So what are in service systems?

A soft systems analysis of in service systems engineering

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Caveats

- This presentation represents the authors personal views and does not necessarily reflect the opinions or policies of HM Government
- This work remains a ‘work in progress’. Some of the activity diagrams have been updated as a result of the work of the UK and international ISS WGs.

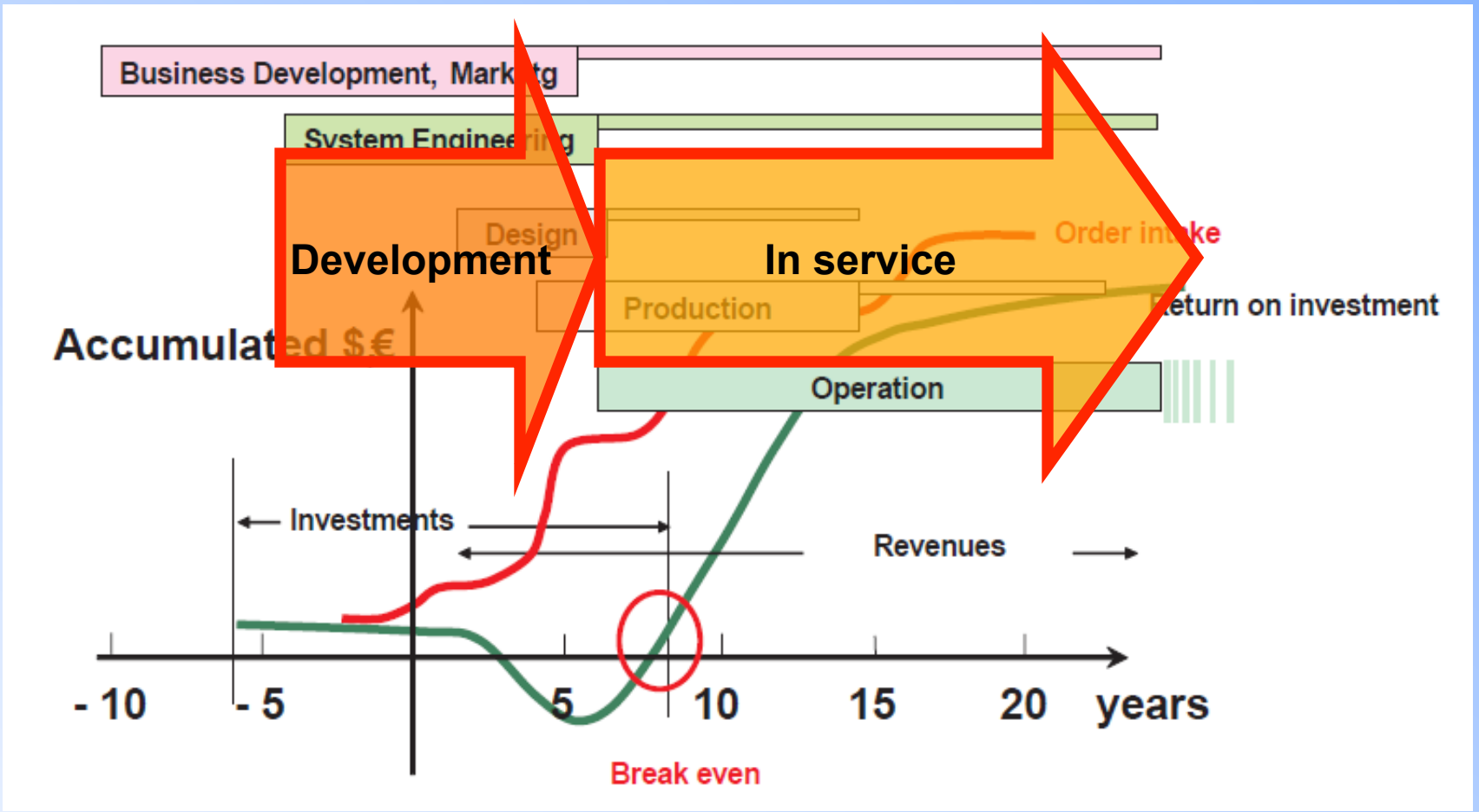
Overview of presentation

- Background
  - In service systems engineering
  - Being the UK MOD's C4 Architect
  - Checkland's soft systems methodology
- Four worldviews
- A journey of discovery
- Summary and conclusions
- Recommendations

Background

- Most systems spend more time ‘in-service’ than in development
- Most systems are upgraded several times through life
- In-service costs dominate through life costs
- Very few SE’s have worked on in-service systems – and most of them have been involved in upgrades/enhancements
- INCOSE UK 2007 workshop and 2008 working paper started to tackle the problem
- … but focussed primarily on upgrade

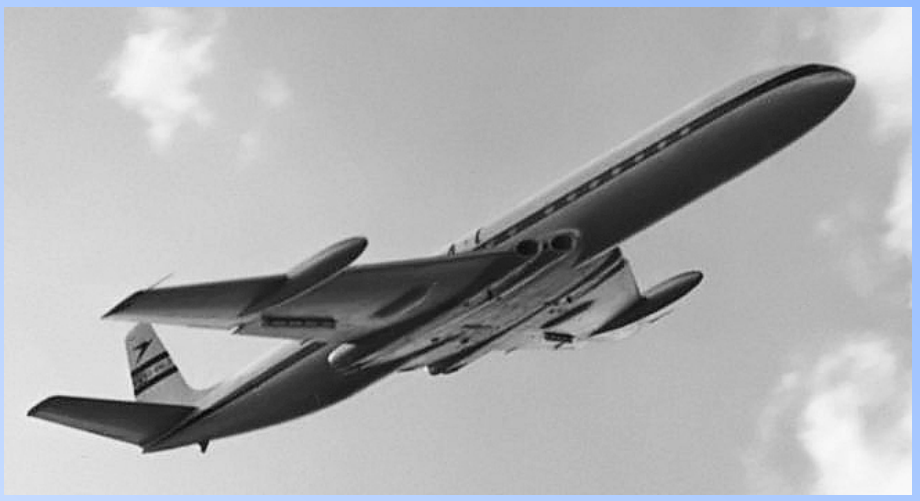
So when do we do SE?



