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Edinburgh, UK
July 18 - 21, 2016

The Value of Systems Engineering in Project Management

Case Study: Developing a Power Control System ConOps

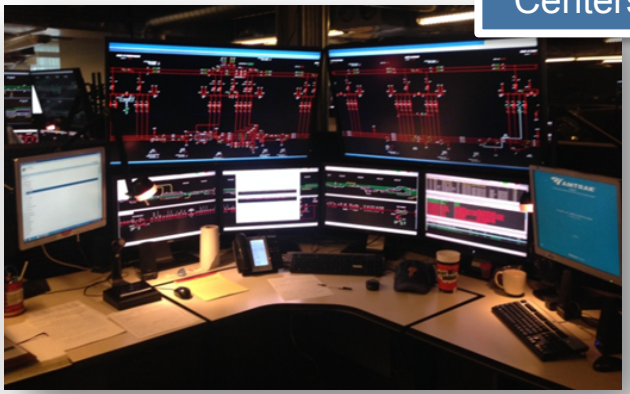
AGENDA

- Task Background
- Problem Statement
- Offered Solution
- Project Management Approach
- Systems Engineering Approach
- Summary & Conclusion

THE VALUE OF SE IN PROJECT MANAGEMENT

TASK BACKGROUND

Power Control Centers (Example)



PROJECT SCOPE:

- Facilitate and Support Development of Concept of Operations for Power Control System
- To Serve as Agreement between Operators / Maintainers and Designers / Implementers
- Mix of Experienced Systems Engineers and Industry & Technology Subject Matter Experts
- Guide Client & Make Recommendations based on Domestic & International Best Practices

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PROBLEM STATEMENT

Waterfall Approach with
Potential Late Surprises & Rework

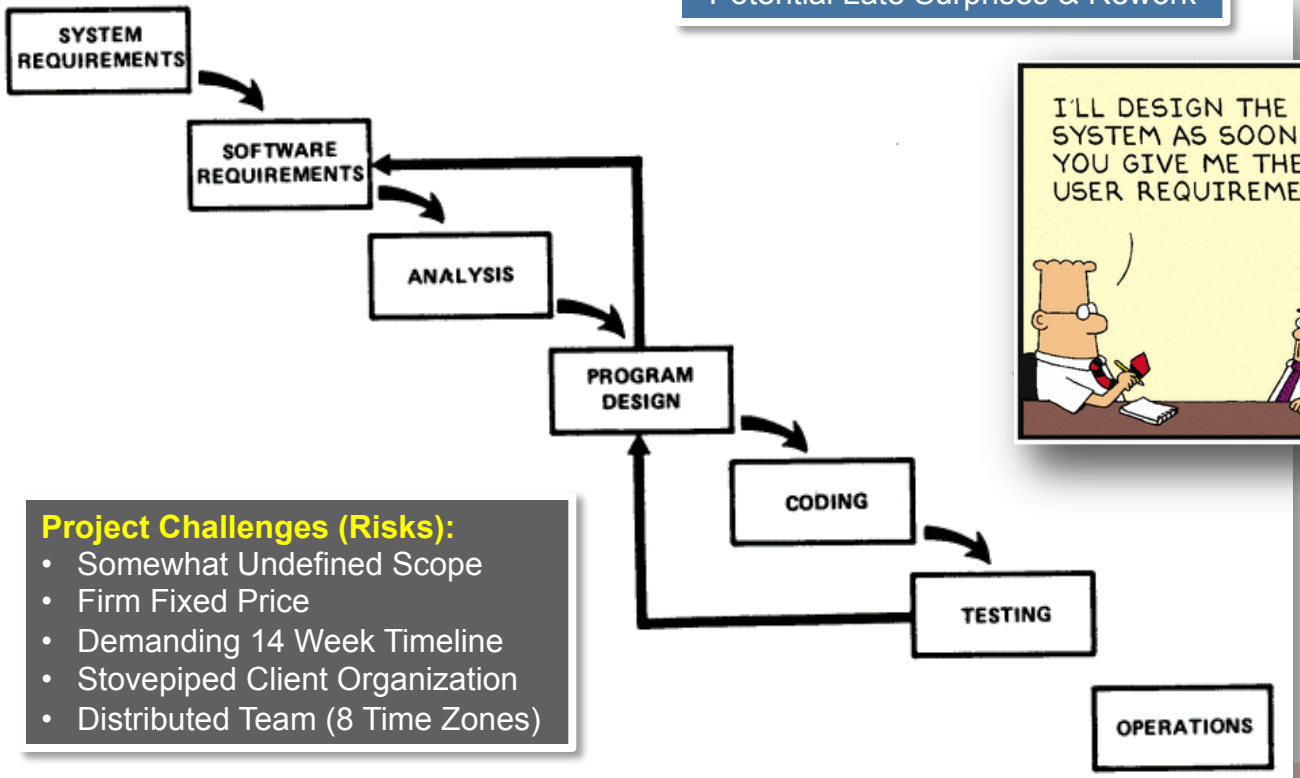
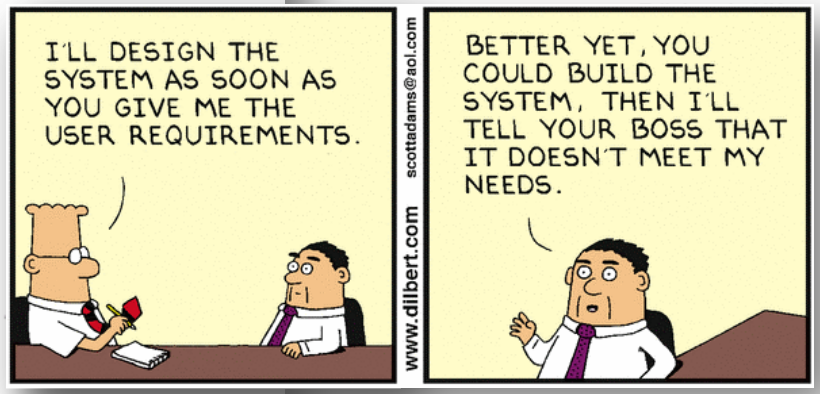


Figure 4. Unfortunately, for the process illustrated, the design iterations are never confined to the successive steps.



