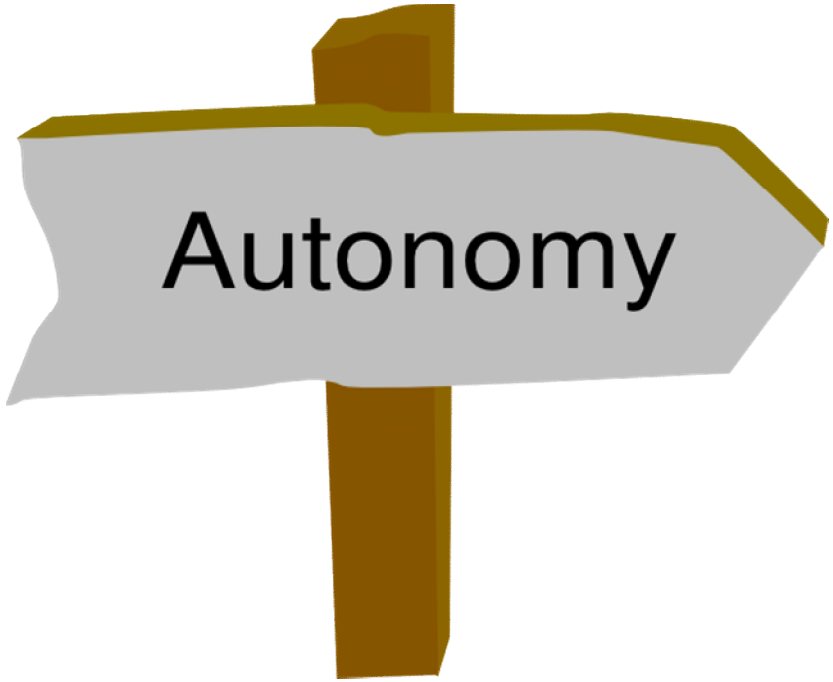
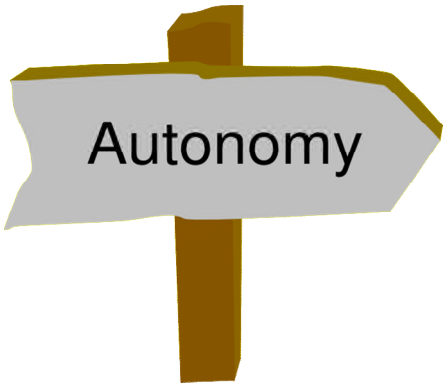
http://www.econsacademy.com



TUD Hauptseminar «Autonomic Computing»

Prof. Dr. Frank J. Furrer

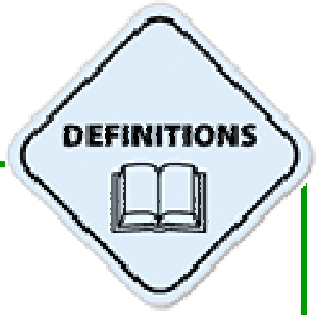


«Autonomic Computing»

Today: Kick-Off Meeting 20-April-2016

Hauptseminar Website:
http://st.inf.tu-dresden.de/teaching/hs/auco16

«Autonomic Computing»



Definition [1]:

A type of ***computing model*** in which the system is self-healing, self-configured, self-protected and self-managed (self-* properties).

An autonomic computing system functions with a high level of ***artificial intelligence*** while remaining invisible to the users.

The autonomic computing system ***operates autonomically*** in response to the inputs it collects and processes.

http://www.webopedia.com/TERM/A/autonomic_computing.html

«Autonomic Computing»

Definition [2]:

Application of advanced technology

to the ***management*** of advanced technology

[IEEE]

http://www.goalsontrack.com

«The prime goal of *autonomic computing* is to enable computing systems to autonomously deal with **(unpredictable) change**, so as to fulfill the **objectives** they were constructed for»

[Lalanda, 2014, ISBN 978-1-4471-5006-0]

Kick-Off Meeting Schedule:

Part 1: Seminar Organization

Part 2: «Autonomic Computing»: Introduction

Part 3: Principles of a good paper

Part 4: Principles of a good presentation

https://www.theproducersperspective.com

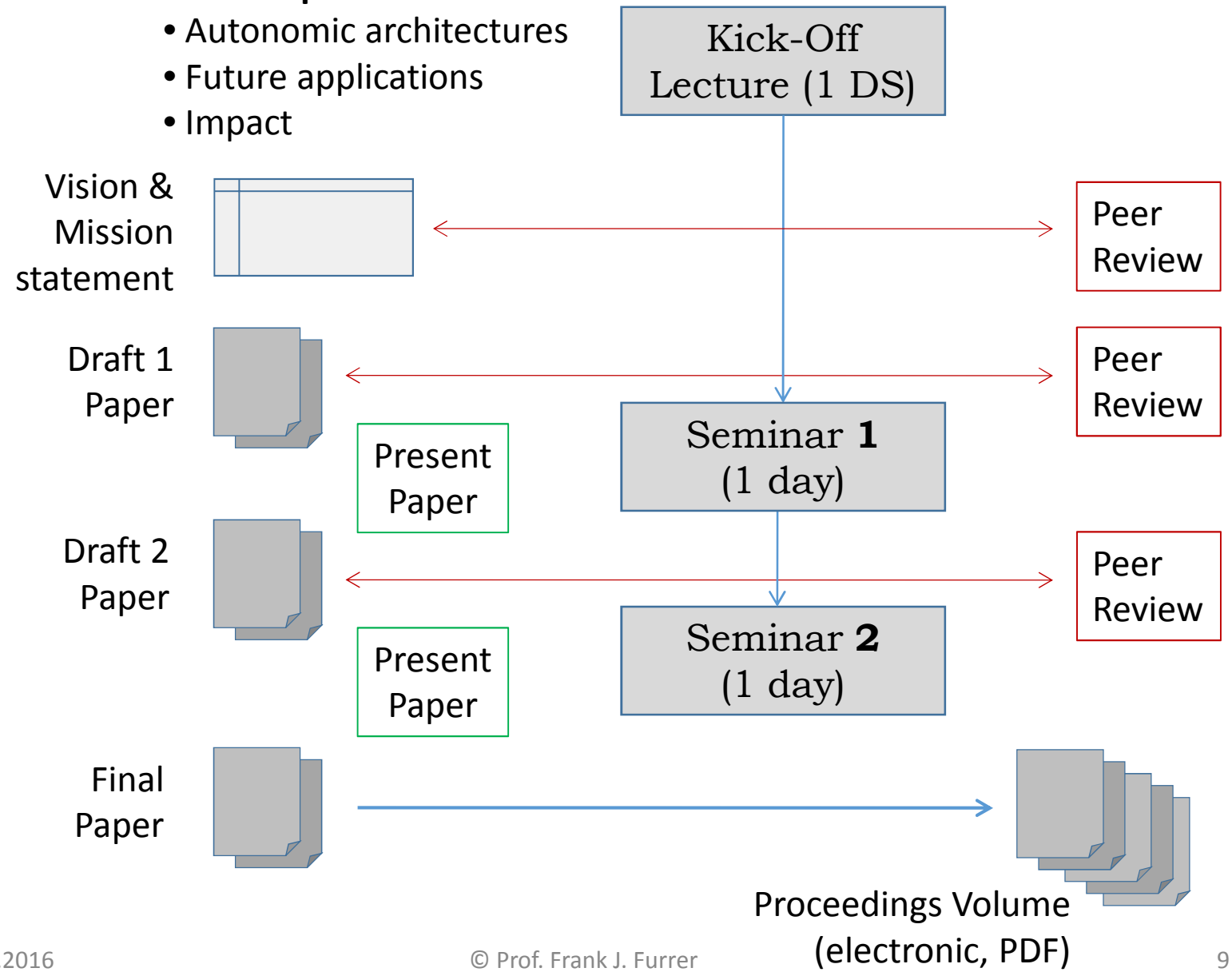
Part 1: Seminar Organization

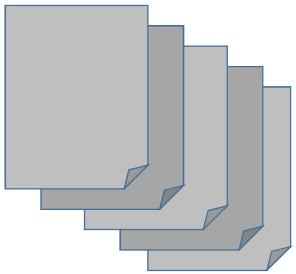
What the Participants will learn:

1. Do focused research in a specific area («Autonomic Computing»)
2. Author a **good** paper
3. Learn (or perfect) the use of TeX®
4. Experience the peer-review process
5. Hold a **convincing** presentation
6. Broaden your perspective in Information Technology

Hauptseminar SS 2016: «Autonomic Computing»

Select topic:
- Autonomic architectures
- Future applications
- Impact





Formats:

Paper: LaTex

Presentation: Powerpoint

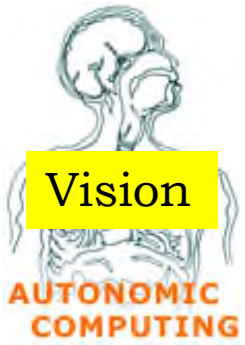
Please use the **Template**:

“Springer LNCS” for your paper.

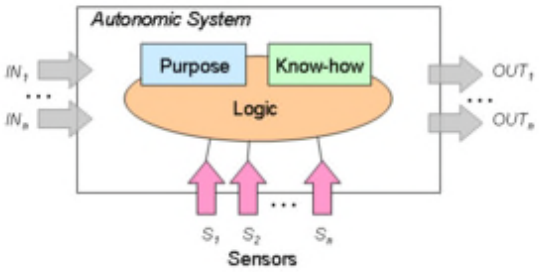
Downloadable from:

ftp://ftp.springer.de/pub/tex/latex/llncs/latex2e/llncs2e.zip

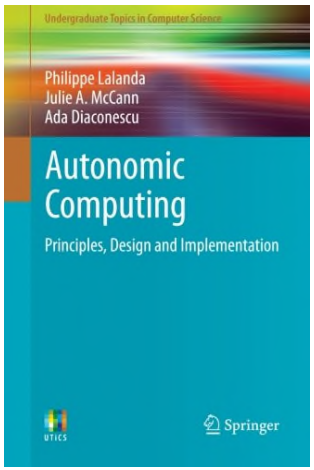
[last accessed: 05.03.2015]



[1] The seminal work:
IBM Research Paper, 2001: ***Autonomic Computing – IBM's Perspective on the State of Information Technology***.
Downloadable from:
http://people.scs.carleton.ca/~soma/biosec/readings/autonomic_computing.pdf [last accessed: 2.2.2016]



[2] Introduction to the Architecture:
IBM White Paper: An architectural blueprint for autonomic computing. 3rd edition, June 2005.
Downloadable from: http://www-03.ibm.com/autonomic/pdfs/AC%20Blueprint%20White%20Paper%20V7.pdf [last accessed: 2.2.2016].



[3] The fundamental knowledge:

Philippe Lalanda, Julie A. McCann, Ada Diaconescu:

Autonomic Computing – *Principles, Design and Implementation*. Springer-Verlag, London UK, 2014. ISBN 978-1-4471-5006-0.

Hauptseminar SS 2016: «Autonomic Computing»

Kick-Off Meeting (Introduction): Wednesday, **April 20**, 2016 / 11:10 – 12:40 in APB/INF 2101

Seminar Day 1: Wednesday, **June 8**, 2016 / 09:20 – 10:50 & 11:10 – 12:40 in APB/INF 2101

Seminar Day 2: Wednesday, **July 13**, 2016 / 09:20 – 10:50 & 11:10 – 12:40 in APB/INF 2101

More information at (TUD HS Website):
http://st.inf.tu-dresden.de/teaching/hs/auco16

Hauptseminar limited to **7** participants

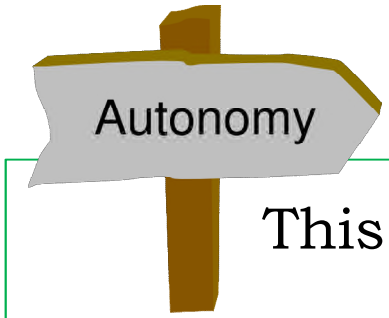
https://moodle.centerville.k12.oh.us

Guidance

http://cliparts.co

Seminar:

- We learn and work together
- We support each other
- We produce a common proceedings volume



This seminar will work on the central question:

Which are the state of the art, the promises, and the impact of Autonomic Computing?

