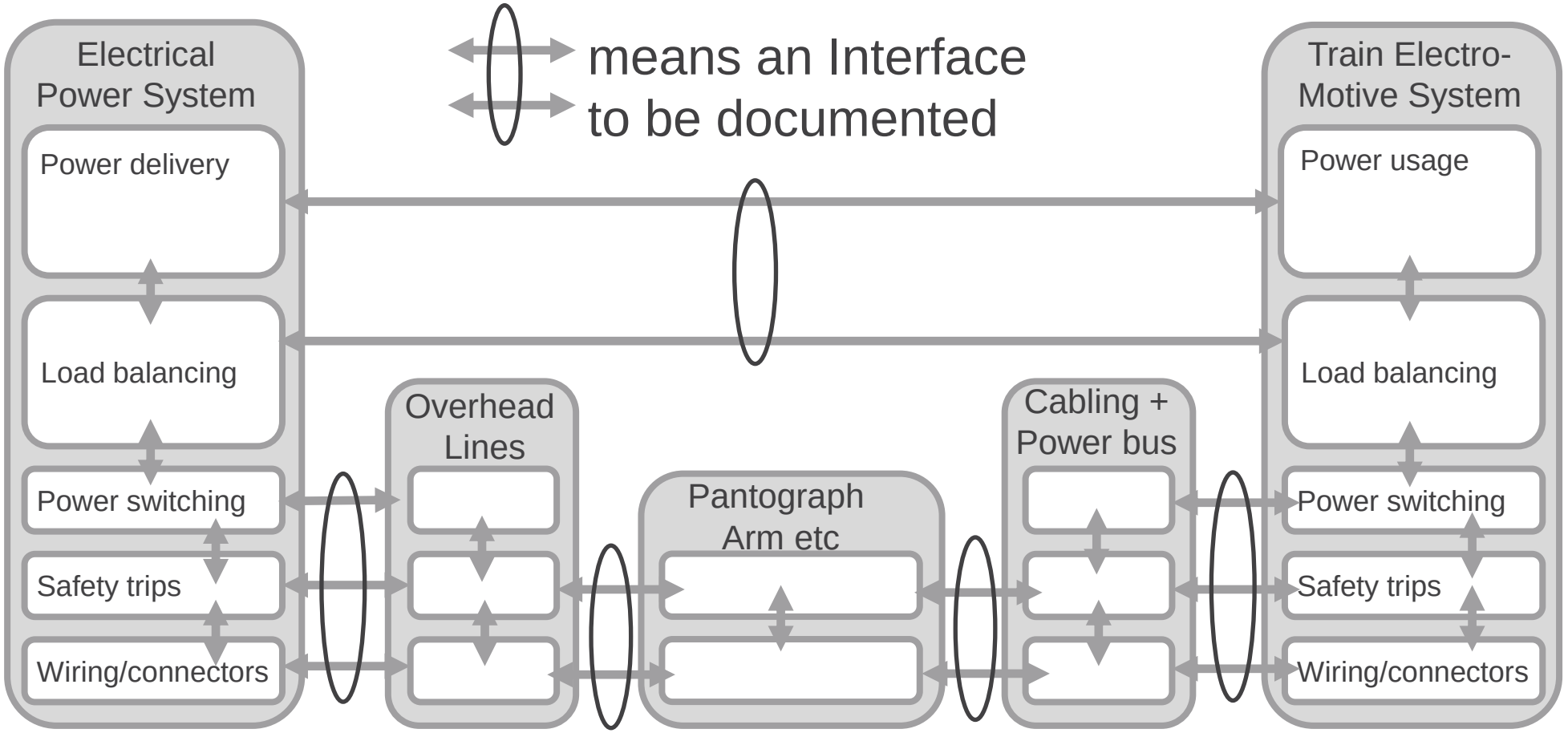
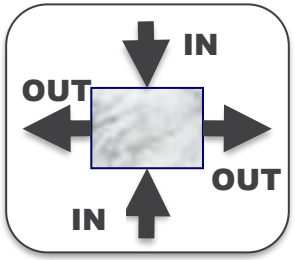


