The Forgotten “-ilities”

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Topics

- What is an “-Ility”?
- How might we organize “-Ilities”?
- How Should Systems Engineers View “-Ilities”?
- Summary

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Most Common Lists of -ilities

RAM-T (Eng)
- Reliability
- Availability
- Maintainability
- Testability

RASR (DBs)
- Reliability
- Availability
- Scalability
- Recoverability

RAMS (Safety)
- Reliability
- Availability
- Maintainability
- Safety

RASUI (SW)
- Reliability
- Availability
- Serviceability
- Usability
- Instability

FURPS (SW)
- Functionality
- Usability
- Reliability
- Performance
- Supportability

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Are there more –ilities?

Accessibility	**Executability**	**Performability**	**Supportability**
Accountability	**Extensibility**	**Portability**	**Suitability**
Adaptability	**Evolvability**	**Practibilty**	**Survivability**
Administrability	**Fidelity**	**Practicality**	**Tailorability**
Affordability	**Flexibility**	**Predictability**	**Testability**
Agility	**Functionality**	**Producibility**	**Traceability**
Availability	**Integratability**	**Recoverability**	**Trainability**
Capability	**Interoperability**	**Reliability**	**Transportability**
Composability	**Interpretability**	**Repeatability**	**Trustability**
Configurability	**Maintainability**	**Responsibility**	**Understandability**
Compatibility	**Manageability**	**Reusability**	**Upgradability**
Demonstrability	**Mobility**	**Scalability**	**Usability**
Deployability	**Modifiability**	**Serviceability**	**Verifiability**
Durability	**Operability**	**Stability**	**Vulnerability**

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What is the Definition of “-ility”

The developmental, operational, and support requirements a program must address (e.g., availability, maintainability, vulnerability, reliability, supportability, etc.).

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What is an “-ility”: Other Terms

“Feature”

“Constraints”

“Characteristic”

“Attribute”

“Quality Goals”

“Other properties”

Most Common: Non-functional requirement

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Functional vs Nonfunctional Requirements (SW)

Functional	Nonfunctional
Product features	Product properties
Describe the work that is done	Describe the character of the work
Describe the actions with which the work is concerned	Describe the experience of the user while doing the work
Characterized by verbs	Characterized by adjectives

Search Software Quality http://searchsoftwarequality.techtarget.com/answer/Functional-and-nonfunctional-requirements

Functional	Nonfunctional
Specific Functions and behaviors	Criteria that can be used to judge the operation of a system
System Design	System Architecture
What a system is supposed to DO	What a system is supposed to BE
	Characteristic of a system that applies across a set of functional or system requirements.

Software Architecture Notes:making the ilities come true http://www.softwarearchitecturenotes.com/architectureRequirements.html

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How Can We Organize “-ilities”?

How can we organize this disparate List?

- Lifecycle phase
- Dependency and Priority
- Cost and value
- Criticality

Group these by

- ***Relationship***
- ***Timeline on Lifecycle***
- ***Dependencies***
- ***Aggregation***
- ***Priority***
- ***Value***

Questions:

- **Do –ilities describe the product**
- **Are they more associated with SE functions leading to design?**
- **Do they drive product design**
- **Are they key to ensuring the product parts can be integrated?**
- **How do they relate to SE processes?**

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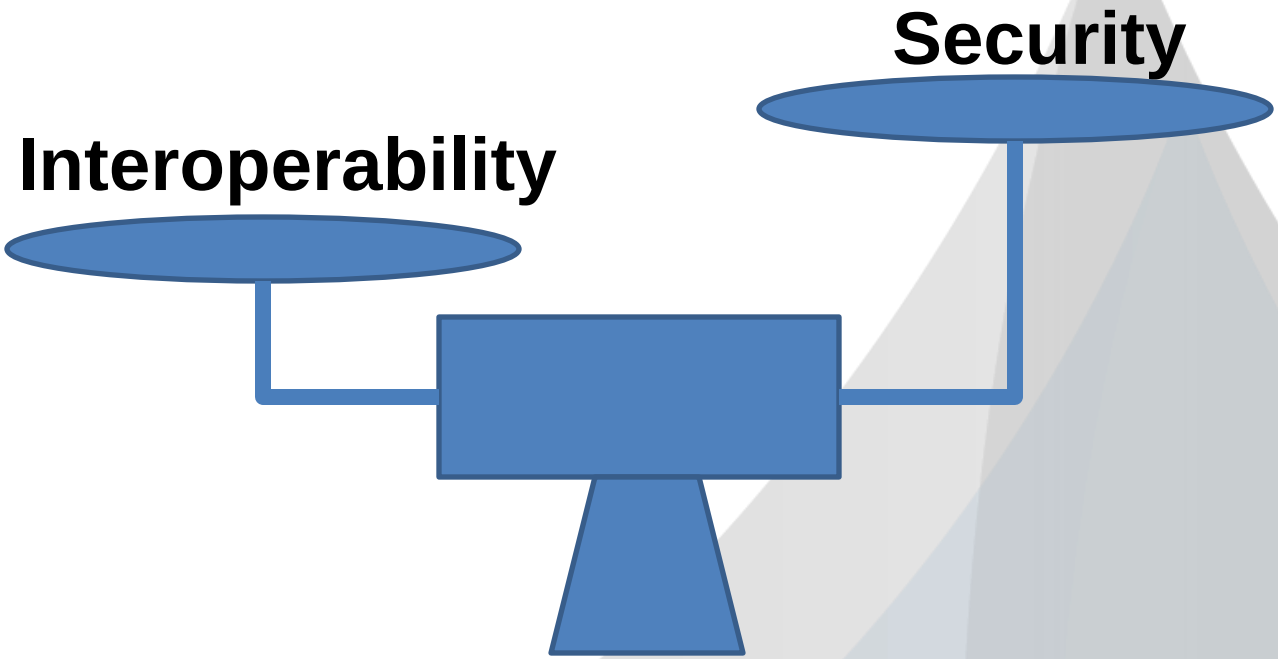
Similar Pairs