From INCOSE Handbook 3.1

Another perspective?

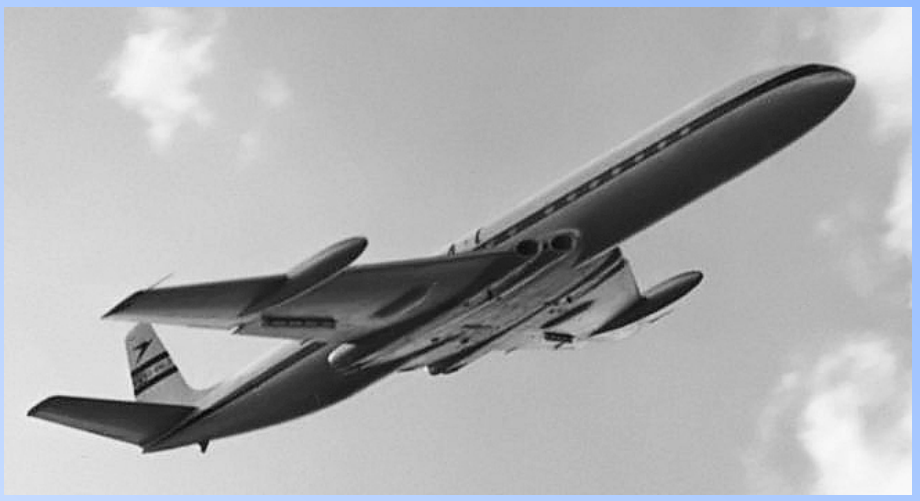
- 2 May, 1952 start of commercial Comet operations
- 10 January 1954, Comet G-ALYP breaks up 20 minutes after taking off from Rome
  - Fleet grounded
  - Board concluded probable cause fire
  - Fire safety improved
- 23 March 1954, flights resume
- 8 April 1954, Comet G-ALYY crashed after leaving Rome
  - Fleet grounded
  - Rig tests on G-ALYU identified serious design flaws
  - Fatigue problems caused by square windows
- Redesigned Comet 4 enters service in 1958



Comet image by RuthAS

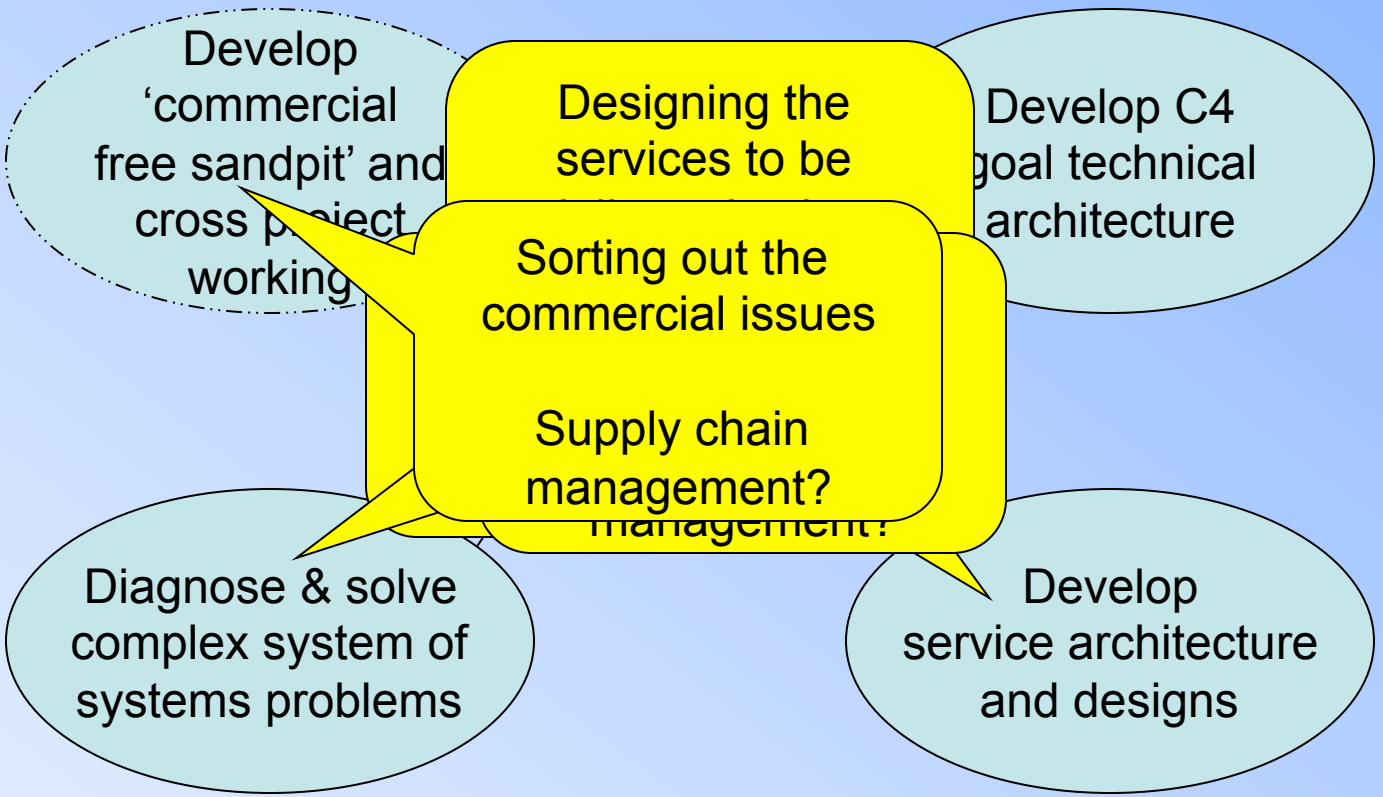
Systems engineering failure and success?