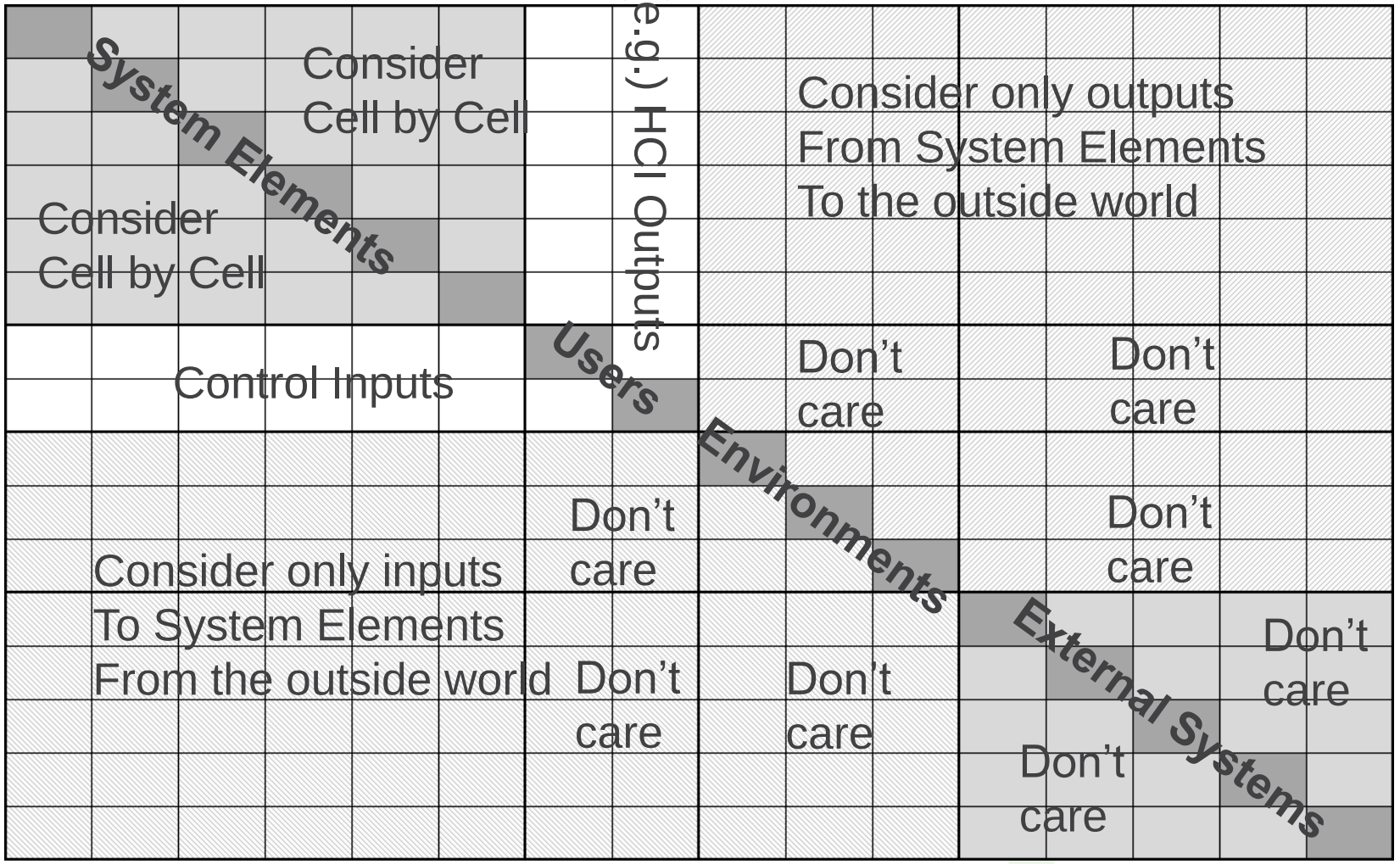
Best practice 5: black box N^2 chart

A -System Of Interest	B requires of A A provides to B	C requires of A A provides to C	D requires of A A provides to D	E requires of A A provides to E
A requires of B B provides to A	B - Users	C requires of B B provides to C	D requires of B B provides to D	E requires of B B provides to E
A requires of C C provides to A	B requires of C C provides to B	C - Physical Environment	D requires of C C provides to D	E requires of C C provides to E
A requires of D D provides to A	B requires of D D provides to B	C requires of D D provides to C	D - External System 1	E requires of D D provides to E
A requires of E E provides to A	B requires of E E provides to B	C requires of E E provides to C	D requires of E E provides to D	E External System 2