Interoperability - Compatibility

Flexibility - Adaptability

Availability - Reliability

Dynamic Relationship



Seeking to establish and maintain balance between two attributes in a dynamic environment

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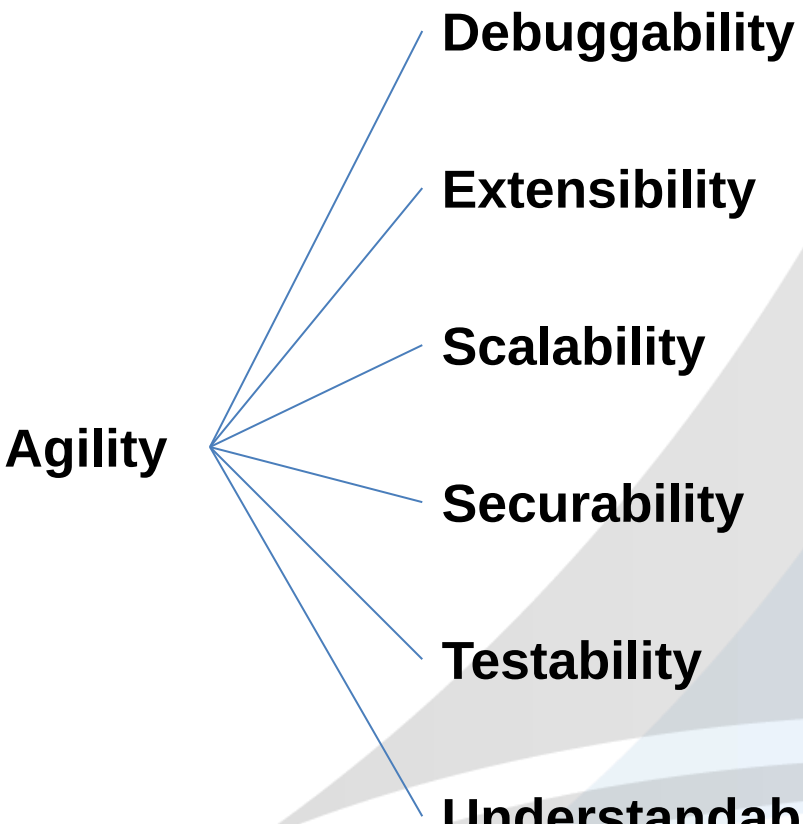
Hierarchical Relationships: Example 1