Project Challenges (Risks):

- Somewhat Undefined Scope
- Firm Fixed Price
- Demanding 14 Week Timeline
- Stovepiped Client Organization
- Distributed Team (8 Time Zones)

Source: Royce, W. W. 1970. *Managing the Development of Large Software Systems*. Proceedings, IEEE WESCON

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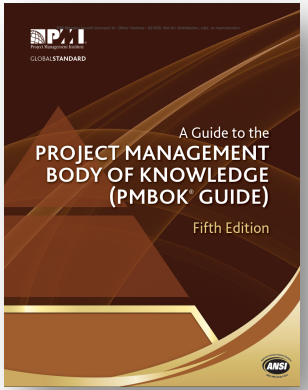
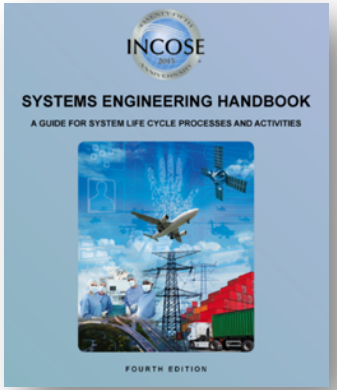
OFFERED SOLUTION – INTEGRATED MANAGEMENT APPROACH

Project Management



- Request for Proposal
- Scope Management
- Cost Management
- Schedule Management
- Risk Management
- Other

Systems Engineering



- Systems Development
- Concept of Operations
- Stakeholder Mgmt.
- Legacy Products & Procedures
- Other

Agile Product Development

Scrum Alliance®

- Early & Often Delivery
- Shippable Product
- Increment (Sprint) Reviews
- Avoid Late Surprises
- Progress Demonstration
- Other

Lean Product Development Flow

- Continuous Work Flow
- Individual “Takt Periods”
- Regular Integration
- Lean Principles (i.e. Pull, Value, etc.)
- Other

PROJECT MANAGEMENT APPROACH

MANAGEMENT OBJECTIVES

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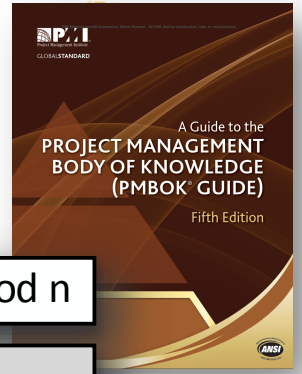
- Satisfy the Client through **early and often delivery** of ConOps, **avoiding late surprises** common to the waterfall approach
- **Incorporate changes** from ConOps reviews and walk-throughs (‘sprint reviews’) into each new revision of the ConOps **before next release**
- **Deliver ‘shippable’ versions**, with an average of three weeks between sprints, keeping the team focused and the Client apprised of the progress
- **Work together with the Client** in frequent stakeholder meetings throughout the project and meet in person whenever possible
- **Use released versions** of the ConOps **as a measure of progress** (demonstrating earned value)
- Provide continuous attention to technical excellence, **using best practices** and building trust with the Client

PROJECT MANAGEMENT APPROACH

PROJECT MANAGEMENT CONSIDERATIONS



Scope Management

Work Breakdown Structure	Resource	PV	Period 1	Period 2	Period n
(D) Deliverable #1					
(A) Activity #1	Res. #1	1d	100%		
(A) Activity #2	Res. #2	1d		80%	
(A) Activity #n	Res. #n	1d			
(D) Deliverable #2					
(D) Deliverable #n					