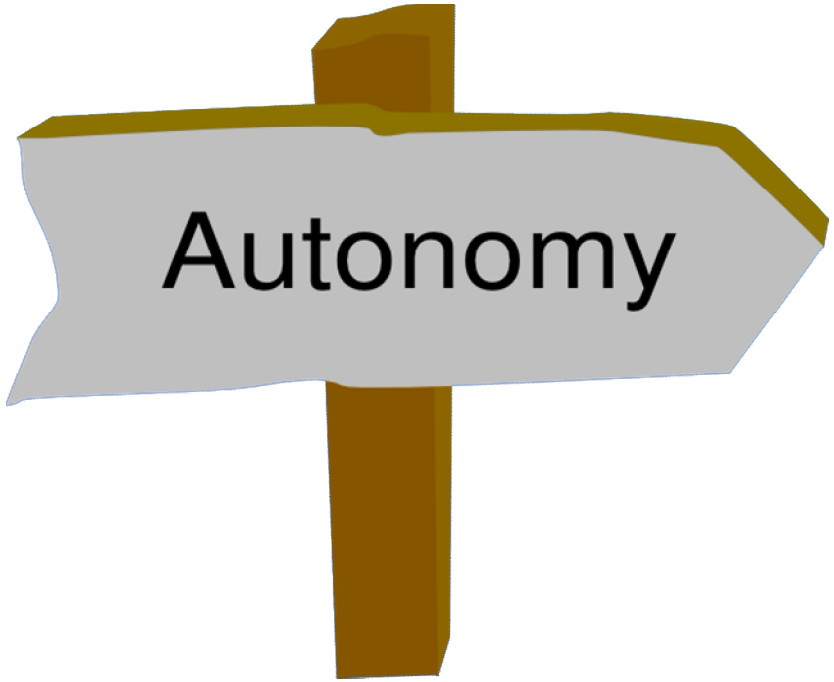
Each participant choses one of the 3 topics:

Q1: Which are the promising software architectures and software technologies for Autonomic Computing?

Q2: How does Autonomic Computing enable future applications?

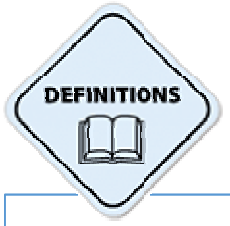
Q3: What is the impact of Autonomic Computing on people, work and society in 2025?

http://www.econsacademy.com



Part 2: «Autonomic Computing»

Introduction



A type of ***computing model*** in which the system is self-healing, self-configured, self-protected and self-managed (self-* properties).

An autonomic computing system functions with a high level of ***artificial intelligence*** while remaining invisible to the users.

The autonomic computing system ***operates autonomically*** in response to the inputs it collects and processes ⇐ *interaction with the physical world.*

http://www.webopedia.com/TERM/A/autonomic_computing.html

http://codeverge.com

Fact:

… our dependency from **software** is nearly total !

http://expertbeacon.com

e-Commerce

(Internet-Shopping)

https://www.zkb.ch

On-Line Banking

(Financial Transactions)

http://www.birminghammail.co.uk

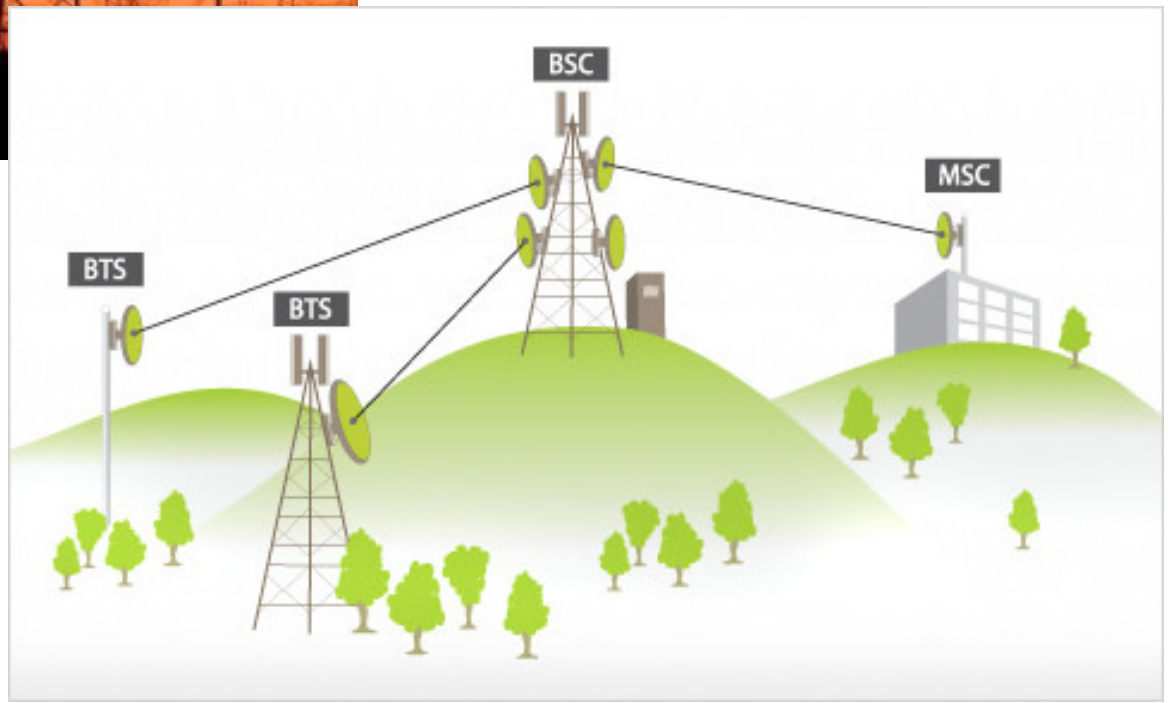
Traffic-Control

https://www.linkedin.com

Airspace Management

http://ecowatch.com

Energy Distribution



http://old.zycomm.co.uk

Mobile Networks

http://www.airlinereporter.com

Computerized Flying

http://www.motorauthority.com

Autonomous Vehicles

Chirurgical Robots

http://www.defense.gouv.fr

Military Equipment

http://21stcenturywire.com

http://kardiologie-potsdam.de

Cardio-Pacemaker

http://techpp.com

GPS-Navigation

… and much, much more!

What is the Problem ?

http://blog.datacracker.com

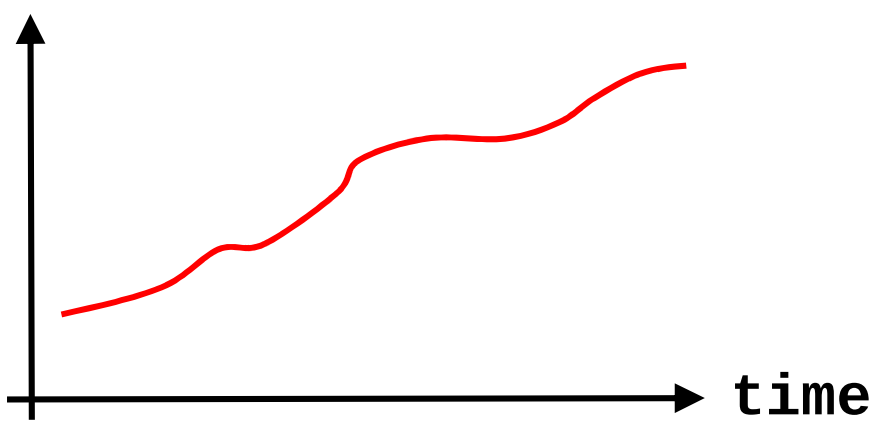
Problem 1: Growing Complexity of the Software

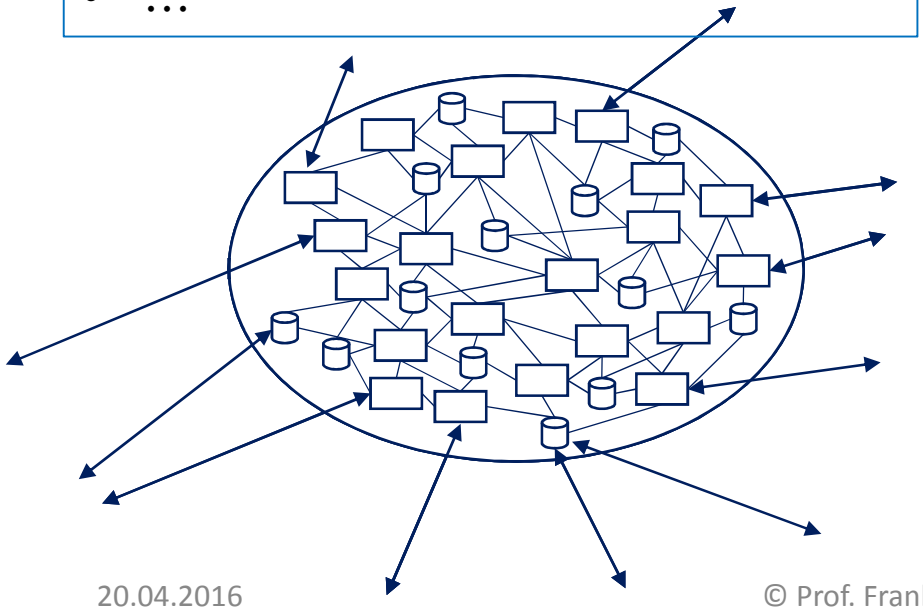
Problem 2: Increasingly Disruptive Environment

Problem 1: Growing Complexity of the Software

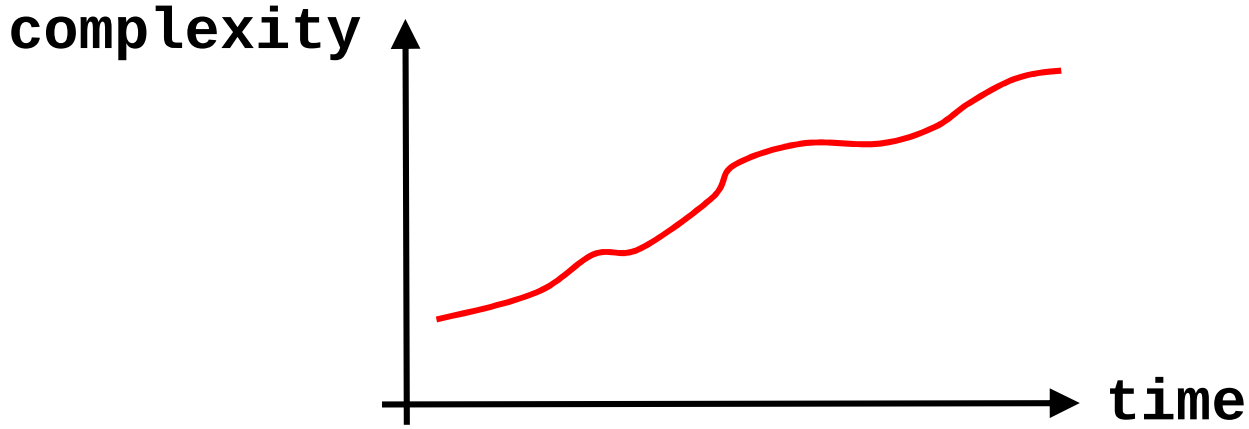
Complexity Measures:

- # of elements/# of relationships
- SLOCs (Source lines of code)
- # of applications
- # of network connections
- Functionality: # of FPs, UCPs
- …





