*SIGAda 2005*

# Tutorial MA1: Systems Engineering and the Impact of Computer Language Selection on It

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# Motivation – Software-Intensive Systems Engineering





**More and more, systems are becoming software intensive, containing millions of lines of code!**

People have to work in teams to produce many kinds of products – one person cannot do it alone in most cases!

# The Systems We Build

- ❖ **Business-Critical**
    - ■ **Financial**
    - ■ **Infrastructure**
- ❖ **Mission-Critical**
    - ■ **Business-Critical**
    - ■ **Domain-Specific**
- ❖ **Safety-Critical**
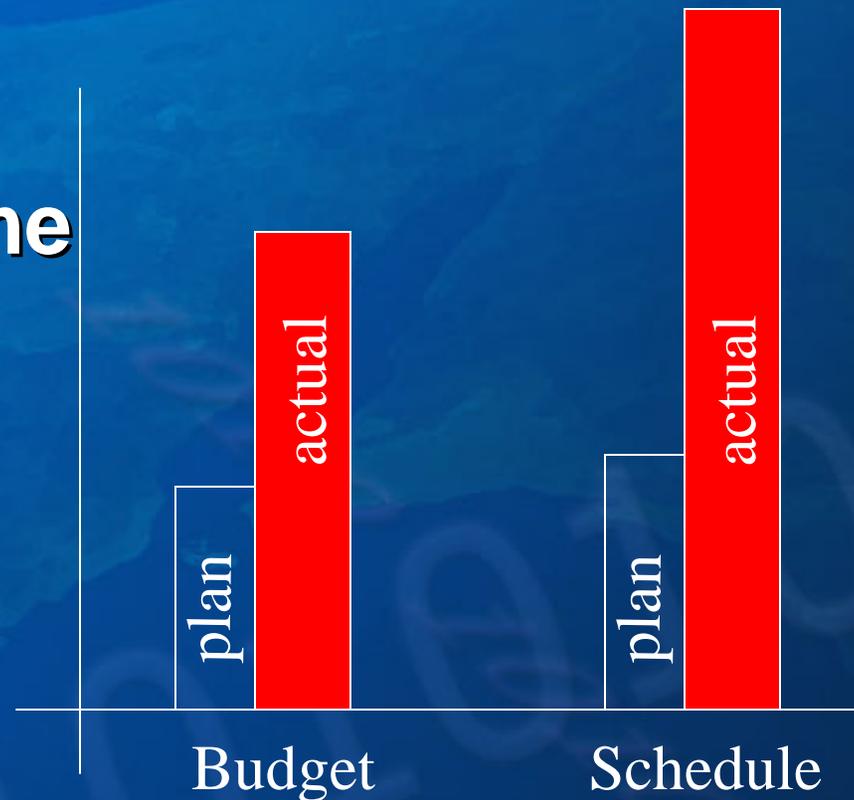    - ■ **Lives are at stake!**

*More and more, failure is NOT an option!*

*Why Systems Engineering?*

# The Systems Engineering Job

- **Produce quality product**
- **Contain costs**
- **Complete on time**

# We Will Discuss 2 Worlds of Approaches

- ❖ **Video – DoD/Lockheed Martin – Focus on Aircraft and other Large Systems**

- ❖ **Video - Microsoft – Focus on Personal and Enterprise Systems (The Future PC)**

**What is the impact of Computer Language selection?**

# We Will Present Multiple Perspectives

❖ **Department of Defense**

❖ **Outsourcing**

❖ **Learning Federation**

❖ **Microsoft**

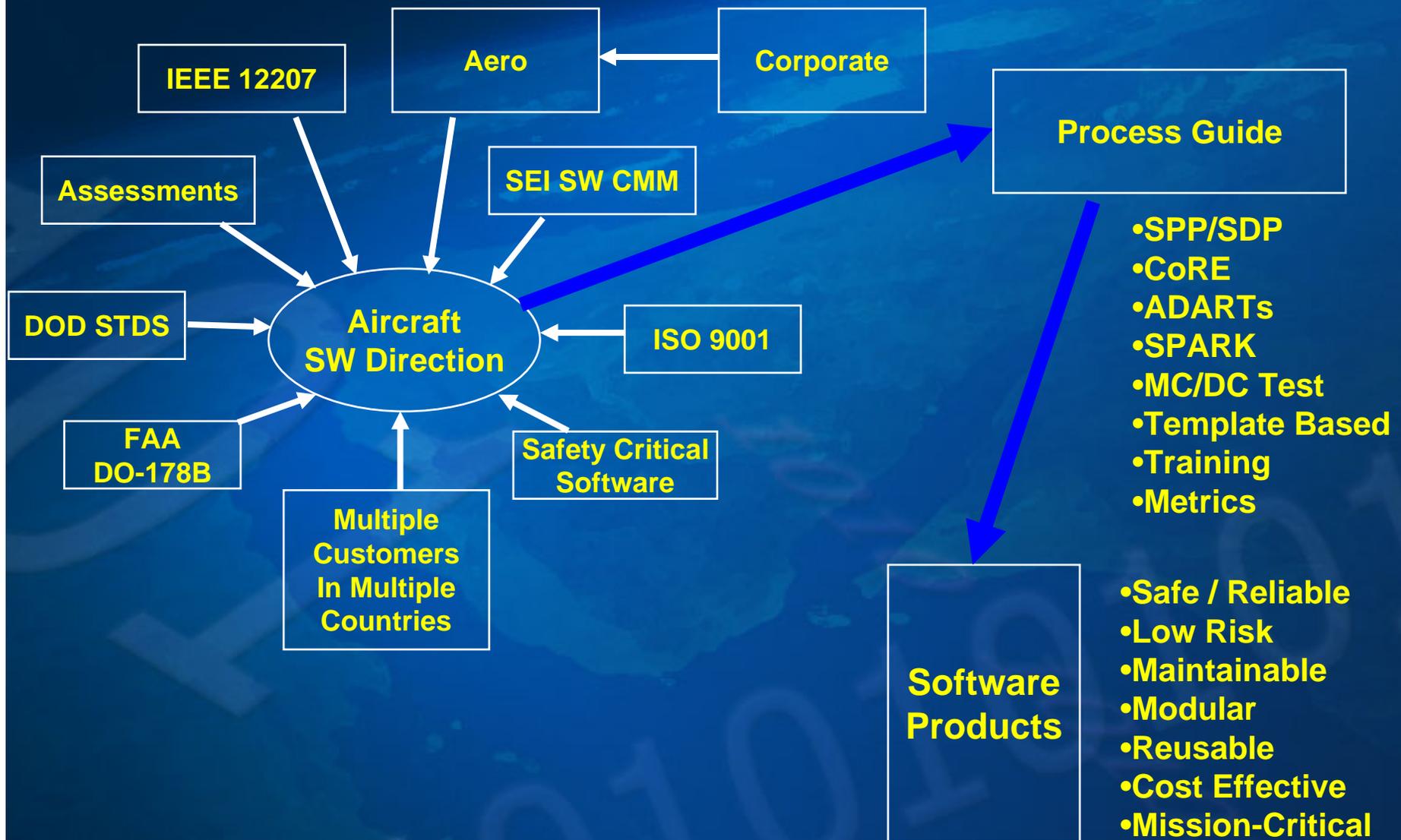What is the impact of Computer Language selection?