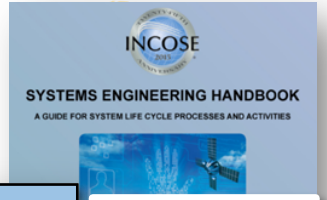
Time Management

Cost Management

Cost & Schedule Performance

PROJECT MANAGEMENT APPROACH

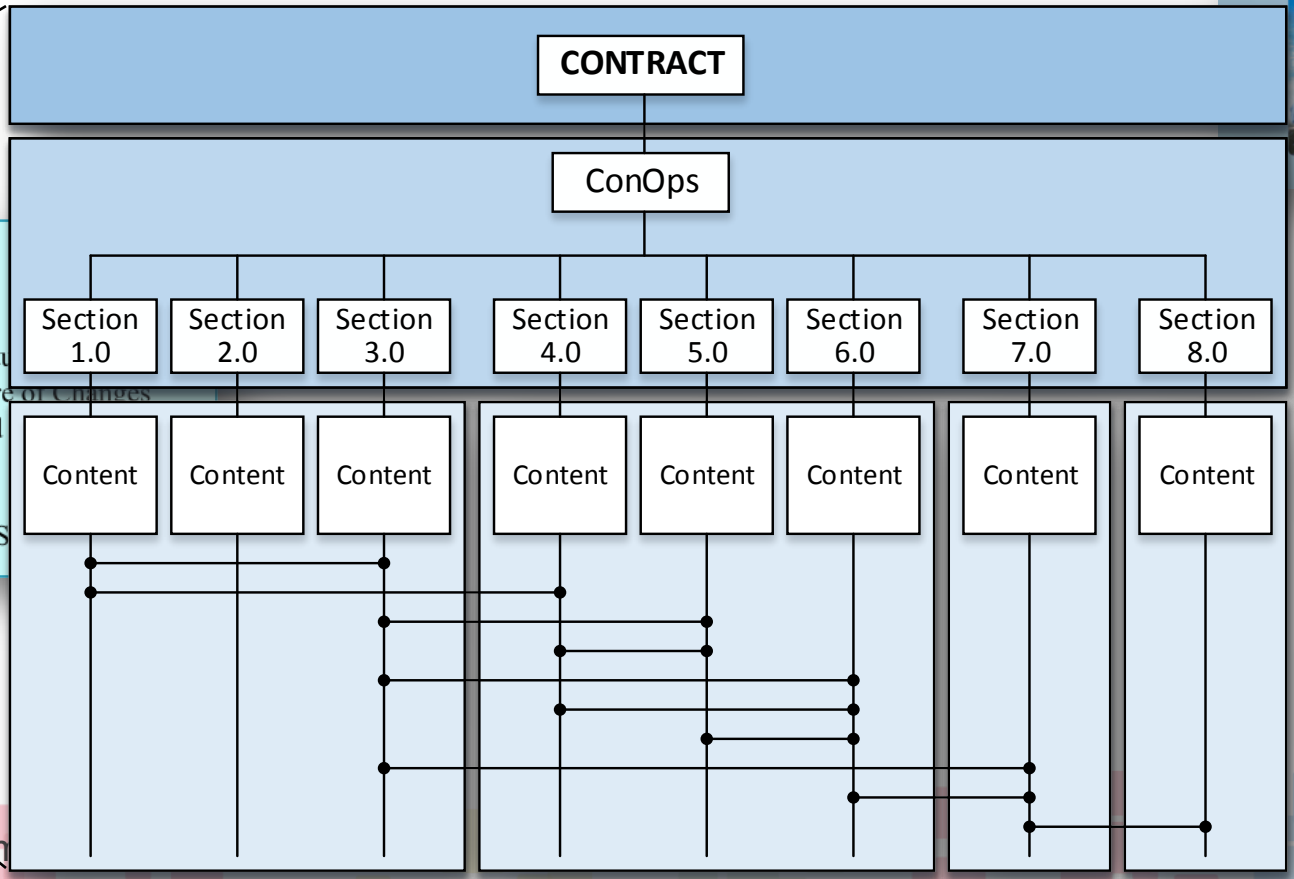
SYSTEMS ENGINEERING CONSIDERATIONS



ConOps Structure

IEEE 1362 Outline

1. Scope
2. Referenced Documents
3. The Current System or Situ
4. Justification for and Nature of Changes
5. Concepts for the Proposed
6. Operational Scenarios
7. Summary of Impacts
8. Analysis of the Proposed S



Stakeholder Requirements

System Requirements

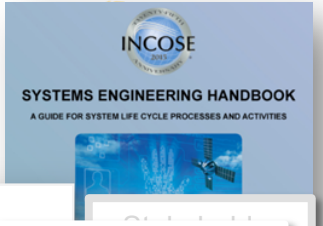
System Architecture

System Elements

Interfaces & Interaction

PROJECT MANAGEMENT APPROACH

SYSTEMS ENGINEERING CONSIDERATIONS (CONT'D)



Stakeholder Requirements

Current **"As-Is"** System

Alternative System Reviews

Planned **"To-Be"** System

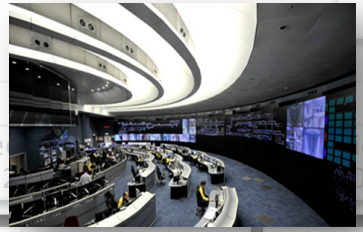
Gap Analysis "As-Is" vs. "To-Be"

ConOps (SDLC) **Output**

People

Processes

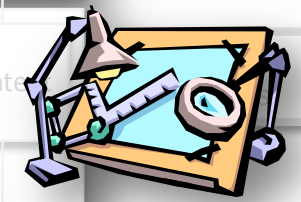
Products



People

Processes

Products



ConOps

System Requirements

System Architecture

Interfaces & Interaction

www.incose.org/syn

PROJECT MANAGEMENT APPROACH

SYSTEMS ENGINEERING CONSIDERATIONS (CONT'D)

Stakeholder Manager

Systems Engineer

CONTRACT

ConOps

Project Manager

Section 1.0 | Section 2.0 | Section 3.0 | Section 4.0 | Section 5.0 | Section 6.0 | Section 7.0 | Section 8.0

Content | Content | Content | Content | Content | Content | Content | Content

Subject Matter Expert(s)

Best Practice Outreach

Stakeholder Requirements

System Requirements

System Architecture

System Elements

Interfaces & Interaction

PROJECT MANAGEMENT APPROACH

AGILE PRODUCT DEVELOPMENT CONSIDERATIONS

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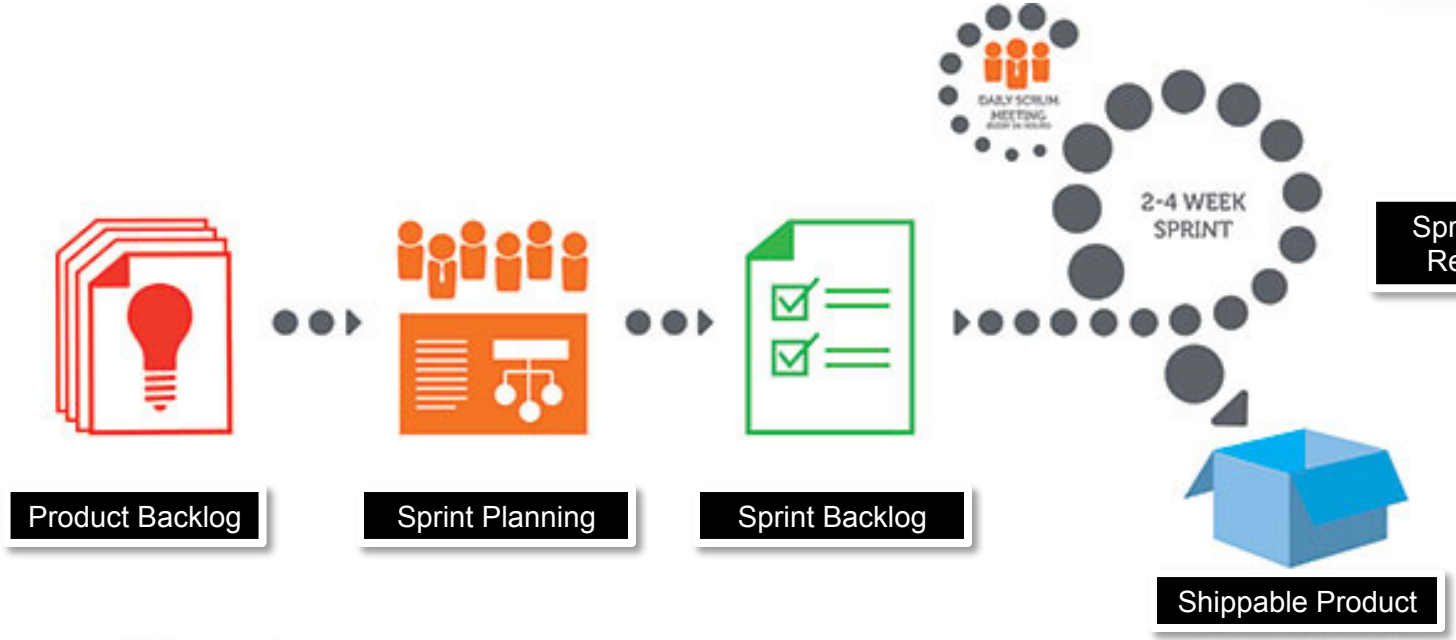