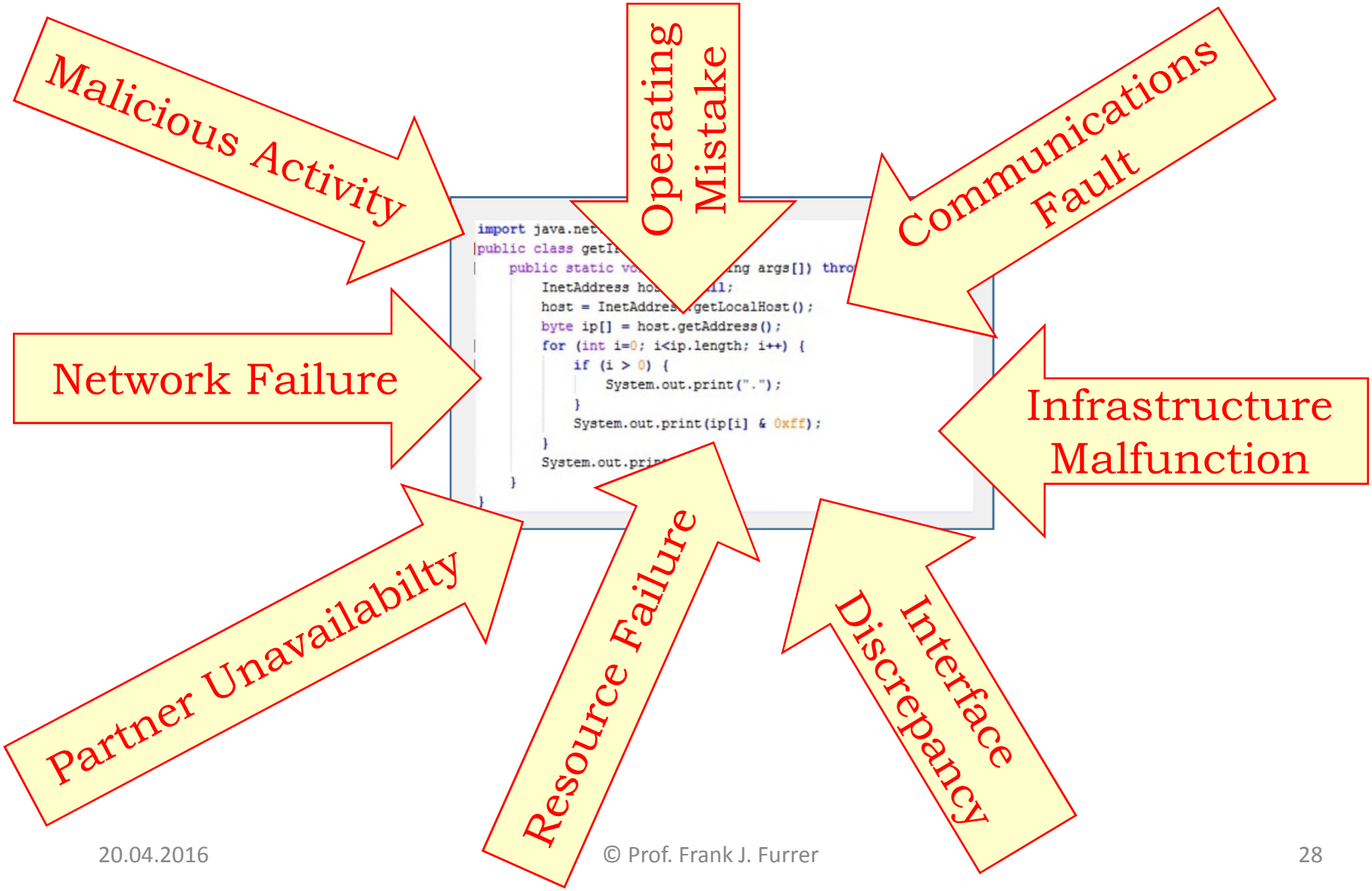
Problem 1: Growing Complexity of the Software



Consequences/Risks of Complexity:

- Much more effort for specification/design/testing/implementation
- Higher risk of functional and non-functional misbehaviour
- Difficult configuration/operation and error/fault-handling
- Complicated fault propagation chains
- Increasing dependency on external parties
- Bad emergent behaviour
- …

Problem 2: Increasingly Disruptive Environment

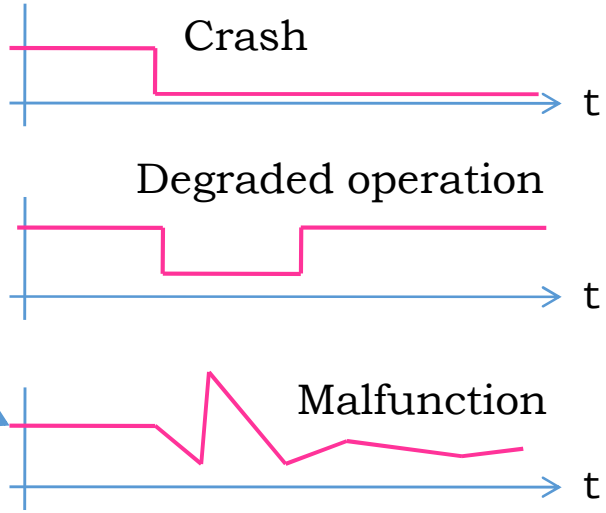


Resilience

Incident

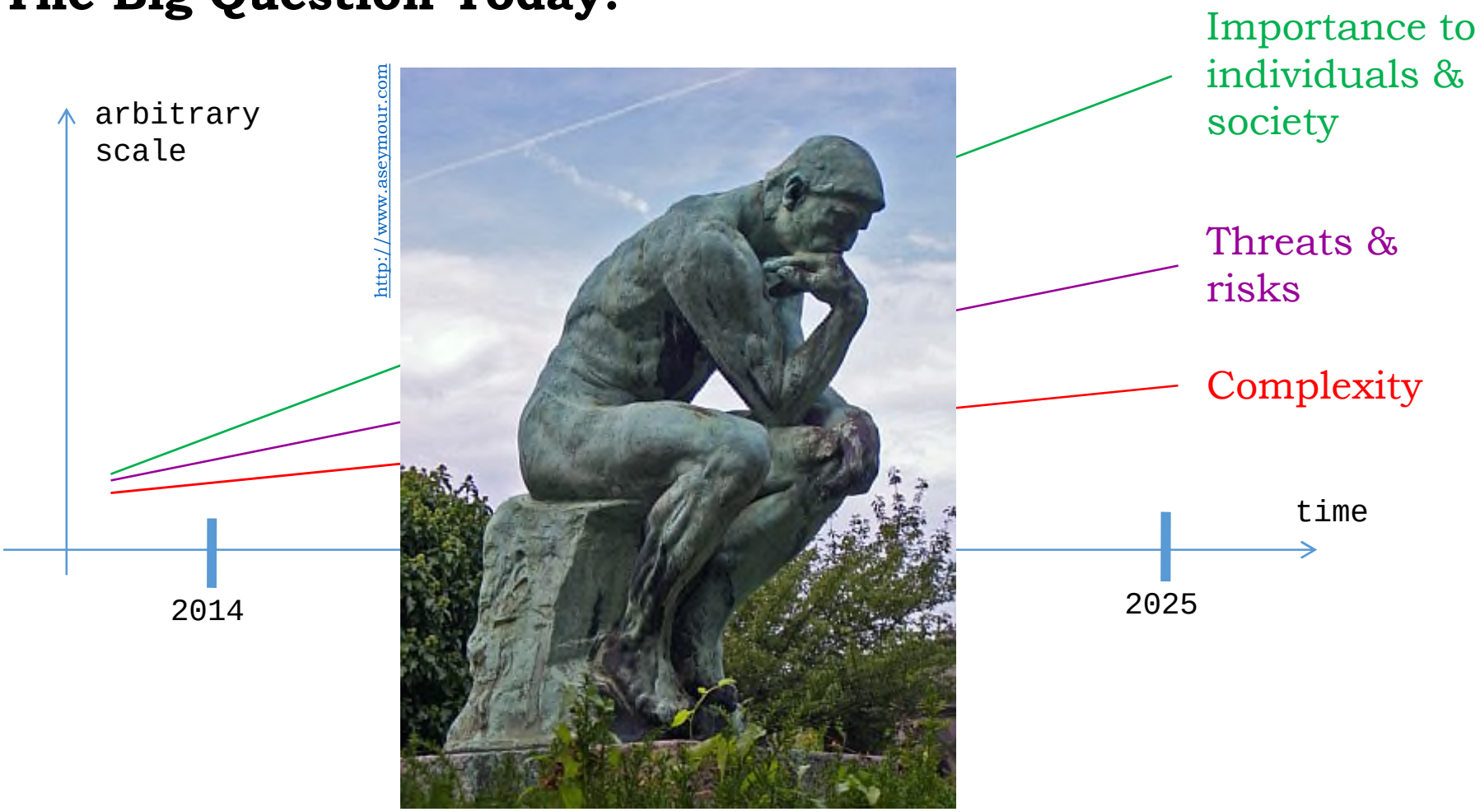
```
import java.net.*;
public class getIP {
    public static void main(String args[]) throws Exception {
        InetAddress host = null;
        host = InetAddress.getLocalHost();
        byte ip[] = host.getAddress();
        for (int i=0; i<ip.length; i++) {
            if (i > 0) {
                System.out.print(".");
            }
            System.out.print(ip[i] & 0xff);
        }
        System.out.println();
    }
}
```

https://soundcloud.com



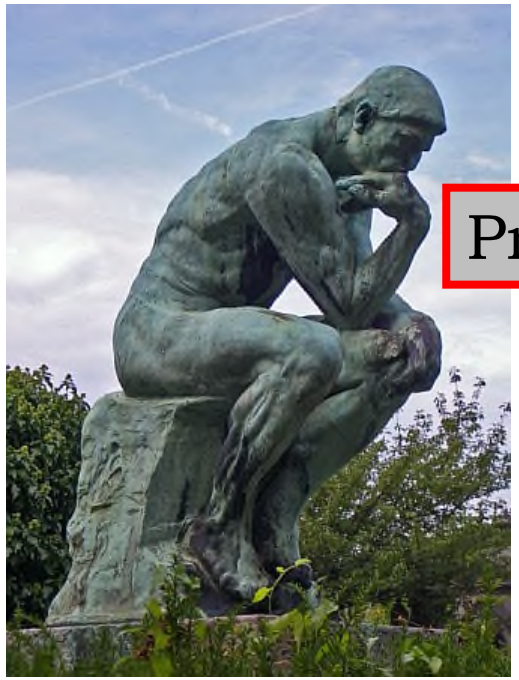
http://kanto.stripes.com

The Big Question Today:

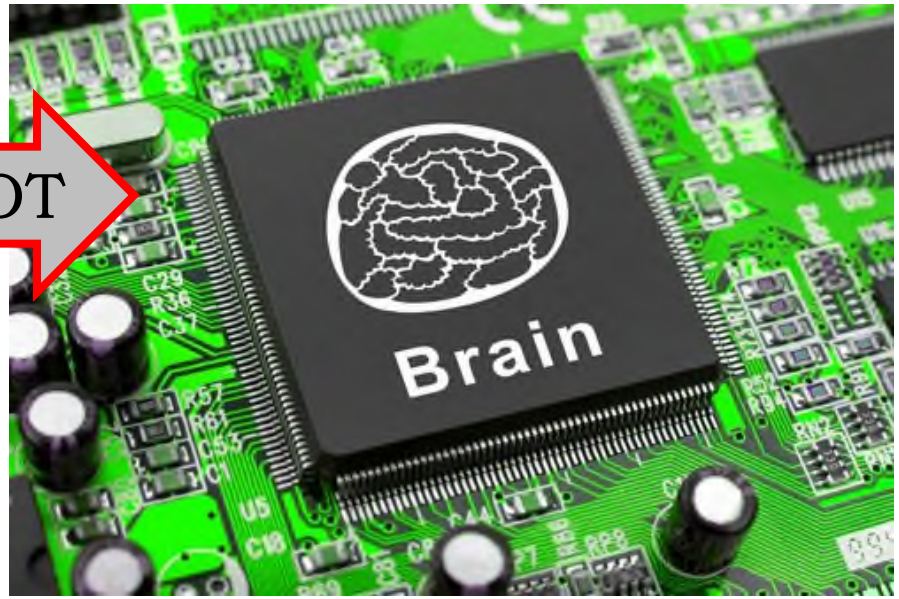


Can we humans successfully cope with these trends ?

http://www.aseymour.com



Probably NOT



http://mcvcbca.blogspot.ch/2012

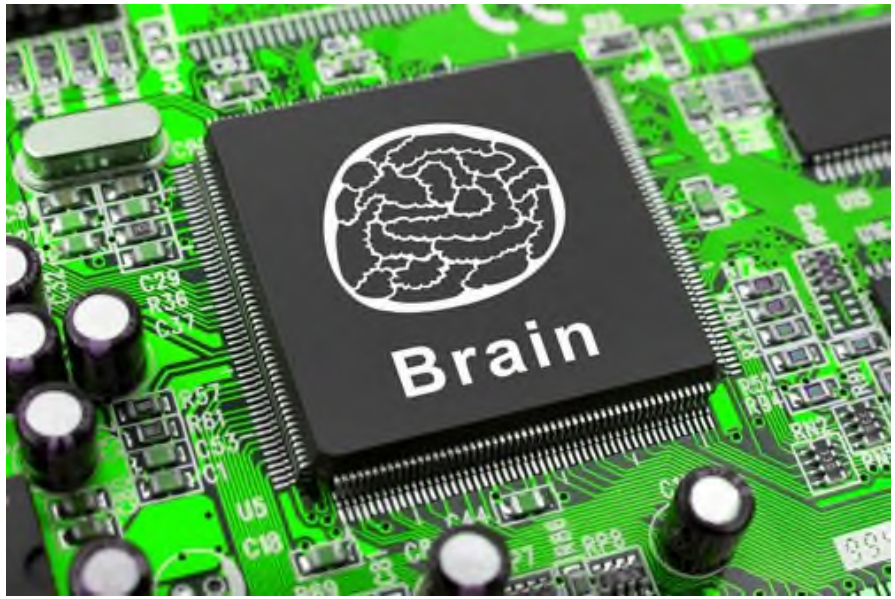
Can we humans successfully cope with the trends of:

- increasing complexity
  - raising importance
- accelerating threats & risks

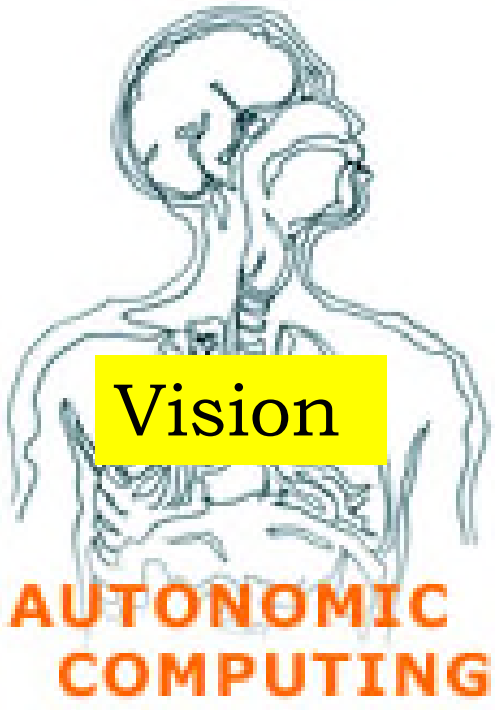
?