- Initial development failures
  - Square windows and stress concentration
  - Lack of full pressurisation cycle testing
- In service management
  - Incident response
  - Initial false diagnosis
  - Failed to wait for reconstruction
  - Full pressurisation cycle testing
  - Comparison with forensic reconstruction
  - Detailed fatigue testing
  - Corrective actions



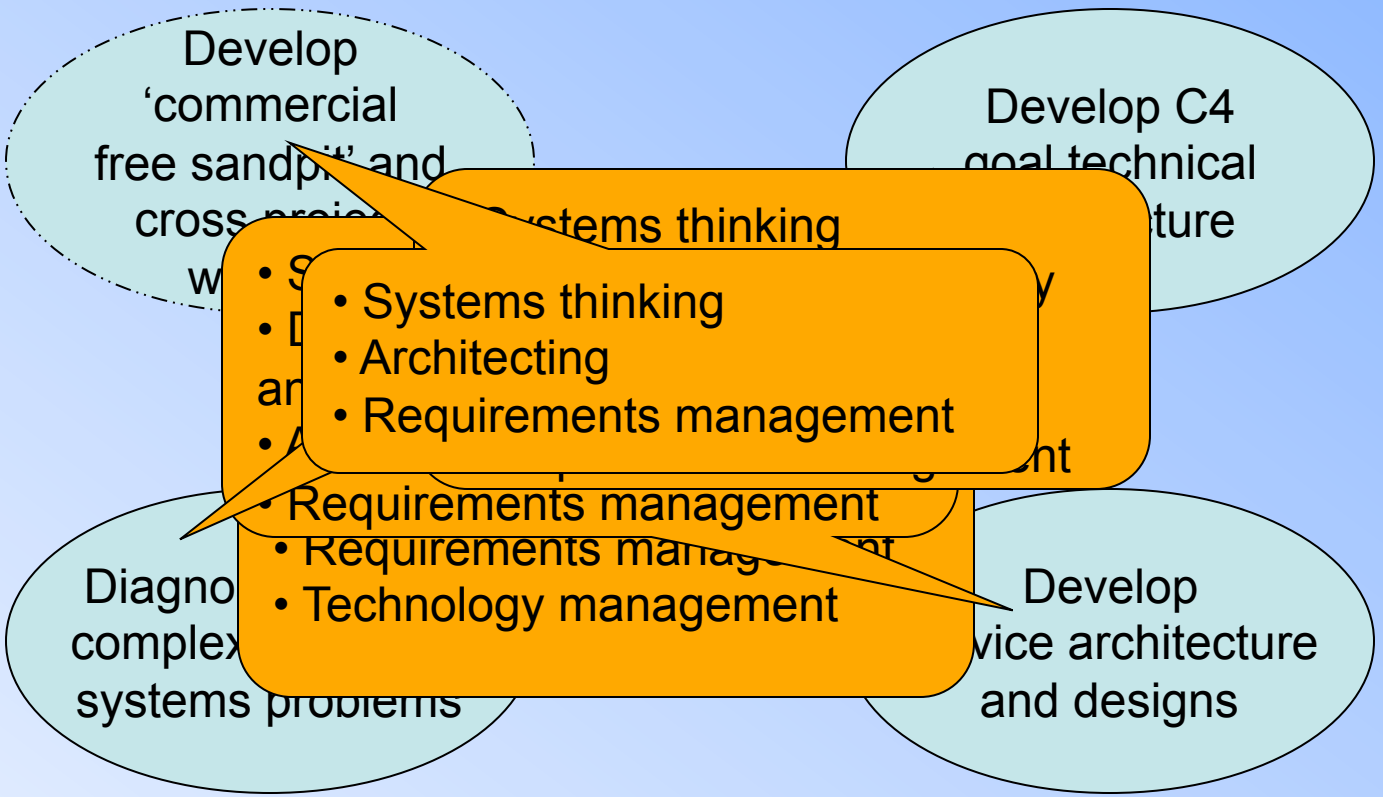
Comet image by RuthAS

So is in service SE just upgrade?



1. Role at end 2008

And what tools and techniques?



1. Role at end 2008

If it looks like SE, smells like SE and feels like SE …

- If you are
  - Developing and using architectures
  - Developing and using FMECA's
  - Designing for performance and supportability
  - Managing requirements
- … it must be SE?
- But where is the project or programme?
- ***In service SE is about Upgrade – but there is something else as well***

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Different perspectives

- Multiple perspectives – more than one of which can be true
- Based upon Checkland's "Systems Thinking, Systems Practice" 1981
- Applying standard systems thinking to human activity systems
- Helps to understand tacit differences in understanding of system

Weltanschauung – a railway example

Alternative Weltanschauung for a railway

1. A business that makes a return on investment for its shareholders
2. A low carbon and low congestion transport system for the economy
3. An organisation to employ the brothers

