Exploring the Temporal Aspects of Software Architecture

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Keynote at ICSOFT 2016

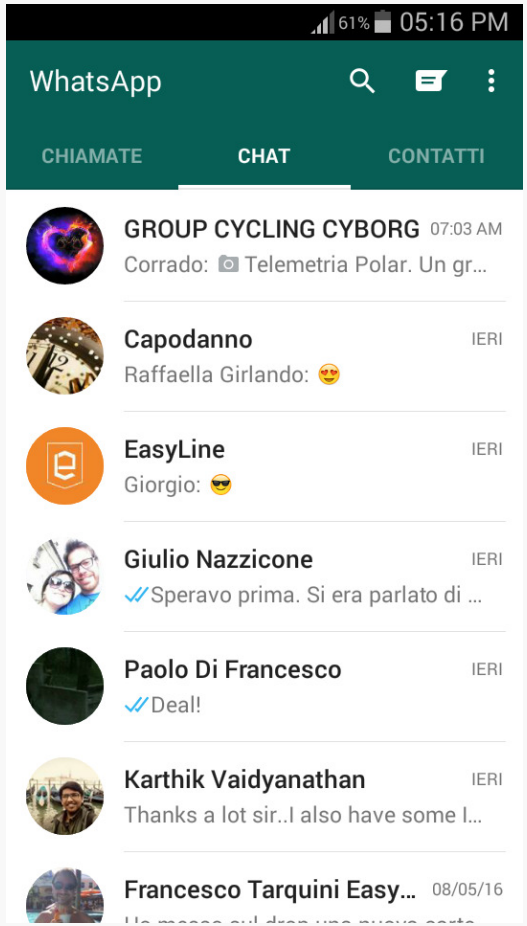
Exploring the Temporal Aspects of Software Architecture

Software/System Architecture

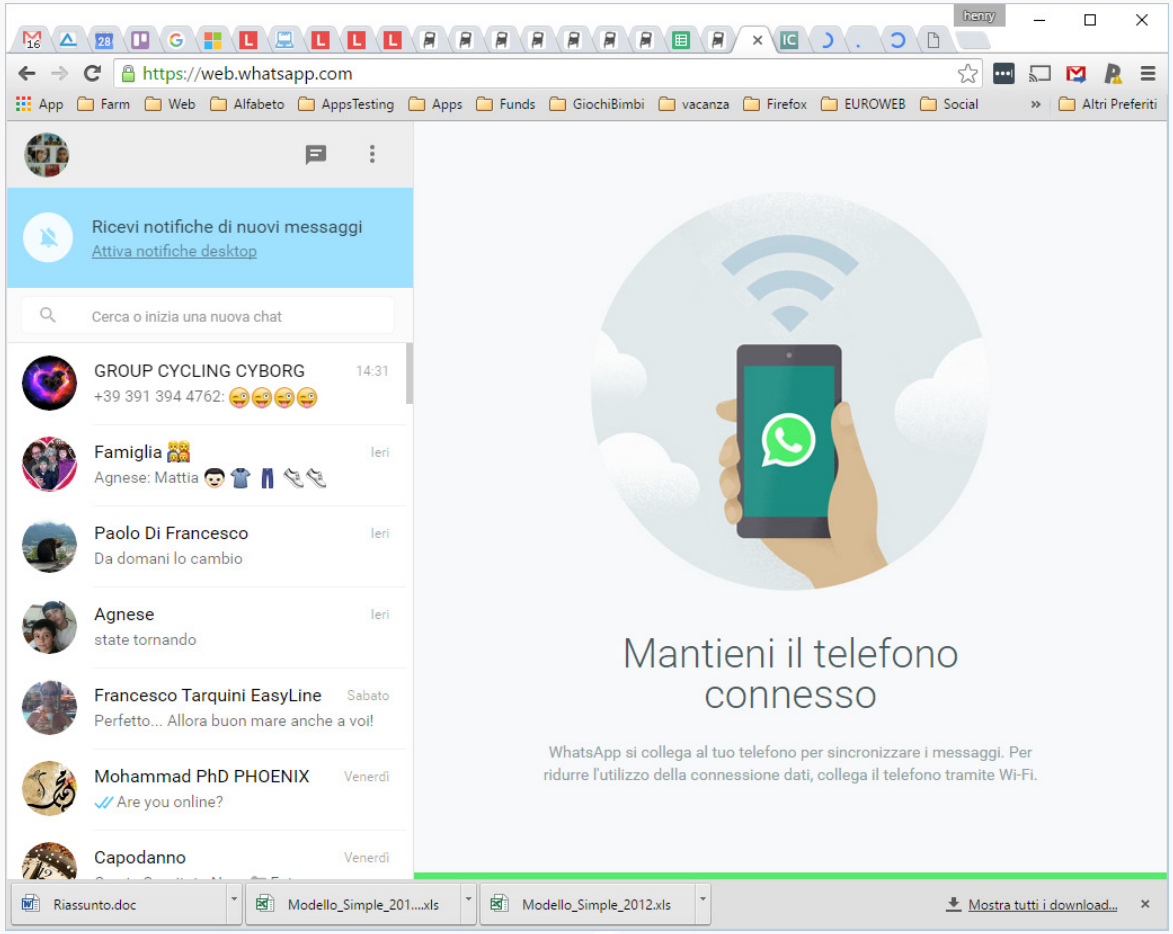
Let us reason about the Gaudi's Sagrada Familia

disim

WHATSAPP



WHATSAPP WEB



Web Software Architecture

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«Store and forward» mechanism for message exchange

no long term storage

Exploring the Temporal Aspects of Software Architecture

WICSA&CompArch

JOIN US IN VENICE THE JEWEL OF ITALY!

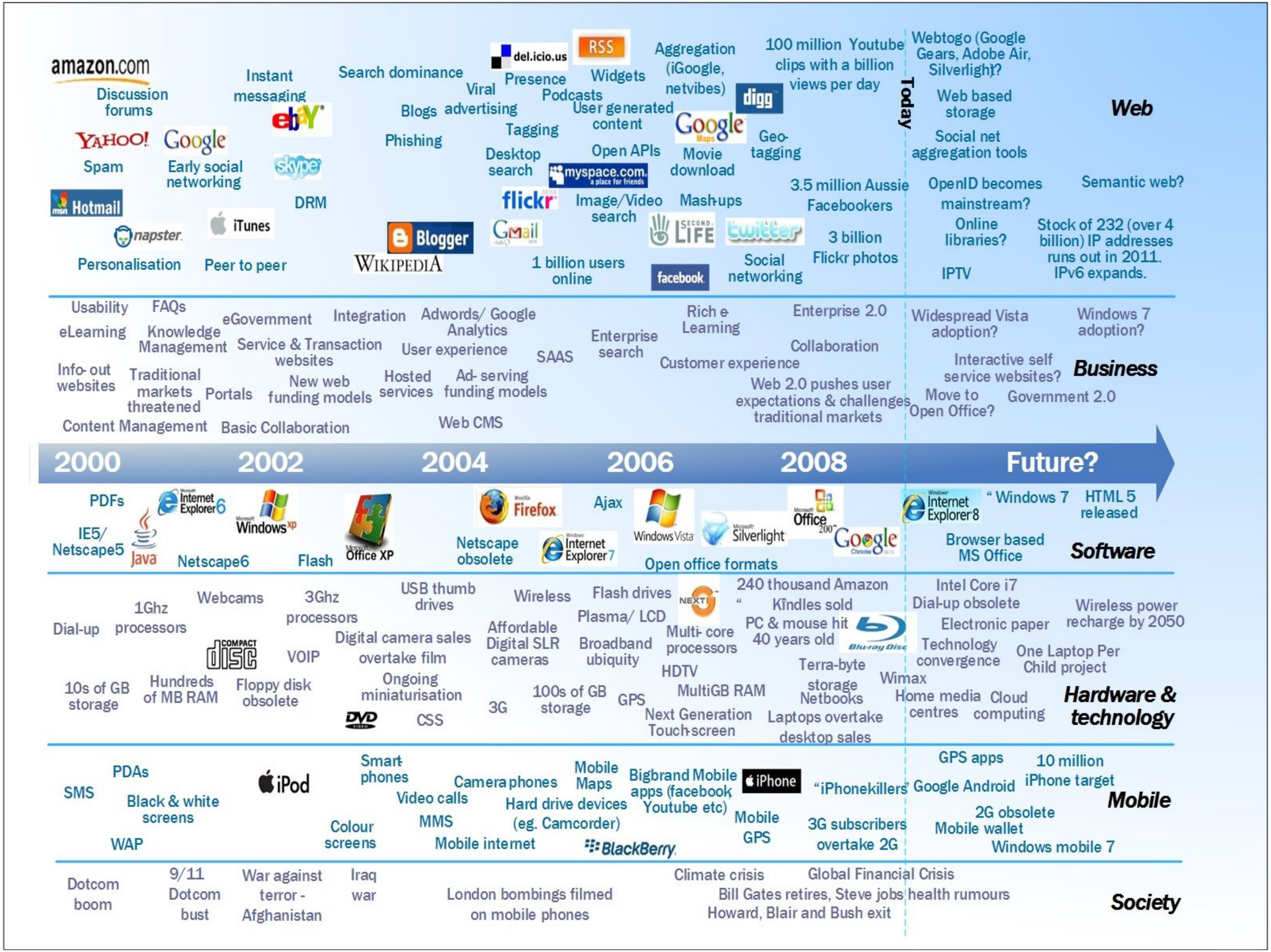
APRIL 2016

*For WICSA 2016 the theme was **"Architecting in time"** – exploring the temporal aspects of software architecture.*

continuity, evolution and decay,

the benefits, consequences and debt from delaying decisions,

architecting practices and experiences in different software development processes, or the related collaborative design activities that fit into the life cycles of systems and applications.


