



Visão geral do processo de engenharia de sistemas

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Workshop sobre ITS - Brasil/EUA
22 de agosto de 2017



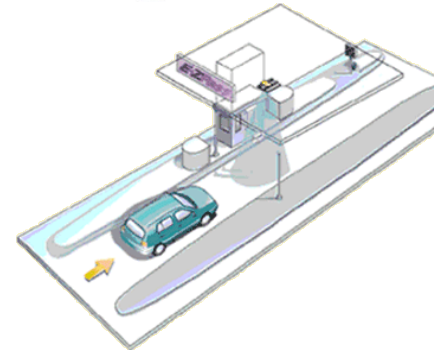
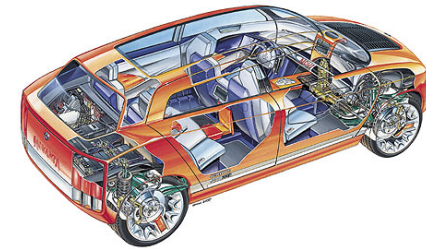
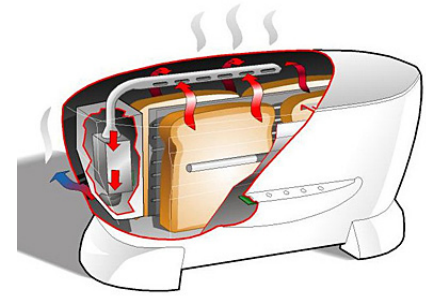
O que é um sistema?

“Uma combinação de elementos interagentes organizados para alcançar um ou mais propósitos declarados.”

Conselho Internacional de Engenharia de Sistemas

“Uma agregação de produtos finais e produtos habilitadores para alcançar um determinado objetivo”

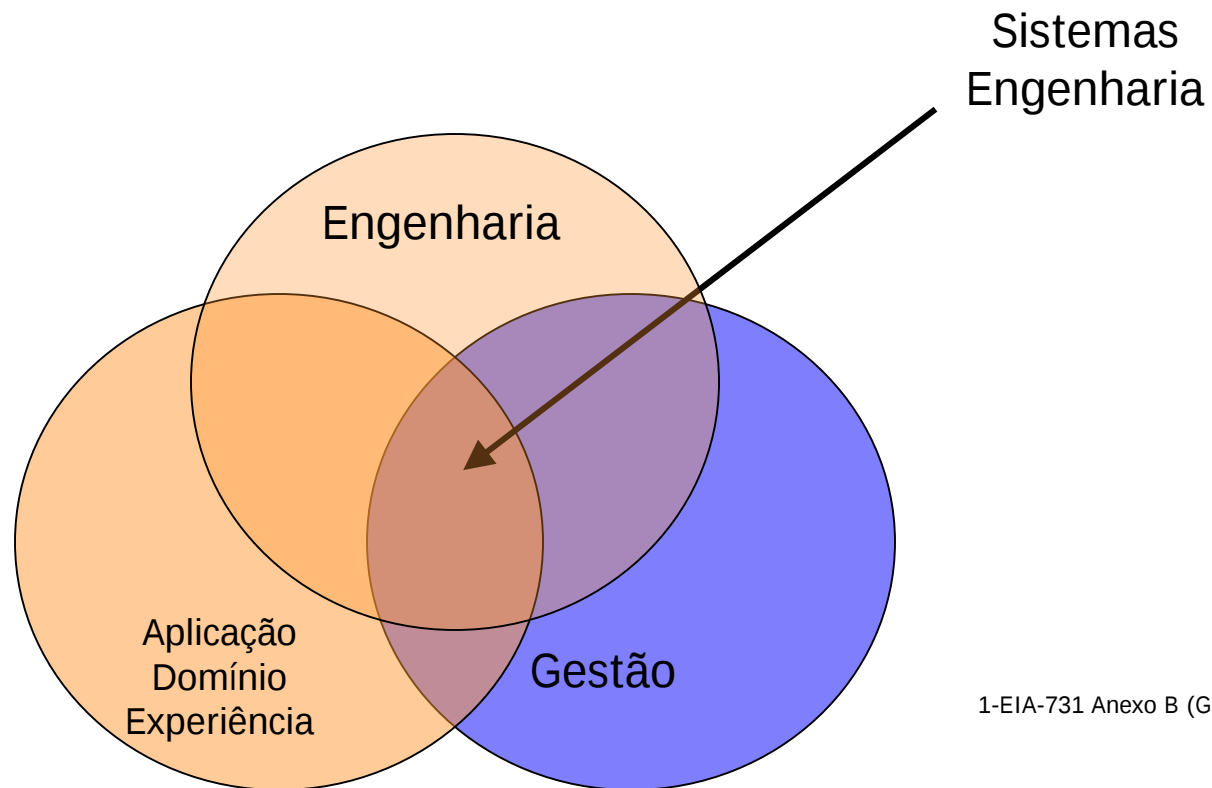
Electronics Industry Association EIA-632





O que é Engenharia de Sistemas?

Uma **abordagem interdisciplinar** e meios para permitir a realização de sistemas bem sucedidos.¹





Engenharia de Sistemas (cont.)