… we will need the support of intelligent machines

⇒ of the software itself !



http://mcvcbca.blogspot.ch/2012

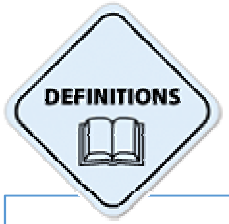


… we will need the support of intelligent machines

⇒ of the **software itself** !

Paul Horn,
IBM, 2001

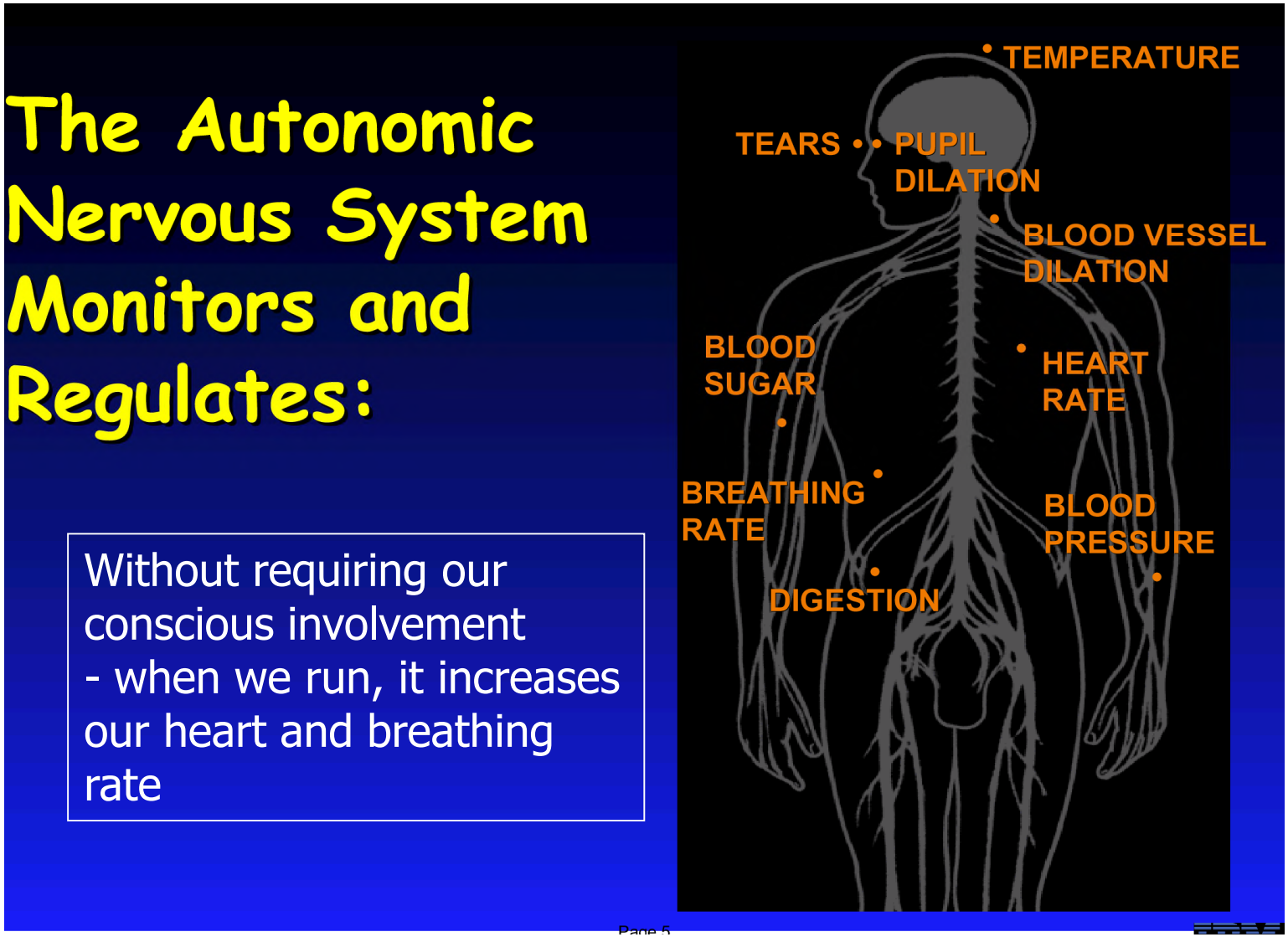
= One approach to the engineering of software systems



A type of ***computing model*** in which the system is *self-healing*, *self-configured*, *self-protected* and *self-managed*

⇒ self-* properties

Autonomic Computing: Convergence of Information Technology and Biology



© Manish Parashar and Omer Rana

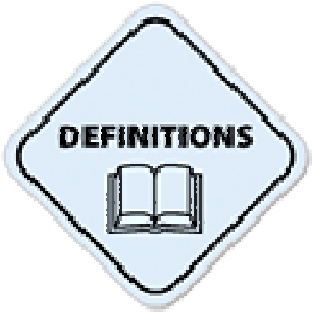
Autonomic Computing (IBM Concept 2001)

https://www.illustrationsource.com

Basic idea: Enable the software for self-defense

Self-Configuring

http://flylib.com



Definition:

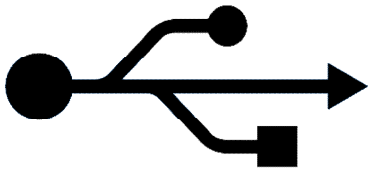
An autonomic system configures and reconfigures itself in order to ***adapt*** to various, possibly unpredictable conditions, so as to continuously meet a set of ***business objectives***

Examples: Integration of new autonomic elements or reconfiguration of the run-time system (number of elements and topology)

Self-Configuring

EXAMPLE

http://www2.elecom.co.jp



Universal Serial Bus USB

USB was designed to standardize the ***connection*** of computer peripherals (including keyboards, pointing devices, digital cameras, printers, portable media players, disk drives, storage, network adapters, …) to personal computers, both to ***communicate*** and to supply electric power.

Self-Configuring

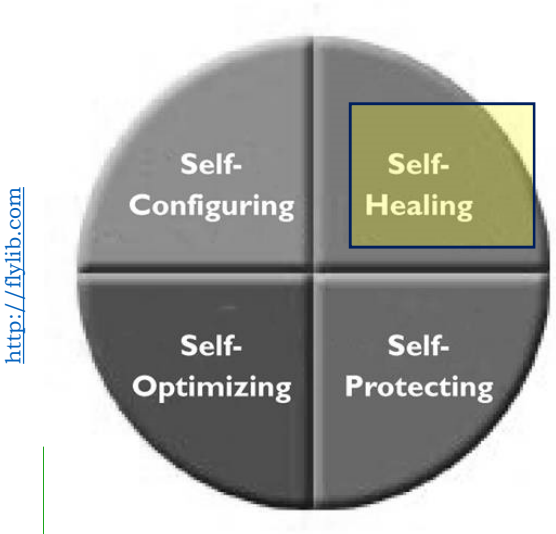
Universal Serial Bus USB

Auto-configuration or ***self-configuration*** is the automatic configuration of devices without manual intervention, without any need for software configuration programs or jumpers.

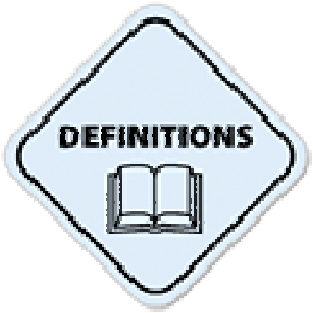
Auto-configuring devices just "***plug and play***".

When plugged in, the computer automatically ***recognizes*** a new device, loads new drivers for the hardware if needed, and begins to ***work*** with the newly connected device

Self-Healing



http://flylib.com



Definition:

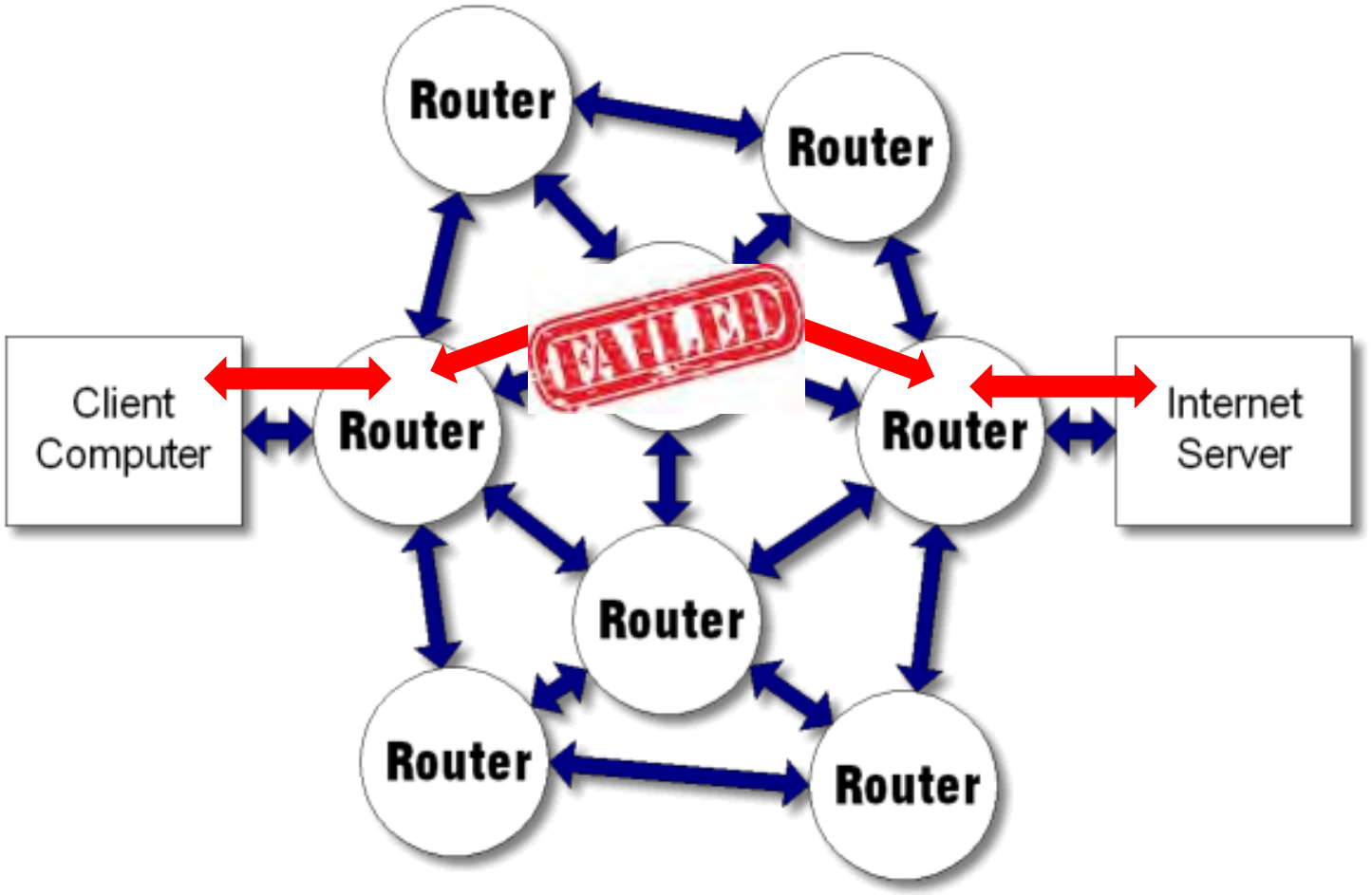
An autonomic system detects, diagnoses and recovers from routine or extraordinary ***problems*** while trying to minimize service ***disruption***