amazon.com
Discussion forums
Instant messaging
Search dominance
del.icio.us
RSS
Aggregation (iGoogle, netvibes)
100 million Youtube clips with a billion views per day
Webtogo (Google Gears, Adobe Air, Silverlight)?
Today
Web
YAHOO!
Google
ebY
Viral advertising
Presence
Widgets
Podcasts
User generated content
digg
Web based storage
Blogs
Tagging
Google Maps
Geo-tagging
Social net aggregation tools
Spam
Early social networking
skype
Phishing
Desktop search
Open APIs
Movie download
myspace.com a place for friends
3.5 million Aussie Facebookers
OpenID becomes mainstream?
Semantic web?
Hotmail
DRM
flickr
Image/Video search
Mash-ups
napster
iTunes
Blogger
GMail
SECOND LIFE
twitter
3 billion Flickr photos
Online libraries?
Stock of 232 (over 4 billion) IP addresses runs out in 2011. IPv6 expands.
Personalisation
Peer to peer
WIKIPEDIA
1 billion users online
facebook
Social networking
IPTV
Usability
FAQs
eGovernment
Integration
Adwords/ Google Analytics
Rich e-Learning
Enterprise 2.0
Widespread Vista adoption?
Windows 7 adoption?
eLearning
Knowledge Management
Service & Transaction websites
User experience
SAAS
Enterprise search
Collaboration
Customer experience
Interactive self service websites?
Business
Info-out websites
Traditional markets threatened
Portals
New web funding models
Hosted services
Ad-serving funding models
Web 2.0 pushes user expectations & challenges traditional markets
Move to Open Office?
Government 2.0
Content Management
Basic Collaboration
Web CMS
2000
2002
2004
2006
2008
Future?
PDFs
Internet Explorer 6
Windows xp
Firefox
Ajax
Windows Vista
Silverlight
Office 2007
Internet Explorer 8
"Windows 7"
HTML 5 released
IE5/ Netscape5
Java
Netscape6
Flash
Office XP
Netscape obsolete
Internet Explorer 7
Open office formats
Google Chrome
Browser based MS Office
Software
1Ghz processors
Webcams
3Ghz processors
USB thumb drives
Wireless
Flash drives
NEXT G
240 thousand Amazon "Kindles sold
Intel Core i7
Dial-up obsolete
Wireless power recharge by 2050
Dial-up
COMPACT disc
Digital camera sales overtake film
Affordable Digital SLR cameras
Plasma/ LCD
Broadband ubiquity
Multi-core processors
PC & mouse hit 40 years old
Blu-ray Disc
Electronic paper
Technology convergence
One Laptop Per Child project
VOIP
HDTV
Terra-byte storage
Wimax
10s of GB storage
Hundreds of MB RAM
Floppy disk obsolete
Ongoing miniaturisation
100s of GB storage
GPS
MultiGB RAM
Netbooks
Home media centres
Cloud computing
Hardware & technology
DVD
CSS
3G
Next Generation Touch-screen
Laptops overtake desktop sales
SMS
PDAs
iPod
Smart phones
Camera phones
Mobile Maps
Bigbrand Mobile apps (facebook Youtube etc)
iPhone
"iPhonekillers"
GPS apps
Google Android
10 million iPhone target
Mobile
Black & white screens
Video calls
Hard drive devices (eg. Camcorder)
Mobile GPS
3G subscribers overtake 2G
2G obsolete
Mobile wallet
WAP
Colour screens
MMS
Mobile internet
BlackBerry
Windows mobile 7
Dotcom boom
9/11 Dotcom bust
War against terror - Afghanistan
Iraq war
London bombings filmed on mobile phones
Climate crisis
Global Financial Crisis
Bill Gates retires, Steve jobs health rumours
Howard, Blair and Bush exit
Society

Two main dimensions

This talk

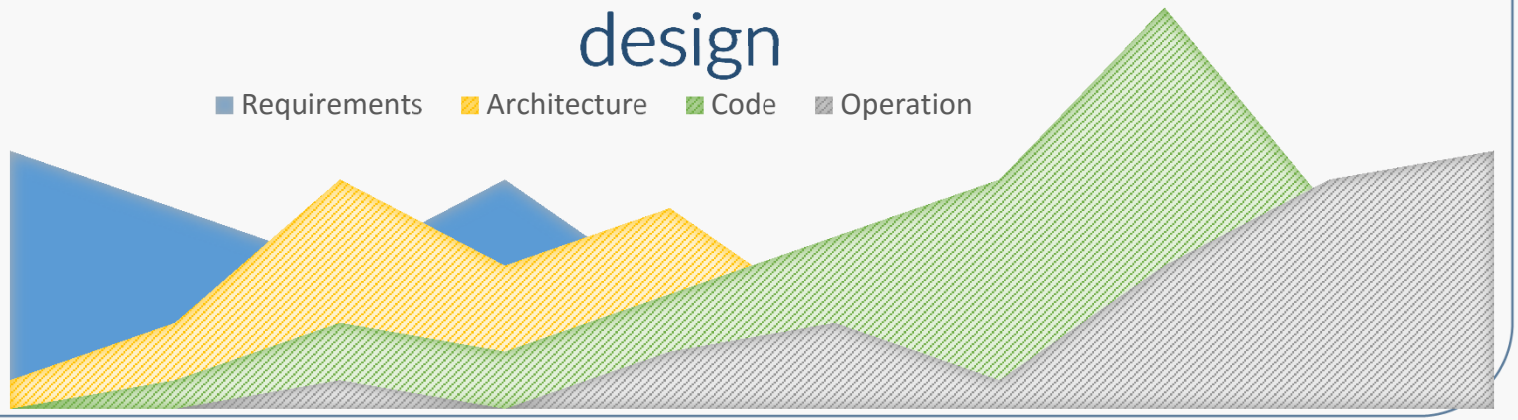
1

The software architecture field evolution over time

1992 → **today**

2

Temporal aspects in software architecture design



Architecting

1

? How the Software Architecture field evolved over time?

We could travel over time...

… or, report information based on our own knowledge, pretending to know everything…

… a more systematic way to look at it…

The history artifacts and works (decorations, wigs, scents) talk about the culture of that time.

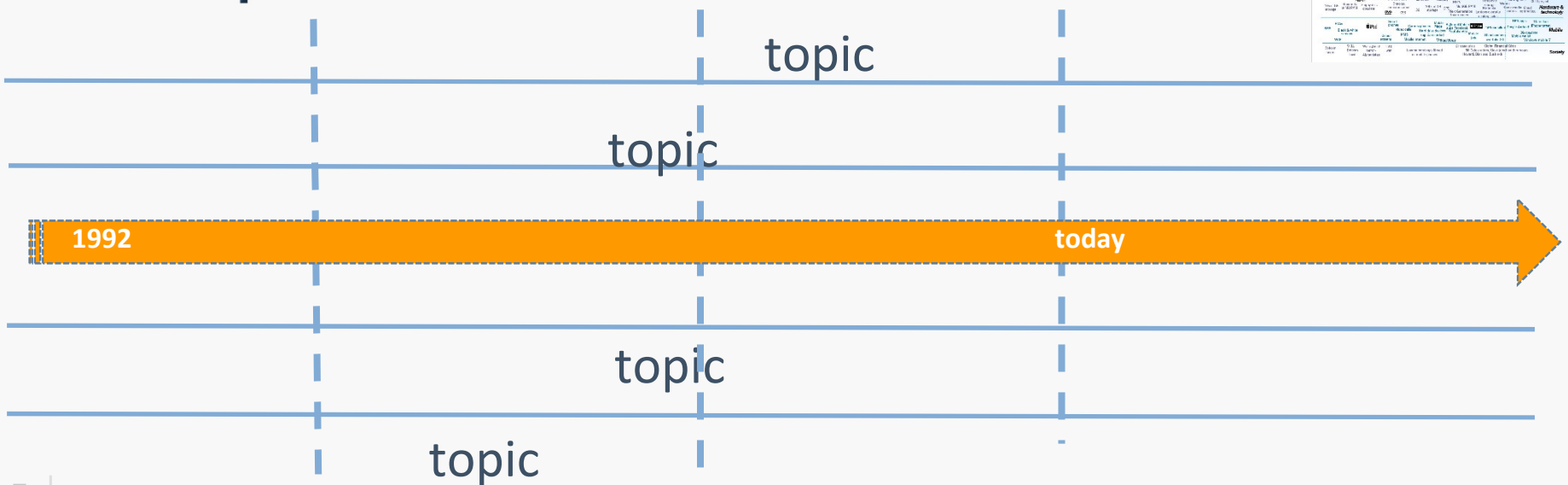
They are not only historical relic, but they speak about that time

Val Parks: https://www.youtube.com/watch?v=LMJh1WTkxws

Goal

? How the Software Architecture field evolved over time?