Each Weltanschauung implies a different

- Boundary
- Actors
- Environment
- Process
- Owner

- … Purpose

Communicating across different Weltanschauung is extremely difficult

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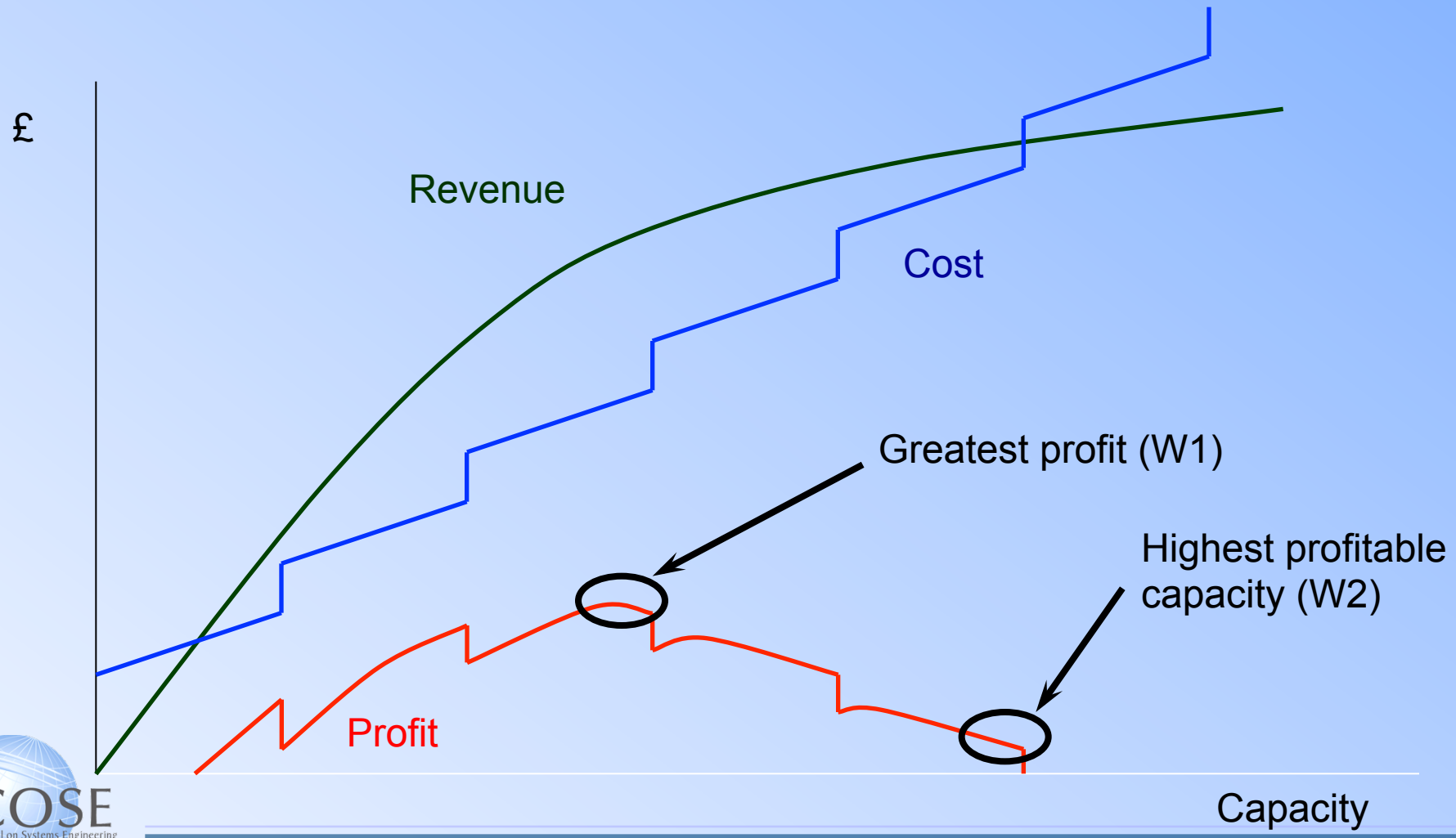
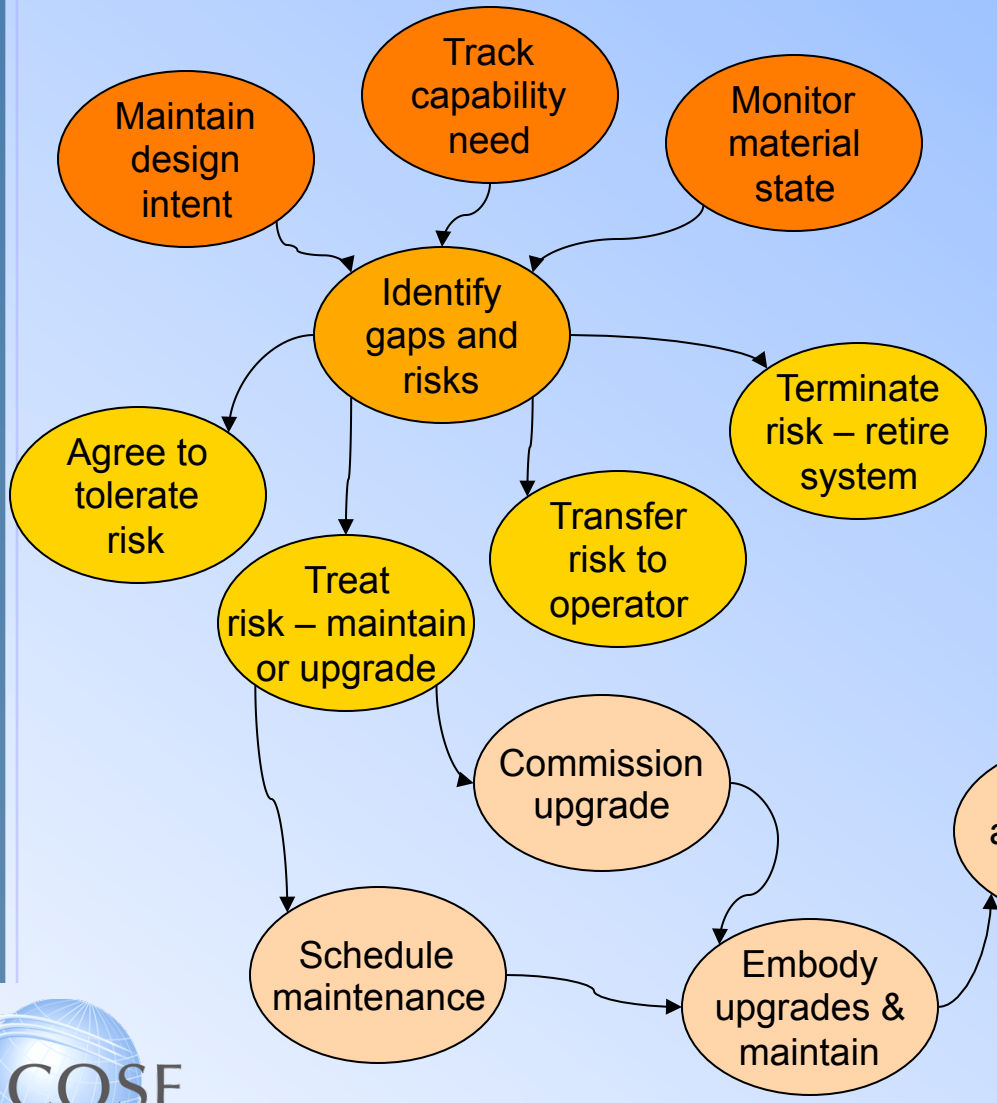
Different weltanschauung – optimum profitable capacity