Examples: Identify and enable alternate resources, download software updates, restart failed elements, request human assistance, eliminate faulty elements

Self-Healing

EXAMPLE

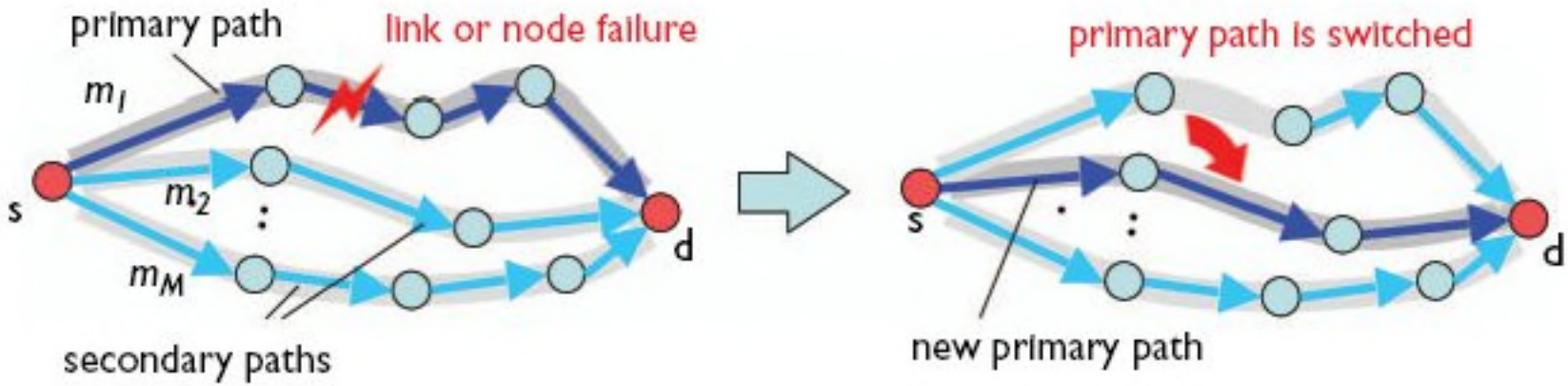
Internet-Routing



http://dtucker.cs.edinboro.edu

Self-Healing

EXAMPLE

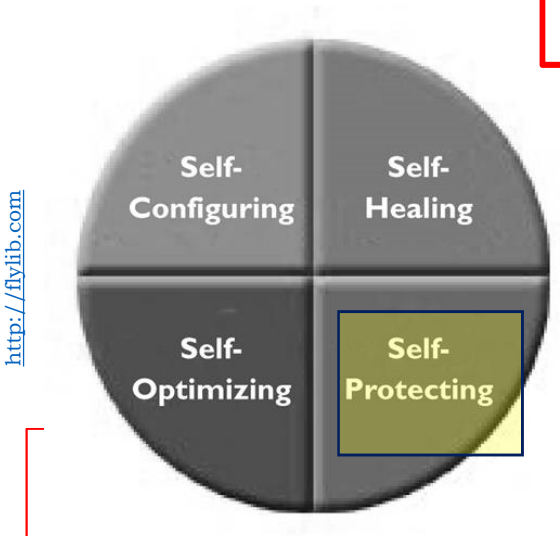


http://deliveryimages.acm.org

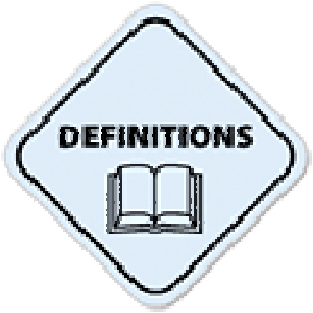
Dynamic routing attempts to solve failure problems by constructing routing tables automatically, based on information carried by routing protocols, allowing the network to act ***autonomously*** in avoiding link and node failures and blockages

Failure: Step 1 = Immediately select new path (no packet loss), Step 2 = Repair ("heal") faulty element (may need human intervention)

Self-Protecting



http://flylib.com



Definition:

An autonomic system anticipates, detects, identifies and protects itself from internal and external ***threats***, in order to maintain ***quality attributes***, such as security, integrity, availability, safety, …

Examples: Identify and enable alternate resources, download software updates, restart failed elements, request human assistance, eliminate faulty elements, neutralize malicious activities

Self-Protecting

For any given *software vulnerability*, the lengthy time window from initial bug report to widespread patch deployment puts cybersecurity analysts at a significant *disadvantage*.

In many cases a *race* ensues between miscreants intending to exploit the vulnerability and analysts who must assess, remediate, test, and deploy a patch before *significant damage* can be done.

https://s-media-cache-ak0.pinimg.com

Self-Protecting

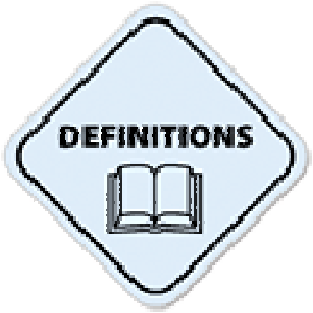
http://www.darpa.mil/program/cyber-grand-challenge

DARPA has launched the ***2016 Cyber Grand Challenge***: a competition that seeks to create automatic defensive systems capable of reasoning about flaws, formulating patches and deploying them on a network in real time.

By acting at *machine speed* and scale, these technologies may someday overturn today's *attacker-dominated status quo*.

Self-Optimizing

http://flylib.com



Definition:

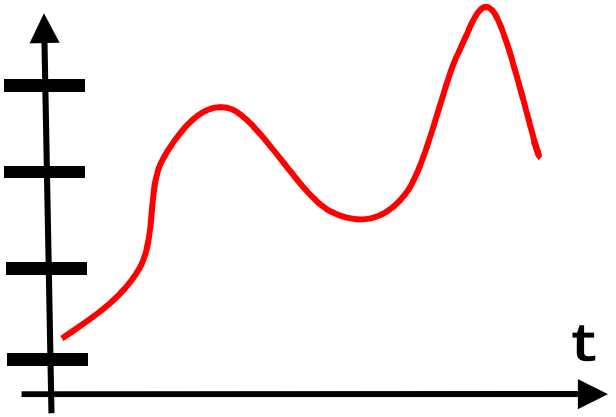
An autonomic system continuously seeks ways and sizes opportunities to ***improve its operation*** with respect to multiple, possibly conflicting, ***criteria***

Examples: Improve and maximise quality of service, performance, power consumption, resilience, etc.

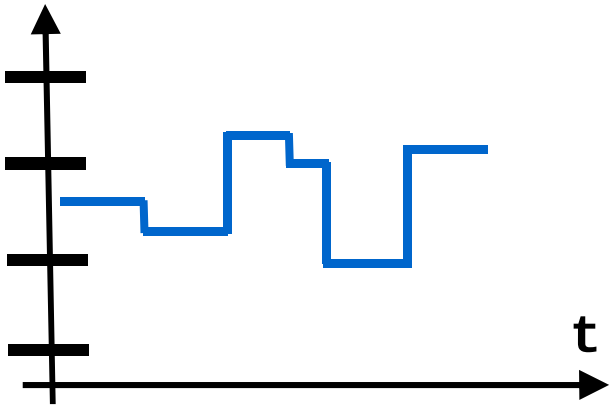
Self-Optimizing

EXAMPLE

Reponse Time



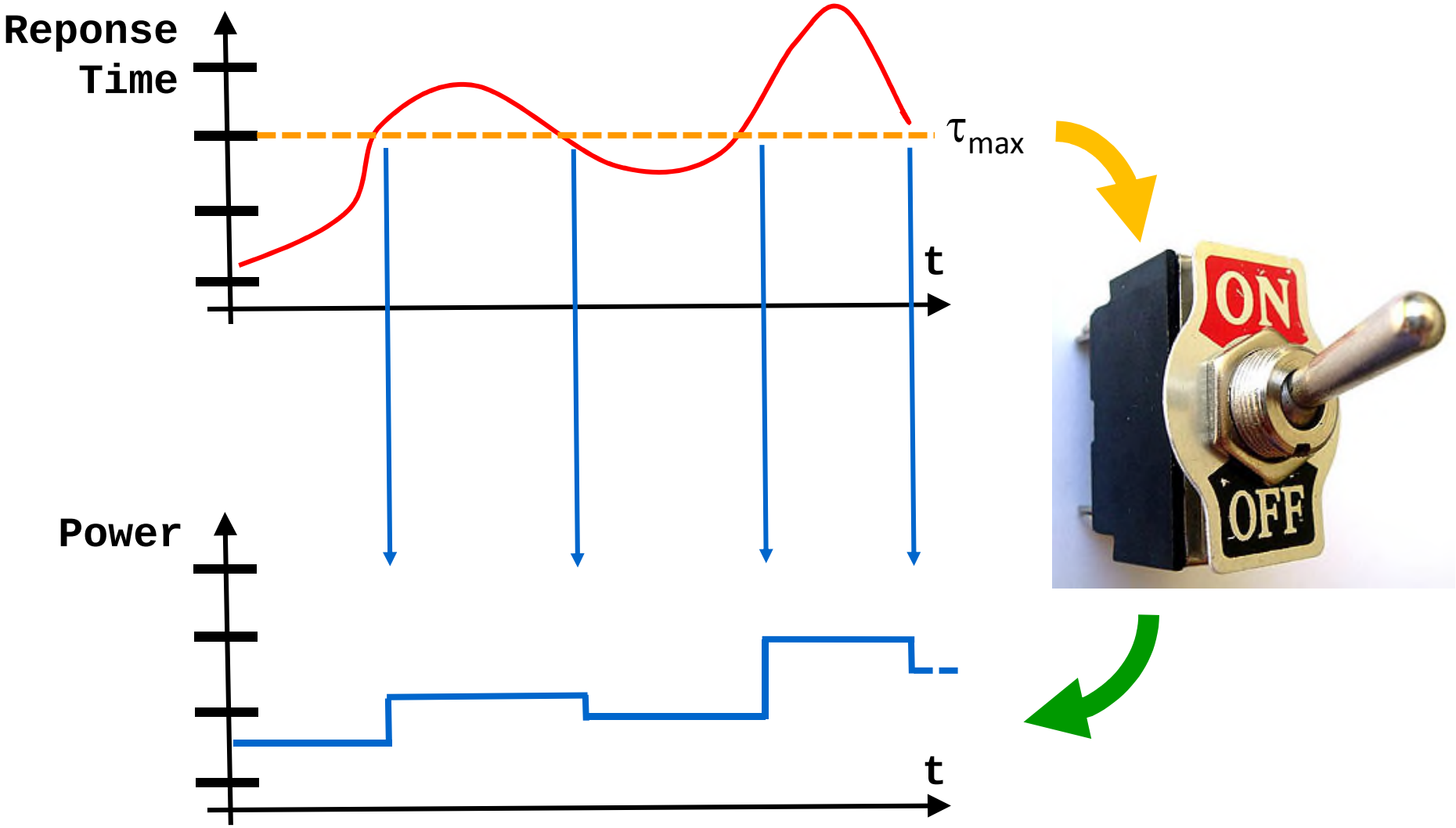
Power



http://brownstonecambridge.files.wordpress.com
http://cdn.grid.fotosearch.com
http://meioambiente.culturamix.com

Self-Optimizing

EXAMPLE



How do we construct Autonomic Systems?

http://freedesignfile.com

We need expertise from many fields:

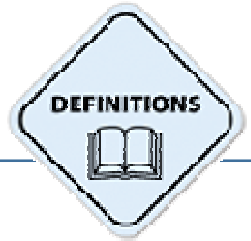
- Software engineering
- Systems engineering
- Control theory
- Artificial intelligence
- Machine-learning
- Multi-agent systems

Foundation

=

Architecture !