Output



The study (specifically) conducted for this speech

?How to travel over time?

Mixed method used for this study:

1. Topics extraction:
   - Personal knowledge + Seminal papers
2. Data mining
   - From the WICSA, CBSE, ECSA, and QoSA conferences
   - From 1999 to 2016
3. Reasoning on the results

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1 Topics extraction (by experience)

20 years of experience in the field

WICSA 2016 PC co-chair

ICSA steering committee member

PC of WICSA, CBSE, ECSA (ICSE, FSE, ASE)

Member of the IFIP WG 2.10 on Software Architecture

Design Decisions

SA Description

Assessment

ADLs

Style

Views

…

SPL architectures

CPS

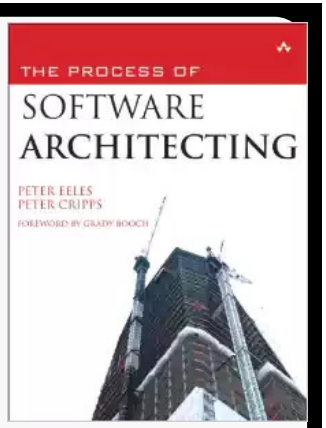
Agile

DevOps

1 Topics extraction (by reference papers)

1992-1994 seminal

FOSE 2000 & 2014



ACM SIGSOFT SOFTWARE ENGINEERING NOTES vol 17 no 4 Oct 1992 Page 40

Foundations for the Study of Software Architectur

Dewayne E. Perry
AT&T Bell Laboratories
600 Mountain Avenue
Murray Hill, New Jersey 07974
dep@research.att.com

Alexander L. Wolf
Department of Computer Science
University of Colorado
Boulder, Colorado 80309
alw@cs.colorado.edu

Software Architecture: a Roadmap

Software Architecture: A Travelogue

David Garlan
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213 USA
garlan@cs.cmu.edu

An Introduction to Software Architecture

David Garlan and Mary Shaw
January 1994

CMU-CS-94-166

School of Computer Science

Also published as "An Int
and Knowledge Engineerin

Also appears

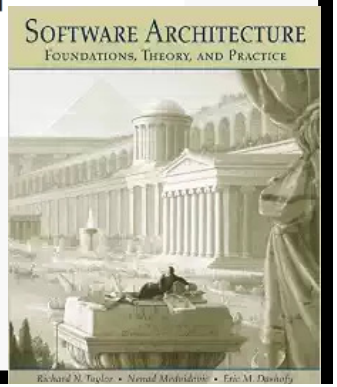
Lightweight and Flexible
Emerging Trends in Software Architecture from the SATURN Conferences

Michael Keeling

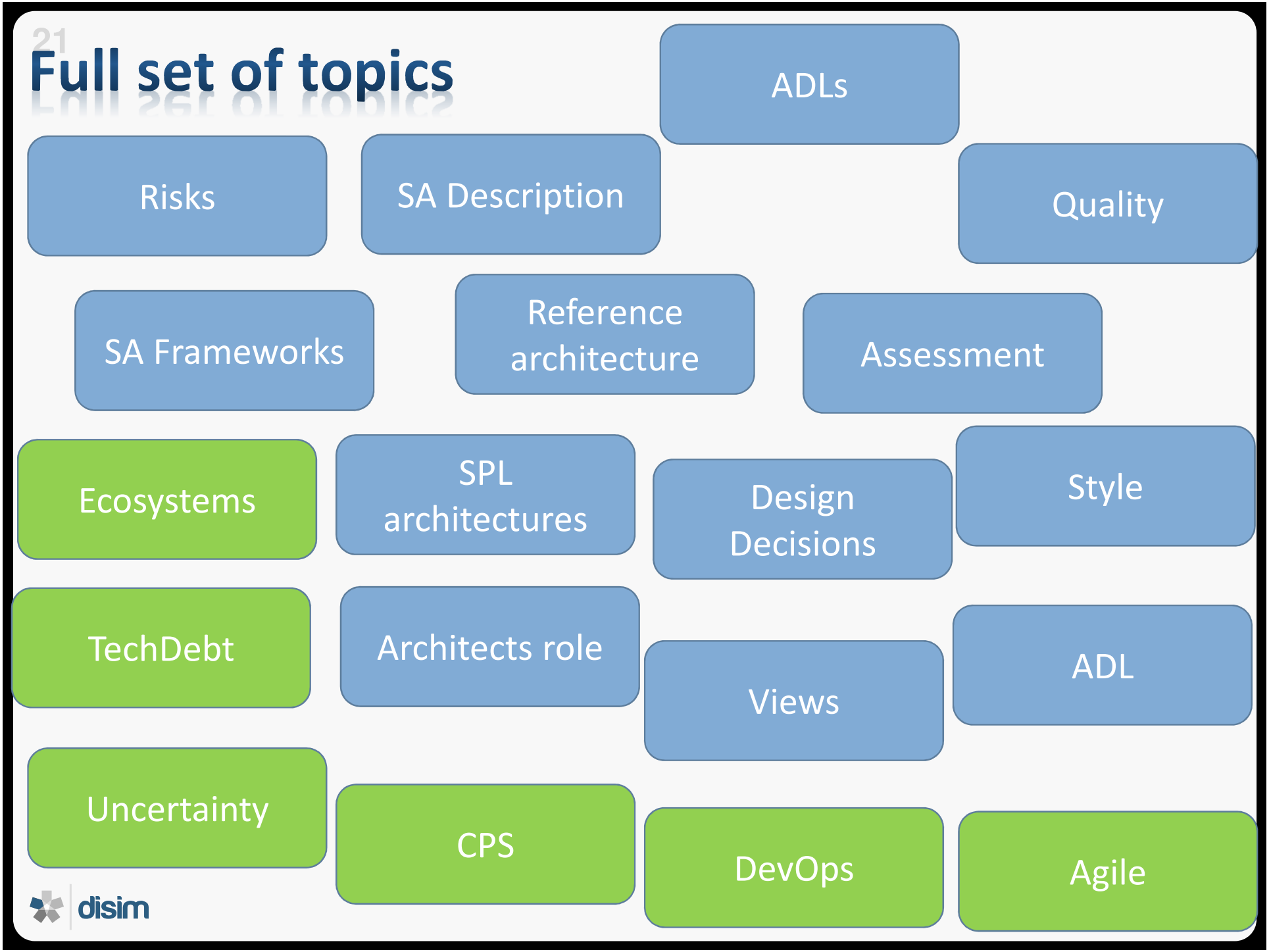
The Past, Present, and Future of Software Architecture

Philippe Kruchten, *University of British Columbia*
Henk Obbink, *Philips Research Europe*
Judith Stafford, *Tufts University*

IEEE SW



Full set of topics



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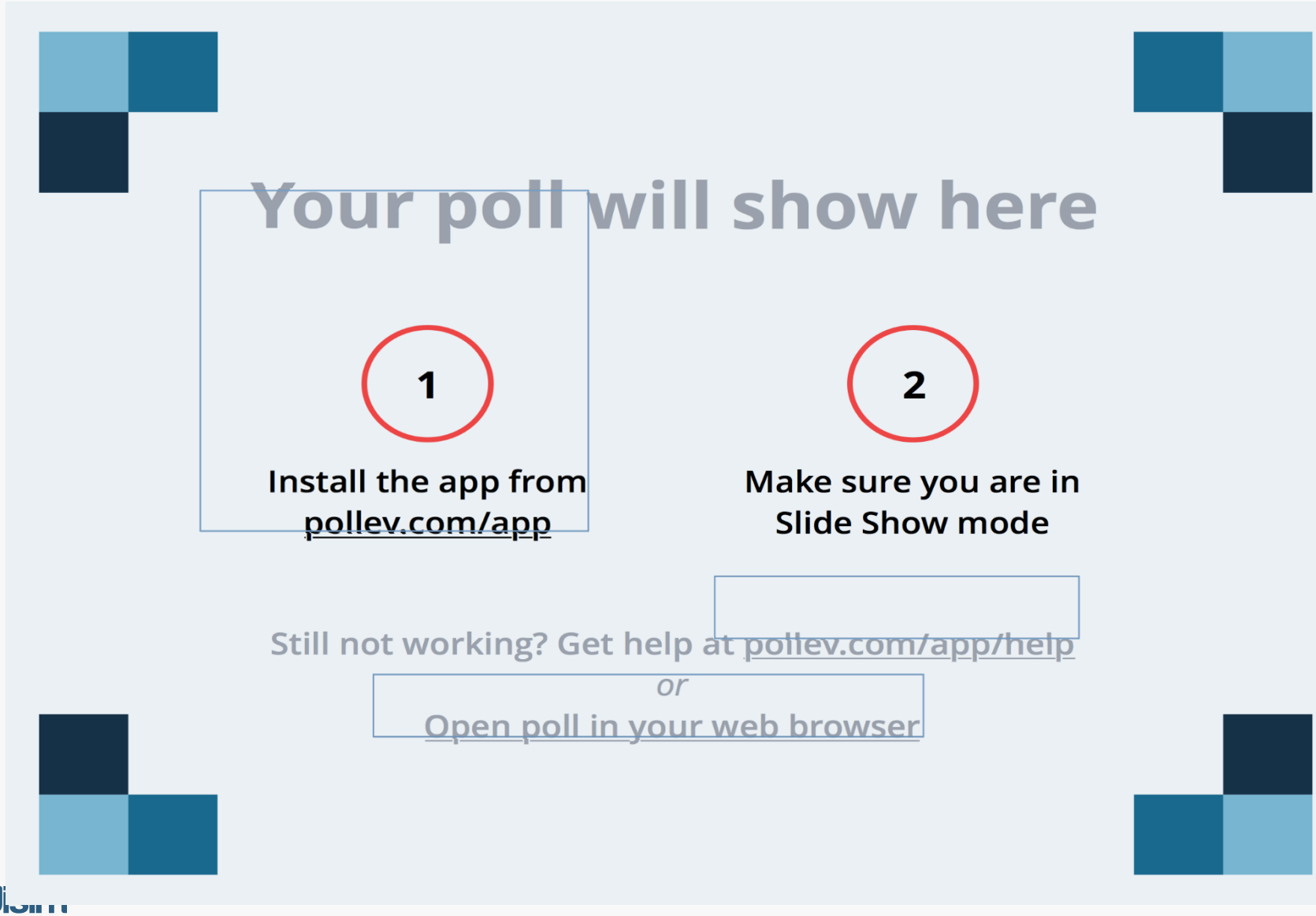
Vote at: goo.gl/Gje2zE