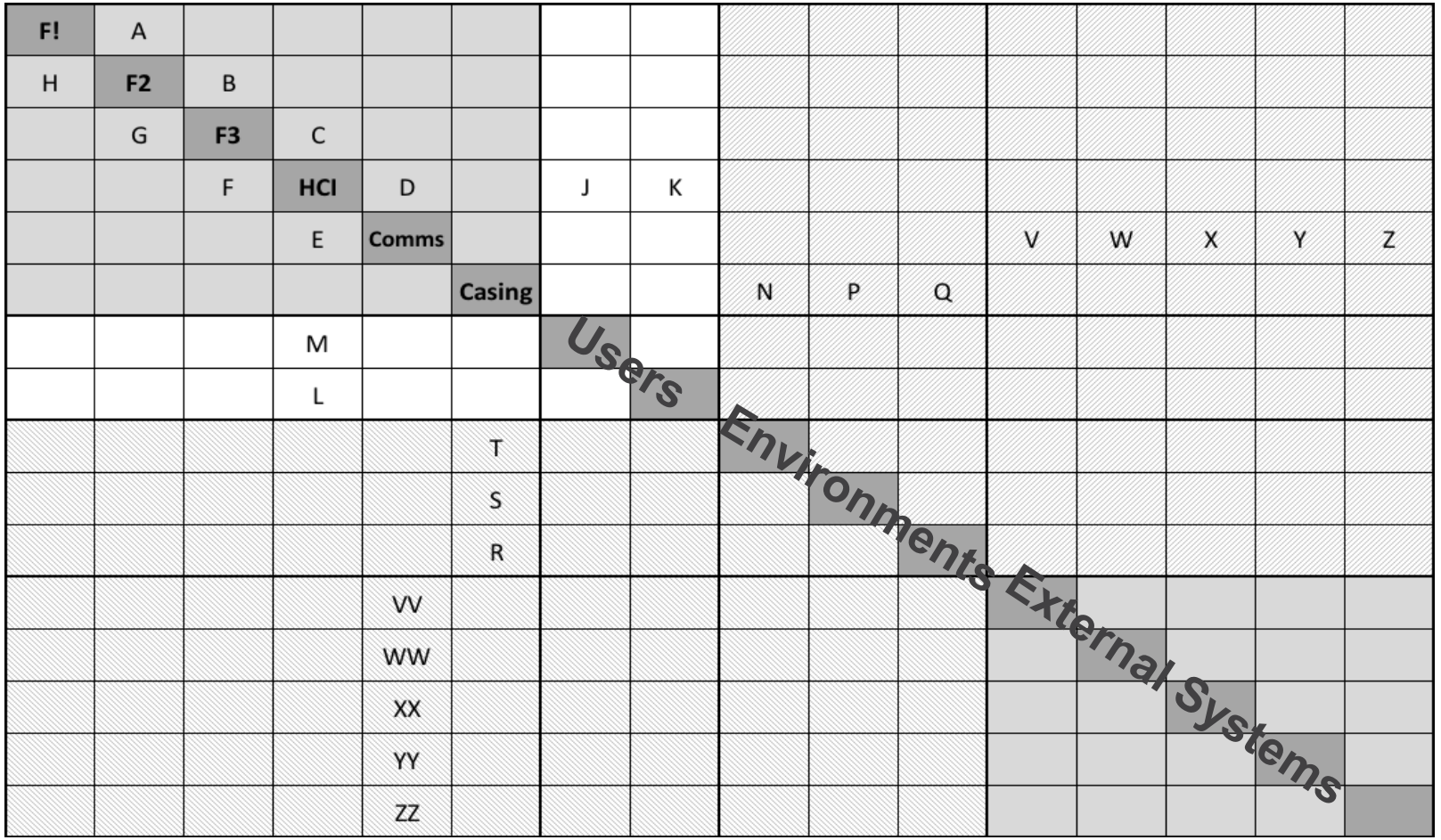


…etc

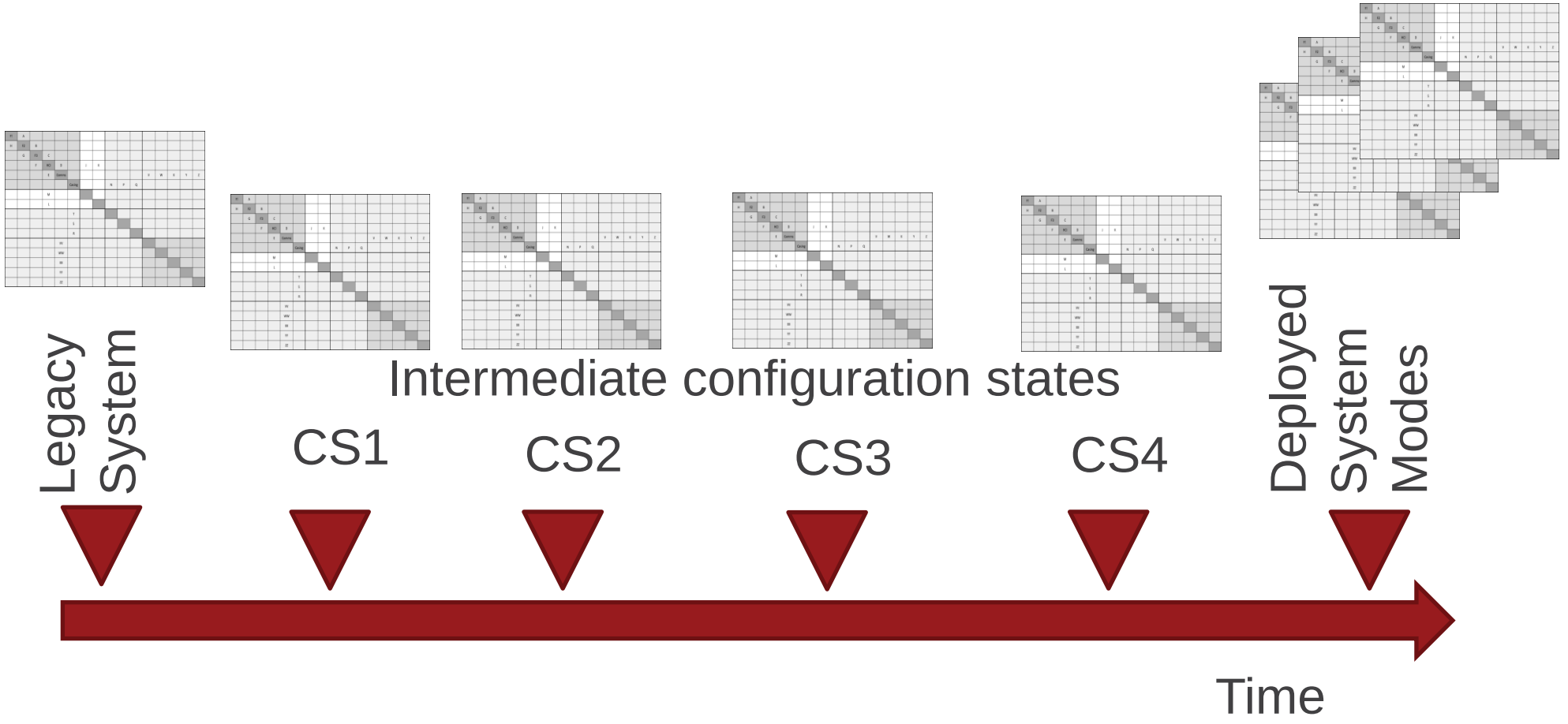
Best practice 6: white box N^2 chart



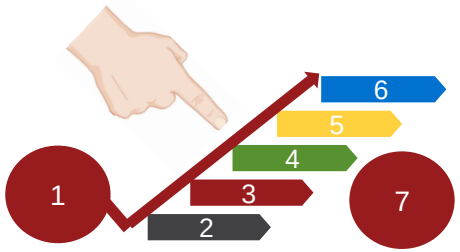
Best practice 7: optimised N^2 chart



Best practice 8: phased implementation N^2



Left-shifting…



Requirements → Architecting → Logical / Functional Design → Physical Design →

Becomes…

{Interface design at successive levels of analysis}

Requirements → Architecting → Logical / Functional Design → Physical Design →

Interface constraints

{Interface analysis feedback loops}

Pantograph example again

Electrical voltage + current (+ spikes)

Vertical forces (time-varying)

Longitudinal forces due to friction

Heat

Flash arcing

Electromagnetic field flux (+RFI)

Vibrational forces (resonance?)

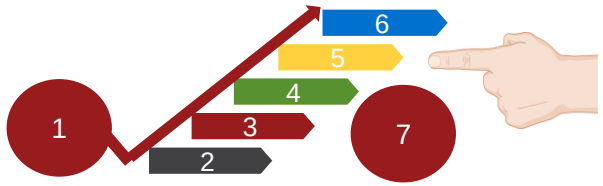
Shock (at joints)