# We Will Discuss 2 Worlds of Approaches

❖ ***Department of Defense – Focus on Aircraft and other Large Systems***

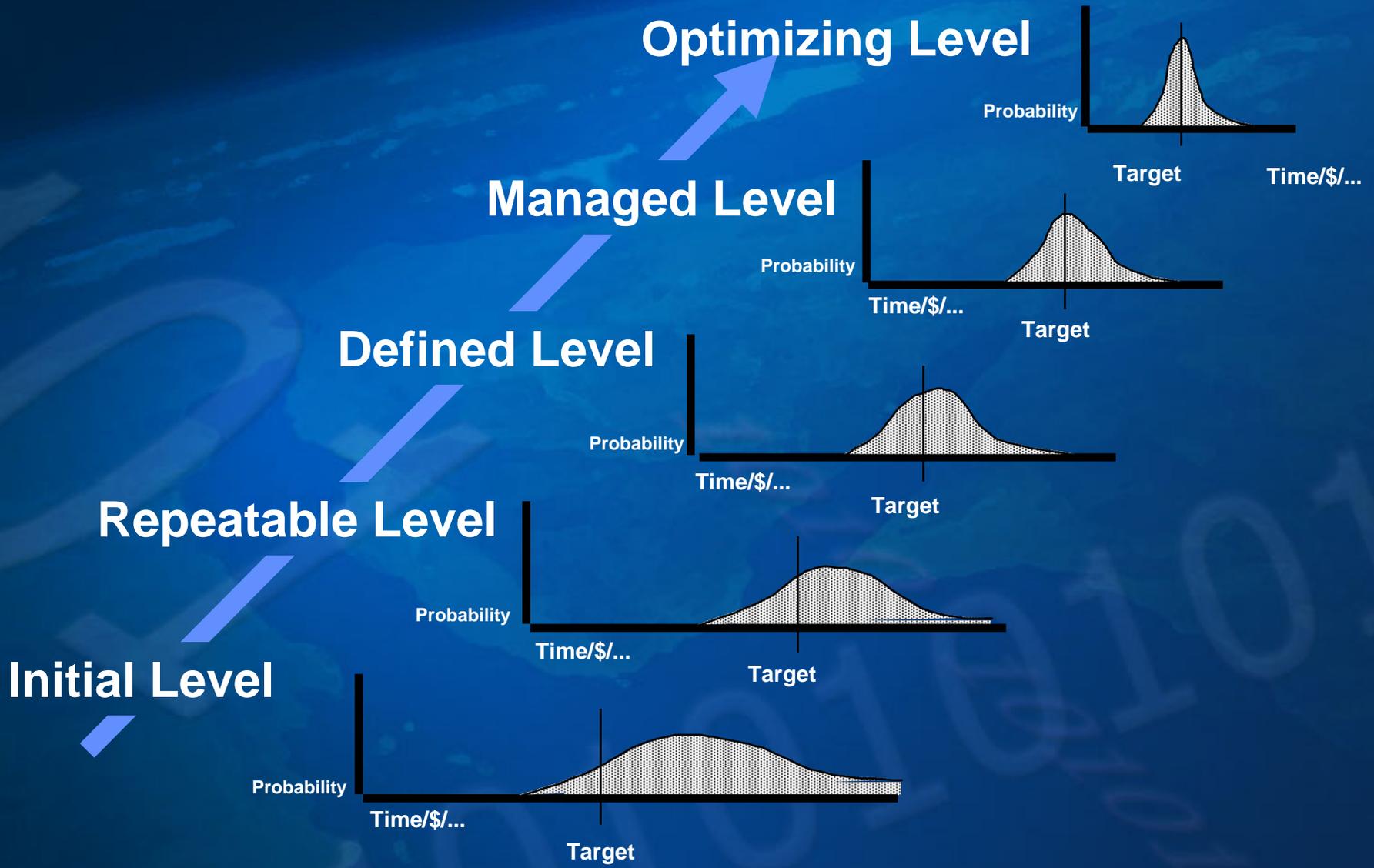❖ **Microsoft – Focus on Personal and Enterprise Systems**

**What is the impact of Computer Language selection?**

# Aircraft Requirements

```
IEEE 12207

Assessments

DOD STDS

FAA
DO-178B

Aero          Corporate

SEI SW CMM

Aircraft
SW Direction        ISO 9001

Multiple       Safety Critical
Customers        Software
In Multiple
Countries
```

**Process Guide**

- SPP/SDP
- CoRE
- ADARTs
- SPARK
- MC/DC Test
- Template Based
- Training
- Metrics

**Software Products**

- Safe / Reliable
- Low Risk
- Maintainable
- Modular
- Reusable
- Cost Effective
- Mission-Critical

# Software Intensive Systems

❖ DUSD(S&T) responsible for
  Software Intensive Systems - Mar 99

❖ Established:

  ■ Software Intensive Systems Directorate

  ■ Software Intensive Systems Steering Group

  ■ Defense Software Collaborators

# DoD's Software Intensive Systems Strategy

- ❖ **SIS Strategy:**

  - ■ **Policy**

  - ■ **Collaboration**

  - ■ **Education and Training**

  - ■ **Science and Technology**

- ❖ **SIS activities are focused on recent Defense Science Board Recommendations.**

# Defense Science Board Recommendations

❖ **Stress software process and past performance**

❖ **Institutionalize independent expert program reviews**

❖ **Improve software skills of acquisition and program management**

❖ **Collect, disseminate and employ best practices**

❖ **Restructure contract incentives**
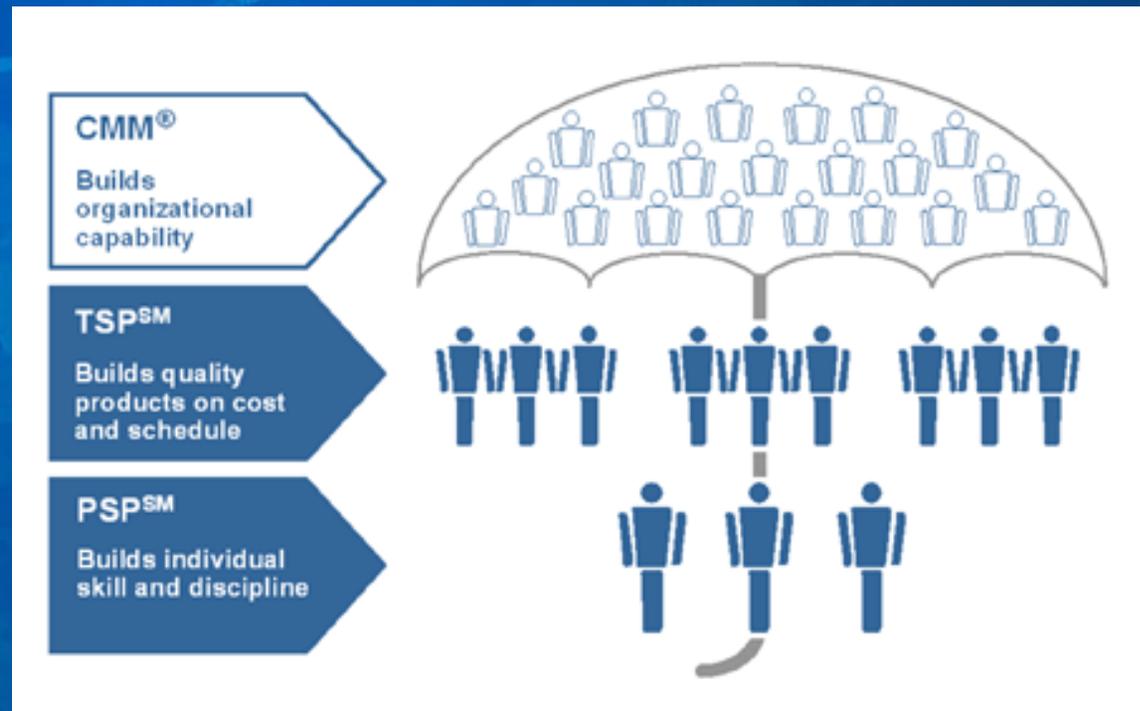
❖ **Strengthen the technology base**

# Capability Maturity Model Integration (CMMI)

❖ **Established to provide a single model framework for engineering process improvement**

❖ **Incorporates critical engineering principles by integrating systems and software engineering**