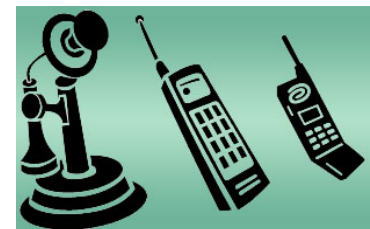
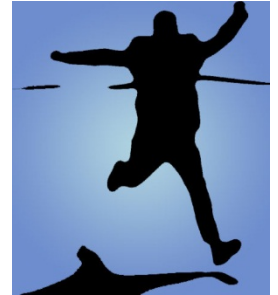
■ Foca em:

- Definir as necessidades do cliente e a funcionalidade necessária no início do ciclo de desenvolvimento
- Documentar requisitos
- Em seguida, prosseguir com o projeto, implementação e validação do sistema, considerando o problema completo



Princípios da engenharia de sistemas

- Comece olhando para a linha de chegada
- Participação das partes interessadas é essencial
- Definir o problema antes de implementar a solução
- Escolhas de tecnologia de atraso



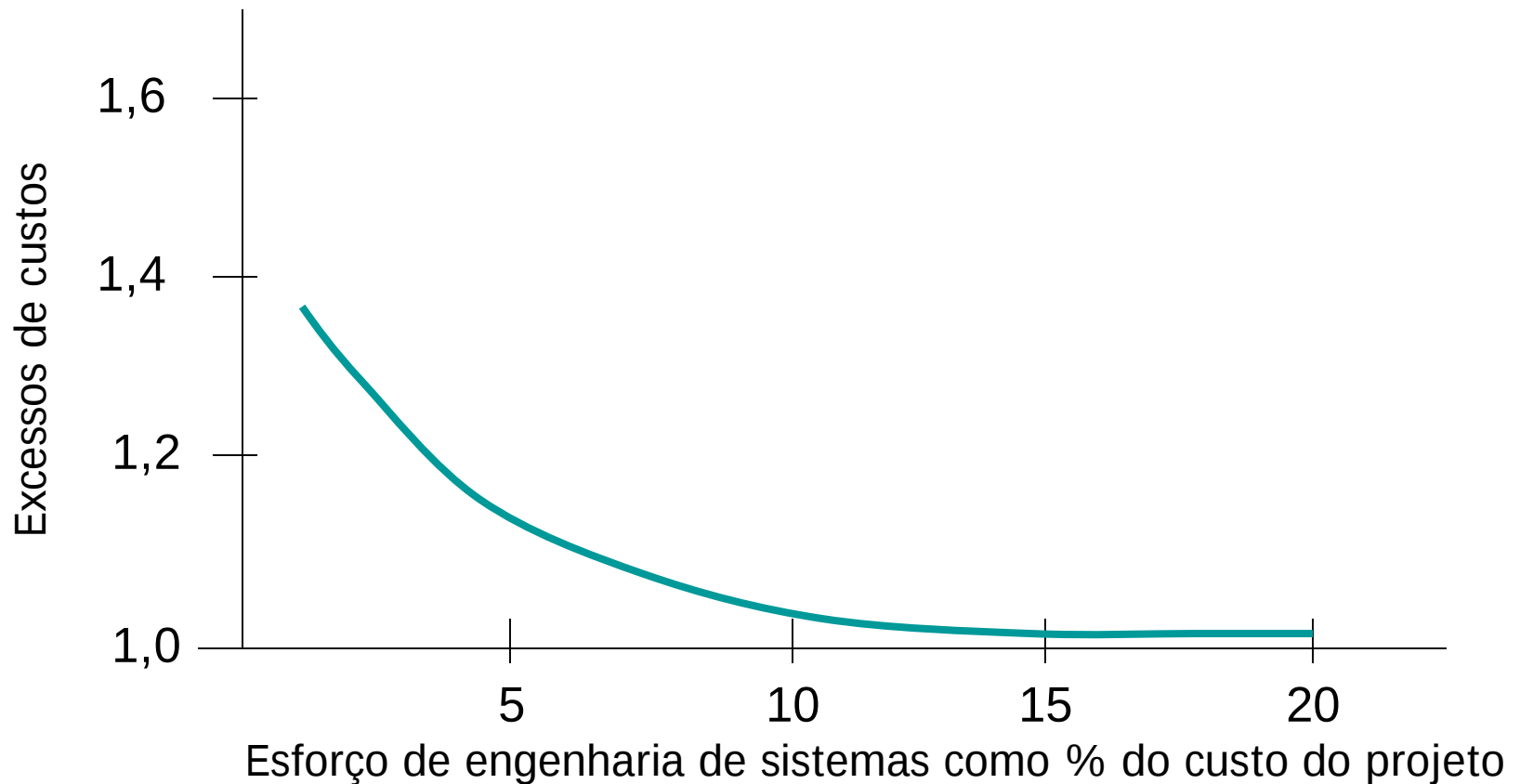


Benefícios da utilização SE

- Redução do risco de cronograma e excessos de custos
- Maior probabilidade de que a implementação atenda às necessidades dos usuários
- Aumento da participação das partes interessadas
- Sistemas mais adaptáveis e resilientes
- Funcionalidade verificada e menos defeitos
- Maior nível de reutilização de um projeto para o próximo
- Melhor documentação