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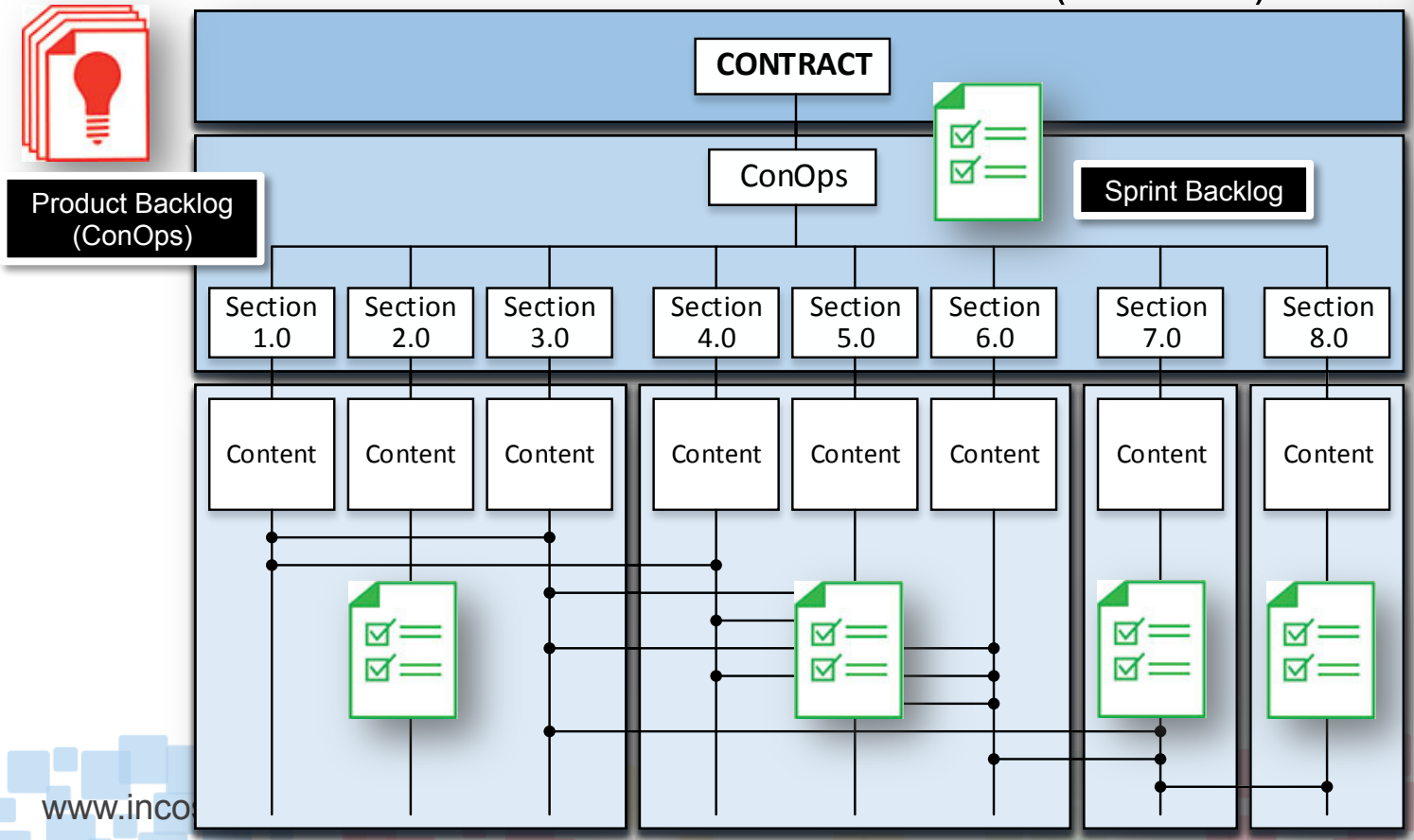
PROJECT MANAGEMENT APPROACH

AGILE PRODUCT DEVELOPMENT CONSID. (CONT'D)