❖ **Oct 99 - Compliance with maturity level 3 required for all DoD contractors**
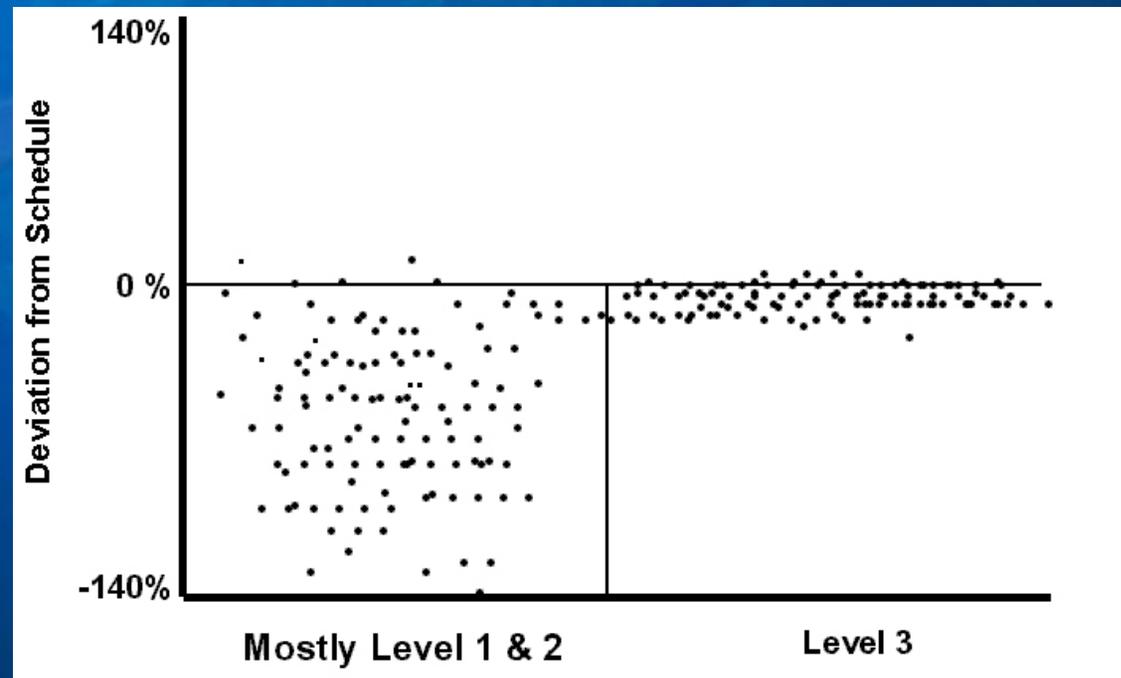
# Context

- ❖ **Maturity is about …**
  - **People**
  - **Following a disciplined process**
  - **To create software-intensive products**



CMM®
Builds organizational capability

TSP℠
Builds quality products on cost and schedule

PSP℠
Builds individual skill and discipline

# People are …

❖ **Members of a Team**

❖ **Assigned one or more leadership/management roles**

- **Team Leader**

- **Development Manager**

- **Planning Manager**

- **Quality/Process Manager**

- **Support Manager**

❖ **Each role has a set of specific responsibilities**

- **These responsibilities vary from process to process**

- **Recurring responsibilities, which are repeated in all processes, also exist**

# The Process is …

❖ A set of activities for producing a product or set of products

❖ Processes may also contain other processes

❖ Each process has at least –
   ■ An entry criteria
   ■ A set of activities or processes to follow
   ■ A set of products to be consumed
   ■ A set of products to be created or modified
   ■ An owner (who can change it), a controller (who runs it)
   ■ An exit criteria
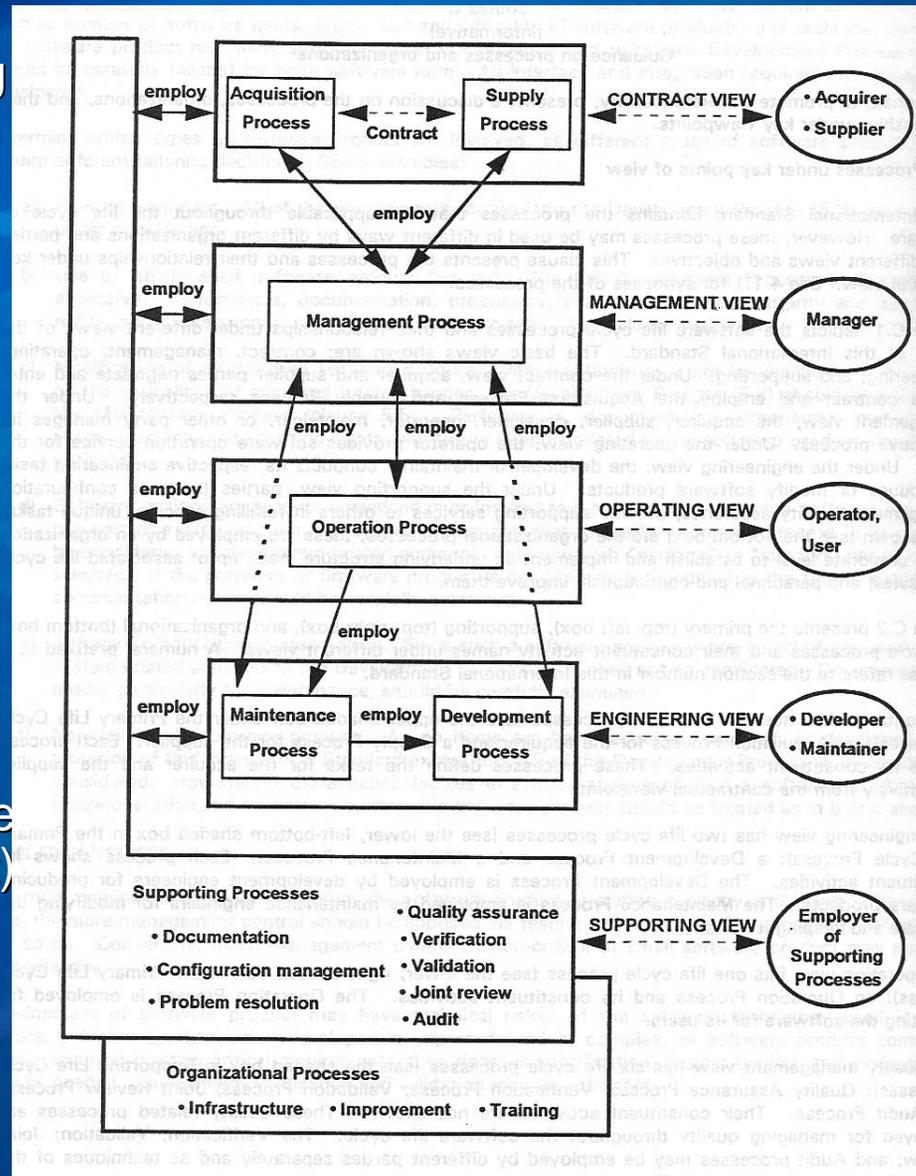
# The Products are …