http://en.wikipedia.org/wiki/List_of_system_quality_attributes

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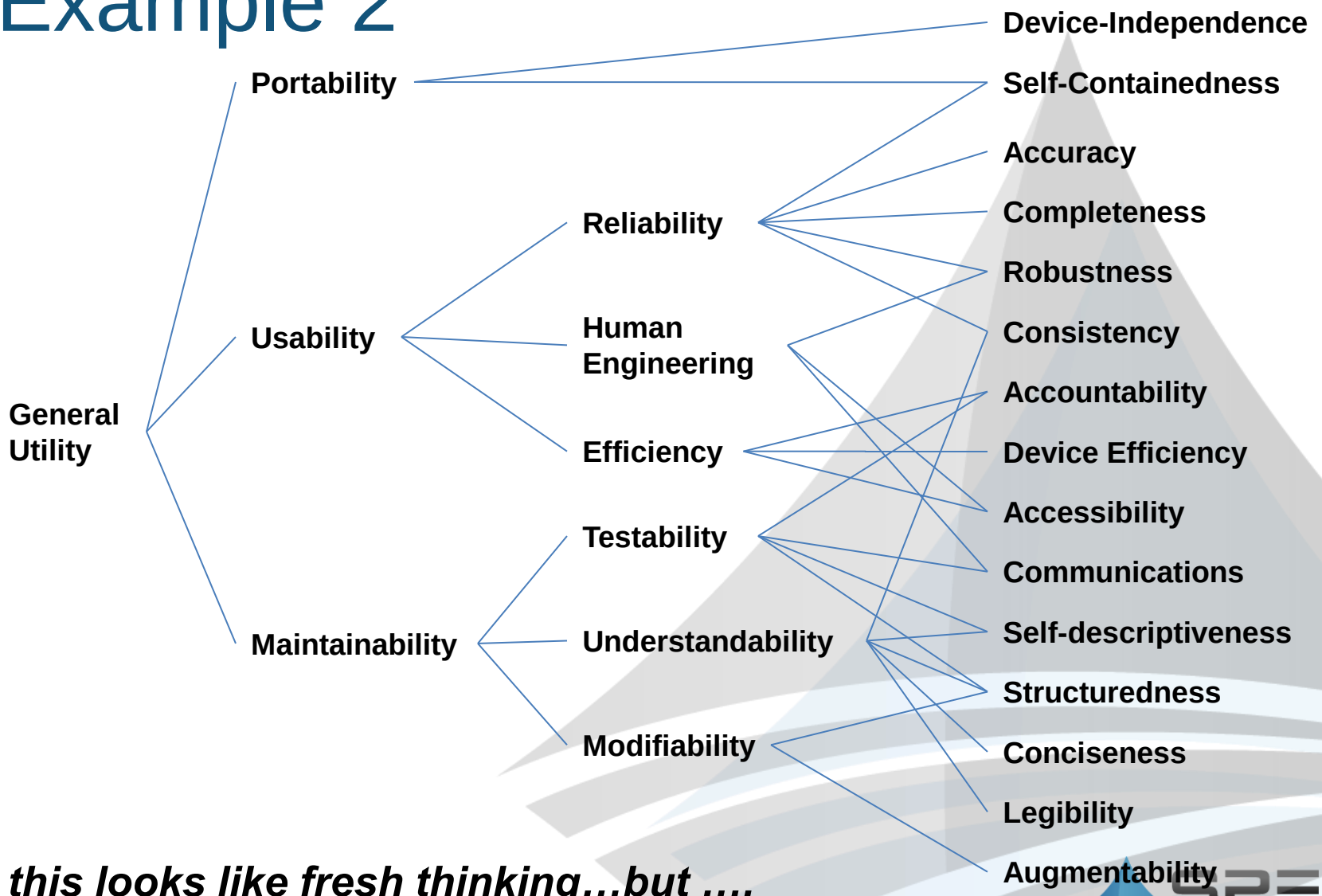
Hierarchical Relationships: Example 2



this looks like fresh thinking…but ….

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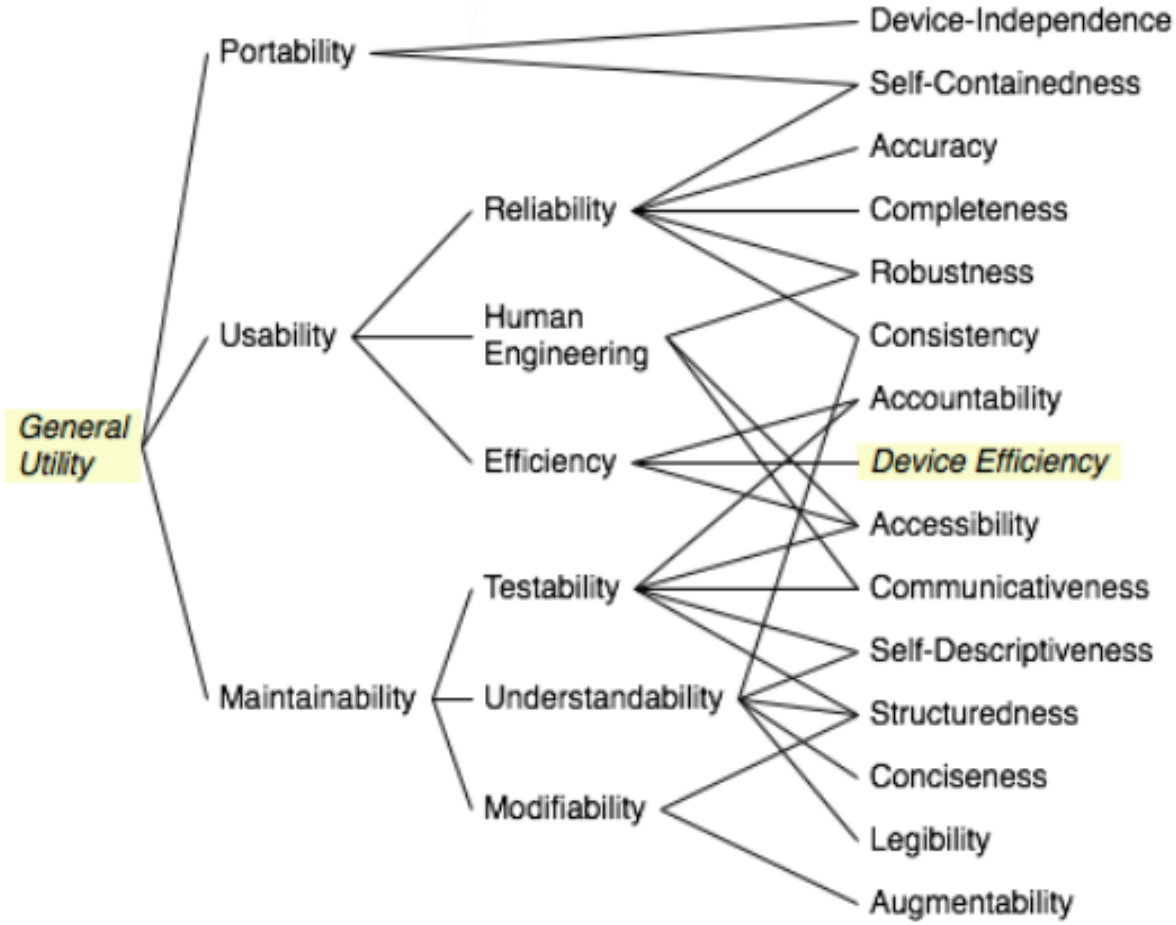
… it was initially put forward 35 years ago