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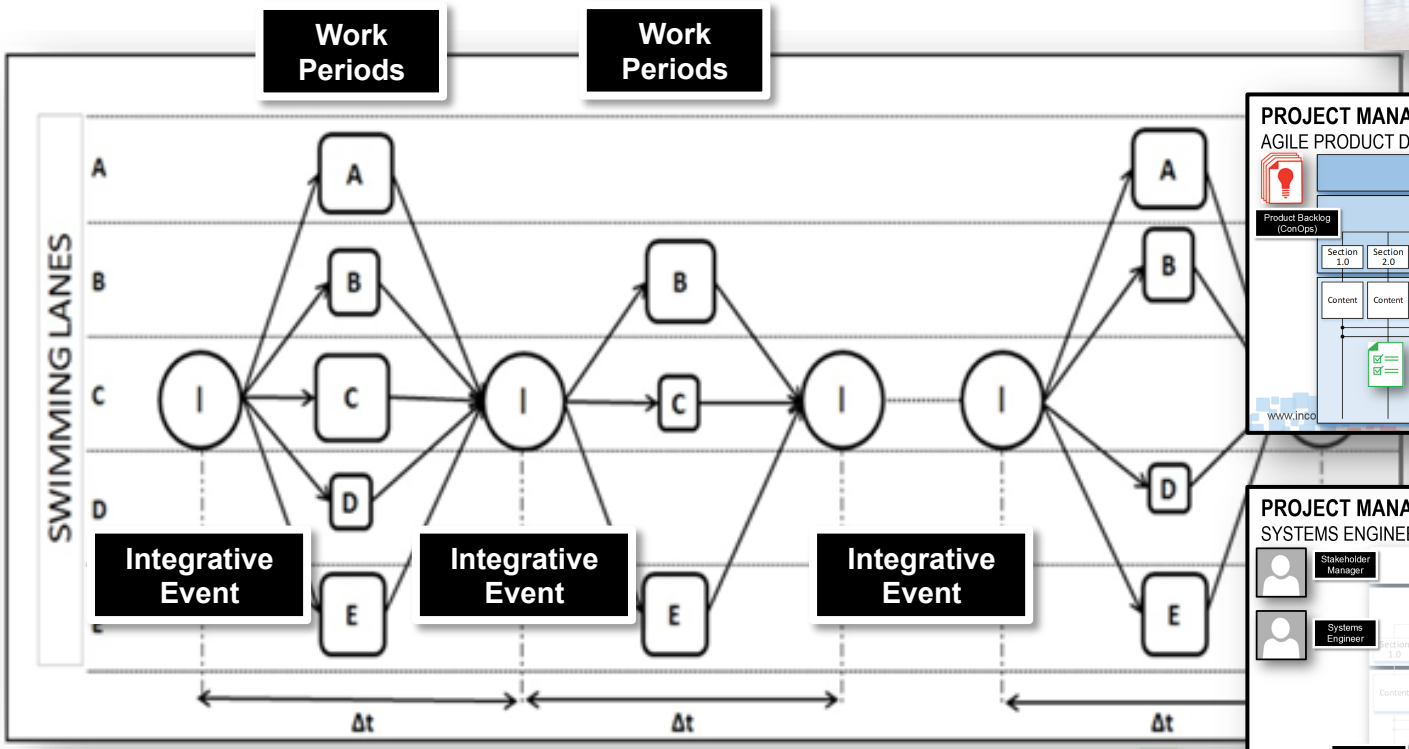
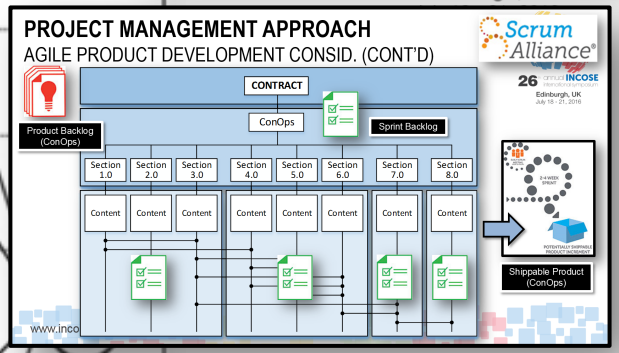
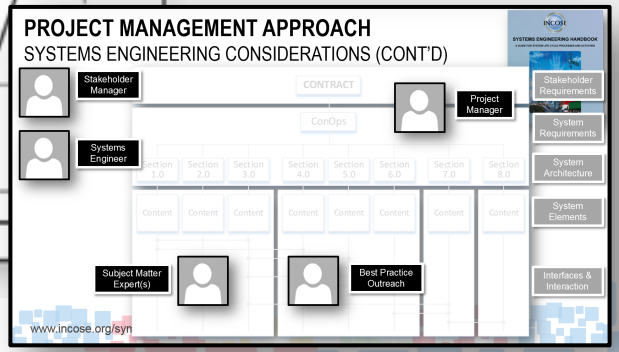
PROJECT MANAGEMENT APPROACH

LEAN PRODUCT DEVELOPMENT FLOW CONSIDER.

Edinburgh, UK

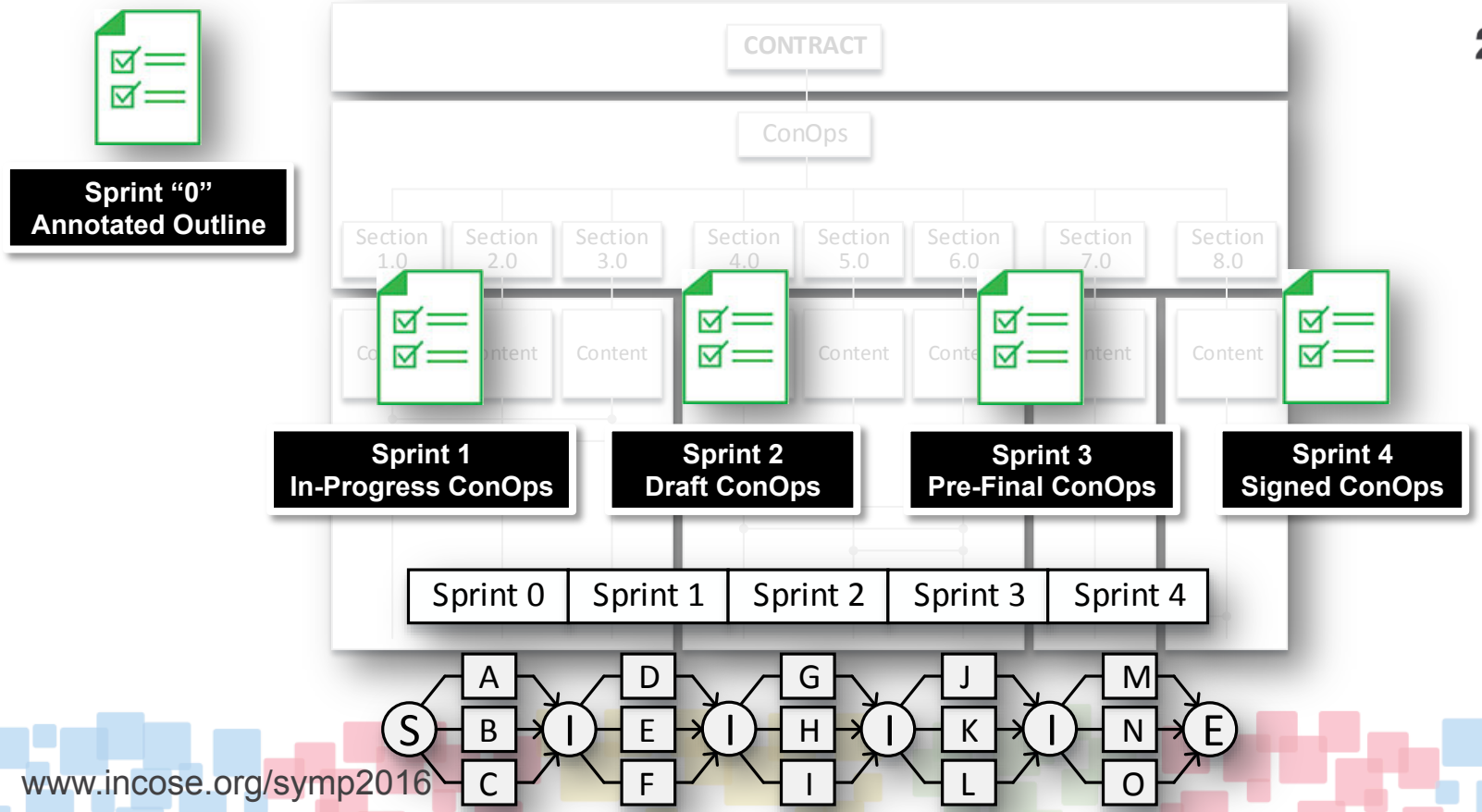






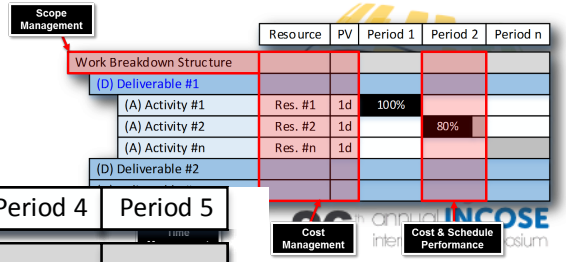
PROJECT MANAGEMENT APPROACH

PUTTING IT ALL TOGETHER



PROJECT MANAGEMENT APPROACH

PUTTING IT ALL TOGETHER (CONT'D)