- **Software (in the context of Software Engineering)**
  - **Code (obviously)**
  - **Documents**
  - **Data**
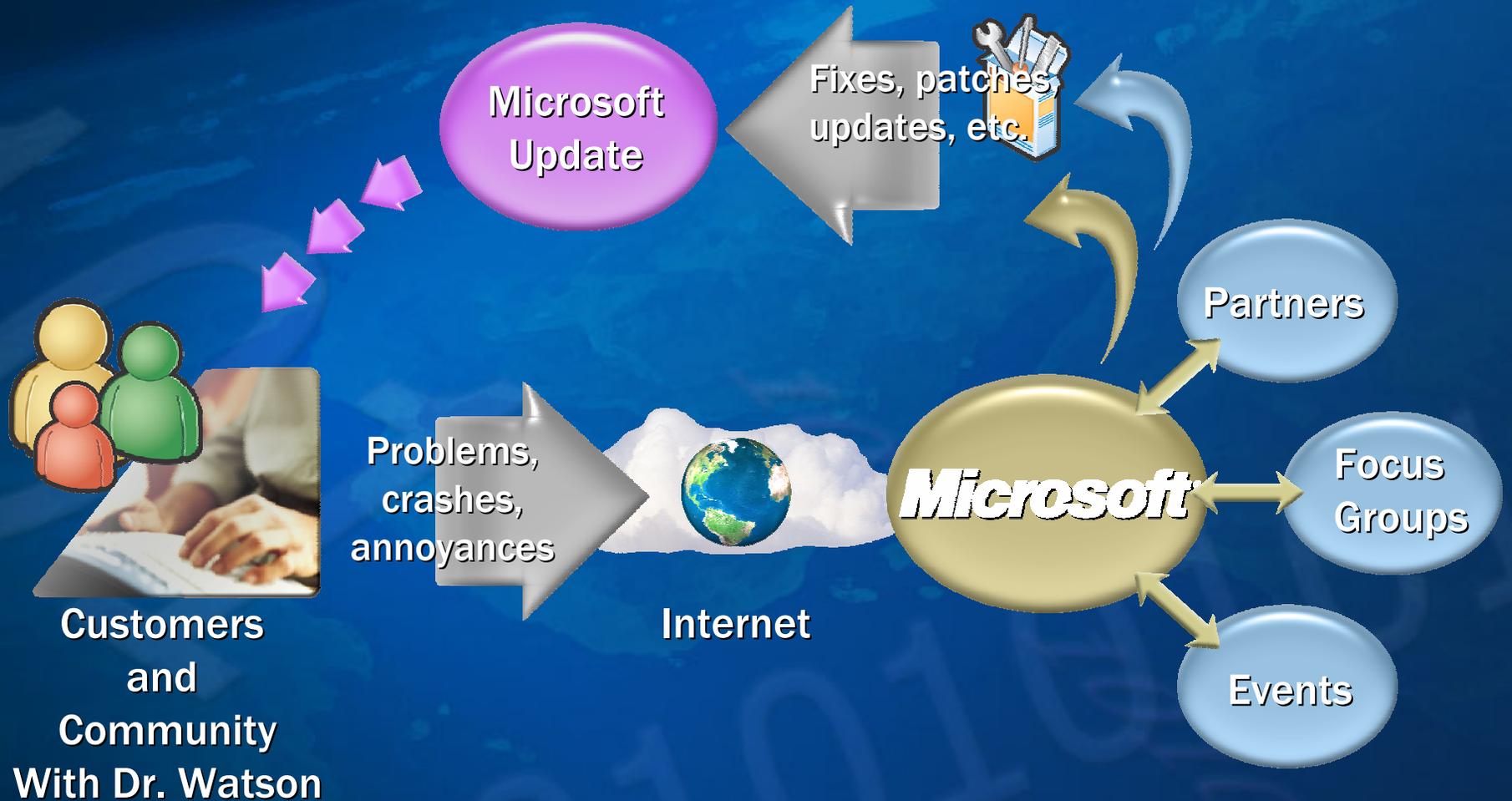- **Hardware**
- **Created by people**
- **Used by people**
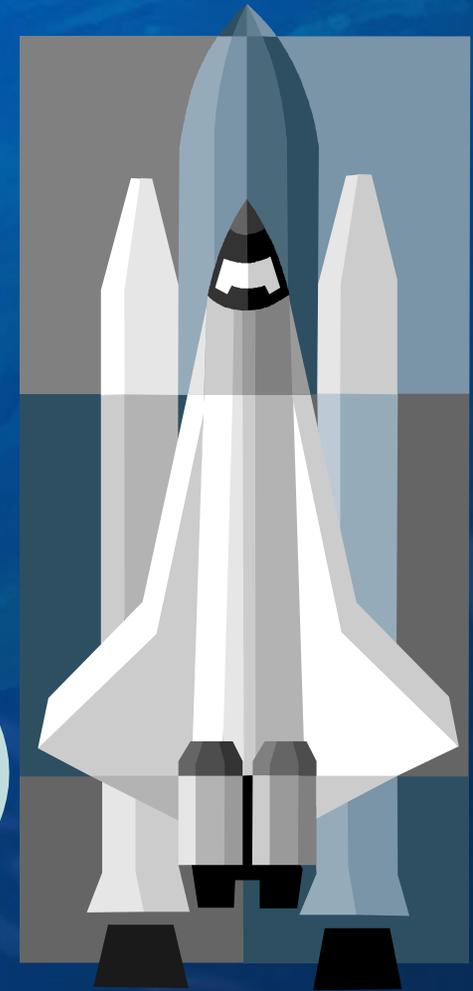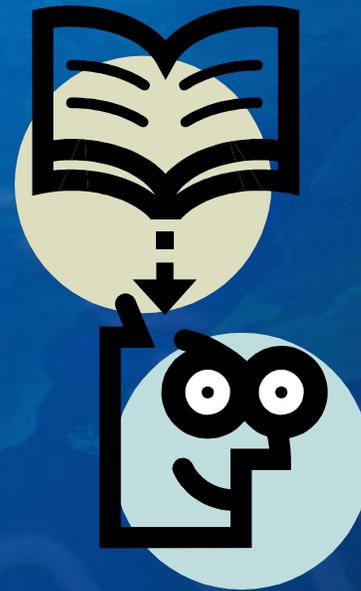
# We Will Discuss 2 Worlds of Approaches

❖ **Department of Defense – Focus on Aircraft and other Large Systems**

❖ *Microsoft – Focus on Personal and Enterprise Systems*

**What is the impact of Computer Language selection?**

# Microsoft Requirements

# Today's Business Environment

- ❖ **Places increasing demands on IT organizations**
  - ■ **Rapid change**
  - ■ **Financial constraints**
  - ■ **Global interconnectivity**
  - ■ **Expanding needs**
  - ■ **Greater variety of stakeholders**

- ❖ **MSF 3 is:**
  - ■ **An adaptable approach**
  - ■ **For successfully delivering technology solutions faster**
  - ■ **With fewer people**
  - ■ **With less risk**
  - ■ **While producing higher quality results**

# MSF 3

- **MSF is:**
  - A deliberate and disciplined approach to technology projects
  - Based on:
    - Microsoft internal practices
    - Experiences of Microsoft Services working with customers and partners
    - Industry best practices

- **Objectives**
  - Address the most common causes of technology project failure
  - Improve success rates
  - Improve solution quality
  - Improve the business impact

- **MSF Describes**
  - How to align business and technology goals
  - How to establish clear project goals, roles, and responsibilities
  - How to implement an iterative, milestone-driven process
  - How to manage risk proactively
  - How to respond to change effectively

- **5 Primary Topic Areas**
  - Team Model
  - Process Model
  - Project Management Discipline
  - Risk Management
  - Readiness Management Discipline

# Microsoft Solutions Framework and Trustworthy Computing

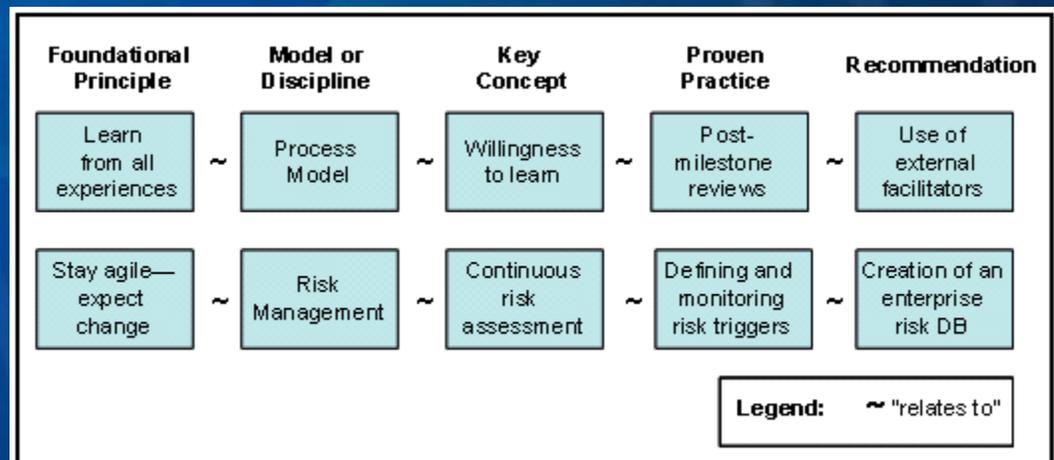- ❖ **Disciplined approach to creating products based on Microsoft technologies involving:**
  - ■ Defined set of principles
  - ■ Models
  - ■ Guidelines
  - ■ Proven best practices
- ❖ **MSF is a Framework**
  - ■ Flexible and scalable – not a prescriptive methodology or process
  - ■ Provides guidance
  - ■ Oriented to the IT domain

- ❖ **MSF Foundation**
  - ■ Open communication
  - ■ Concise, shared vision
  - ■ Empower team members
  - ■ Clear accountability, shared responsibility
  - ■ Focus on delivering business value
  - ■ Stay agile, expect change

| Foundational Principle | | Model or Discipline | | Key Concept | | Proven Practice | | Recommendation |
|---|---|---|---|---|---|---|---|---|
| Learn from all experiences | ~ | Process Model | ~ | Willingness to learn | ~ | Post-milestone reviews | ~ | Use of external facilitators |
| Stay agile—expect change | ~ | Risk Management | ~ | Continuous risk assessment | ~ | Defining and monitoring risk triggers | ~ | Creation of an enterprise risk DB |

Legend: ~ "relates to"