Boehm+Brown+Lipow1976 fig.1, corrected to match qualities named in text
"General Utility" and "Device Efficiency" are not defined there

How Should Systems Engineers View “-ilities”?

What is a System?

…combination of interacting elements organized to achieve one or more stated purposes.

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January 2011

…an integrated set of elements, subsystems, or assemblies that accomplish a defined objective. These elements include products (hardware, software, firmware), processes, people, information, techniques, facilities, services, and other support elements.

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What is a System?

People

Things

Processes

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LML Taxonomy Provides System Descriptions

- Technical
  - ***Action (Processes)***
  - Artifact
  - ***Asset (People & Things)***
  - ***Characteristic ("ilities")***
  - Input/Output
  - Link
  - Statement
- Programmatic/Technical
  - Cost
  - Issue
  - Location
    - Physical, Orbital, Virtual
  - Risk
  - Time
    - Duration, Timeframe, Point-in-Time

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What is a System?

	People (*Asset*)	**Things (*Asset*)**	**Processes (*Actions*)**
Characteristics	**Operability** **Suitability** **Survivability** **Trainability** **Understandability**	**Affordability** **Adaptability** **Agility** • • • • **Usability** **Verifiability** **Vulnerability**	**Integratability** **Performability** **Repeatability**

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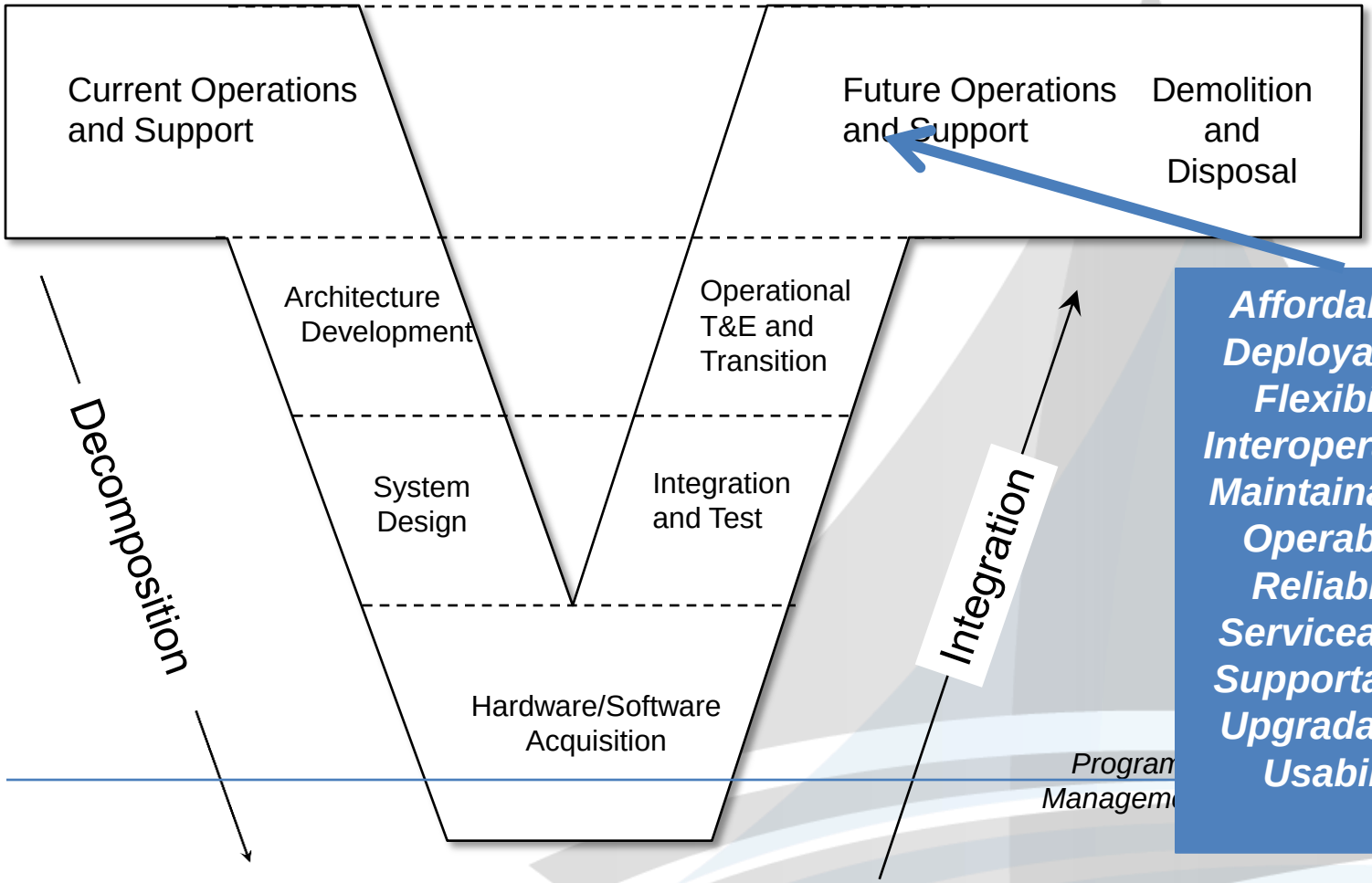
Systems Engineering Lifecycle