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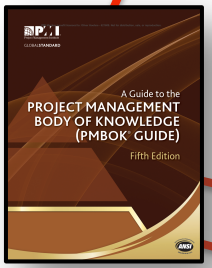
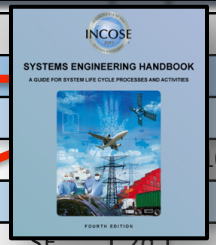
Scope





Work Breakdown Structure	Resource	PV	Period 1	Period 2	Period 3	Period 4	Period 5
(D) Concept of Operations							
(D) Annotated Outline							
(A) ...			100%				
(D) In-Progress Revision							
(A) Incorporate Comments	SE	2d					
(A) Prepare Section 1.0	SM	6d					
(A) Prepare Section 2.0	SE	2d					
(A) Integrate & Submit	SE	1d					
(D) Draft Revision							
(D) Pre-Final Revision							
(D) Signed Revision							
(D) Other Deliverables							
(D) ...							

Time

AC/EV

Agile SE/PM

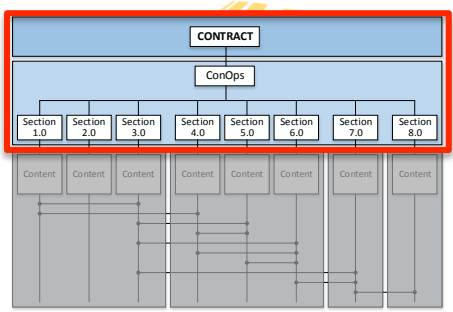
Scrum Alliance®

Lean SE/PM

Sprint 0	Sprint 1	Sprint 2	Sprint 3	Sprint 4
S	I	I	I	I
A	D	G	J	M
B	E	H	K	N
C	F	I	L	O
				E

SYSTEMS ENGINEERING APPROACH

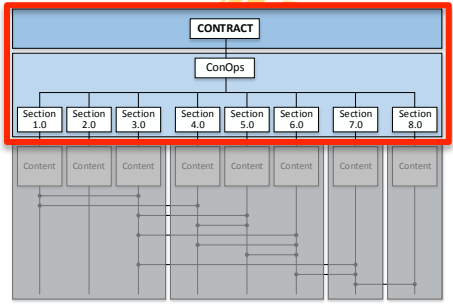
SPRINT #0 – ANNOTAED CONOPS



- The objectives of Sprint #0 were:
  - to agree the ConOps ‘System’ requirements (i.e. the stakeholder’s needs);
  - to define the architecture (the boundary and structure of the ConOps document).

SYSTEMS ENGINEERING APPROACH

SPRINT #0 – ANNOTAED CONOPS



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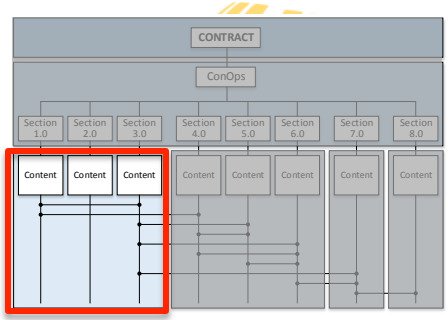
Sprint #1