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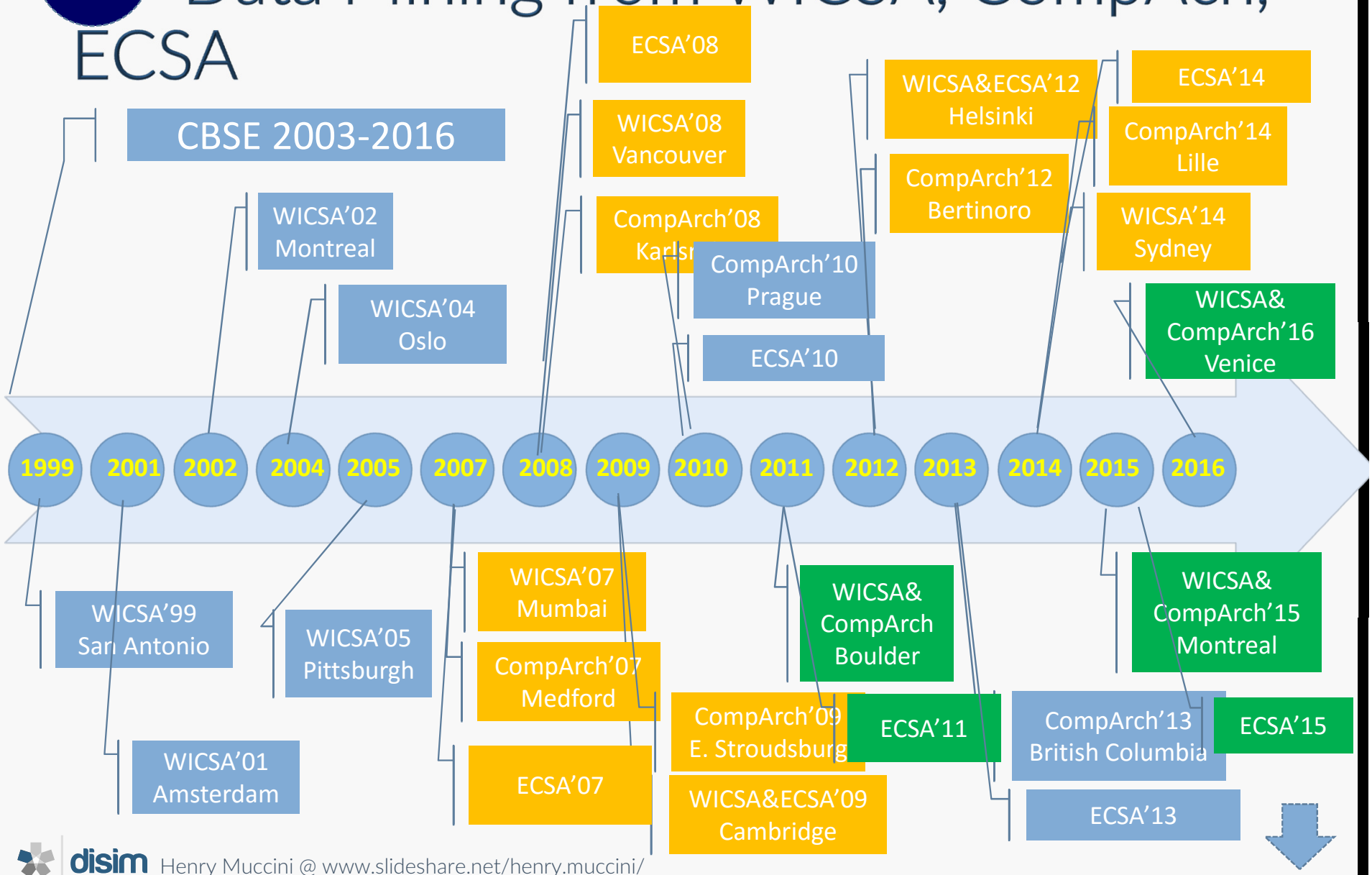
2 Data Mining from WICSA, CompAch, ECSA



2 Data mining… in numbers

What: 4 conferences, 42 editions, 1999-2016,
811 articles analysed

How: topics search

- Search of topics and synonyms in
  - Title
  - Keyword
  - Abstract

Place	Year	Title	Keywords	Abstract	style T	style K+A	pattern T	Pattern K+A	style # papers		view* K+A	view #papers	Analysis T	Analysis K+A	consistency T	consistency K+A	performance T	performance K+A	Performance TOTAL	security T	security K+A	Security TOTAL	Analysis #papers (all fields) total	Design Decision T	Design Decision K+A	Decision T
YEAR 1999				**TOTAL**					3			1							0			2	4			
WICSA	1999		Design rec		0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0,5	0	0	0
WICSA	1999				1	1	0	0	0,8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0,5	0	0	0
WICSA	1999				1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0,8	0	0	0
WICSA	1999				0	0	0	0	0	0	1	0,5	0	1	0	0	0	0	0	0	1	0,5	0,8	0	0	0
WICSA	1999		software a		0	0	0	0	0	0	1	0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999		creation a		0	1	0	0	0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0,5	0	0	0
WICSA	1999				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YEAR 2001				**TOTAL**					2			1							1			1	2			
WICSA	2001				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,5	0,3	0	0	0
WICSA	2001				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				0	0	0	0	0	0	1	0,5	0	0	0	0	0	1	0,5	0	0	0	0,3	0	0	0
WICSA	2001		KBAC, ORI		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				0	0	1	1	0,6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001		Software		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				0	0	0	1	0,3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
WICSA	2001		Architectu		0	1	0	0	0,5	0	0	0	0	1	0	0	0	0	0	0	0	0	0,5	0	0	0
WICSA	2001				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001		architectu		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WICSA	2001				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TUTTO | Overall | Style | View | Analysis | DesignDecision | ProductLine | Agile | D Ops | TechDebt | AD | ReferenceArc | CPS | Ecosys | Risk | CostEst | Foglio1 | note

J3 =MIN(SOMMA(MAX(PRODOTTO(F3;0,8);PRODOTTO(G3;0,5));MAX(PRODOTTO(H3;0,6);PRODOTTO(I3;0,3)));1)

	A	B	C	D	E	F	G	H	I	J
1	Place	Year	Title	Keywords	Abstract	style T	style K+A	pattern T	Pattern K+A	style # papers
2	YEAR 1999				TOTAL					3
3	WICSA	1999		Design rec		0	1	0	1	0,8
4	WICSA	1999				1	1	0	0	0,8
5	WICSA	1999				0	0	0	0	0
6	WICSA	1999				1	1	0	1	1

If Title contains the keyword, paper highly ranked with respect to the keyword

If Keyword/abstract contains the keyword, …

If synonym contains the keyword, …

SUM

Max (0*0,8);(0*0,5)

Max (1*0,8);(1*0,5)

Tests

This approximation formula has been tested on:

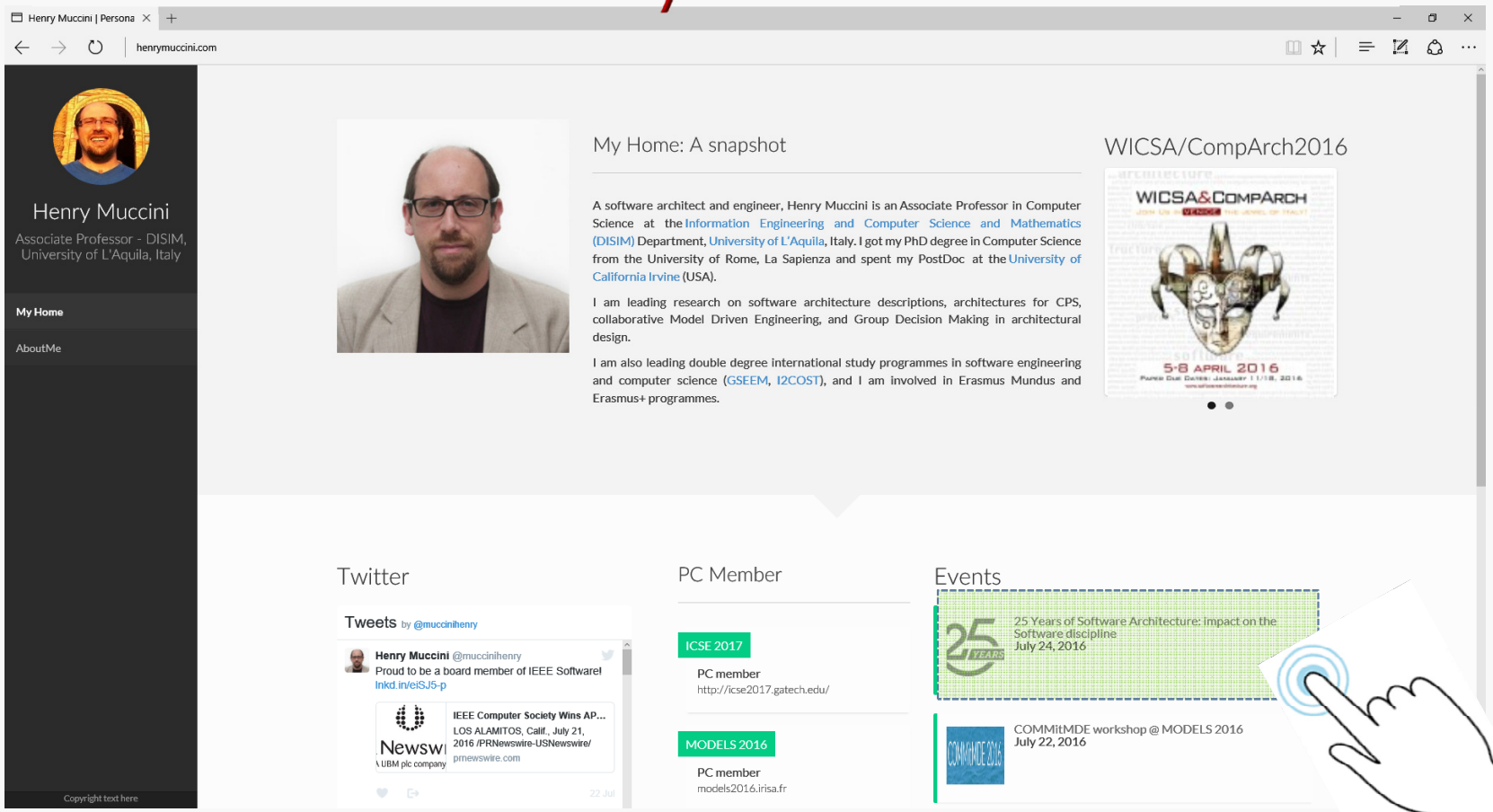
- 50 papers
- Two topics:
  - Ecosystems
  - Design Decisions

Disclaimer…

The results presented here are preliminary and partial, with respect to the…

25 Years of Software Architecture: impact on the Software discipline

Want to know more about this work? Leave a comment at www.henrymuccini.com



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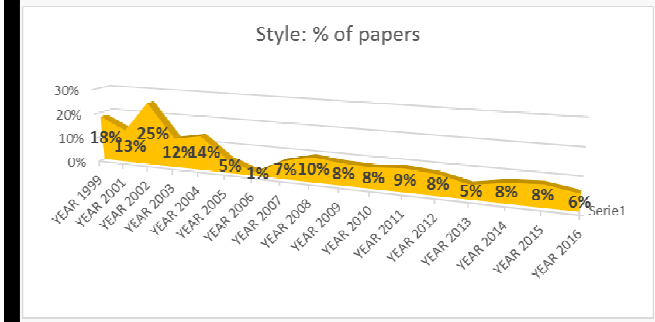
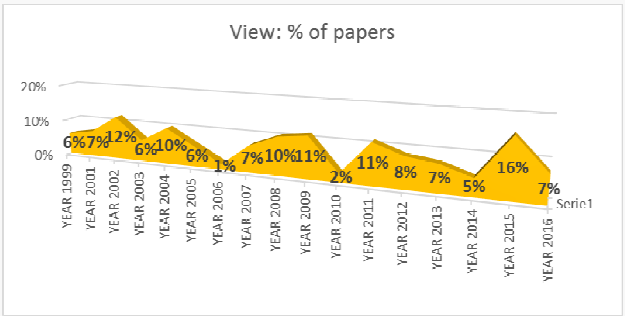
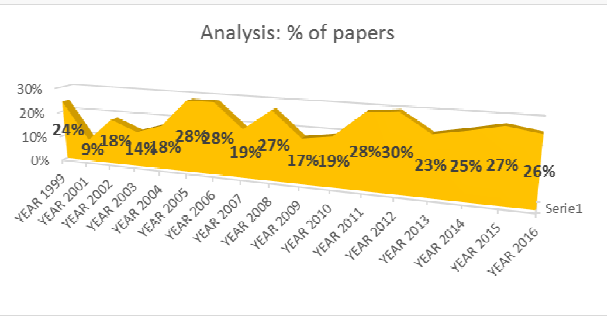
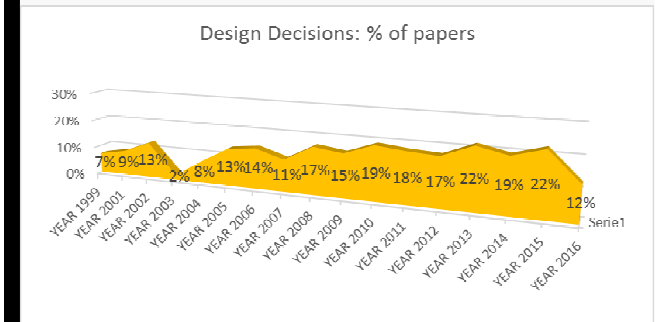
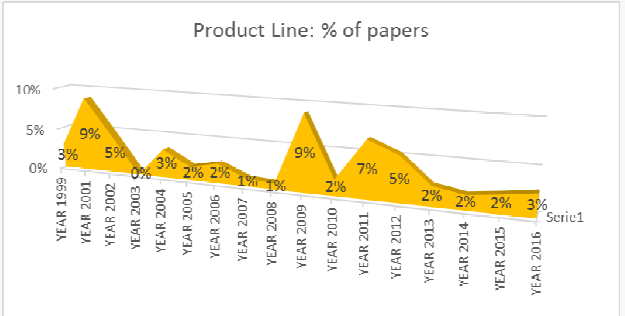
3 Results and Reasoning