# MSF (continued)

❖ **MSF Process Model**
  - ■ **Flexible, based on phases and milestones**
    - ■ **Phases – periods of time in which certain activities produce deliverables**
    - ■ **Milestones – review and synchronization points**
  - ■ **Allows response to customer requests and changes to a product in midcourse**
  - ■ **Allows delivery of key portions of a product faster, moving less critical functions to later releases**
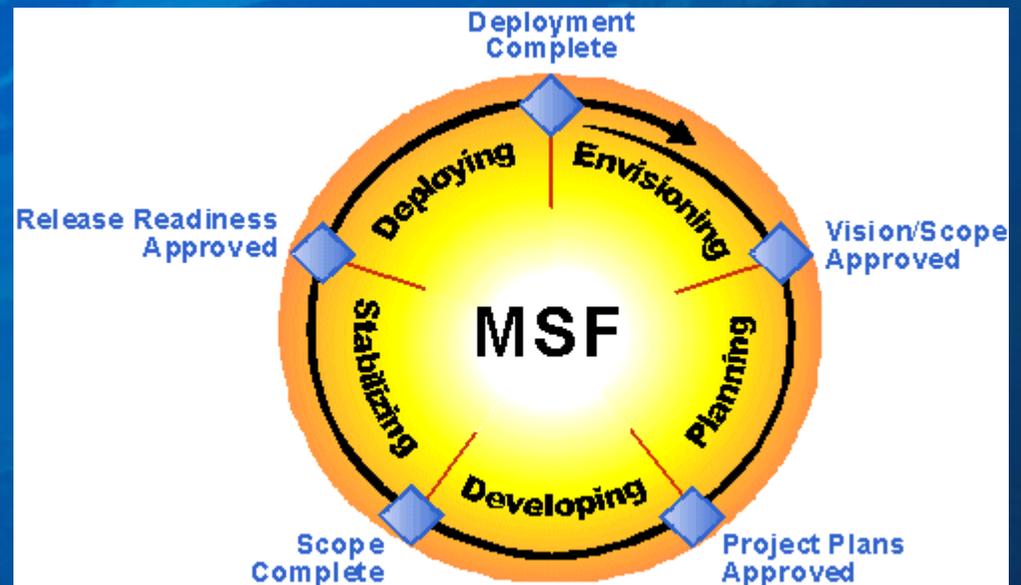
# MSF (continued)

❖ **MSF Team Model**

- **Program Management – deliver within project constraints**

- **Development – deliver to product specifications**

- **Test – Release after addressing all issues**

- **Release Management – Smooth deployment and Ongoing Management**

- **User Experience – Enhance user performance**

- **Product Management – See to customer satisfaction**

# MSF (concluded)

❖ **MSF Disciplines**

- **Project Management - Aligned with the major project management bodies of knowledge with the domain of technology-oriented projects**
  - **Project Management Institute**
  - **International Project Management Association**
  - **Prince2 (Projects in Controlled Environments)**
- **Risk Management – 6-step risk management process integrated into both the Team and Process Models**
- **Readiness Management – Measures the current versus the desired state of knowledge, skills, and abilities of the people in an organization**

❖ **MSF integrates with Microsoft's Trustworthy Computing Initiative**

- **A collaboration between Microsoft, its customers, its business partners, its suppliers, and government agencies, such as the NSA**
- **Includes, but is not limited to:**
  - **A proactive security-oriented development process**
  - **Several best practices in writing secure code**
  - **Threat modeling**
  - **Testing with security in mind**
  - **Reviewing code with security in mind**
  - **Addressing privacy concerns in coding**

# Trustworthy Computing

**Security**

❖ **Resilient to attack**

❖ **Protects confidentiality, integrity, and availability of data and system**

**Privacy**

❖ **Individuals control personal data**

❖ **Products and online services adhere to fair information principles**

**Reliability**

❖ **Dependable**

❖ **Available when needed and performs at expected levels**

**Business Integrity**

❖ **Responsive and responsible handling of customer product and service issues**
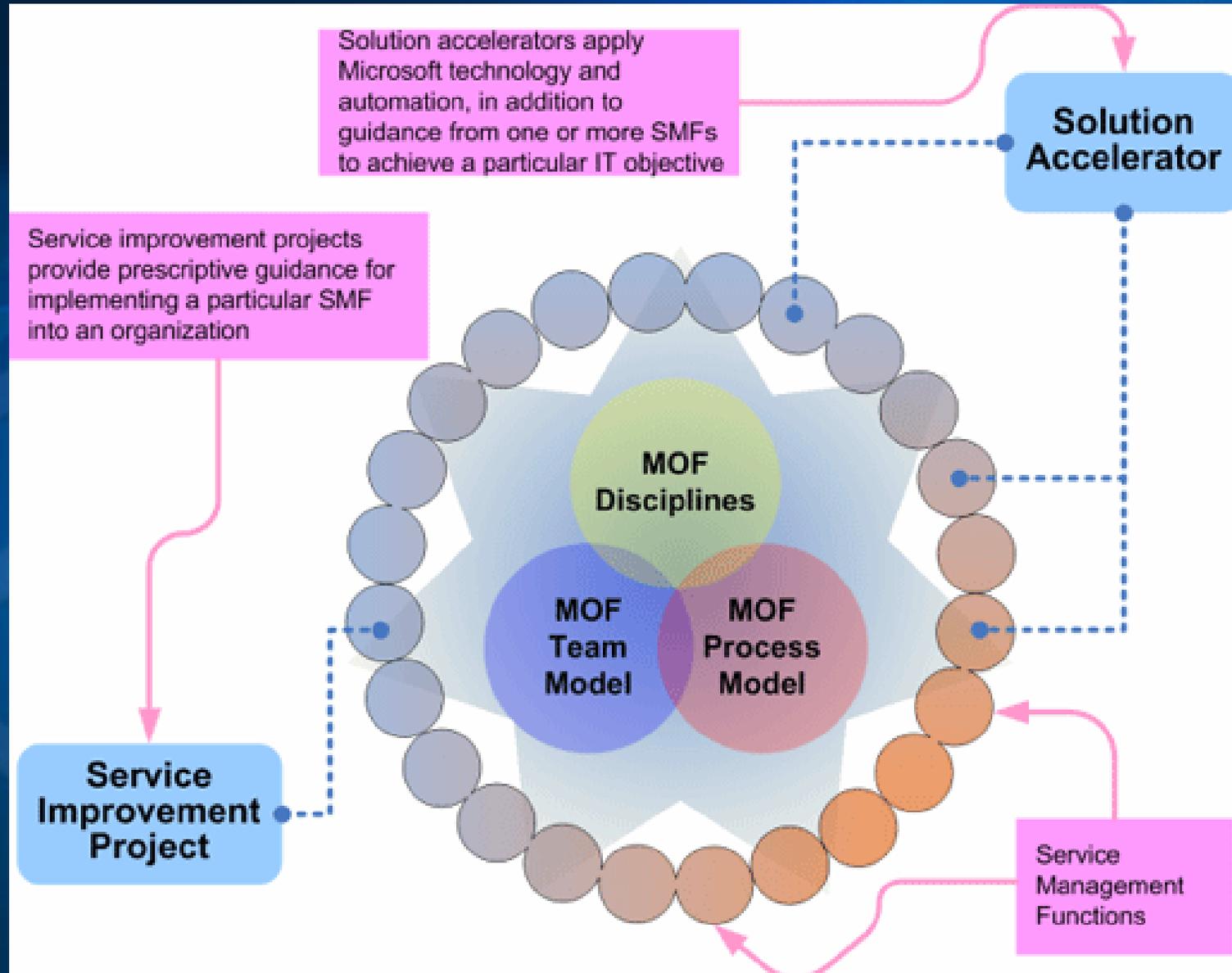
# What is the MOF?