Affordability
Deployability
Flexibility
Interoperability
Maintainability
Operability
Reliability
Serviceability
Supportability
Upgradability
Usability

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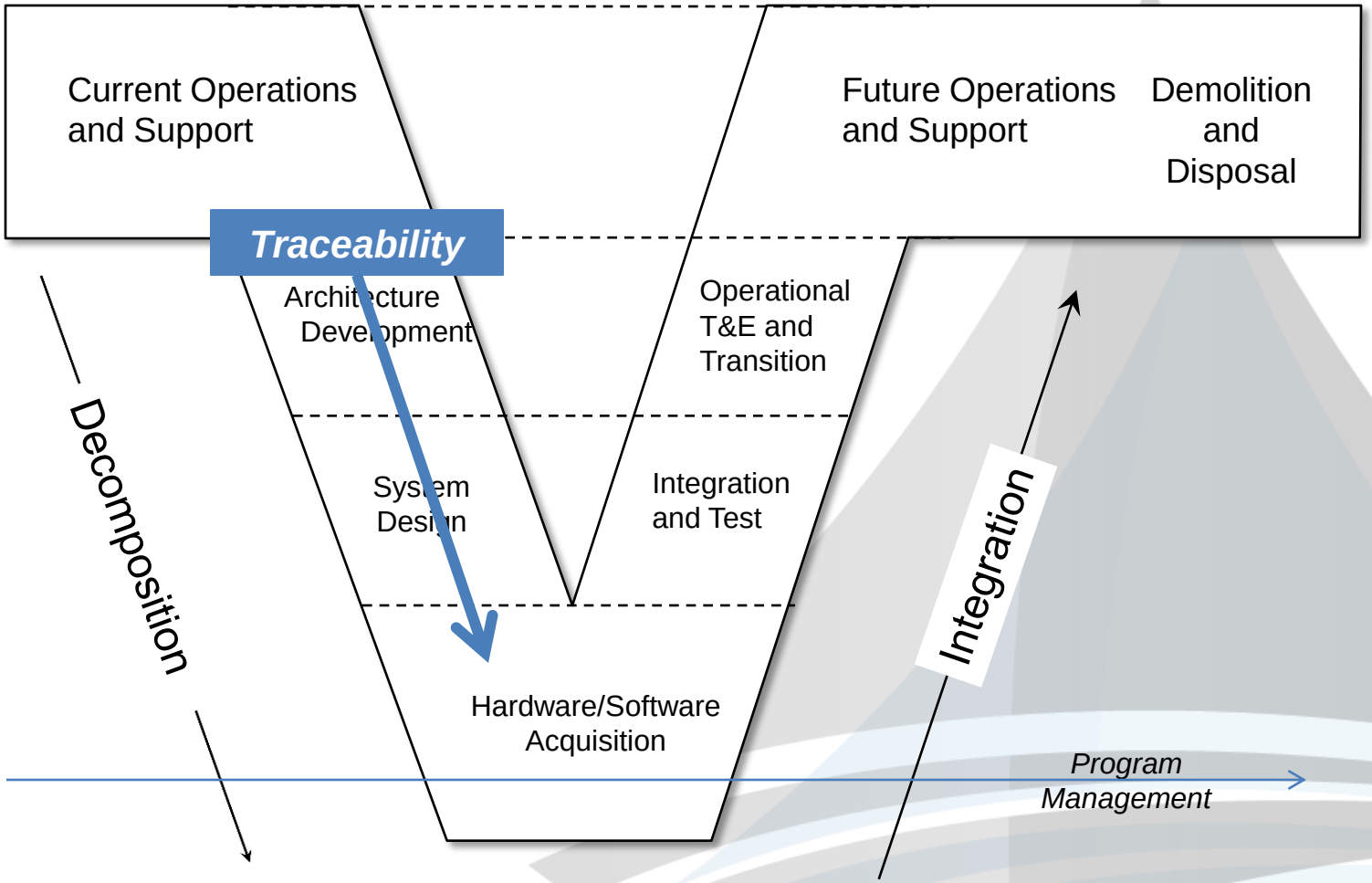
Systems Engineering Lifecycle: Traceability