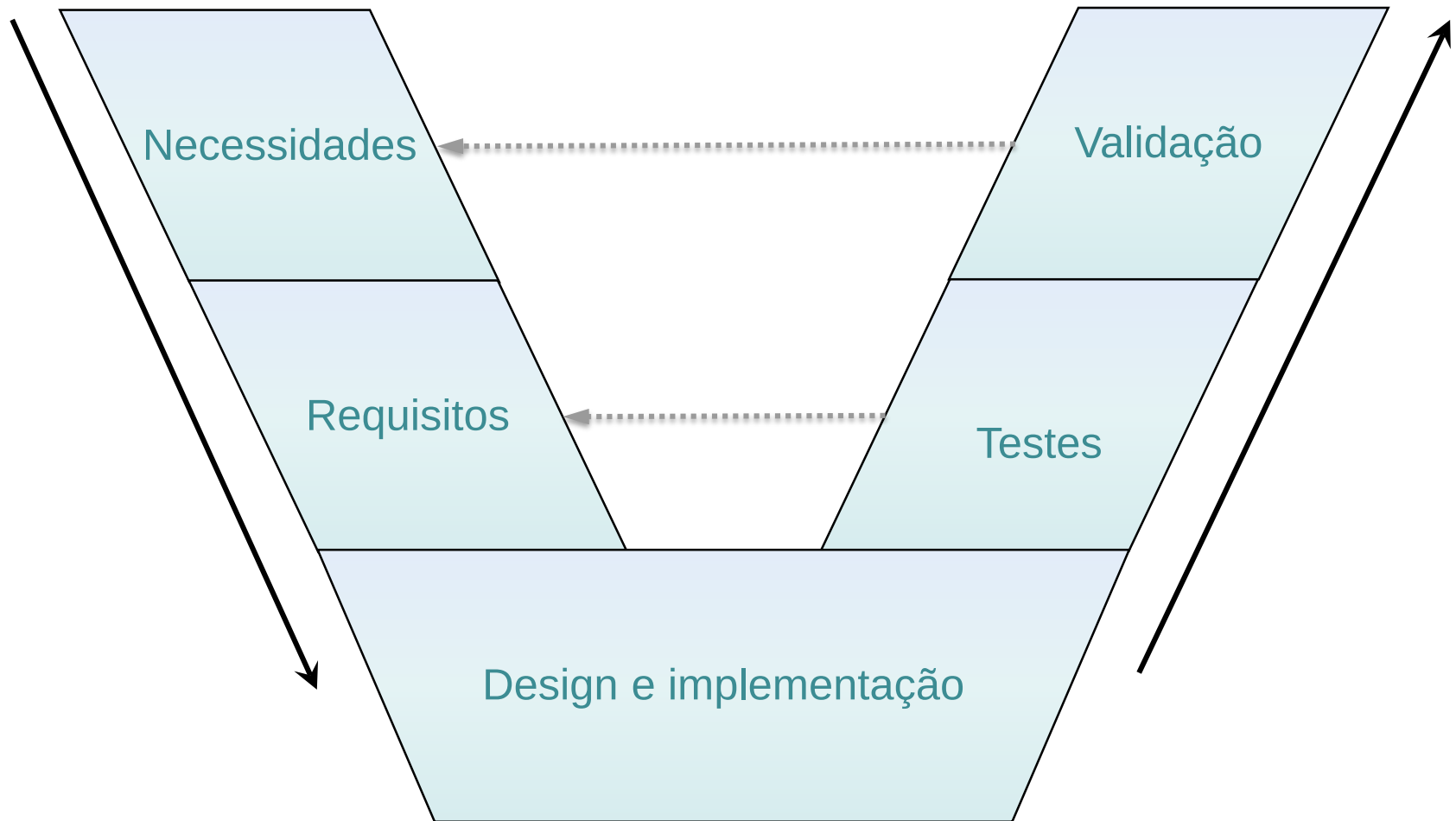
Impacto da engenharia de sistemas: Custo do projeto vs. Custo SE



Fonte: Honour, et al., 2004, *Value of Systems Engineering*, Honourcode, Inc., Pensacola, FL

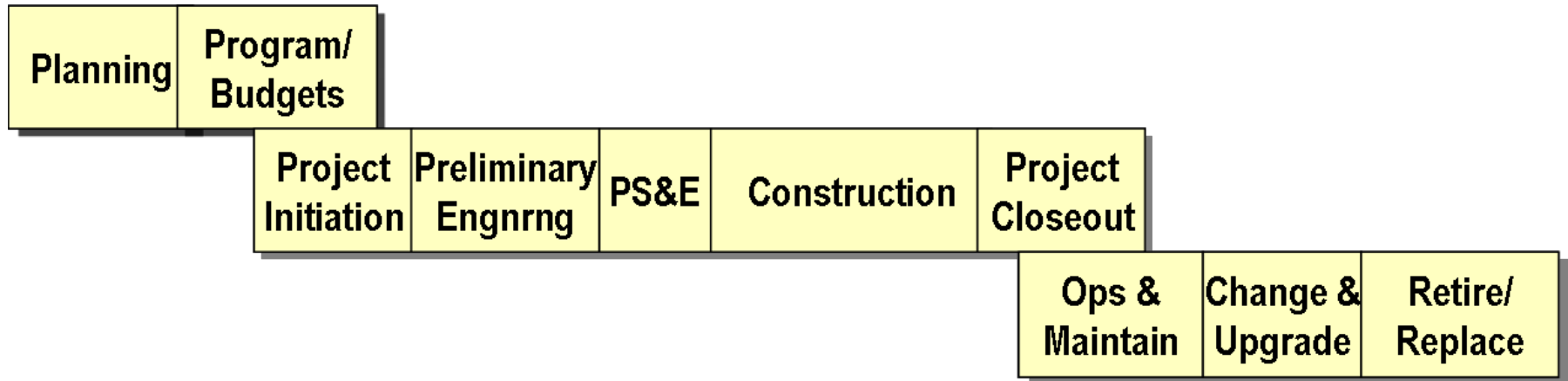


Processo de engenharia de sistemas



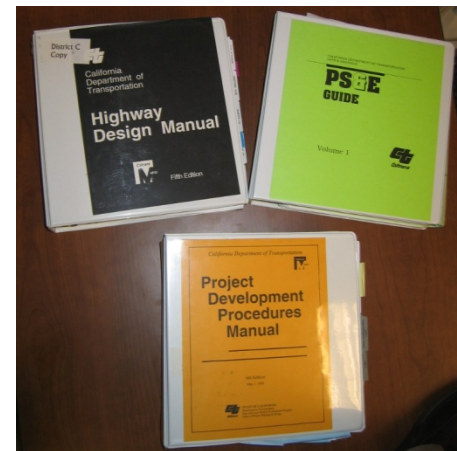


Um processo de desenvolvimento de projetos tradicional levou ao sucesso



Baixo risco de implementação sem sucesso!