Sprint #2

Sprint #3

SYSTEMS ENGINEERING APPROACH

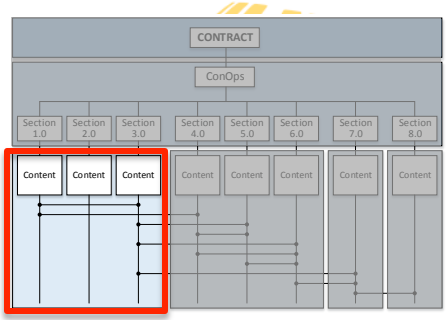
SPRINT #1 – IN-PROGRESS CONOPS

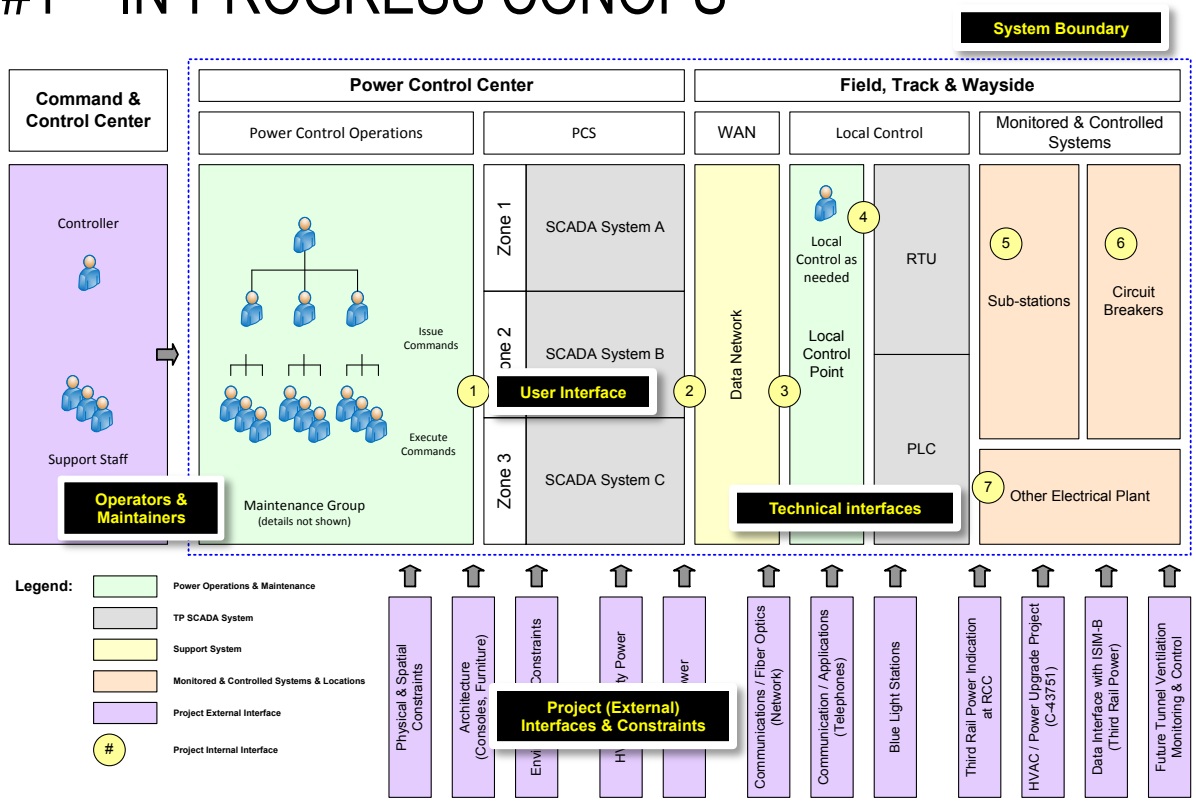


- The objectives of Sprint #1 were:
  - to define the boundary of the PCS System of Interest (SoI); and
  - to understand and describe the ‘As-Is’ system architecture, users, functions and capability.

SYSTEMS ENGINEERING APPROACH

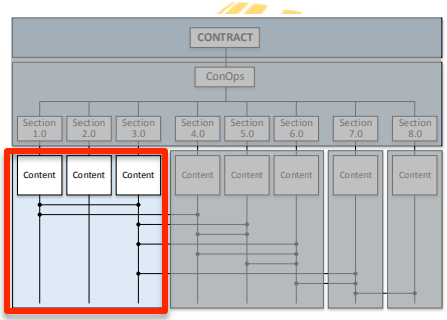
SPRINT #1 – IN-PROGRESS CONOPS





SYSTEMS ENGINEERING APPROACH

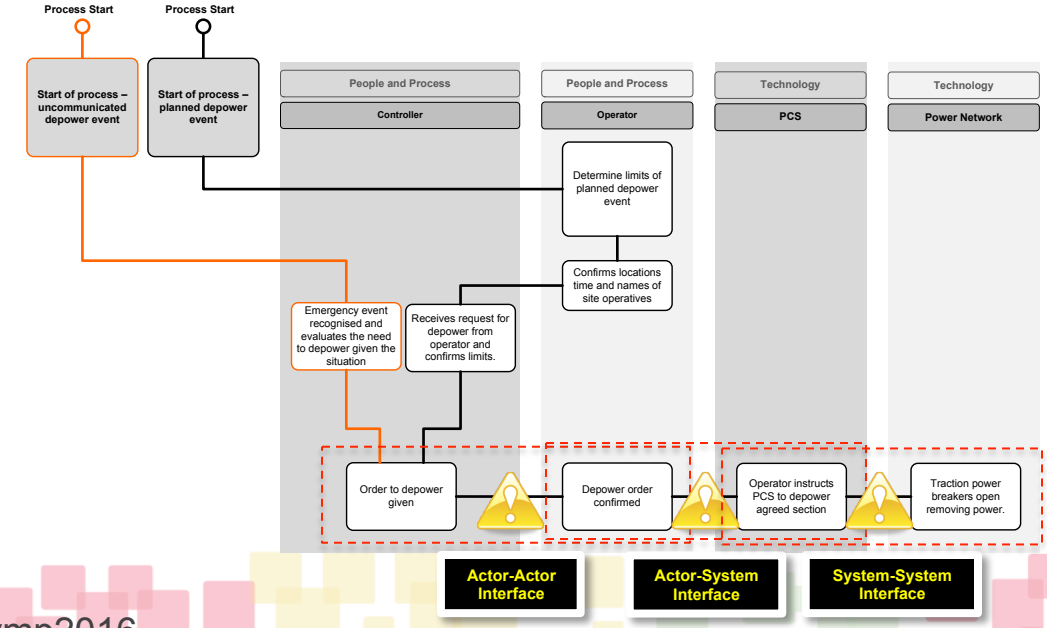
SPRINT #1 – IN-PROGRESS CONOPS



Operational Process Execution Diagram:
Function: Removal and Restoration of Electrical Power

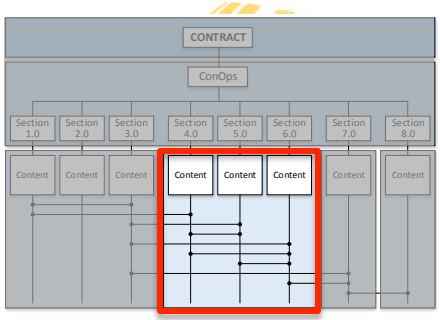
Key:
- Process Element
- **Process start/end condition**

Modes of operation:
- Normal – Scheduled Request for depower made through General Order notice
- Emergency - Communicated emergency depower event



SYSTEMS ENGINEERING APPROACH

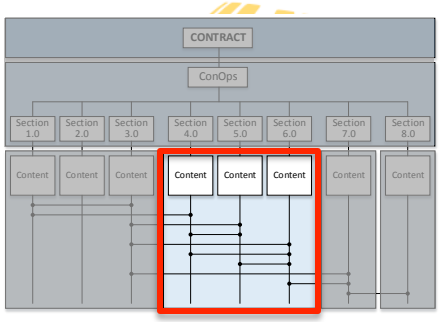
SPRINT #2 – DRAFT CONOPS Objectives



- The objective of Sprint #2 were:
  - to develop a concept for the ‘To-Be’ system (or future state) jointly with users, stakeholders and engineering;
  - to identify and evaluate the gaps between the As-Is and To-Be states; and
  - to brief the ConOps to decision makers and gain acceptance of the principles and requirements captured within it.