Four Weltanschauung

- Asset Management
- Upgrade
- Service Delivery
- Supply chain management

W1 – Asset Management



Purpose: Manage operational and safety risks

Key actors: Design authority
Maintainers
Operators / sponsor

Issues: Continuous monitoring process
Risks are operational, availability and safety
Upgrade is a 'black box'

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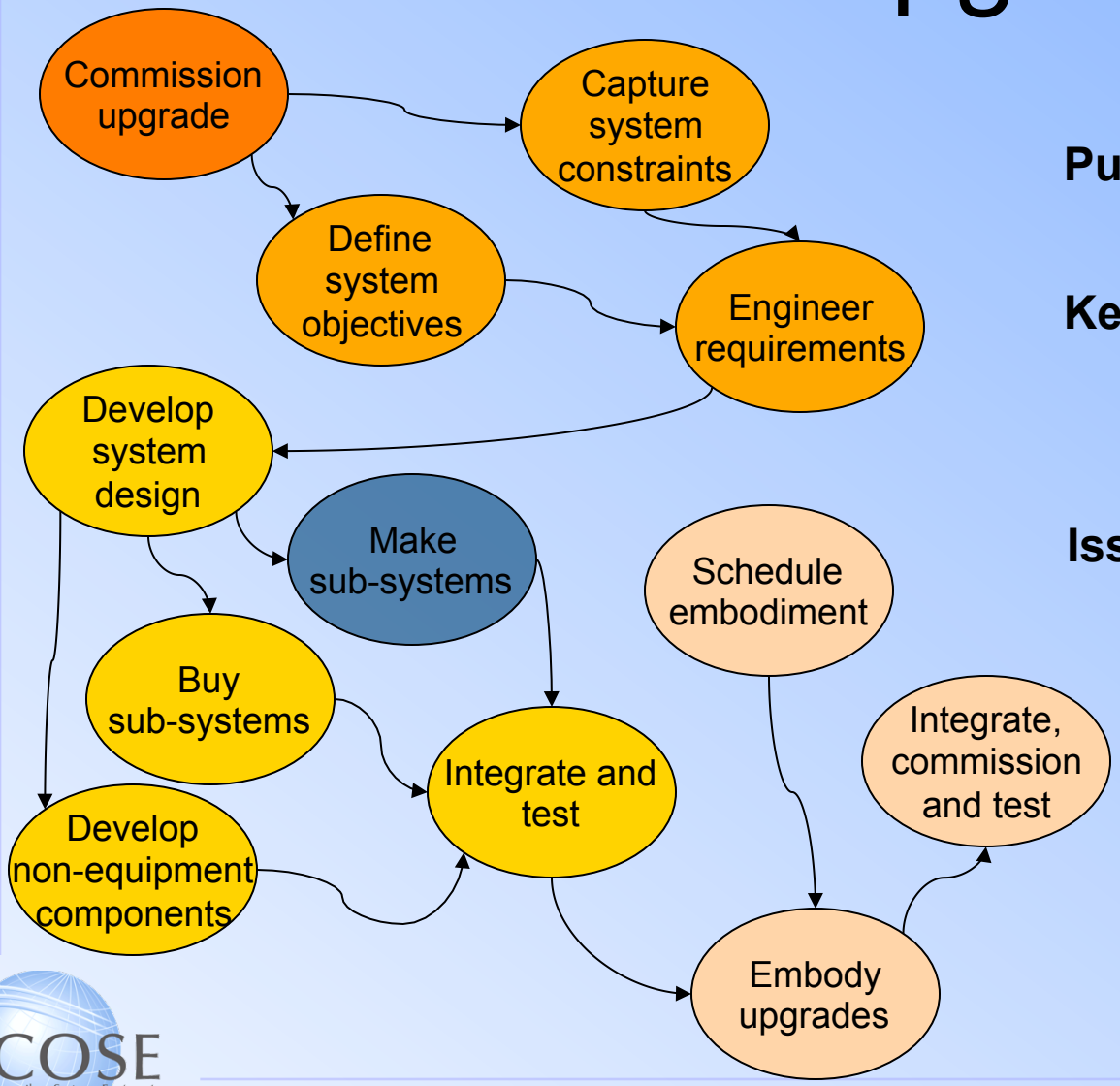
Asset management example

- 5/3/09 – Door motor burns out after 1937 hours
  - Replace motor
  - Record - NFA
- Next month three further door motors burn out at ~ 2000 hours
- Initiate diagnosis
  - FMECA suggests manufacturing error or moisture ingress
  - Door motors examined on three trainsets in depots – signs of condensation next to motors
  - On board monitoring identifies significant increase in moisture levels in final car due to recently introduced selective door opening
- Tolerate the risk in the short term
  - Increased inspections
- Treat the risk
  - Manufacturer offers more expensive motor with higher environmental spec
  - Upgrade action initiated

W2 – Upgrade



Purpose: Improve system performance

Key actors: Design authority
Upgrade manager
Upgrade developer
Maintainers

Issues: Problem understanding and option trade-off already completed …
Embodiment through 'modification kit'
Factory and installed testing