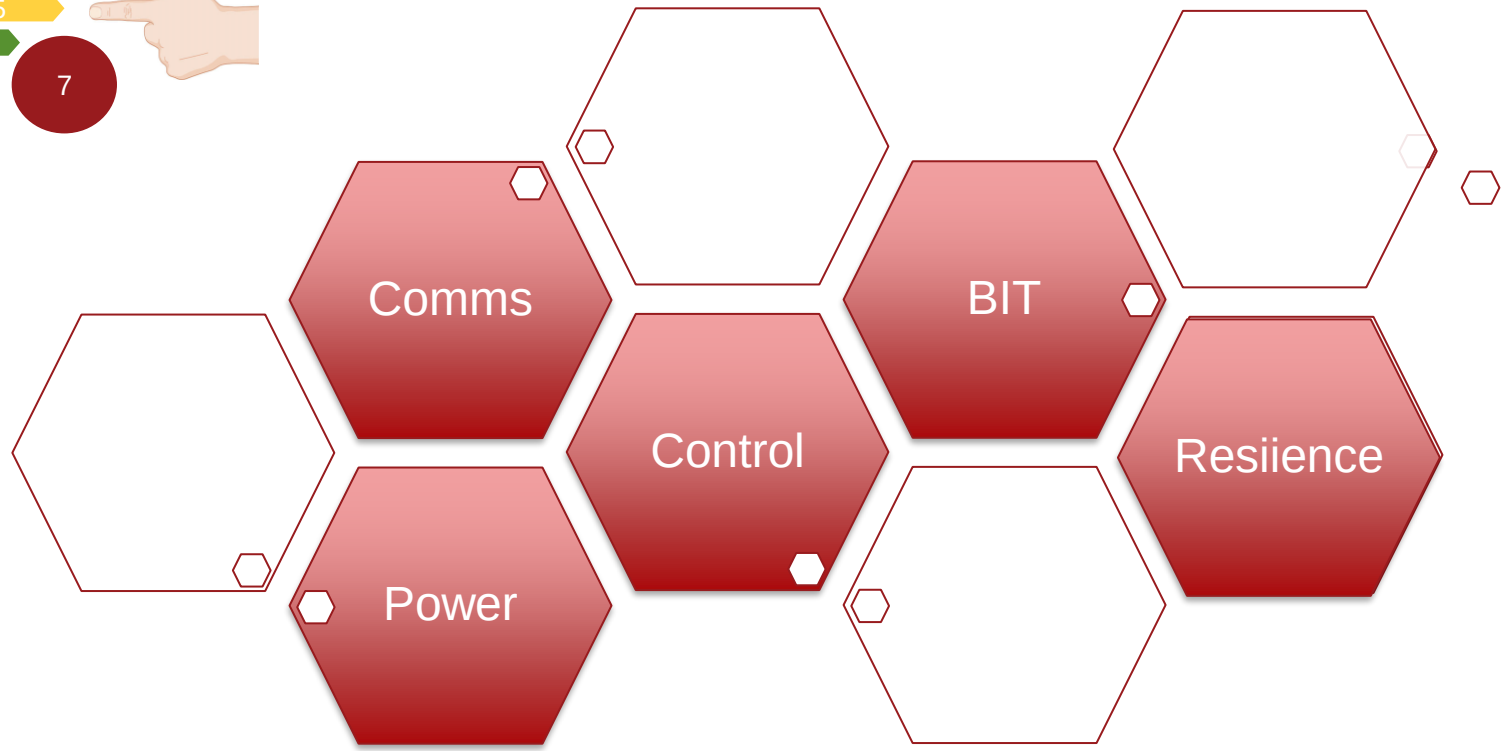
Moisture & salt deposition

Carbon deposits, rust, crud

The flows across the interface drive extra functional and non-functional requirements on the System Elements at each end

Residual architecting decision patterns for interfaces





Lifecycle of interface-based architecting

Draw the context