Foundation = Architecture

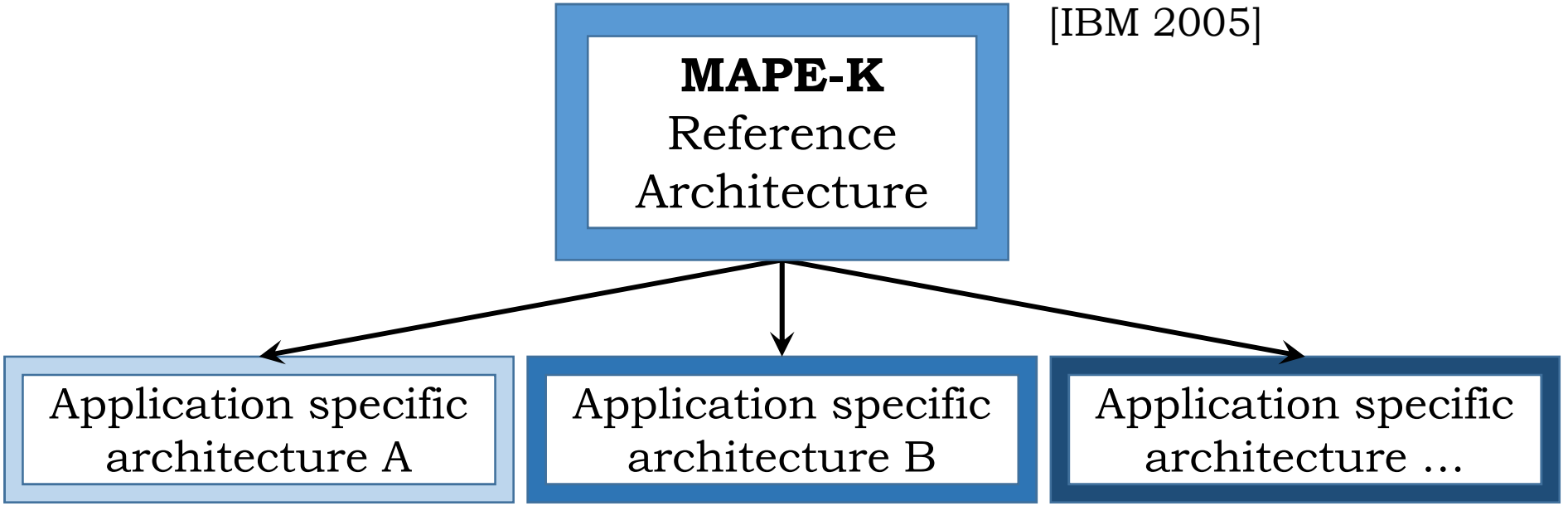


IT Architecture Definition:

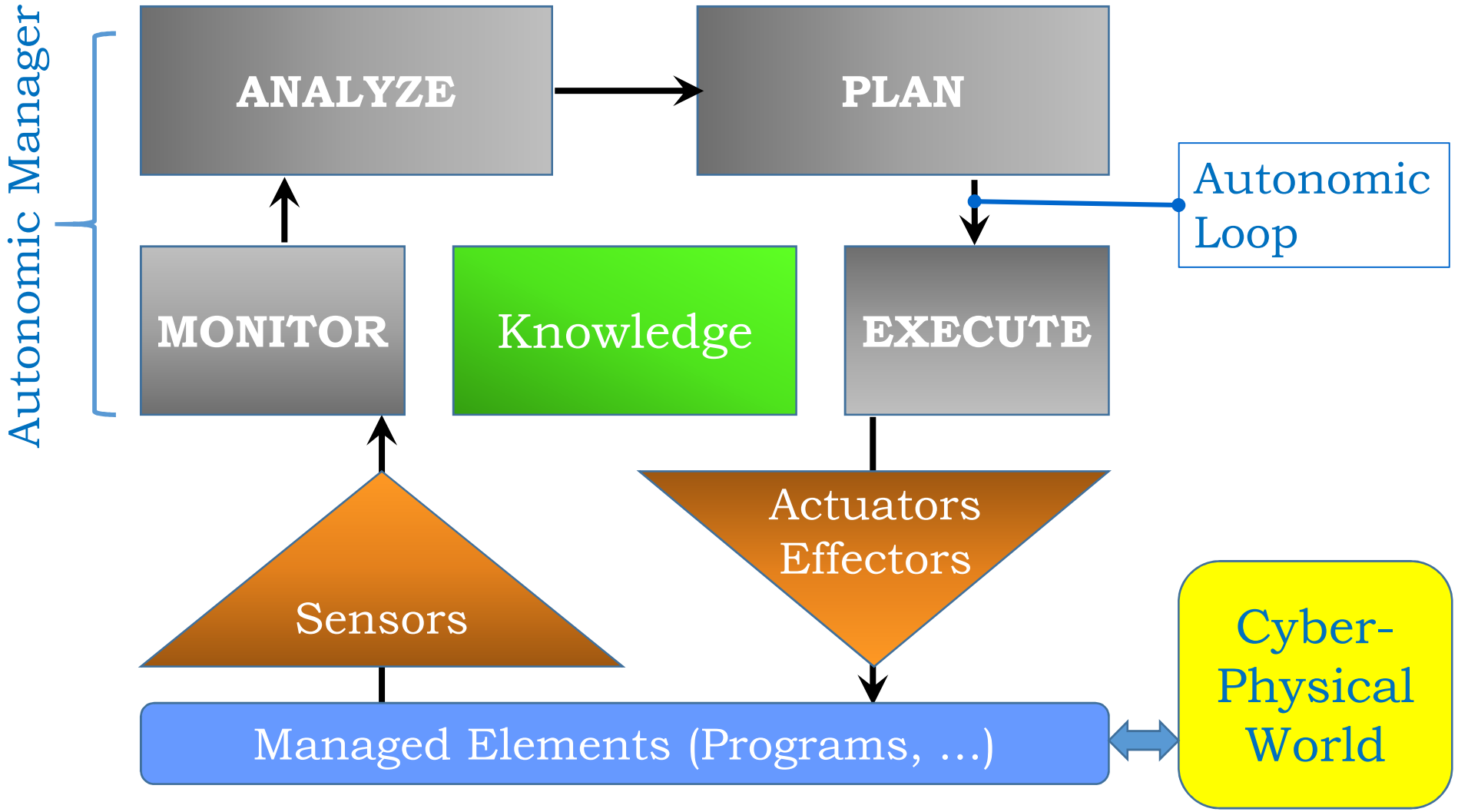
"The fundamental *organization* of a system embodied in its *parts*, their *relationships* to each other and to the environment, and the *principles* guiding its design and evolution"

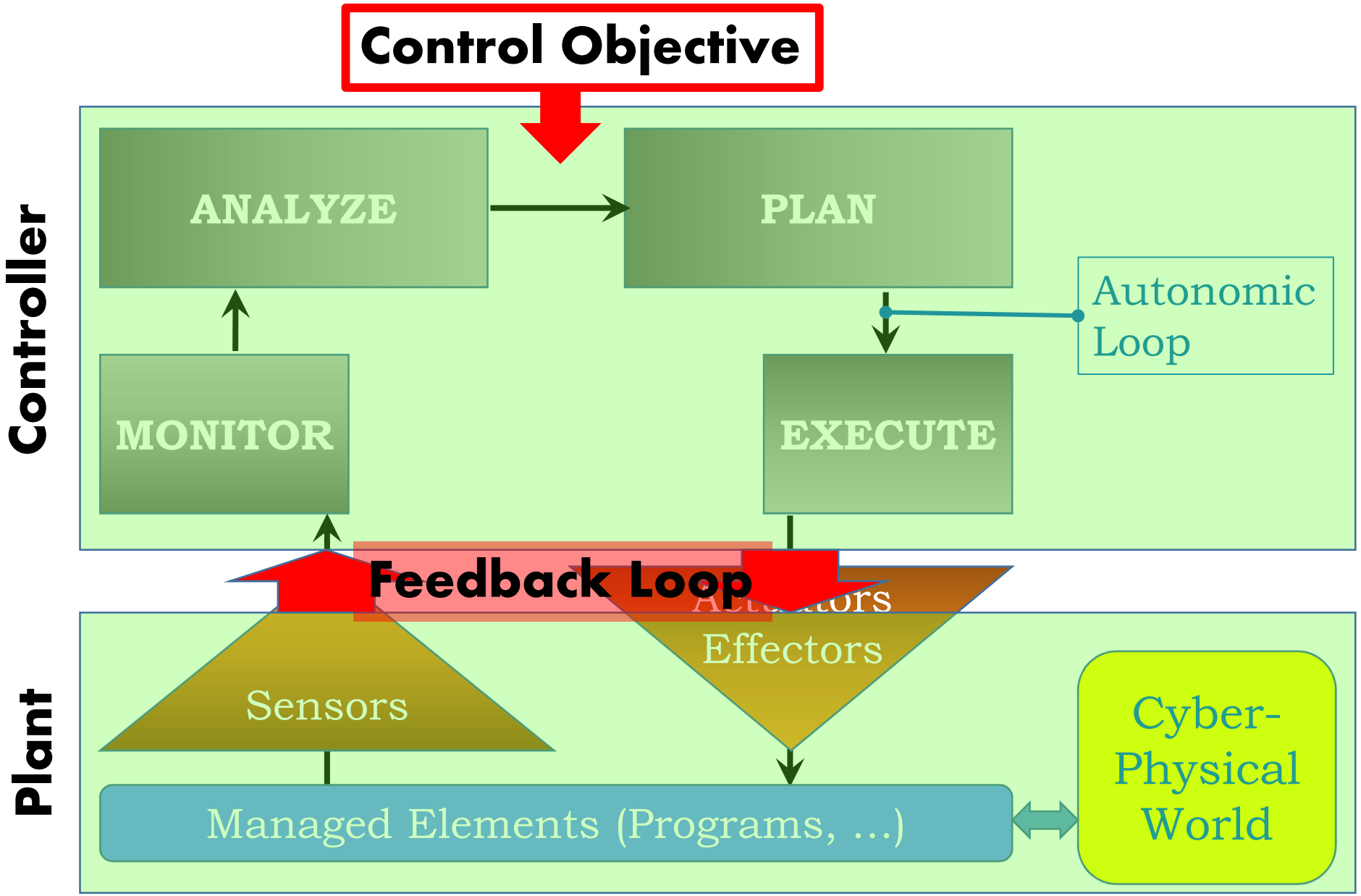
[IEEE]

[IBM 2005]



Autonomic System **Reference Architecture**




Control Objective
Controller
ANALYZE
PLAN
Autonomic Loop
MONITOR
EXECUTE
Feedback Loop
Effectors
Plant
Sensors
Cyber-Physical World
Managed Elements (Programs, …)

Each participant choses one of the 3 topics:

Q1: Which are the promising **software architectures** and **software technologies** for Autonomic Computing?

Q2: How does Autonomic Computing enable **future applications**?

Q3: What is the **impact** of Autonomic Computing on people, work and society in 2025?

Q1:

Which are the promising

software architectures

and

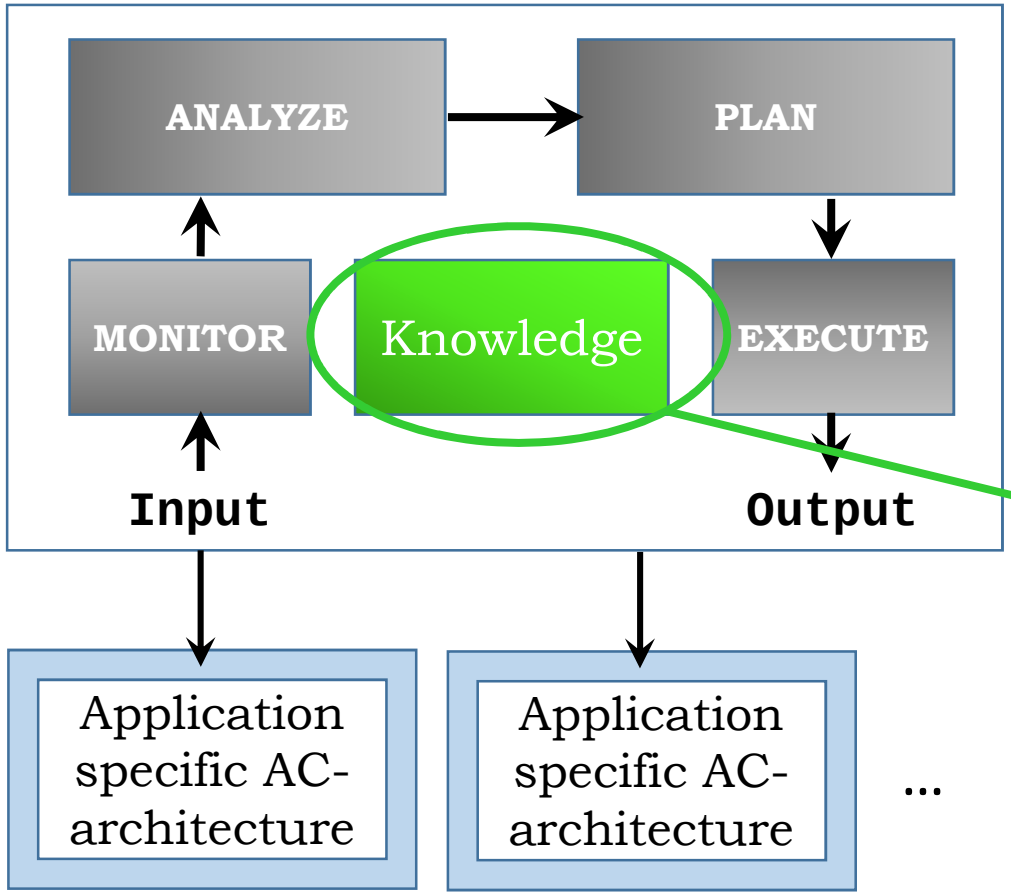
software technologies

for autonomic computing ?