- ❖ **The Microsoft Operations Framework (MOF) defines …**
  - ■ **Proven team structures**
  - ■ **Operational processes**
  - ■ **Best IT practices**
- ❖ **Goals are to Improve …**
  - ■ **Efficiency of IT organizations**
  - ■ **Quality of IT operations**
- ❖ **Core Components**
  - ■ **Team Model**
  - ■ **Process Model**
  - ■ **Risk Management Discipline**
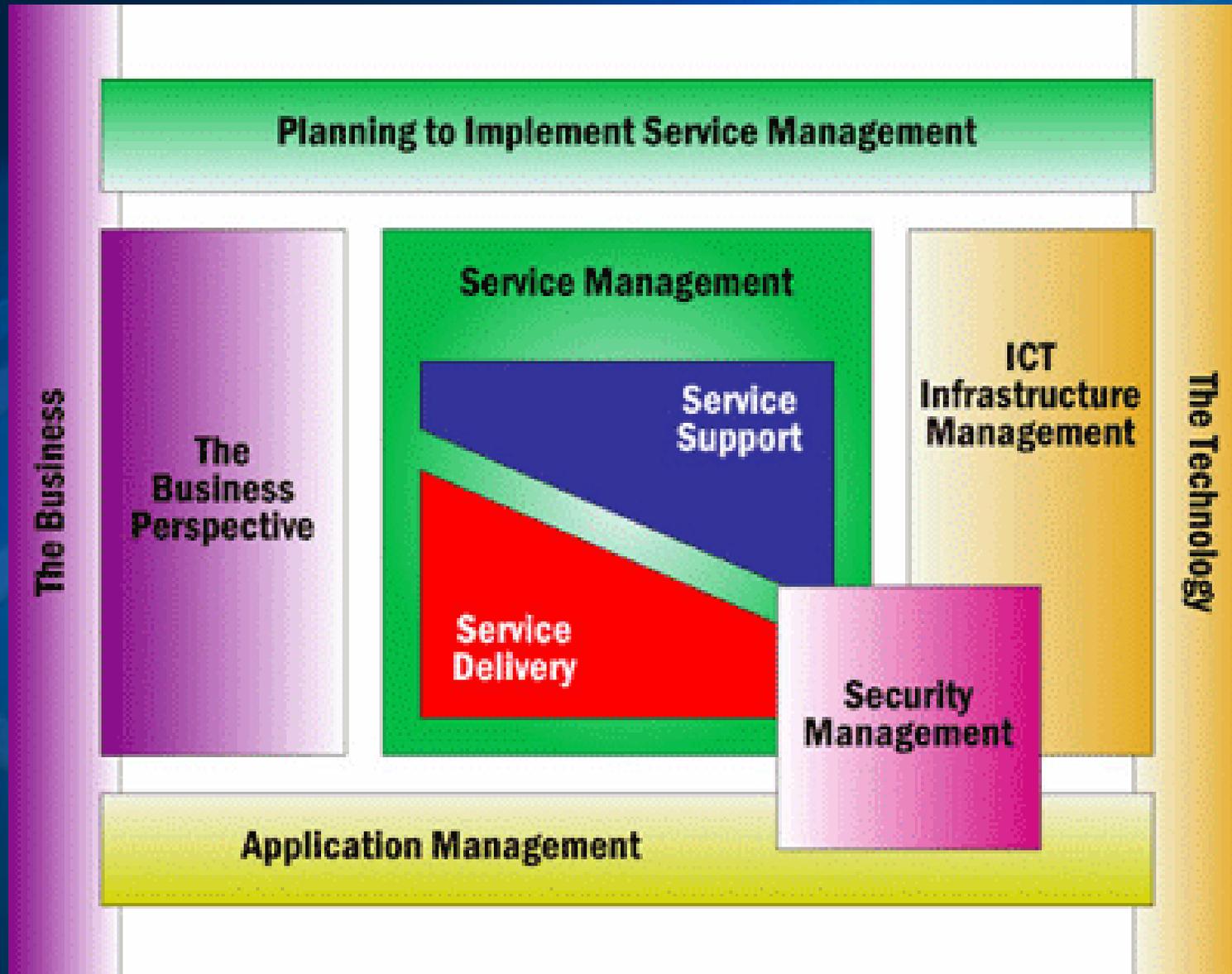
# The MSF and the MOF
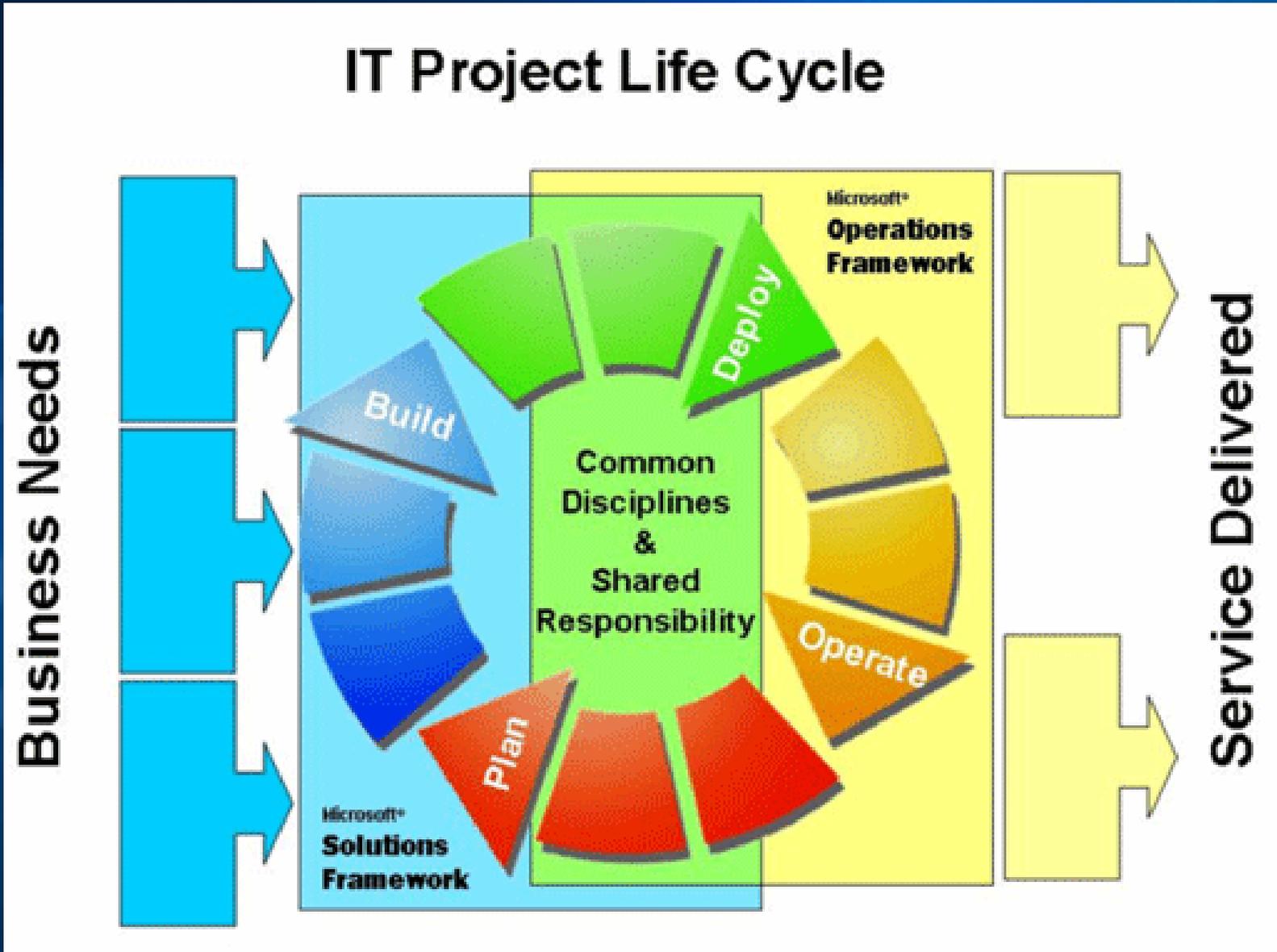
# MOF Core Guidance