Identify the external I/Fs

Current vs Future

Agree way forward

Trial decomposition into subsystems

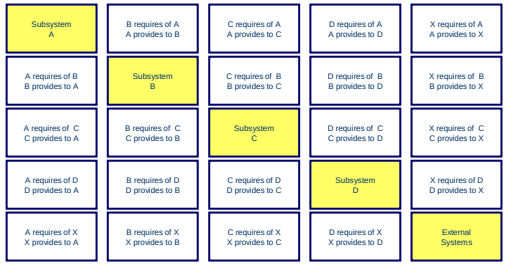
Evaluate effect on interface decompositions

- Organisations
- Complexity
- Number
- Risk

OK?

N

Y

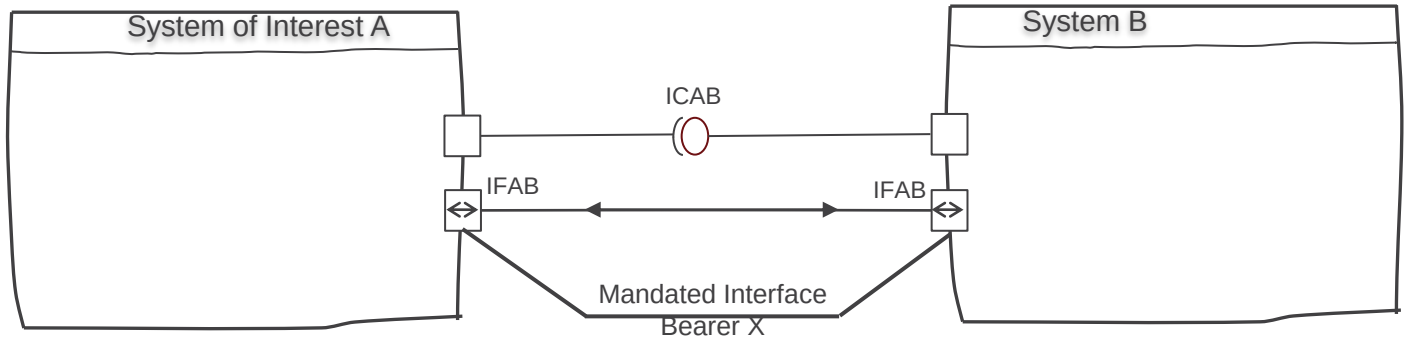


Generate Specification tree

Get on with it!