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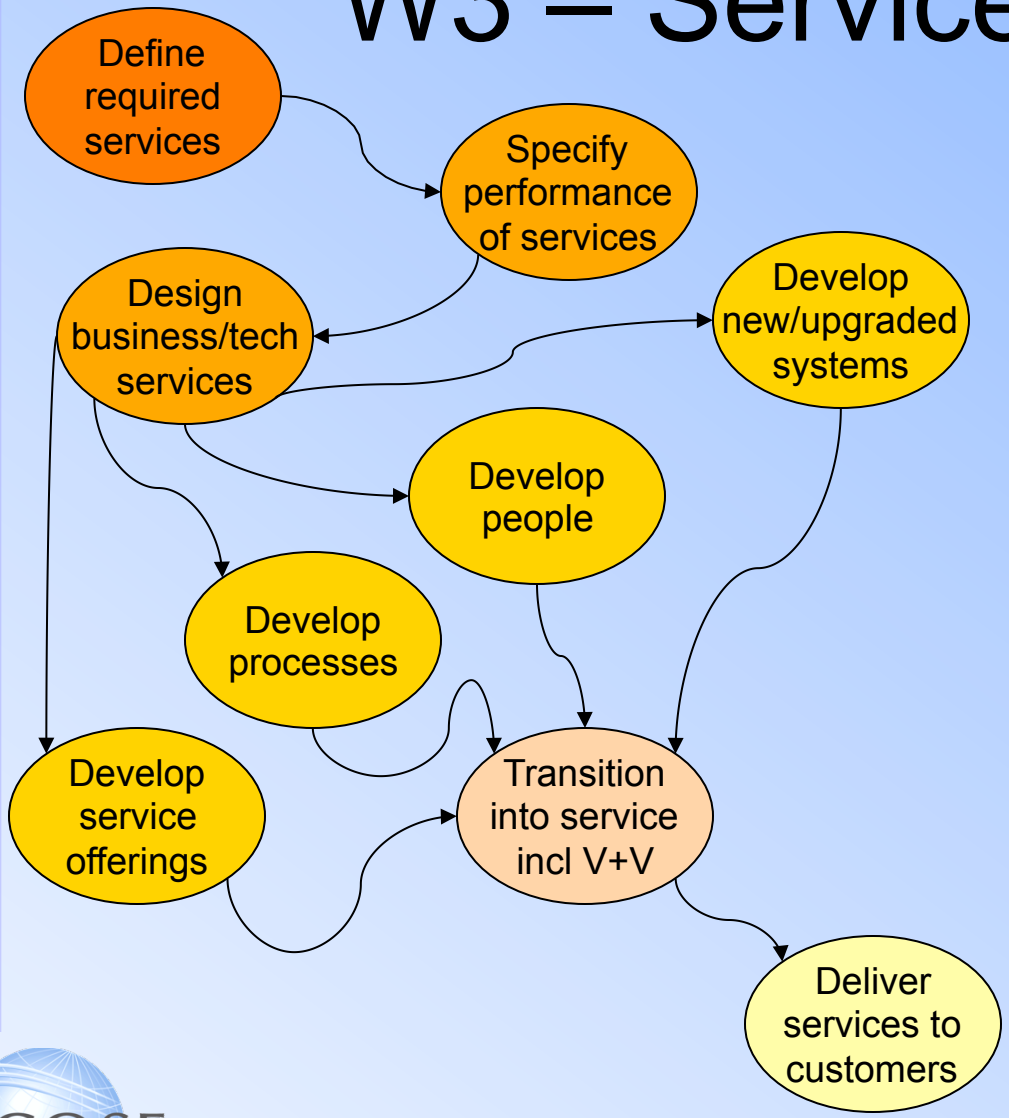
Upgrade example

- Submarine combat system upgrade commissioned to improve reliability and effectiveness of current system
- System requirement developed based upon
  - Fitting in with current submarine constraints (power, cooling, weight, space, …)
  - Required capability enhancements
- High level architecture for combat system developed, including
  - Sonar, command system, data highway, …
  - Interfaces between elements and with current submarine
- Components developed and proved in shore integration facility
- New combat system installed at appropriate maintenance period
  - Components delivered in easy to install packages
  - Installed and set to work
- Harbour then user acceptance. Crew workup on new combat system

W3 – Service delivery



Purpose: Deliver services to customers

Key actors: Operator
Business strategy
Service designers and integrators

Issues: Multiple lifecycles (strategy, system, service)
All are asynchronous!
Lots of many to many relationships