# Some Available Solution Accelerators

❖ **Business Desktop Deployment**

❖ **Enterprise Messaging**

❖ **Internet Data Center**

❖ **Service Monitoring and Control**

❖ **Domain Server Consolidation and Migration**

❖ **Patch Management (several versions)**

❖ **Windows Server Deployment**

# MOF and ITIL

- **MOF aligns and builds on the IT service management practices documented in the IT Infrastructure Library (ITIL) maintained by the United Kingdom's Office of Government Commerce (OGC)**
  - **OGC is a U.K. government executive agency**
  - **Charter: develop best-practice advice and guidance on the use of IT in service management and operations**
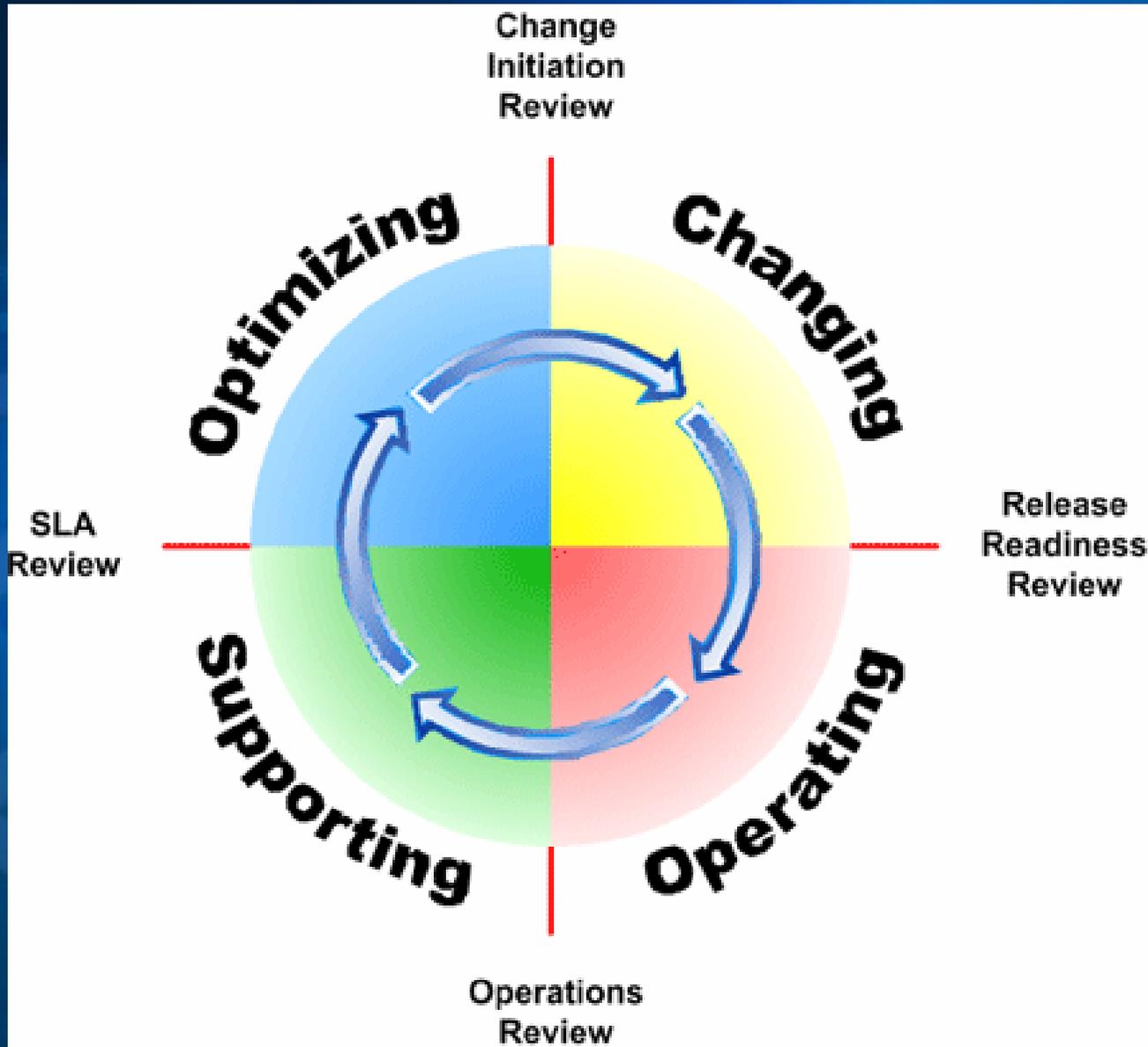  - **Microsoft has been involved in the ITIL community since 1999**

# MOF and ITIL (concluded)
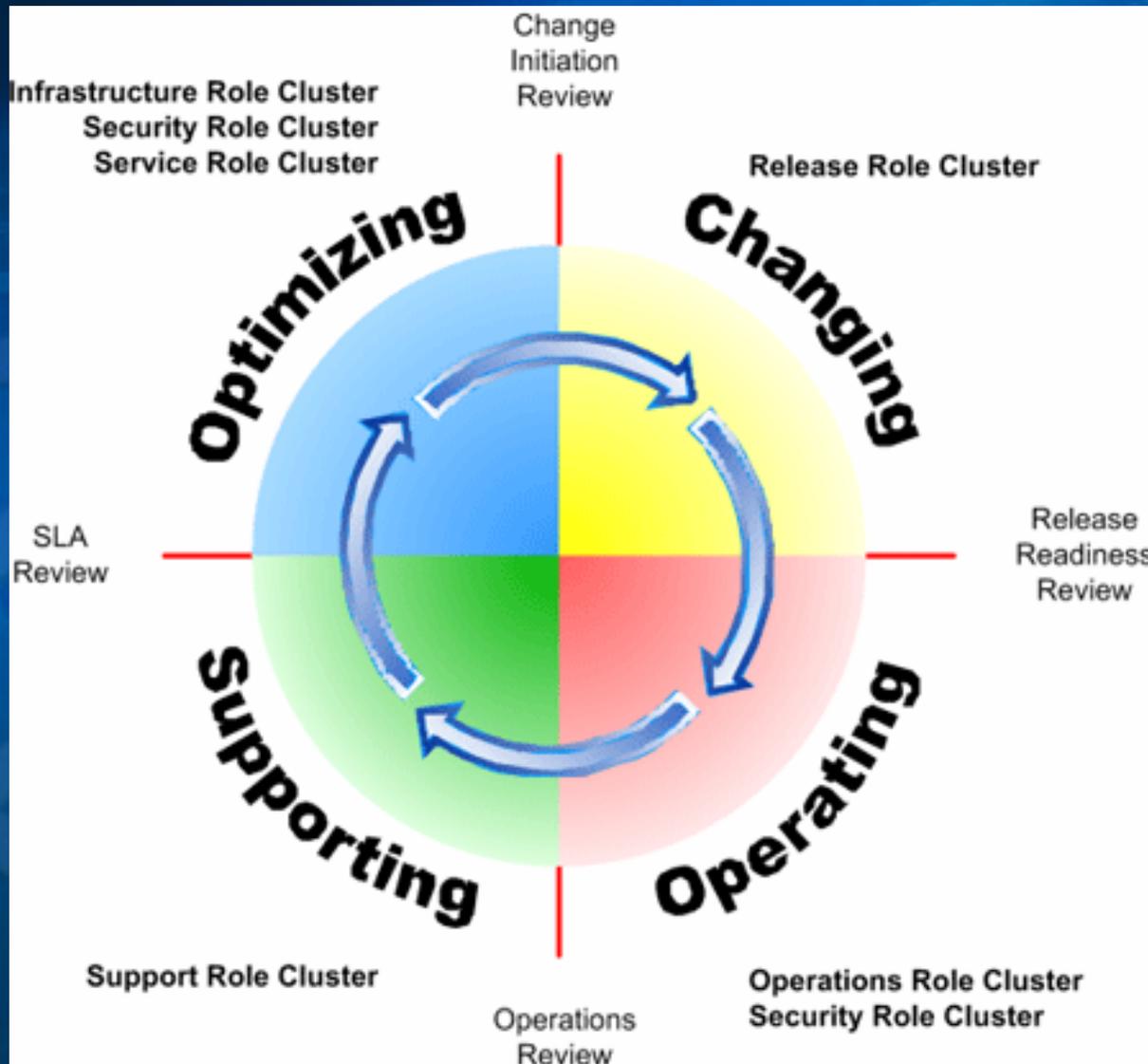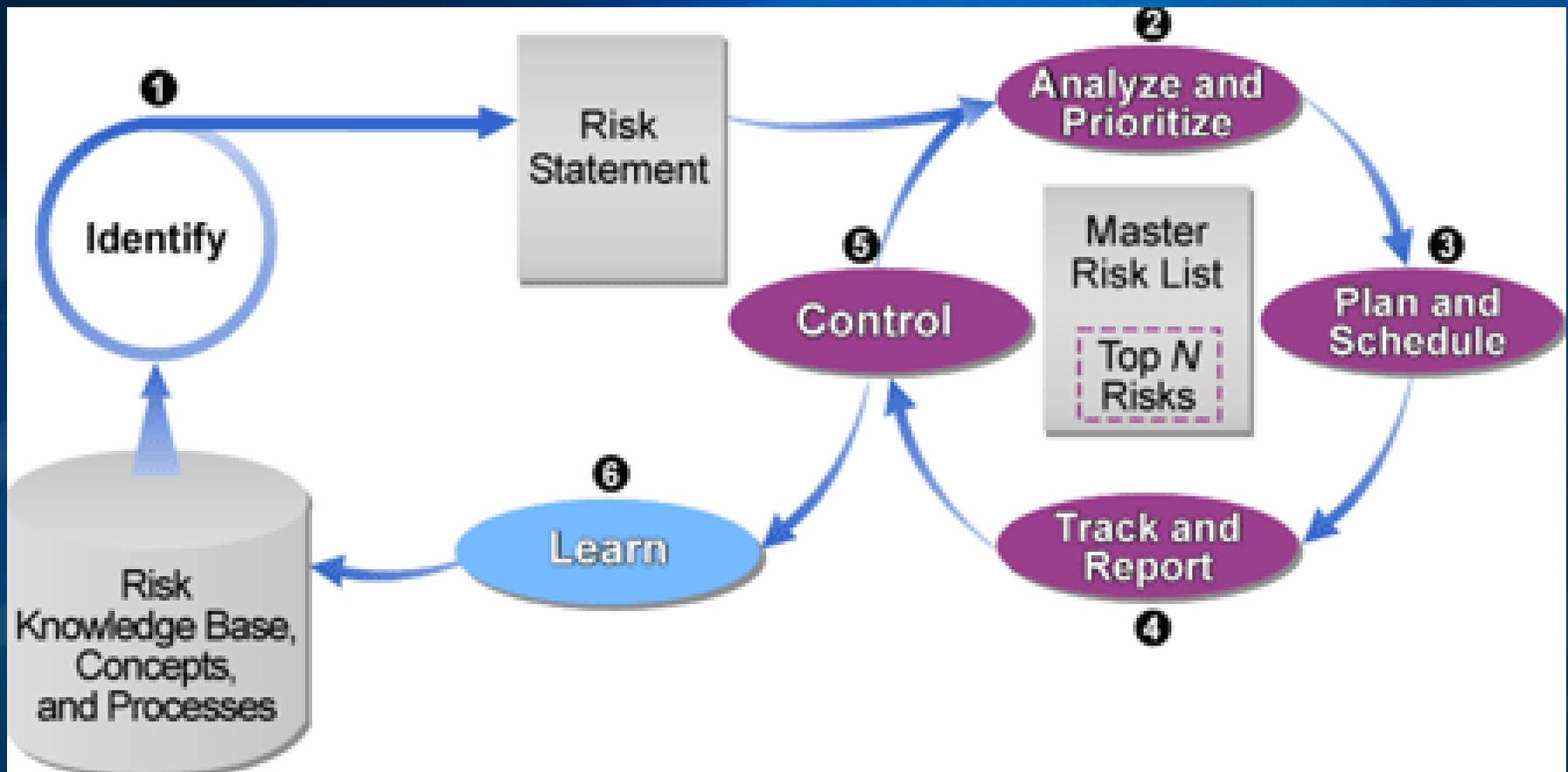
# MOF Models – Team Model with Role Clusters