Phased testing

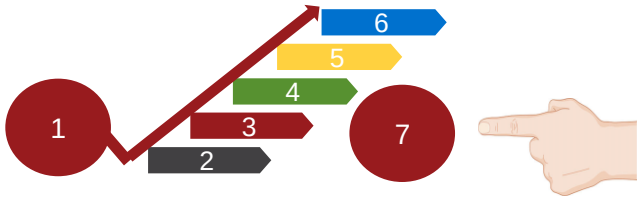
The requirement from hell, and future-proofing



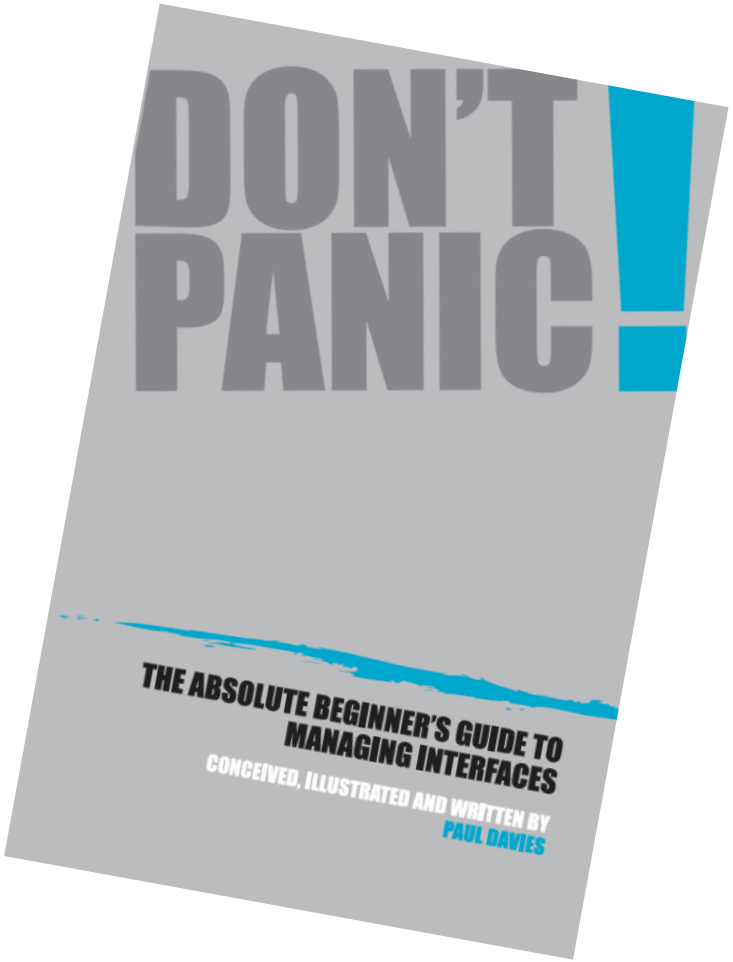
“System A shall interface to System B via bearer X”

- Bearer X in service; System B to be accepted
- System A envisaged, with interfaces
- IDD published for X; IRS created for A<->B
- System B accepted; ITT for System A uses IRS + IDD
- System A procured at lower cost & risk
- Negotiations between suppliers for A and B brokered -> ICD

Conclusions



- We have looked at gaps in the literature, and started to overcome the lack of a lifecycle-oriented view of interface evolution.
- We have outlined some key principles associated with interfaces, and looked at some best practice methods of representing and elaborating them.
- We have stressed the use of interface analysis in architecting Systems throughout their lifecycle.
- We have encouraged engineers to look outside the box.



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