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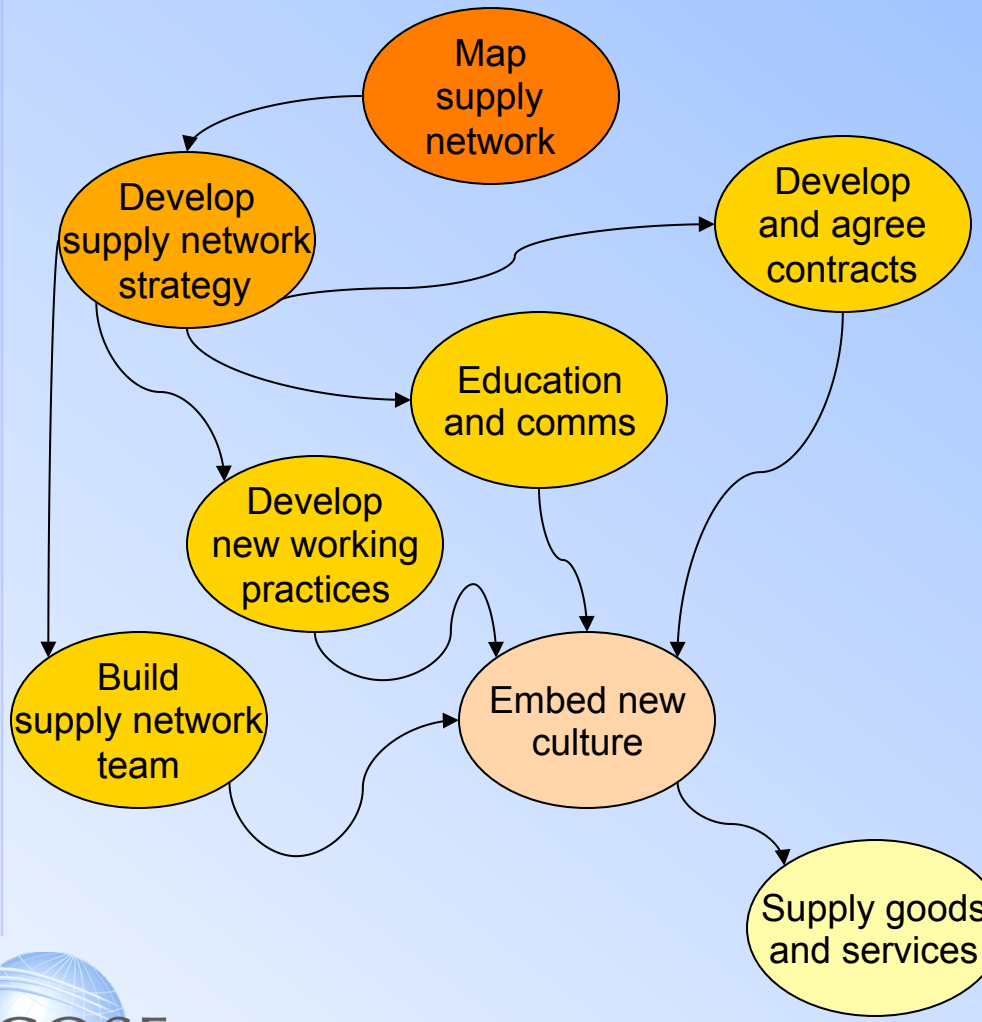
Service delivery example

- Agree need for global secure e-mail
- Determine geographic coverage, security levels, required message transit time, users
- Design service, including:
  - Communications, IT and applications
  - Interfaces, standards and customisation
  - End-to-end performance analysis
  - Agree support arrangements
- Customise current equipment, develop and prove interfaces, produce training material, trail support arrangements, address lists
- Transition into service – rollout plan, roll back plans, …
- Deliver global e-mail services – monitor performance, resolve faults, …

W4 Supply network optimisation



Purpose: Improve value for money

Key actors: Customers
Business strategy
Procurement
Asset managers
Programme managers

Issues: Spectrum of supply chain approaches
Transformation to implement

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Supply network example

- Map armoured vehicle supply network
- Develop power train support strategy
  - Improve power train reliability
  - Cope with increased range of environmental conditions
  - Reduce costs
  - Long term power train alliance
- Establish alliance
  - 15 year partnering deal with extensions if costs and profits favourable to all parties
  - Gain/pain share commercial agreement
  - Partnering breakthrough – develop processes, behaviour, incentives
- Senior and working level meetings to ensure
  - Partnering culture is embedded
  - Benefits are being delivered to all parties

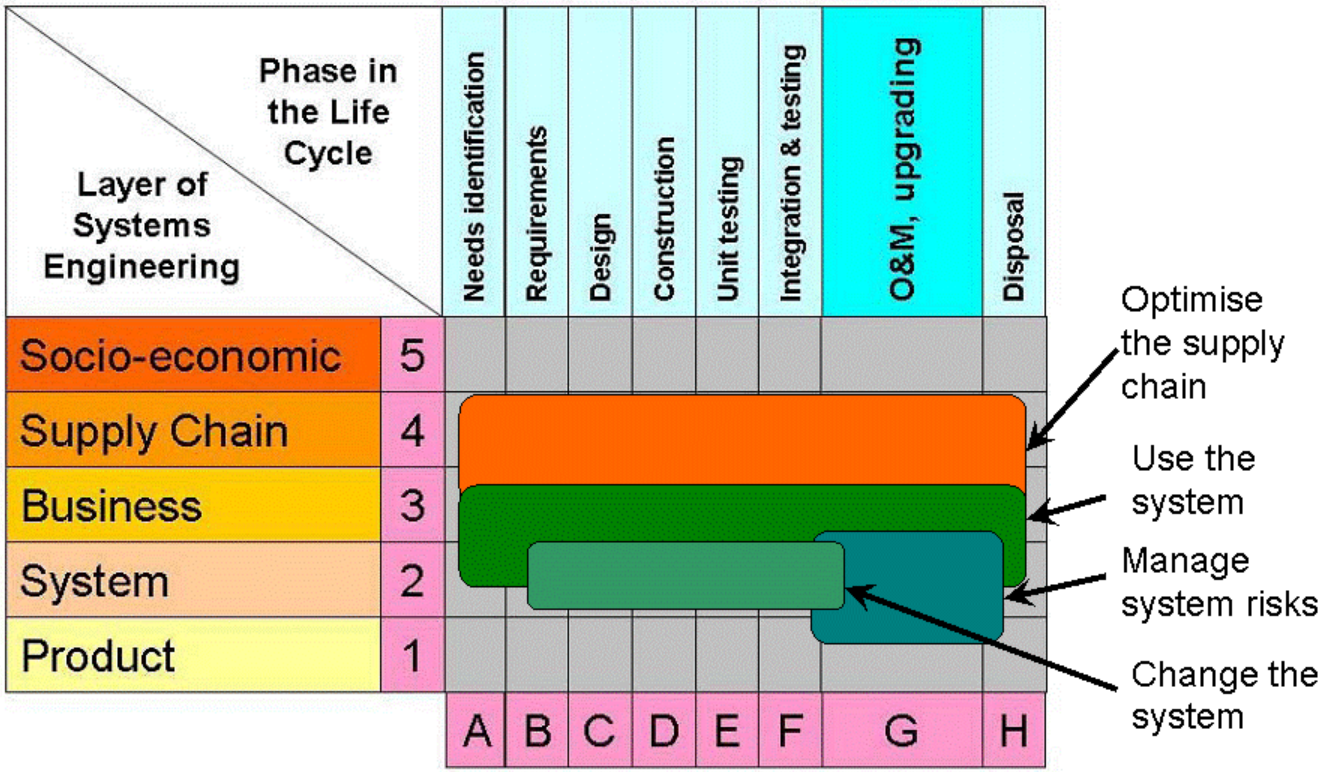
So what can the different approaches deliver?