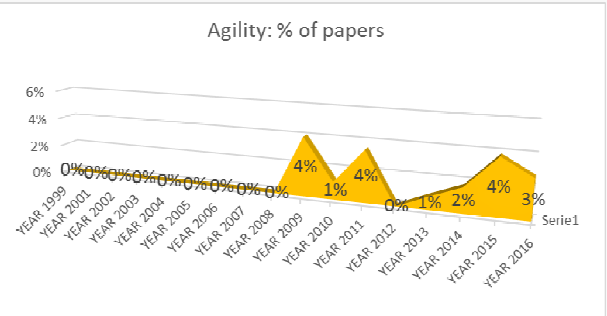


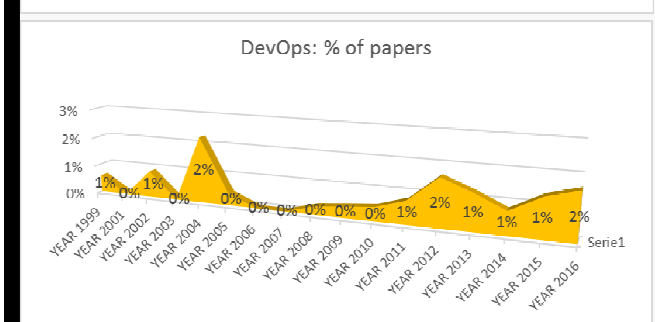


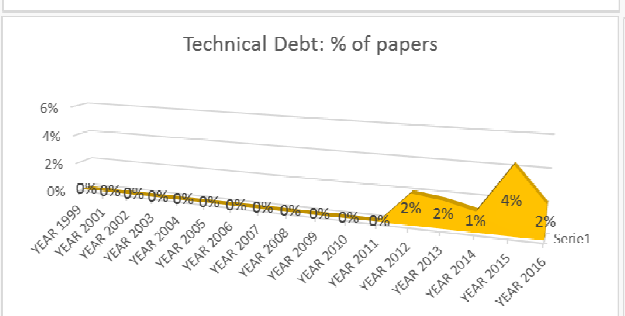


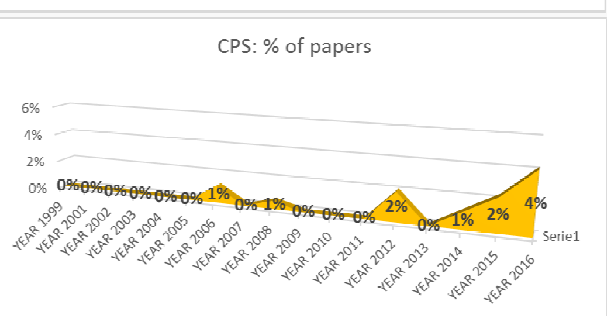












Disclaimer

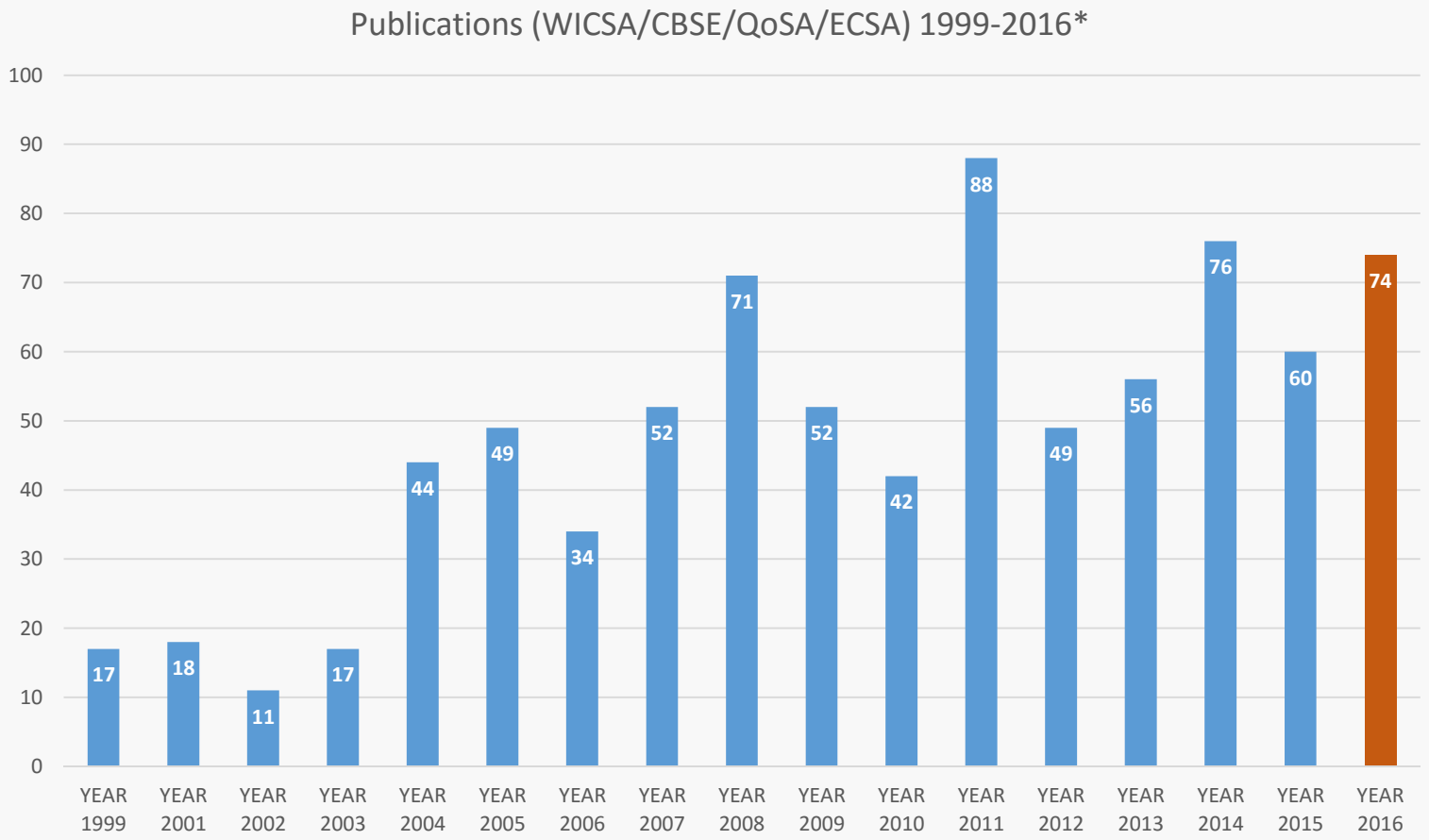
Topics Granularity (look at the trend!)

«Only» four (domain-specific) conferences

2016 is incomplete! (ECSA 2016 missing)

OVERALL VIEW ON RESULTS

Overall View on Results: # of publications per year



Overall View on Results: Most published topics ?

Quality

Risks

Views

Assessment

Analysis

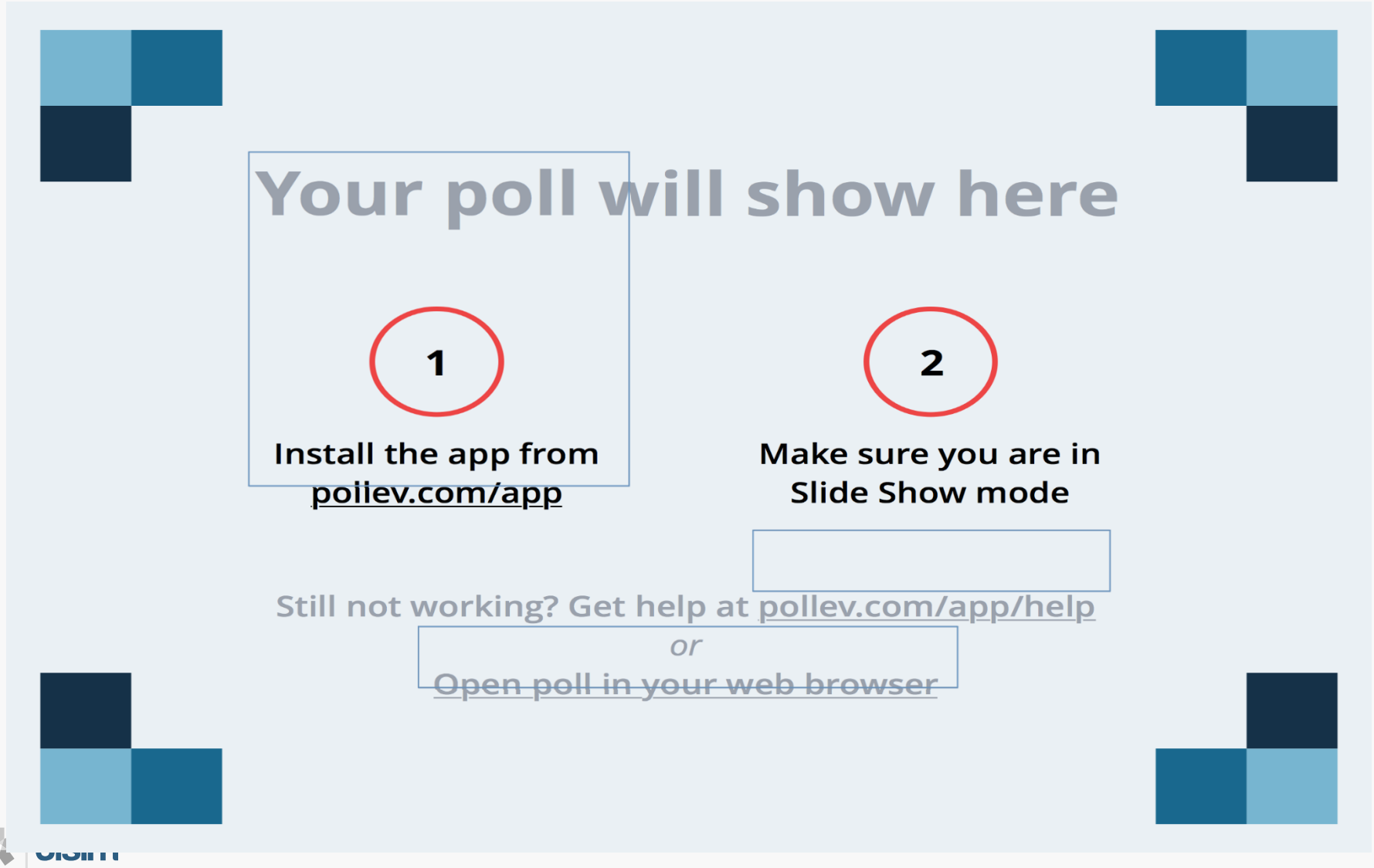
Style

Product Line Architecture

Architecture Description Languages

Design Decisions

Vote at: goo.gl/Gje2zE

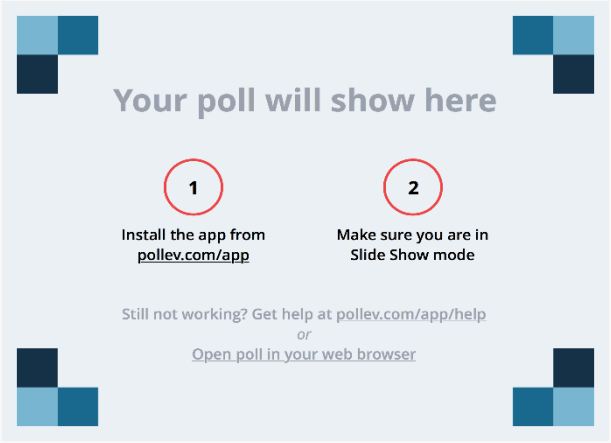


Overall View on Results: Most published topics (1/3)