MAPE-K: IBM Reference Architecture

Knowledge

Monitor – **A**nalyze – **P**lan - **E**xecute



Artificial Intelligence Technologies:

- Modeling
- Reasoning
- Data Analysis
- Machine Learning
- Agent systems
- Inference
- Control theory
- …

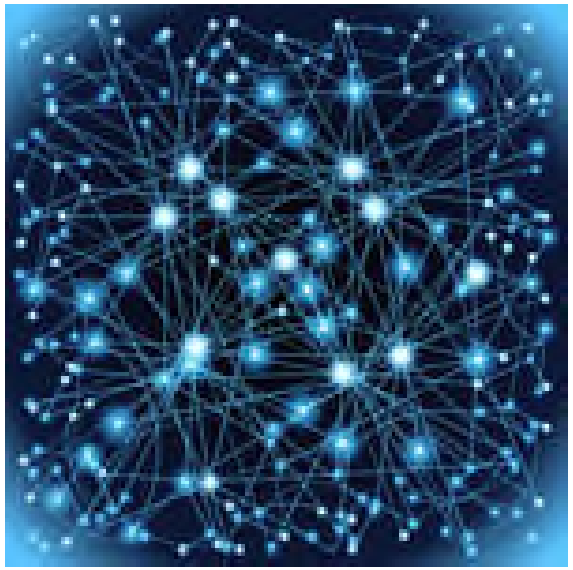
Q2:

How does

autonomic computing

enable

future applications ?



http://de.clipart.me

self-* properties ⇒ new applications

Examples:

- Run-time models for Self-Managing Systems and Applications
- Autonomic Network Management
- Real-time defense against malicious activities (virus, …)
- Self-optimizing systems, e.g. energy, safety, security, …
- …

Q3:

What is the

impact

of autonomic computing

on people, work and society ?

[Time horizon: 2025]

New autonomic application

New autonomic application

New autonomic application

Impact ?

Work

Society

People

http://www.alternet.org

An Autonomic Computer may take **Decisions** – based on its Artificial Intelligence

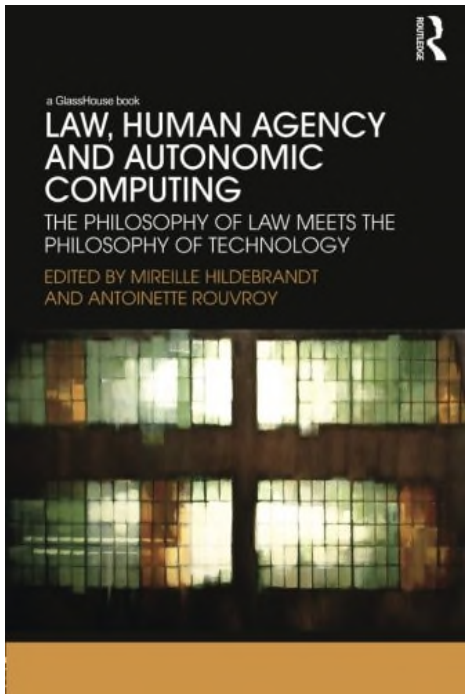
http://www.plusfinancials.com

Example: Impact on people, work and society

Autonomic Application

Decision

Impact



Mireille Hildebrandt, Antoinette Rouvroy:
Law, Human Agency and Autonomic Computing – *The Philosophy of Law meets the Philosophy of Technology*
Routledge (Taylor & Francis), Milton Park, UK, 2011. ISBN 978-0-415-72015-1

http://de.123rf.com

Part 3: Principles of a Good Paper

A good paper has:

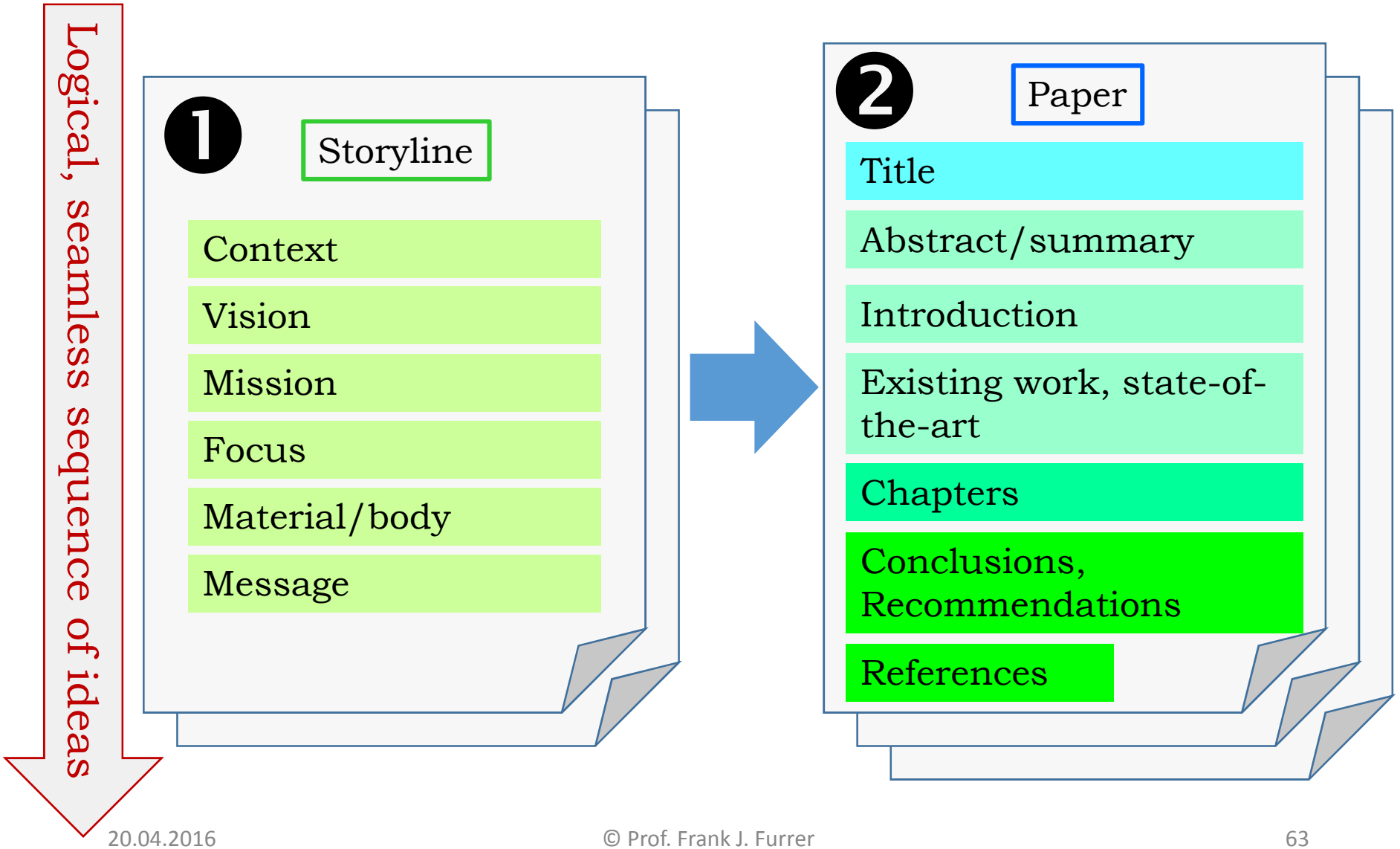
http://www.florian-ultra.de

- A *valuable* message that will be *remembered*

- A *pleasurable* experience while reading it

http://gibloemfontein.sites.caxton.co.za

Key element = An interesting, consistent and complete storyline



Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

What we want to **achieve**

„... how do we see an improved world"

(State [Utopia])

What we want to **do**

„... how do we improve the world"

(Action [Way to ...])

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

Example:

Modern individual traffic

Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

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

VISION

The vision is to keep traffic fluid, efficient and with low rates of accidents.

One promising approach is to support – or even replace – the drivers by electronic driving assistance systems.

Clear and comprehensive statement of the long-term goal
⇒ **Vision Statement**

Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

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

MISSION

This paper demonstrates the feasibility and implementation of one important electronic driving assistance system.

We present and discuss the sensor-based collision-avoidance systems.

Many such systems are under development - some of them can even be found in modern production cars.

Our target audience are graduate students in mechanical, electronics and computer science

Precise statement of the work

⇒ **Mission Statement**

Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

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

CONTEXT

Individual traffic using trucks and private cars forms an important element of our economy and of our individual life-style.

In the last decades the amount of traffic has increased considerably.

The results are daily congestions and higher accident rates.

They cause significant damage to the economy and to our individual mobility.

Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

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

FOCUS

Sensor-based collision-avoidance systems is a wide field of research.

It encompasses sensor-, software-, image processing- and safety engineering.

We focus on one specific system: The system developped by Mercedes-Benz which can be found in most of their current production cars.

We explain its architecture, functionality, features and limitations.

Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

Restrict, restrict, restrict !

Organize, organize, organize !

Avoid all unnecessary concepts.

Establish a clear state-of-the-art, of prior work and of relevant references

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

Storyline:

- Context
- Vision
- Mission
- Focus
- Material/body
- Message

This paper has demonstrated the great value of collision-avoidance systems.

Such systems could greatly be improved by using real-time environmental information.

Therefore, research should continue into car-to-car and car-to-infrastructure communications

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

Style

The **content** of your paper is:

- correct
- precise
- clear
- brief
- ethical

Your material must be free from error and in accordance with facts

If it is vague, it is not scientific writing

If it is unclear or ambiguous, it is not scientific writing either

If it is long-winded and unnecessarily discursive, it is poor scientific writing

Fair, truthful, respectful, references, copyrights, …

- precise
- clear

Importance of definition of terms

Many terms are highly ambiguous, context-dependent, author-dependent, time-dependent etc.

`System, element, module, component, domain, …`

Term „Human“ [Definition]:

We are bilaterally, symmetrical, sexually differentiated bipeds located on one of the outer spirals of the Milky Way, capable of recognising the prime numbers …

[NASA Deep Space Probe]

- brief

Clear is more important than brief

Acronyms and abbreviations are poison for the reader

⇒ Avoid them (whenever possible)

If necessary, introduce them (1x or 2x) at the beginning:

„This paper introduces the concept of System-of-Systems (SoS)“.

An SoS …

The vehicle can be seen as an SoS, with many CS, such as ABS, ESC, BA and possibly a CAS.

http://dailygrail.com

Part 4: Principles of a Good Presentation

Principle 1: **Understand** your audience

Background ?

Prior Knowledge ?

Expectations ?

Reason for attendance ?

http://www.englishandculture.com

Tailor your presentation
to the background and needs
of your audience

Principle 2: **Key Message**

What is your message ?

Why is it important ?

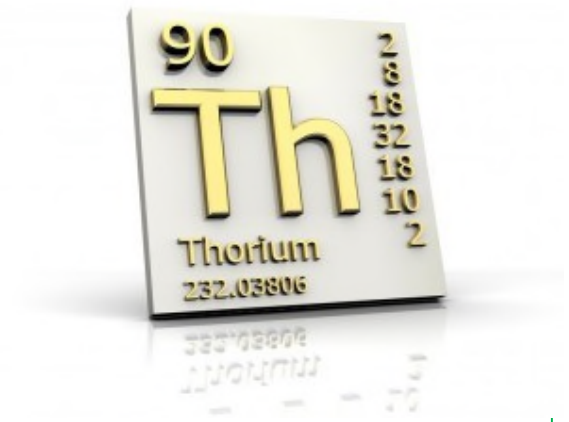
What does it mean to your audience ?