	Improve effectiveness	Improve reliability	Reduce cost	Improve safety
Asset management	Essential to maintain performance	Essential to maintain reliability	Minimal	Essential to maintain safety
Upgrade	Deliver step change in performance	Deliver step change	Deliver step change – with significant implementation costs	Deliver step change
Service delivery	Range of improvements in effectiveness	Range of improvements	Minor reductions	Range of improvements
Supply chain optimisation	Minor improvements	Range of improvements	Potential significant improvements	Minor improvements

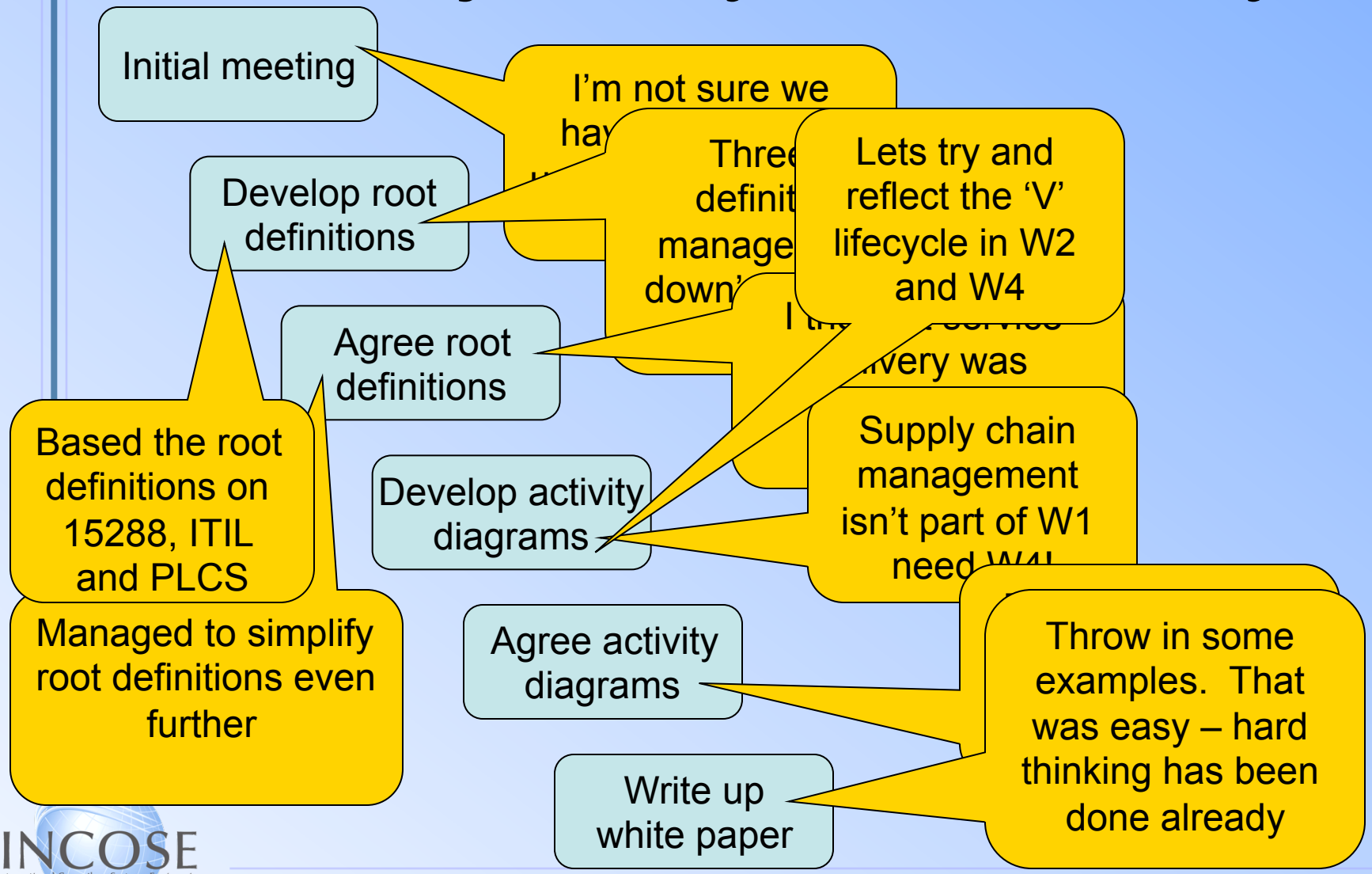
Continuous, continual and single shot - lifecycles

- Single shot (W2)
  - Beginning, middle and end
  - Waterfall, V, etc
- Continual (W3, W4)
  - Repeated cycles to defined ‘drumbeat’
  - Spiral, DSDM, etc
- Continuous (W1)
  - Sense and react
  - Overwatch, OODA, etc
  - Not a conventional ‘lifecycle’?

So what System and what SE?



The journey of discovery



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Cost benefit analysis

Analysis

- Confirmed that there were multiple perspectives of in-service systems engineering
- Confirmed that the guidance should cover all of them
- Confirmed that the structure of the guidance should follow the worldviews

- Took 1-2 days effort over 4-5 weeks to develop
- Similar effort (in total from reviewers)
- All conducted by e-mail and telephone

- With a team that had hardly met before – and never worked together

Conclusions

- In service SE is multi-faceted
  - Asset management
  - Upgrade
  - Service delivery
  - Supply network optimisation
- Each has different applicability in driving
  - Safety and reliability improvement
  - Cost reduction
  - Effectiveness improvement
- Each worldview follows a different type of lifecycle:
  - Single shot
  - Continual
  - Continuous
- SSM is really good at improving the quality of dialogue