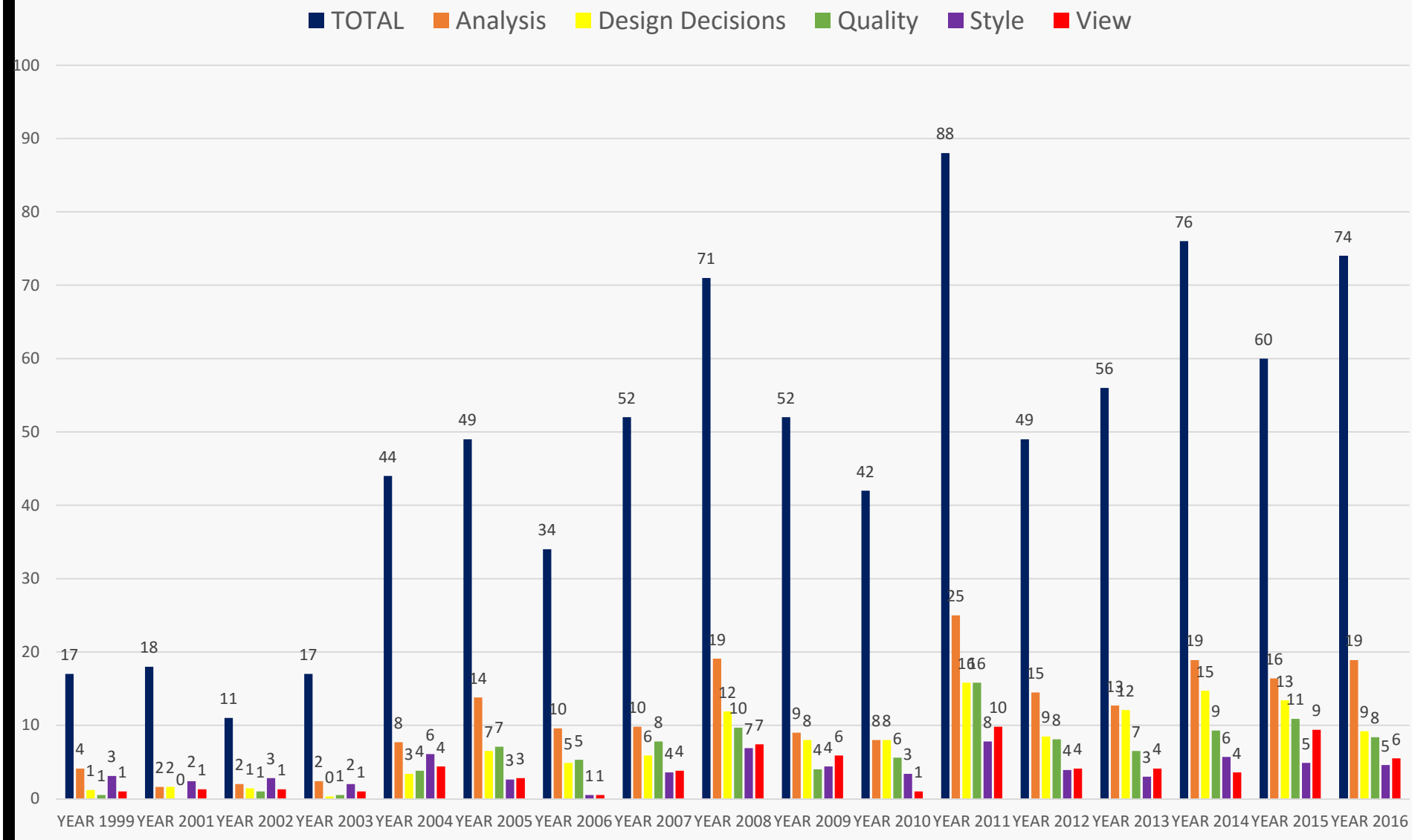
Top five:

1. Analysis (194)
   - Performance (96)
   - Security (27)
   - Consistency (24)
2. Design Decisions (127)
3. Quality (104)
4. Style (68)
5. Views (67)

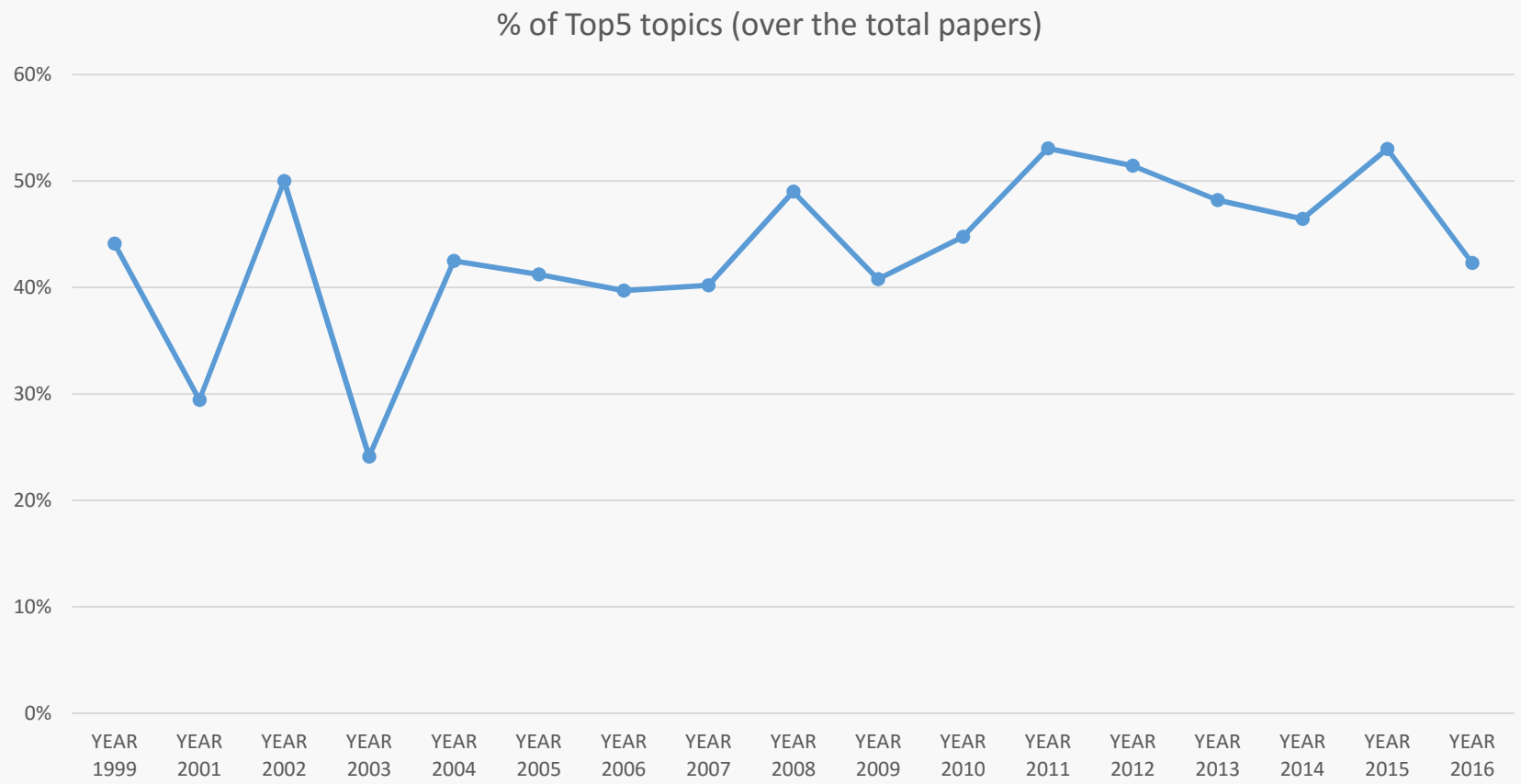
(TOT=811 papers)