- ✓ Desempenho de produtos e materiais bem compreendido
- ✓ Requisitos bem definidos e compreendidos
- ✓ Tecnologia comprovada e bem conhecida
- ✓ Projetos documentados e comprovados



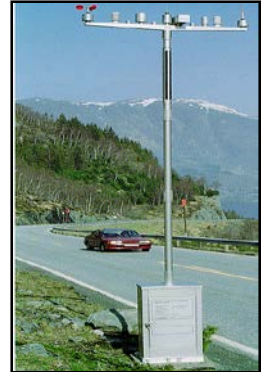
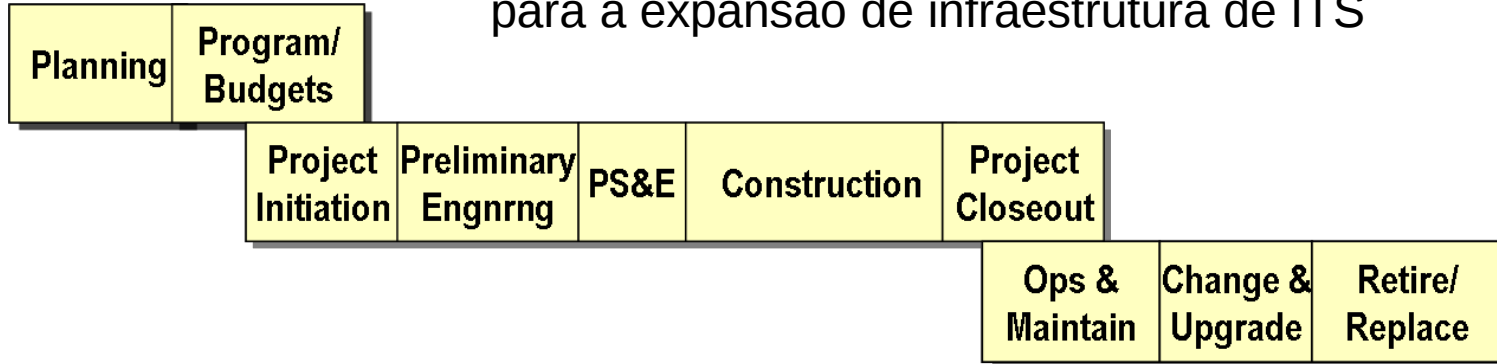


Resultado: Rodovias de longa duração são projetadas, construídas e testadas



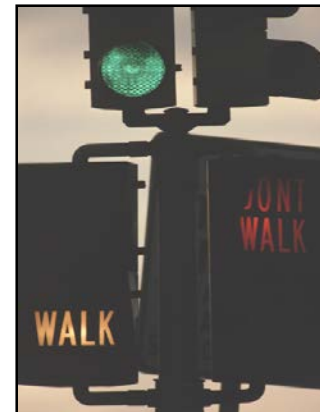


O desenvolvimento tradicional de projetos também funciona para a expansão de infraestrutura de ITS



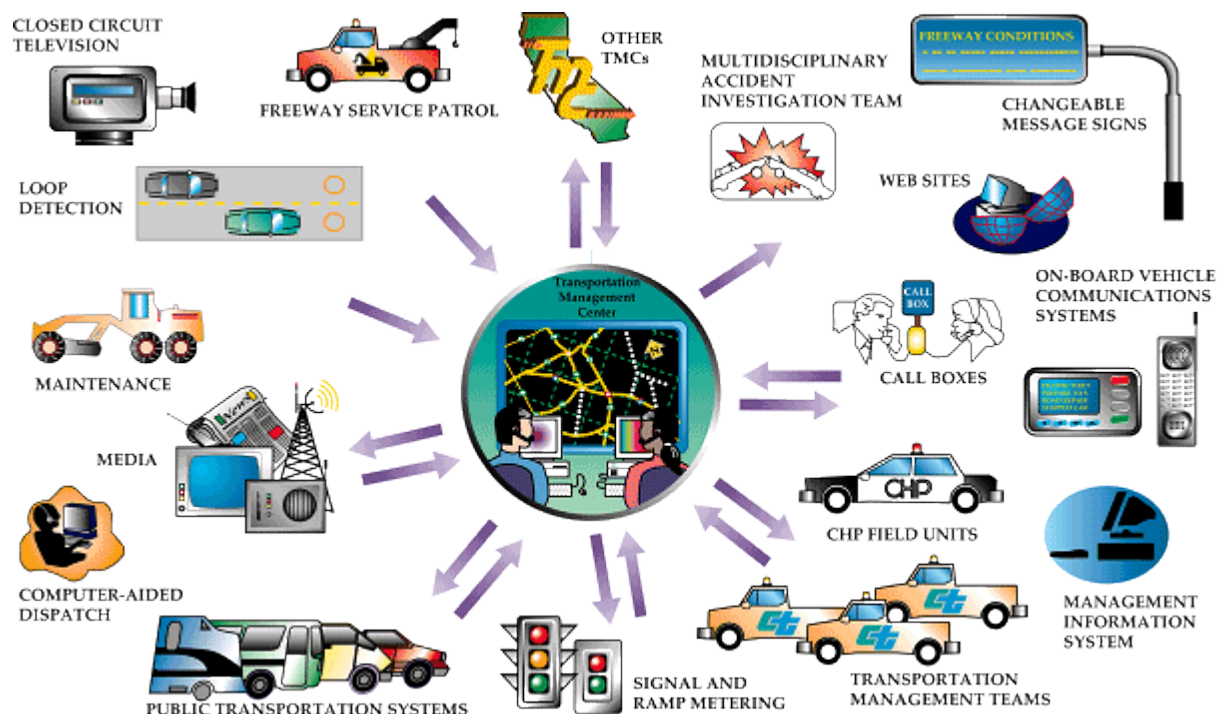
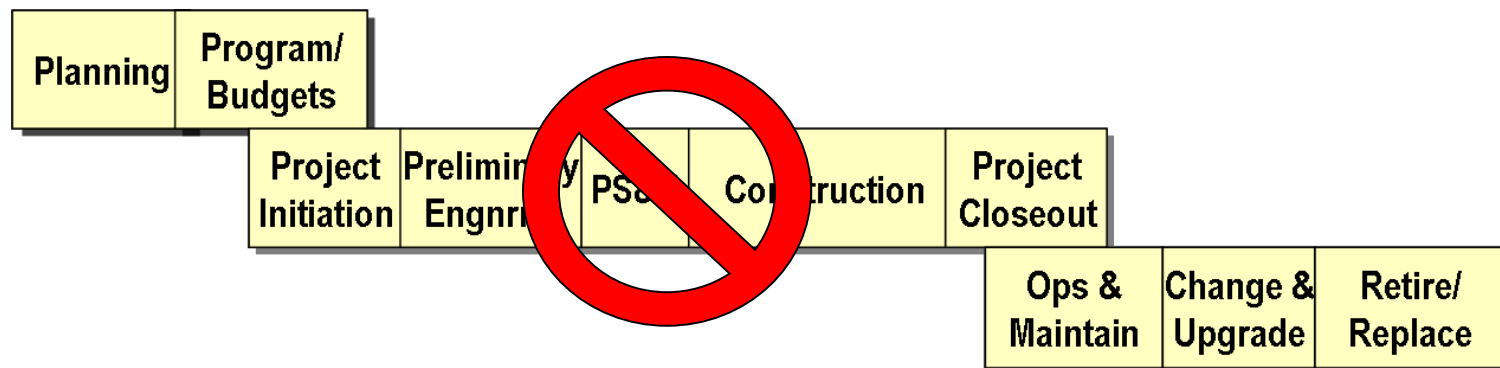
Expansão da infraestrutura de ITS: Projetos de baixo risco