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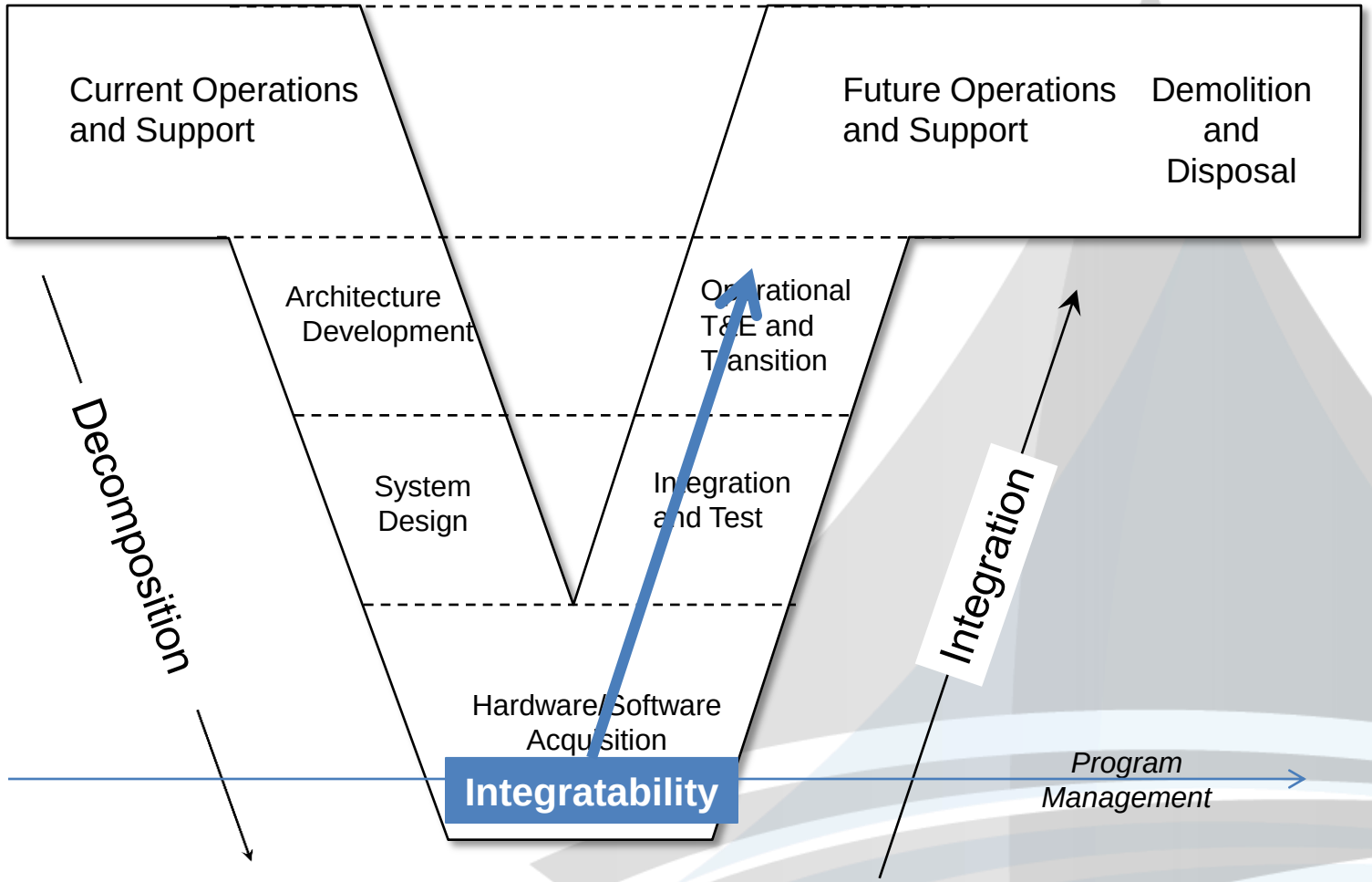
Systems Engineering Lifecycle: Integratability