What do you want them to remember ?

http://www.mediafane.com

The key message is the continuous focus of your presentation

Example: Thorium Nuclear Energy



Audience: YOU!

- *Background*: mathematical-physical-engineering education
- *Prior knowledge*: basic nuclear physics
- *Expectations*: Possible solution to world's energy problem?
- *Reason for attendance*: critical assessment, gain of knowledge

Key message:

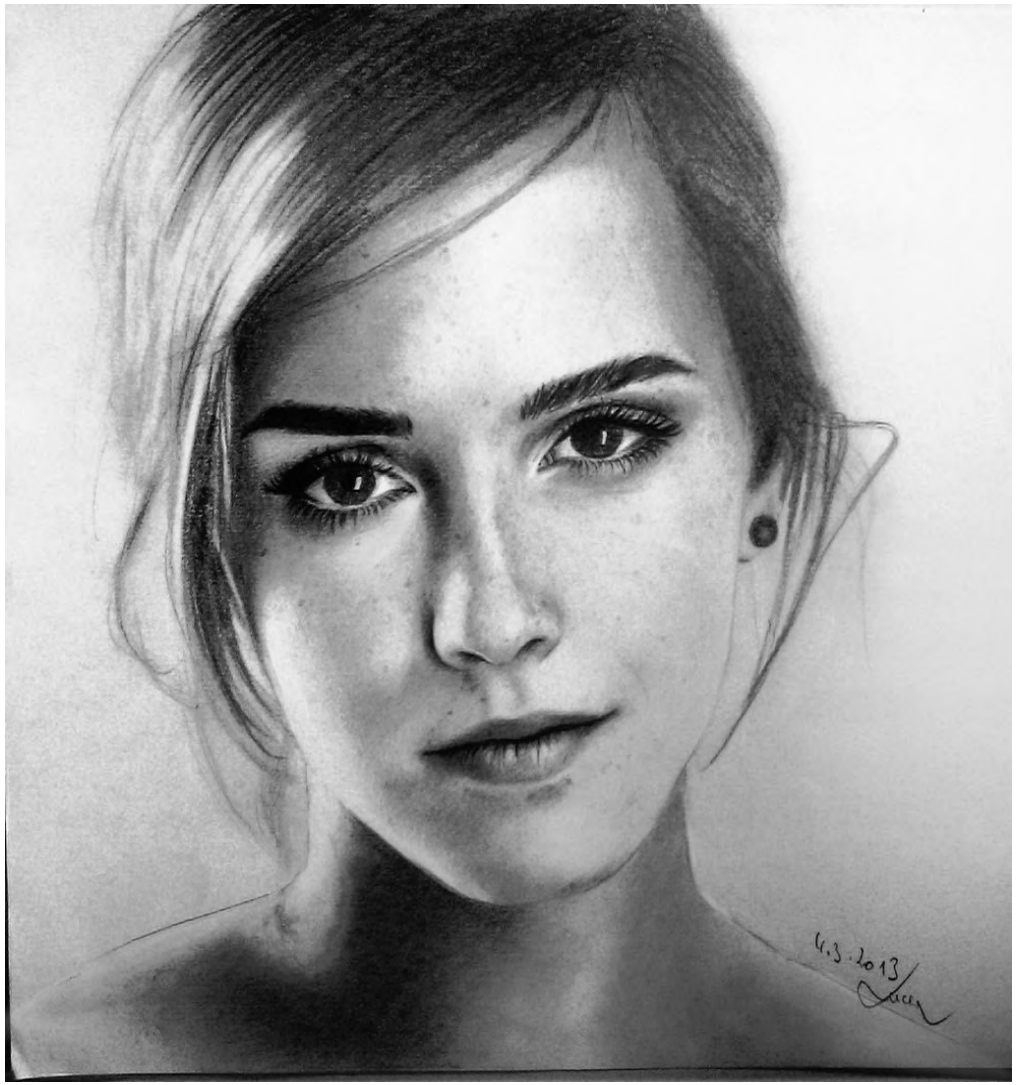
«THORIUM – The Green Energy Source of the Future»

Richard Martin: **Superfuel – *Thorium, the green energy source of the future***.
Palgrave McMillan Publishers, New York, USA, 2012. ISBN 978-0-230-11647-4

Paper ⇔ Presentation ?

- Illustrations/pictures
- Animations
- Personal style

- emotion
- feeling
- provocation



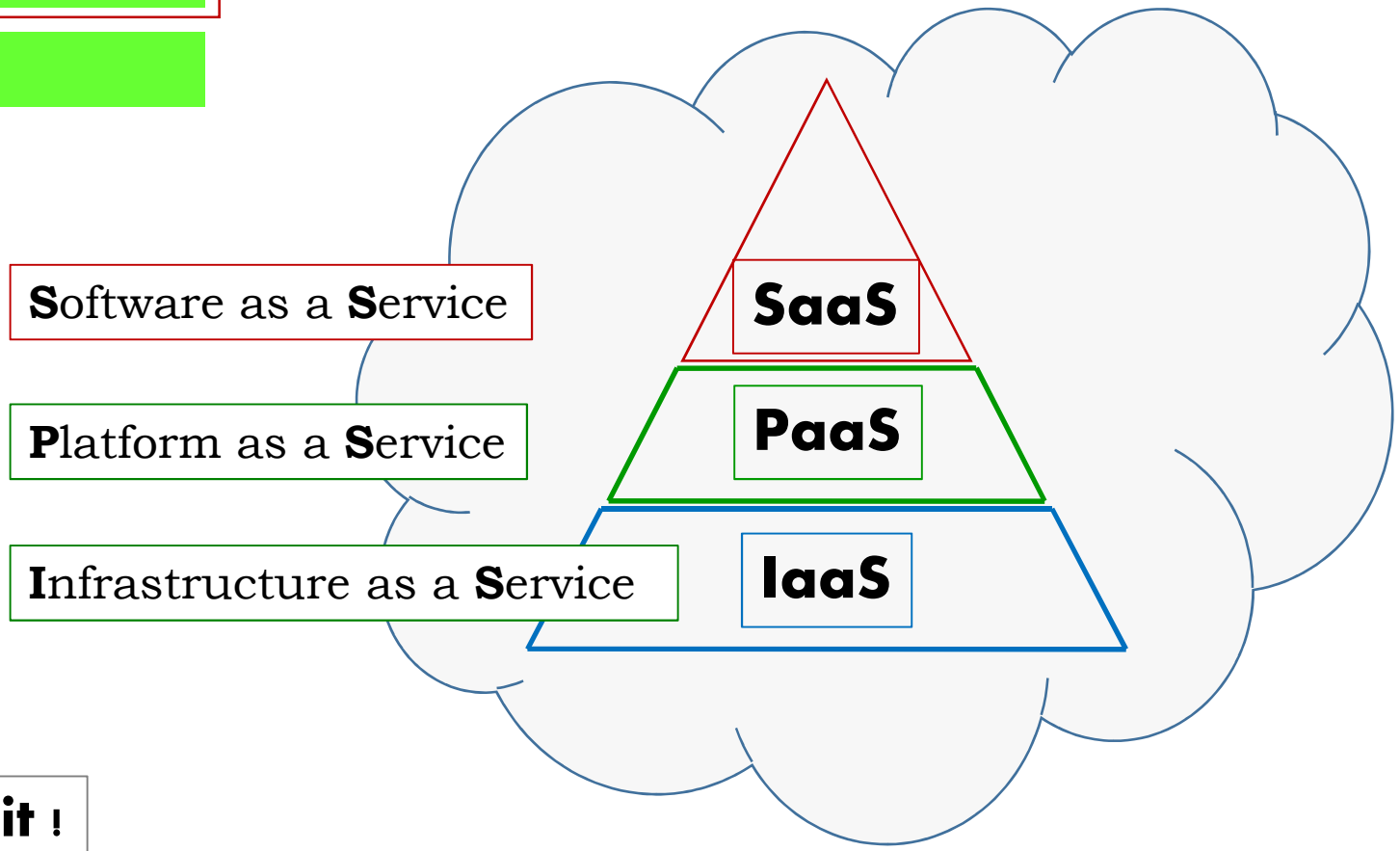
http://www.thanod.com

Illustrations/pictures

Animations

Personal style

Cloud Definitions:



Don't overdo it !

Illustrations/pictures

Animations

Personal style

- relate to your audience
- be highly present
- be strongly engaged

http://dailygrail.com

Elements of a bad presentation:

- Small (< 22 pt) or unreadable fonts
- Too dense slides
- Few illustrations, pictures
- Excessive animations
- (Extensive) use of bullet point lists
- Unclear message, bad storyline
- Introduction of superfluous concepts
- … and some more

Garr Reynolds: **Presentation ZEN** – ***Simple Ideas on Presentation Design and Delivery.***

New Riders Publishing, Berkeley CA, USA, 2008. ISBN 978-0-321-52565-9

Elements of a bad presentation:

- Smal
- Too
- Few
- Exce
- (Ext
- Uncl
- Intr
- … ar

http://img.galerie.chip.de

Garr Reynolds

New Riders Publishing, Berkeley CA, USA, 2008. ISBN 978-0-321-52565-9

What is the sure **death** of a good presentation ?

http://www.wfs.org

http://hqwallbase.pw/82449-a-step-forward/

Next Steps

Hauptseminar SS 2016: «Autonomic Computing»

Please send an e-mail to:

frank.j.furrer@bluewin.ch

confirming your participation

and state:

- Full name
- Reason for attending
- Studiengang

Latest Saturday, April 23, 2016 – Thank you

Hauptseminar limited to **7** participants

Next Steps

Select 2 **peer reviewers** from the participants Note: **All** papers will also be reviewed by Dr. F.J. Furrer (as 3rd peer reviewer)	Monday, April 25, 2016
Deliver your **choice of topic** (i.e. Question 1, 2 or 3) and a short **vision/mission statement** to the 2 peer reviewers and to F.J. Furrer Note: Content and structure of the "vision/mission statement" will be explained in the Kick-Off Meeting	Friday, April 29, 2016
Feedback from Reviewers	Friday, May 6, 2016
Deliver 1st draft of both your storyline and your paper to your peer reviewers Note: Content and structure of the "storyline" and "paper" will be explained in the Kick-Off Meeting	Friday, May 20, 2016
Feedback from Reviewers	Friday, May 27, 2016

2 documents

Next Steps

1st Seminar Day	**Wednesday, June 8, 2016: 09:20 – 10:50/11:10 - 12:40 (2. + 3. DS)** **Room APB/INF 2101**
Deliver 2nd, improved draft of your paper to your peer reviewers	Friday, June 17, 2016
Feedback from Reviewers	Monday, June 27, 2016
2nd Seminar Day	**Wednesday, July 13, 2016: 09:20 – 10:50/11:10 - 12:40 (2. + 3. DS)** **Room APB/INF 2101**
Deliver final version of your paper	Latest: Friday August 5, 2016
pdf-volume of collected papers ready	September 2016 [may be delayed because of TUD procedures]

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Babaoglu05	Ozalp Babaoglu, Márk Jelasity, Alberto Montresor, Christof Fetzer, Stefano Leonardi, Aad van Moorsel, Maarten van Steen (Editors): **Self-star Properties in Complex Information Systems** Springer Lecture Notes in Computer Science, Volume 3460, 2005. ISBN: 978-3-540-26009-7
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DARPA16	Defense Advanced Research Projects Agency (DARPA): ***DARPA Cyber Grand Challenge Competitor Portal***. 2016 Downloadable from: https://cgc.darpa.mil/ [last accessed 15.3.2016]

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Tianfielda04	Huaglory Tianfielda, Rainer Unland: ***Towards autonomic computing systems*** Engineering Applications of Artificial Intelligence 17 (2004), 689–699 Downloadable from: https://www.researchgate.net/profile/Rainer_Unland3/publication/222433987_Towards_autonomic_computing_systems/links/00b7d51d039fb794b1000000.pdf [last accessed 5.4.2016]
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TTU16	***Cloud and Autonomic Computing Center*** Texas Technical University (TTU) http://www.depts.ttu.edu/cac/

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http://st.inf.tu-dresden.de/teaching/hs/auco16