Processos e manuais aprovados
TAMBÉM em vigor para
instalação em campo de
muitas tecnologias ITS





MAS este processo tradicional NÃO funciona para projetos de ITS complexos





O que é diferente no projeto de sistemas complexos?

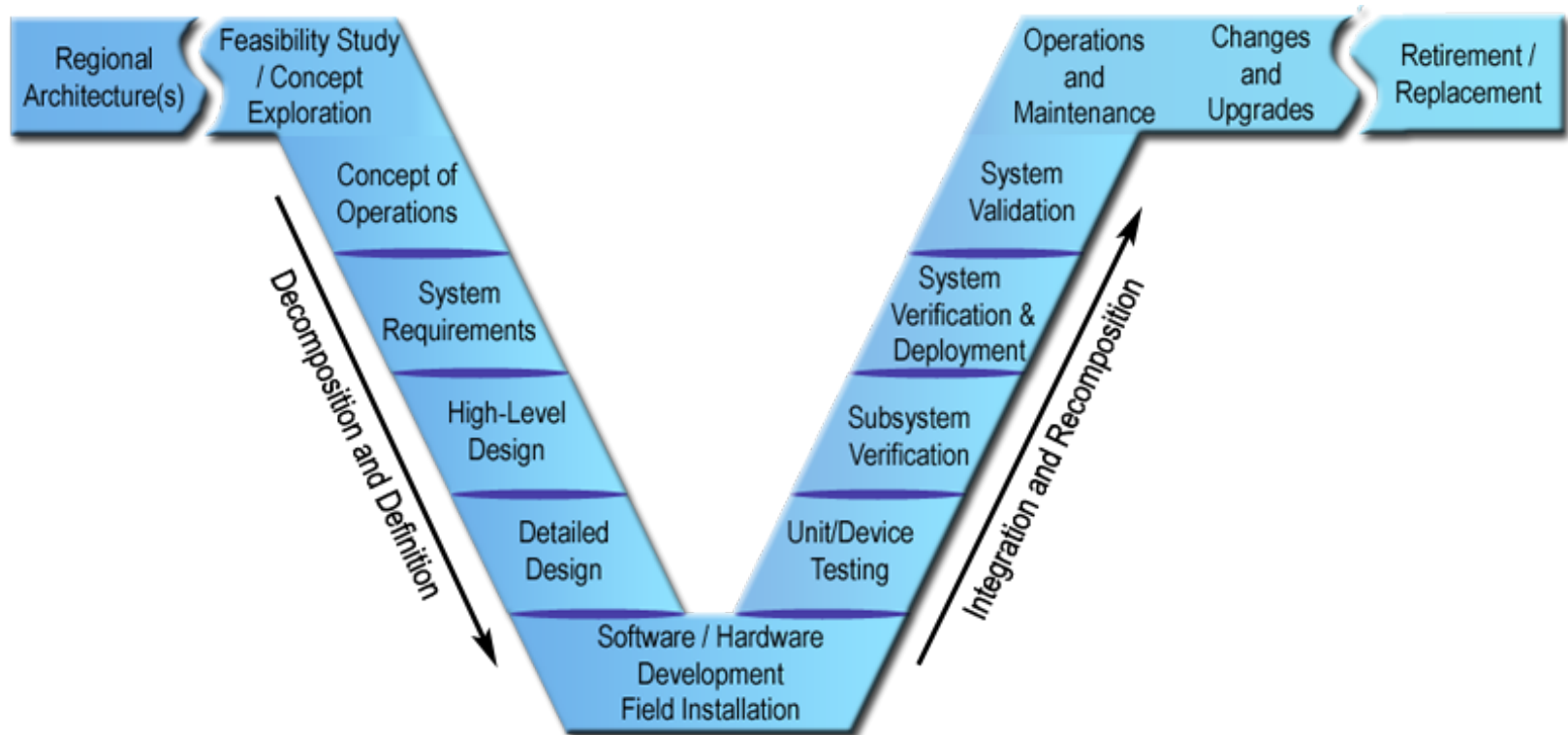
Software e tecnologia de computadores estão envolvidos!

Então, *como* você gerencia o desenvolvimento de sistemas quando o software ou integração com outros sistemas está envolvido?