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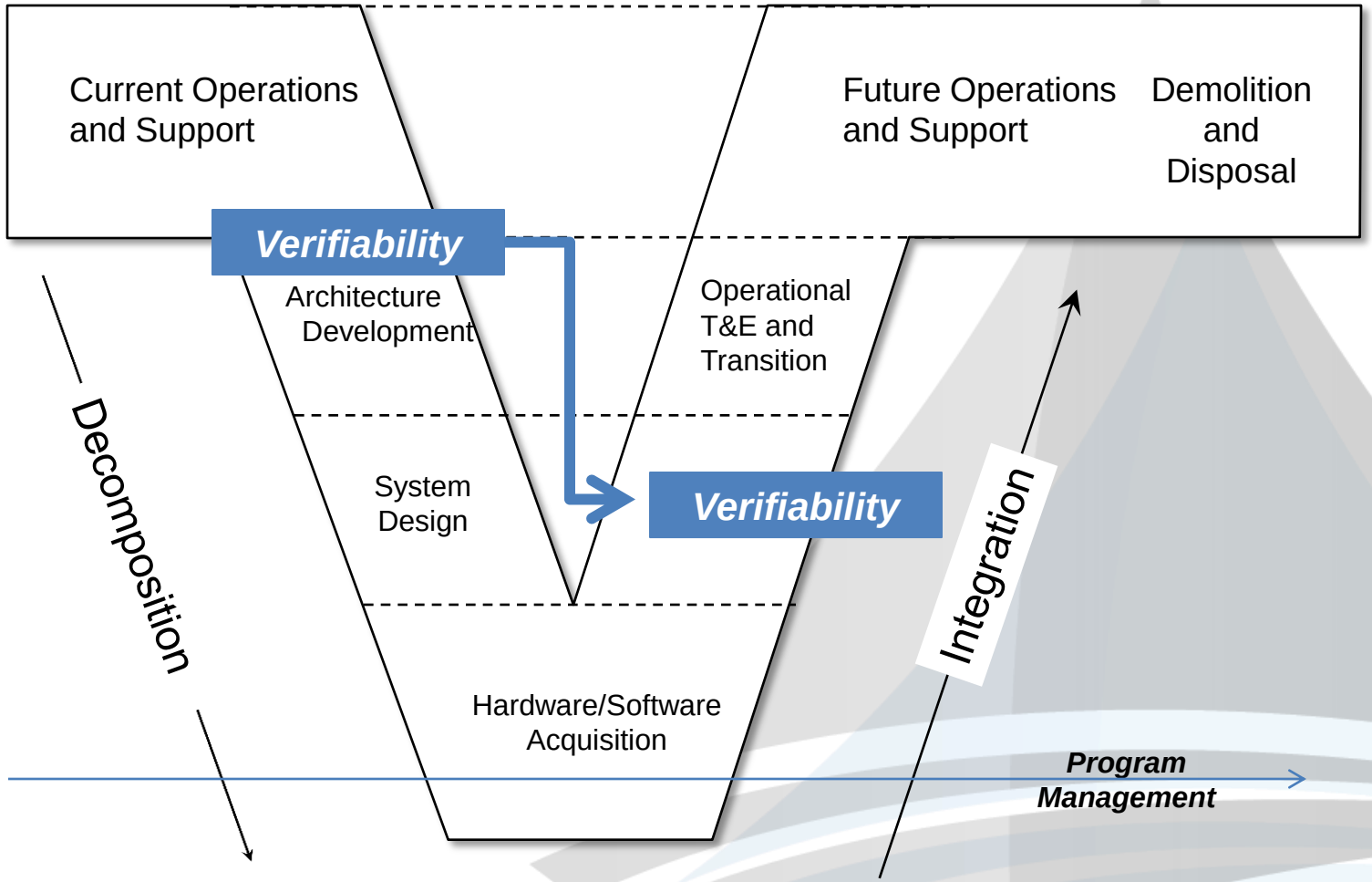
Systems Engineering Lifecycle: Verifiability



Measurement of –ilities

- Standard measurements – not always agreed to
- Some accepted measurements
  - Availability - $P_A = 1 - \frac{MTTR}{MTBF}$
  - Maintainability - MTTR *mean to repair (or restore)*
  - Reliability – MTBF *mean time between failure*
  - SW Maintainability - Lines-of-code measures, McCabe Measures, Halstead Complexity Measures
  - Security – Malware statistics, Firewall statistics, Vulnerability

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-ility Related Research

- 2006-2007 John W. Dahlgren MITRE
  - "System Complexity, the "ilities" and Robustness" Project

- Current - SEAri Systems Engineering Advancement Research Initiative - MIT
  - Research Summit 2011 MIT 21 Oct 2011
  - "Ingenuity, Innovation, and the ilities: Creating Capabilities for the Long Run"