Change Management
Release Engineering
Configuration control / asset management
Software distribution / licensing
Quality assurance

Intellectual property protection
Network and system security
Intrusion detection
Virus protection
Audit and compliance administration
Contingency planning

SLA drafting/negotiation
Service catalog management
SLA review
Service improvement initiation
Customer relationship management
Service level management

**Release**

**Security**

**Service**

**Partner**

**Infrastructure**

Managed service outsourcers
Software / hardware suppliers
Maintenance vendors
Environment support
Training partners

**Operations**

**Support**

Enterprise architecture
Infrastructure / systems engineering
Capacity management
Cost / IT budget management
Resource and long-range planning

Messaging operations
Database operations
Network administration
Monitoring / metrics
Availability management

Service desk / help desk
Production / production support
Problem management
Service level management

# MOF Process Model

# MOF Process Model with Service Management Functions (SMFs)

Service Level Management
Capacity Management
Availability Management
Security Management
Infrastructure Engineering
Financial Management
Workforce Management
Service Continuity Mgmt.

Change
Initiation
Review

Change Management
Configuration Management
Release Management

**Optimizing**

**Changing**

SLA
Review

Release
Readiness
Review

**Supporting**

**Operating**

Service Desk
Incident Management
Problem Management

Operations
Review

Service Monitoring & Control
System Administration
Network Administration
Directory Services Administration
Security Administration
Storage Management
Job Scheduling

# Aligning Team Model Role Clusters with the Process Model

# Risk Management Process

# The Next Generation

- ❖ **MSF is advancing**
  - ■ **With Visual Studio 2005, we are starting to see MSF Version 4 emerge**
  - ■ **MSF Version 4 supports both Agile and CMM/CMMI Methodologies**
- ❖ **MOF is advancing as well**
- ❖ **Classic DoD and Microsoft Approaches are merging!**
- ❖ **People are seeing multiple perspectives …**

# We Will Present Multiple Perspectives

❖ **Department of Defense**

❖ **Outsourcing**

❖ **Learning Federation**

❖ **Microsoft**

What is the impact of Computer Language selection?

# DoD Perspective

- ❖ **Briefing - Undersecretary of Defense for Science and Technology Briefing (2001)**
- ❖ **Documents - DoD**
  - ■ **The Road Ahead**
  - ■ **DoD Directive 5000.1**

**customer**

# Outsourcing Perspective

❖ **Video - Building Airplanes in the Sky**

❖ **Briefing – A View of Outsourcing**

### Figure 1 — Definition of an Adaptive Organization

An adaptive organization is one that focuses on dramatically improving the economics of business change to enhance the organization's performance (e.g., profitability, growth, liquidity, integrity). This is accomplished by harnessing IT to automate new forms of collaboration, innovation, resource sharing, and sourcing to dynamically optimize loosely coupled modular resources (e.g., people, products, services, technologies, processes) in a timely fashion and in a constantly changing competitive market.

Source: META Group

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# Learning Federation Perspective

❖ **Briefing - What is the Learning Federation?**

❖ **Briefing - Roadmaps for the Future**

❖ **Briefing and Videos on iCampus**

  ■ **Briefing – MIT iCampus**

  ■ **Video – PREP**

  ■ **Video - InkBoards**

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# Microsoft Perspective

- ❖ **Briefings**
    - ■ **Research Faculty Summit 2003**
    - ■ **Executive Summit 2003**
    - ■ **Government Leaders Summit 2003**
    - ■ **Industry Analyst Summit 2003**
    - ■ **WinHEC 2003**
    - ■ **CES 2003**
- ❖ **Videos**
    - ■ **VS.NET Academic Case Study**
    - ■ **Newport News Shipbuilding**
    - ■ **.NET Mobility**
    - ■ **Smart Client**
    - ■ **South Africa Digital Divide**

**Briefings (Speeches) by Bill Gates**

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# Closing

# New World Order

Our society depends on software for its day-to-day existence, and the failure of software systems is increasingly becoming intolerable.

Software Engineering is entering universities around the world, becoming a necessary component of an education in computer science and information technology.

➢Universities such as MIT, Carnegie Mellon University, and Stanford have had software engineering programs

➢Computing Curriculum 2001 of the Association for Computing Machinery's Special Interest Group in Computer Science Education contains Software Engineering Knowledge Units and Software Engineering 2004 has been released

➢Software Engineering program accreditation by the Accreditation Board for Engineering and Technology (ABET) began in the Fall of 2002

➢Systems Engineering is coming! USC (TRW), UMR (Boeing), SPSU (Lockheed), UHCL (NASA)

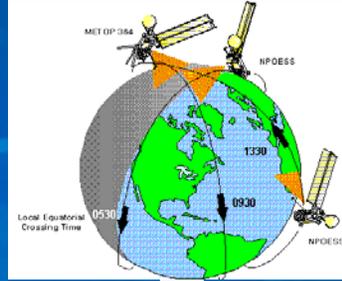# All Science & Technology Efforts Require Partnerships

**Link to the User**

**Expanded Resource Base**

**New Ideas, Knowledge**



*Research Labs*

*DARPA, Microsoft Research, and other Funding Sources*

*Interagency*

**Maximum National Payoff**

*Universities*

*Industries*

**High Risk, High Payoff**

*International*

**Coalition Capability**

**Innovation, Transition**