SYSTEMS ENGINEERING APPROACH

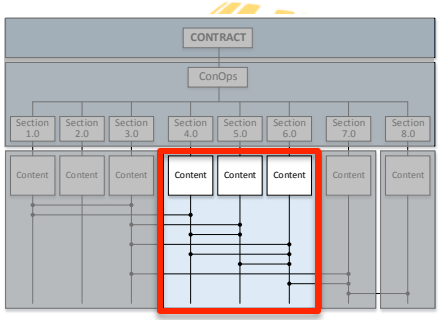
SPRINT #2 – BEST PRACTIVE REVIEW

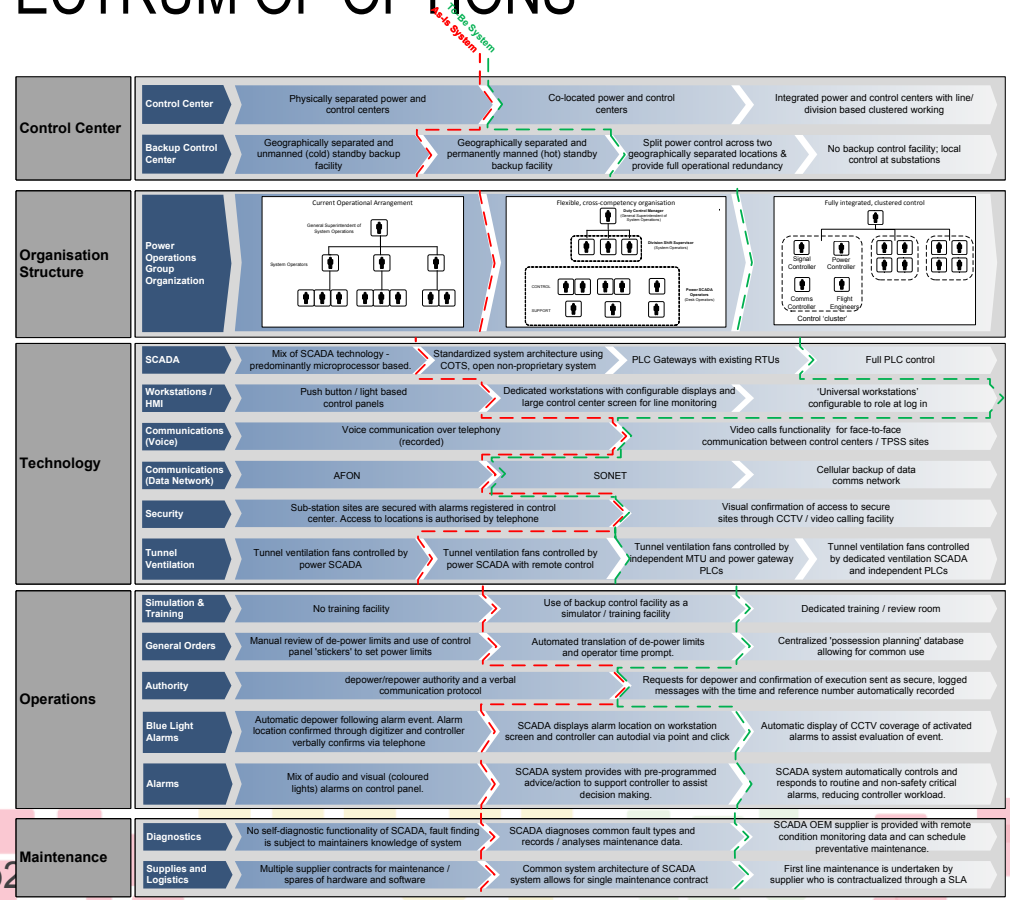


- Utilize a structured approach
- Prepare detailed questionnaire
  - current challenges, needs, and future vision
- Identify diverse set of domestic / international peers and suppliers
  - spread of technology, levels of automation and command/control integration
- Interview appropriate staff
  - Peer agencies shed light on technology they used, new technology implementation challenges, organizational impacts, and ease, or lack, of O&M;
  - Suppliers helped us to understand their respective product roadmap and a peek into the possibilities likely to be available in the future
- Inform the ConOps ‘spectrum of options’

SYSTEMS ENGINEERING APPROACH

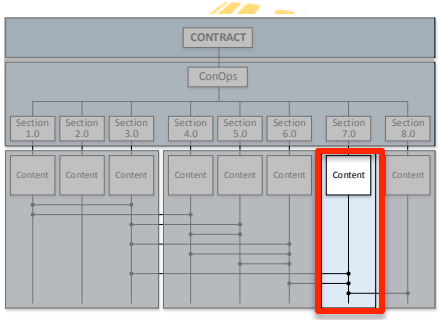
SPRINT #2 – SPECTRUM OF OPTIONS





SYSTEMS ENGINEERING APPROACH

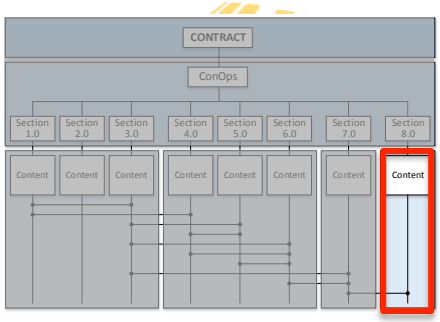
SPRINT #3 – PRE-FINAL CONOPS (Steve)



- The objectives of Sprint #3 were:
  - to evaluate the gaps between the ‘As-Is’ and ‘To-Be’ systems;
  - to develop a migration strategy for seamless deployment of the upgraded power control system; and
  - to provide a complete set of system and process requirements for inclusion in the PCS specification.

SYSTEMS ENGINEERING APPROACH

SPRINT #4 – FINAL CONOPS (Steve)



- ConOps document was updated and distributed to the key decision makers, identified from the Stakeholder Management Planning stage in Sprint #0,
- Final ConOps document signed.

SYSTEMS ENGINEERING APPROACH

SUMMARY & CONCLUSIONS (Steve)

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- Innovative application of the PM and SE processes resulted in the project
  - being delivered on time,
  - within budget , and
  - meeting the expectations of the Client.
- The application of Agile and Lean approaches avoided many of the common challenges associated with ‘waterfall’ project lifecycles
  - early agreement on the Client’s requirements
  - continuous review/feedback at the completion of each ‘sprint’.
  - ConOps delivered within a timescales of 14 weeks; considerably shorter than typical ConOps production.
- International best practice review revealed a variety of approaches for power control, which were evaluated against Client’s requirements.
- ‘Spectrum of Options’ presented the direction of operational and technical change observed from the best practice review.

THE VALUE OF SE IN PROJECT MANAGEMENT

QUESTIONS & ANSWERS

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