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Increasing Emphasis and Demand

In DoD

- Interoperability
  - *CJCSI 6212.01E Interoperability And Supportability Of Information Technology And National Security Systems*
- Producibility
  - *DoDI 5000.02 Operation of the Defense Acquisition System*
- *DOTMLPF (*Doctrine, Organization, Training, Materiel, Leadership and education, Personnel, and Facilities)
  - *Embedded throughout Joint and Service Standards*

Commercial World…

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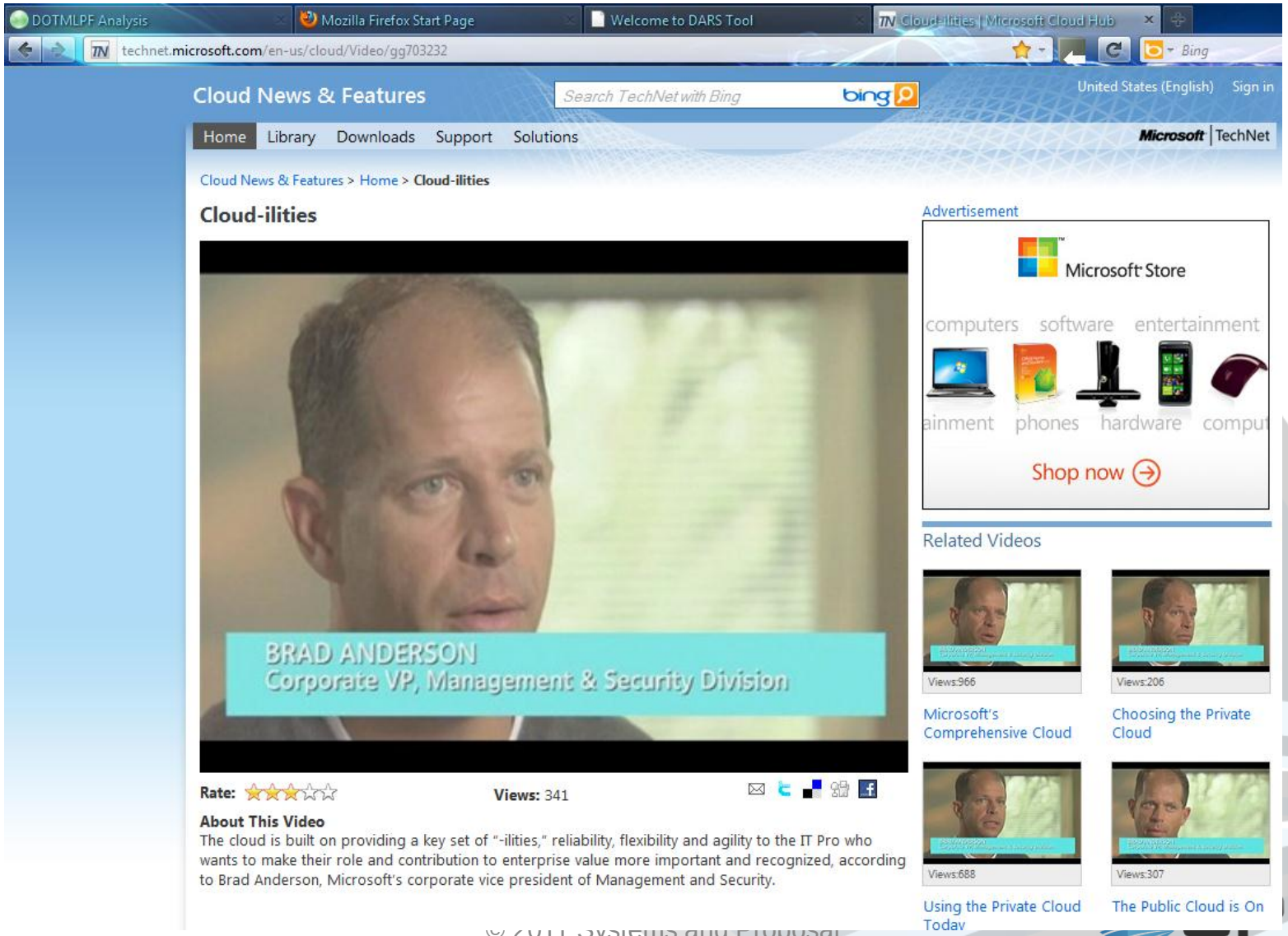
Even Commercial Interest is Increasing



Summary

- Little recent SE discussion and writing on ‘-ilities”
- “-ilities” are key system attributes
- Many useful and/or necessary “-ilities” are
  - Not understood well
  - Often forgotten…or ignored
- Systems Engineers should work to integrate more –ilities into systems development

- Recommendation: Increase discussion and interchange among SEs on the topic of “-ilities” and how to best incorporate them into SE

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