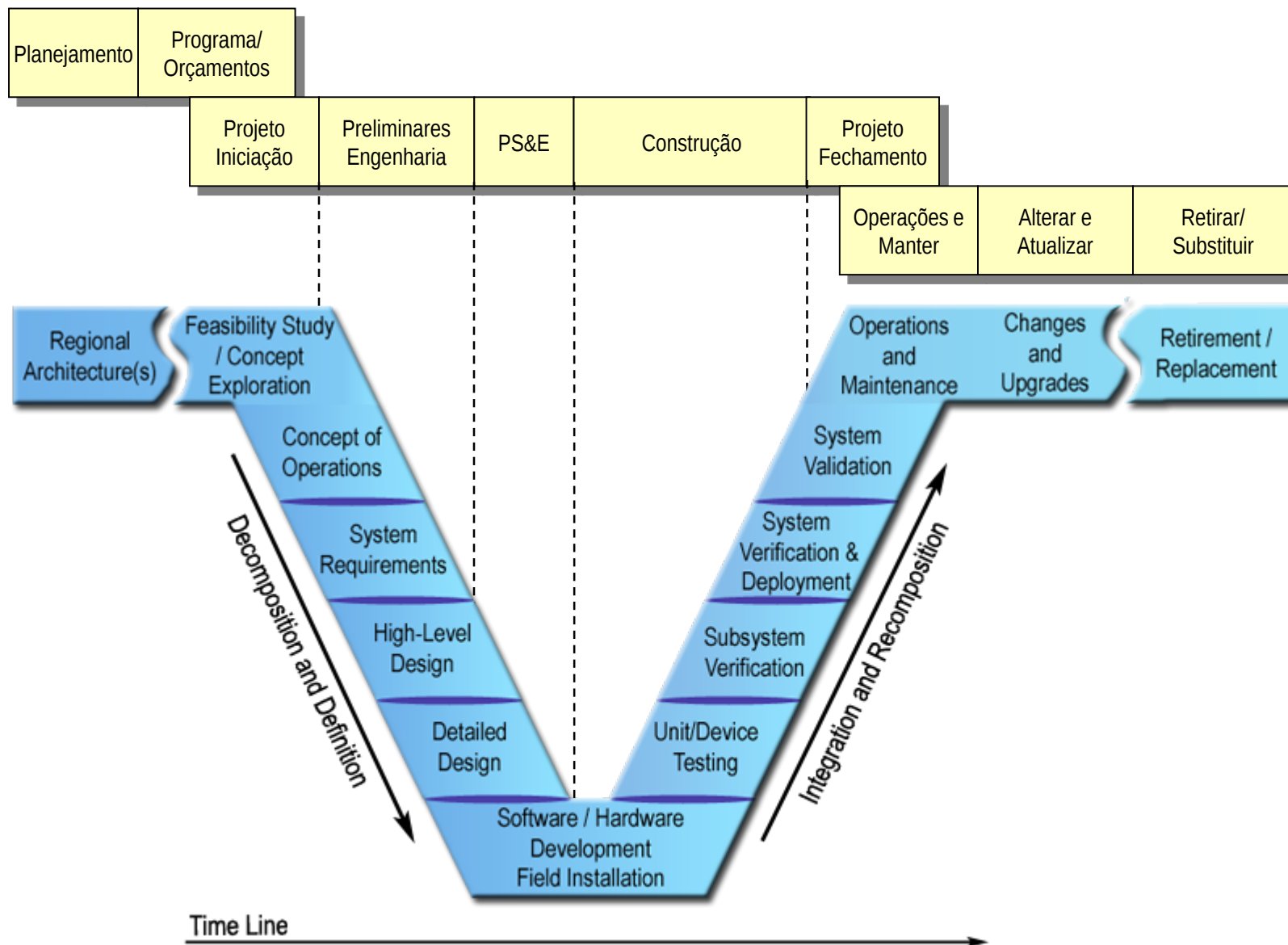
Processo “V” de Engenharia de Sistemas

- Representação amplamente adotada do processo SE
- Representação do processo de desenvolvimento de sistemas
- Aborda do ciclo de vida do projeto





SE “V” e o Processo de Desenvolvimento de Projetos Tradicional





Departamento de Transporte Regulamentos federais exigem Engenharia de Sistemas

Rule/Policy



Implementação do projeto 23 CFR 940.11

- **“Todos os projetos ITS financiados com fundos fiduciários rodoviários devem se basear em uma análise de engenharia de sistemas”**
- **“A análise deve ser em escala compatível com o escopo do projeto”**
- Define 7 requisitos para uma análise SE
- Incluindo a identificação de partes da arquitetura regional de ITS

Administração do projeto 23 CFR 940.13

- **“Antes da autorização dos fundos fiduciários rodoviários para construção ou implementação de projetos ITS, deve ser demonstrado cumprimento com §940.11”**
- Conformidade monitorada sob procedimentos de supervisão com auxílio federal



Como são os documentos SE?

- Conceito de Operação
- Requisitos
- Verificação
- Validação



Exemplo: Programa de substituição de DMS

The image displays three overlapping Microsoft Word documents. The background document is titled "DMS Upgrade and Expansion Program Concept of Operations" and is Version 1.1, dated February 25, 2008. It is prepared for the Virginia Department of Transportation (VDOT) Northern Region Operations by ITERIS. The foreground document is titled "DMS ConOps Appendix 1 High-Level Requirements" and is Draft Version 0.4, dated February 25, 2008. It includes a revision history and a list of requirements. The third document is titled "DMS ConOps Appendix 2, Validation Plan" and is Draft Version 0.3, dated February 25, 2008. It includes a revision history and an introduction to the validation process.

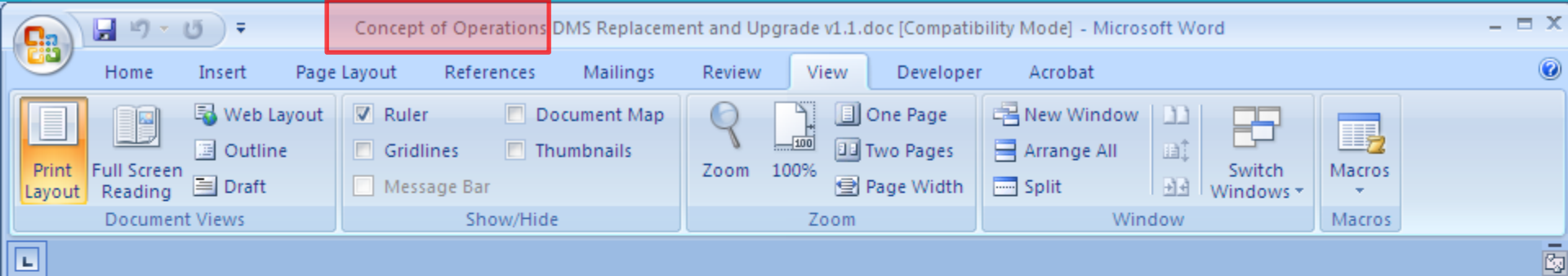
DMS Upgrade and Expansion Program Concept of Operations
Version 1.1
February 25, 2008
Prepared for
VDOT
Virginia Department of Transportation
Northern Region Operations
By
ITERIS

DMS ConOps Appendix 1 High-Level Requirements
Draft Version 0.4, February 25, 2008
Revision History
Version 0.2, October 31, 2007
Initial draft version corresponding to ConOps
Version 0.3, February 20, 2008
Working draft incorporating most requirements
Version 0.4, February 25, 2008
Added high-level requirements with separate
Version 1.1
These requirements respond to the Concept of Operations. The requirements address broad capabilities. These requirements provide the basis for design, development, and testing of the system. These requirements are documented and fulfilled as part of the design, development, and testing of the system.
Some of the requirements pertain to the ATM development efforts. ATM requirements are documented in the ATM Requirements document. This Appendix, titled DMS Upgrade and Expansion, provides the requirements for the DMS.
Traceability is explicitly shown in a separate table, titled DMS Upgrade and Expansion Requirements Traceability Matrix.
1. DMS Message Display Requirements
1.1. DMS Message Display Requirements
1.1.1. Sign Size
The DMS shall provide a display of 20 characters per line, with a line height of three lines.

DMS ConOps Appendix 2, Validation Plan
Draft Version 0.3, February 25, 2008
Revision History
Version 0.2, October 31, 2007
Initial working draft corresponding to Concept of Operations
Version 0.3, February 25, 2008
Draft incorporating revisions to Concept of Operations
Introduction
Validation is the process by which an agency determines whether a system is installed, "Correct" in this context means that the system fully and directly supports the intended activities of the agency. The validation test, therefore, comprises using the system as part of those activities to determine that the system supports rather than conflicts with those activities. Validation is a step that relates ultimate operation and maintenance of the system to the model of those activities as described in the Concept of Operations. Therefore, the validation test is directly related to the model of those activities.

DMS Upgrade and Expansion Requirements Traceability Matrix
The table shown below provides requirements traceability between the DMS Upgrade and Expansion Concept of Operations, and the High-Level Requirements Appendix to that document. The table is designed to be used to track requirements and design elements as the project proceeds.
Each column references the version of the document from which the requirement was derived.

User Need	ConOps Section	High-Level Requirements Number
Concept of Operation 1.1,	ConOps 1.1,	Ver 0.4,



VDOT technicians perform board-level repair of DMS hardware rather than electronic component-level repair. When an electronic component on a circuit board fails, VDOT technicians troubleshoot to determine which board failed, and then return the faulty board to the manufacturer for repair. VDOT's mechanism for paying for these repairs is limited, and the use of extended warranties is preferred.

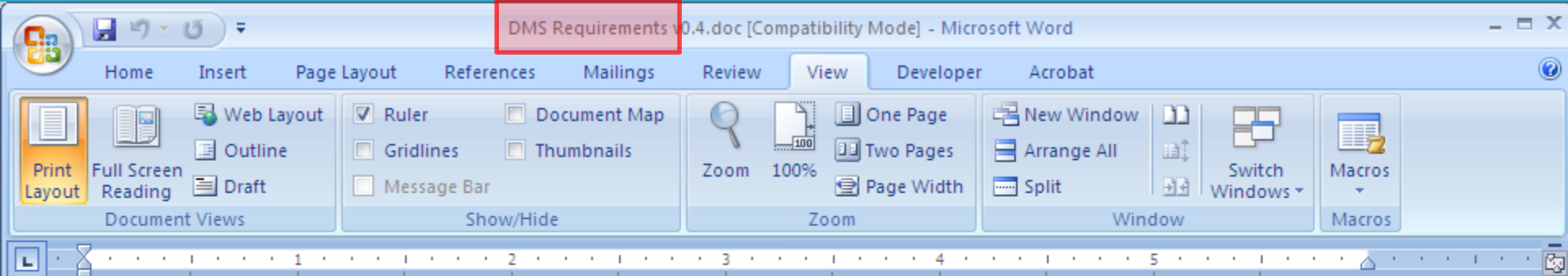
The expected field-serviceable lifespan of the signs is 10 years.

4.2.5. Maintenance Diagnostics

Technicians need to be able to diagnose sign faults as completely as possible from their shop location, or in consultation with ATMS operators.

4.2.6. Sign Location for Maintenance

Field technicians need to be able to effect maintenance and repair on the sign in all weather conditions without closing any lanes of the facility to traffic. Technicians need to be able to park maintenance vehicles safely with reasonable access to the sign, ground control cabinet, and all pull boxes for maintenance, without closing lanes and without deploying extensive work zone traffic management. Maintenance vehicles do not include buckets or lifts, and therefore need to access signs using secure access from the ground for technicians in accordance with state and federal worker safety requirements.



4. Maintainability Requirements

4.1. *DMS Location for Field Accessibility*

The DMS shall be located such that field technicians are able to effect a repair on the sign, ground cabinet, and pull boxes in all weather conditions without closing any part of the facility to traffic.

4.2. *DMS Design for Field Accessibility*

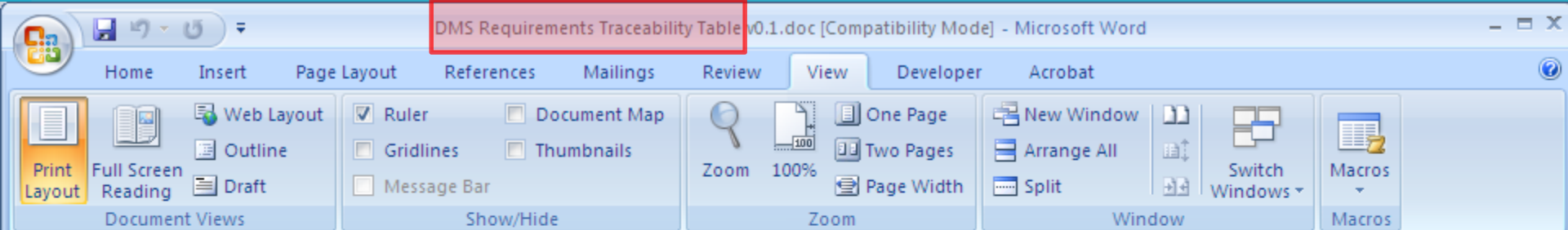
The DMS shall be physically designed to protect the field technician from inclement weather, so that the field technician can effect a board-level repair in all weather conditions without closing the facility to traffic and without exposing sign components to damage from inclement weather.

4.3. *DMS Overhead Accessibility*

The DMS shall be accessible by field technicians without requiring the use of bucket trucks or other personnel lifting devices.

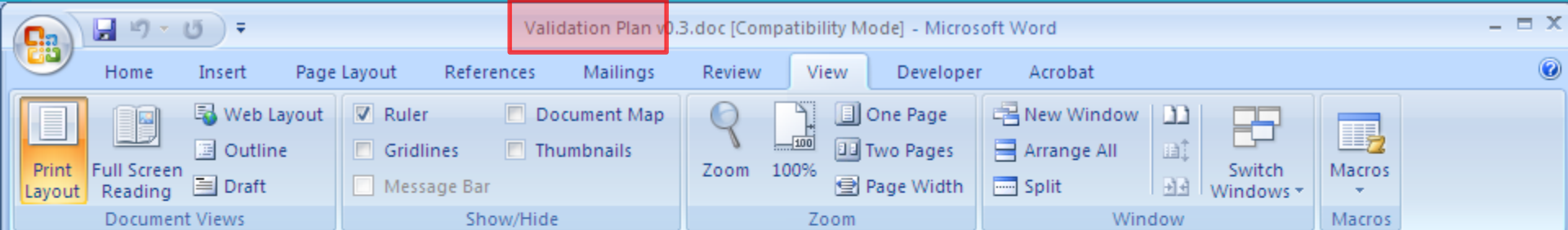
4.4. *DMS Access Safety*

The DMS shall be designed such that technician access conforms to all state and federal worker safety requirements.



Sign Location for Maintenance	4.2.6			
Reparable in all weather conditions while protecting technician and sign components	4.2.6	4.2 DMS Design for Field Accessibility	The DMS shall be physically designed to protect the field technician from inclement weather, so that the field technician can effect a board-level repair in all weather conditions without closing the facility to traffic and without exposing sign components to damage from inclement weather	
Sign location provides maintenance vehicle parking area without blocking traffic	4.2.6	4.1 DMS Location for Field Accessibility	The DMS shall be located such that field technicians are able to effect a repair on the sign, ground cabinet, and pull boxes in all weather conditions without closing any part of the facility to traffic	
Sign components accessible from parking area, including sign, ground control cabinet, and all pull boxes	4.2.6	4.1 DMS Location for Field Accessibility	The DMS shall be located such that field technicians are able to effect a repair on the sign, ground cabinet, and pull boxes in all weather conditions without closing any part of the facility to traffic	
Signs serviceable without the use of bucket trucks or personnel lifting devices	4.2.6	4.3 DMS Overhead Accessibility	The DMS shall be accessible by field technicians without requiring the use of bucket trucks or other personnel lifting devices	
Sign access conforms to state and federal worker safety requirements	4.2.6	4.4 DMS Access Safety	The DMS shall be designed such that technician access conforms to all state and federal worker safety requirements	

User Need	ConOps Section	High-Level Requirement Number and Title	High-Level Requirement	Function Requirement Number
Concept of Operation 1.1, 2/25/08	ConOps 1.1, 2/25/08	Ver 0.4, 2/25/08	Ver 0.4, 2/25/08	



2.3. *Field Accessibility*

Are signs located to allow field technician access in all weather conditions without closing lanes? Are signs located to minimize knockdowns? Can technicians safely perform all work on the sign without requiring a bucket truck?

2.4. *Reliability*

Do signs operate properly in all ambient conditions? Do the signs maintain at least 99.9% reliability? Is the sign designed for 100,000-hour MBTF (10,000 hours for routine maintenance items)?

2.5. *Reparability*

Are technicians able to effect repairs without special tools or manipulation of software? Can those repairs be made within 20 minutes of diagnosis?

2.6. *Maintenance Diagnostics*

Are technicians able to request and receive relevant diagnostic information from the sign?

2.7. *Sign Location for Maintenance*



RAD-IT e SET-IT podem ajudar

- A arquitetura RAD-IT/ITS Regional fornece uma representação de alto nível da visão das partes interessadas para ITS e veículo conectado
- SET-IT facilita a criação do conceito de operações, requisitos do projeto e muito mais