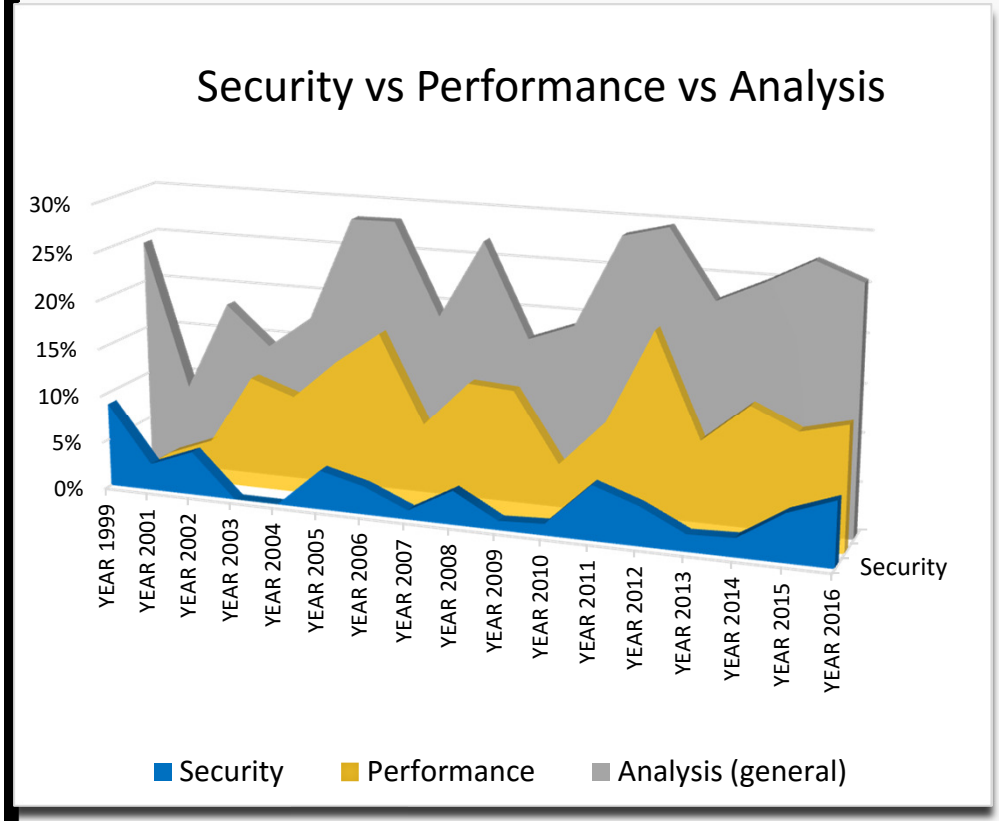
of papers on a topic

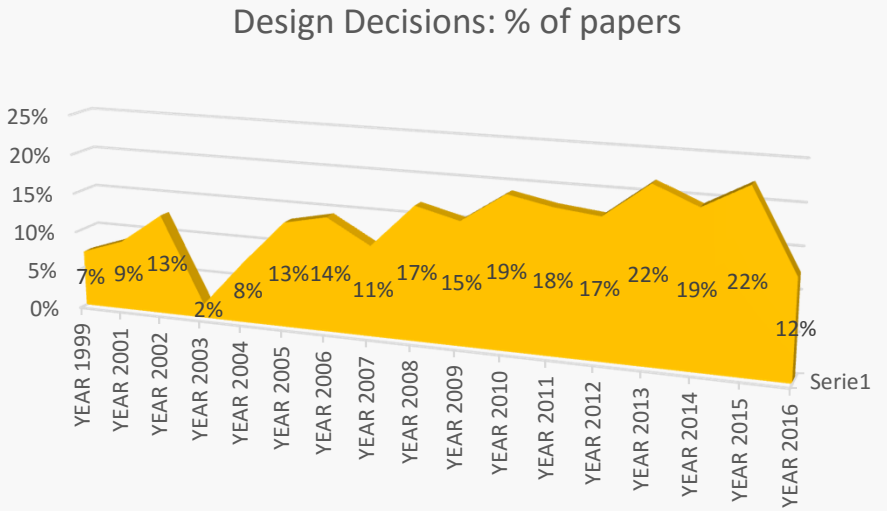


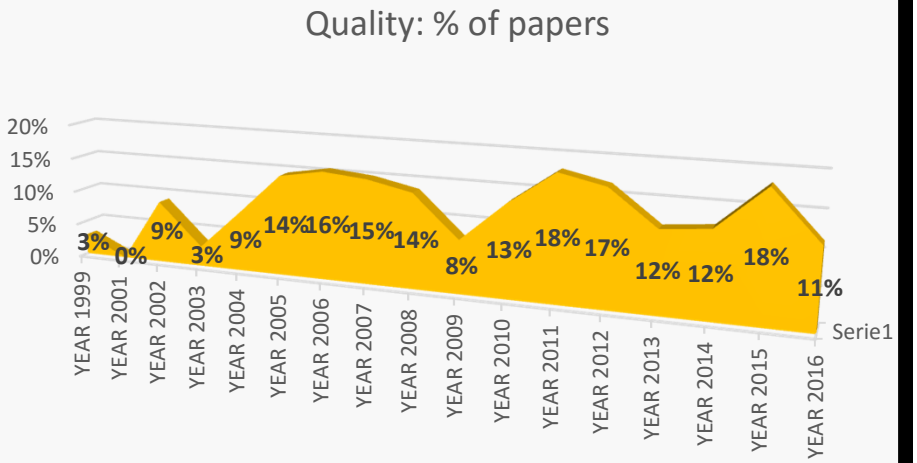
of papers on Top5 topics (without repetition)



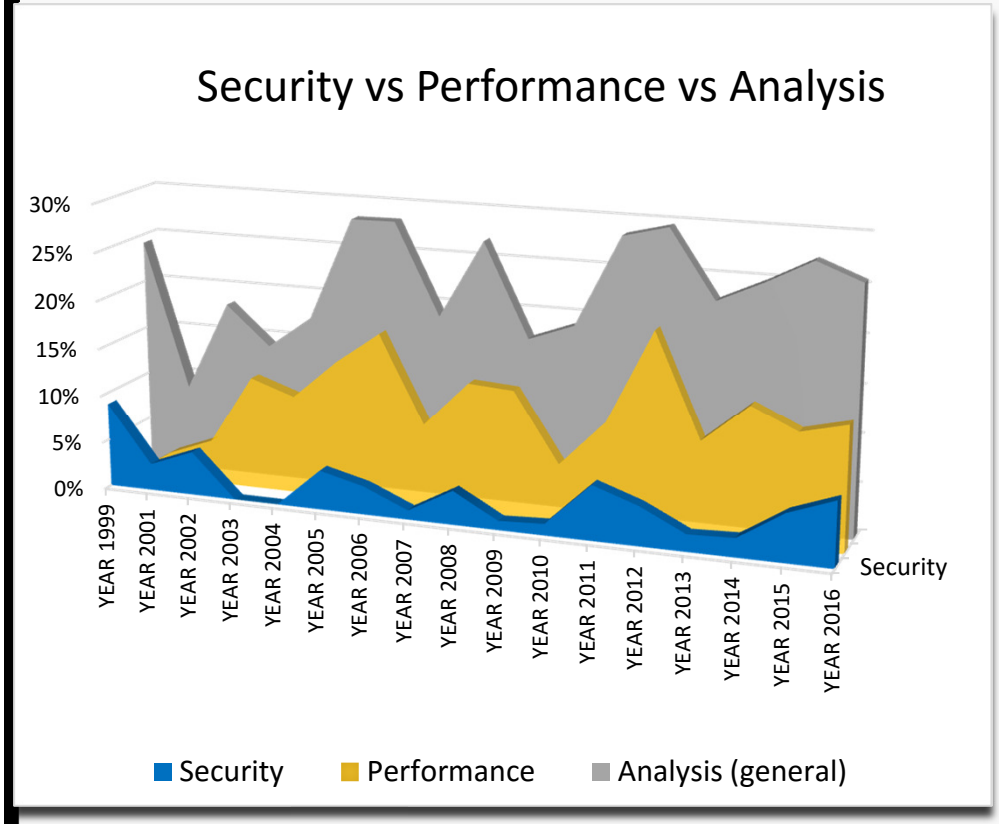
Overall View on Results: Most published topics (2/3)

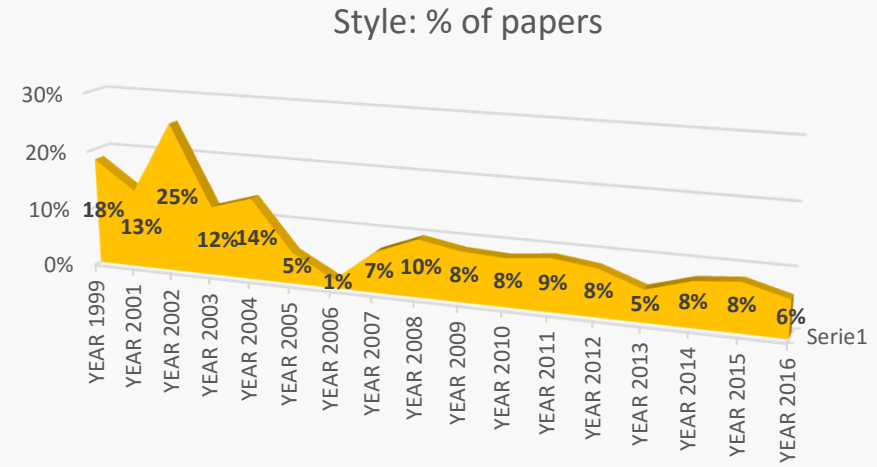


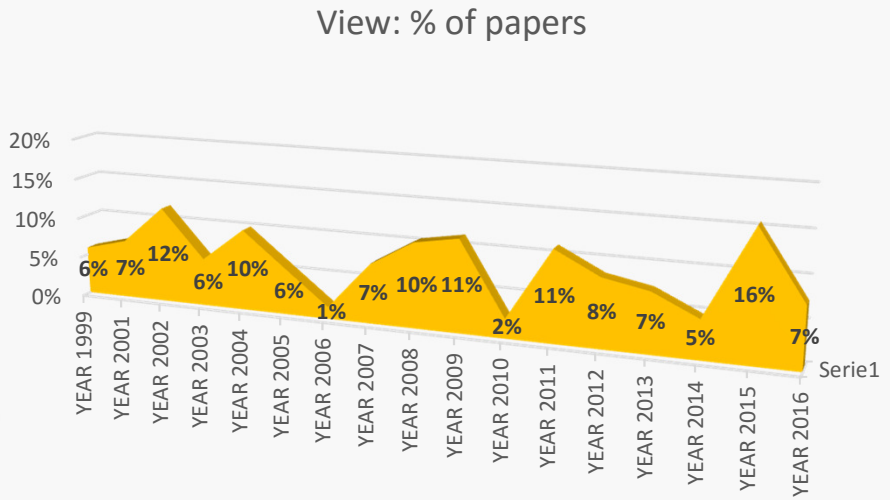




Overall View on Results: Most published topics (3/3)

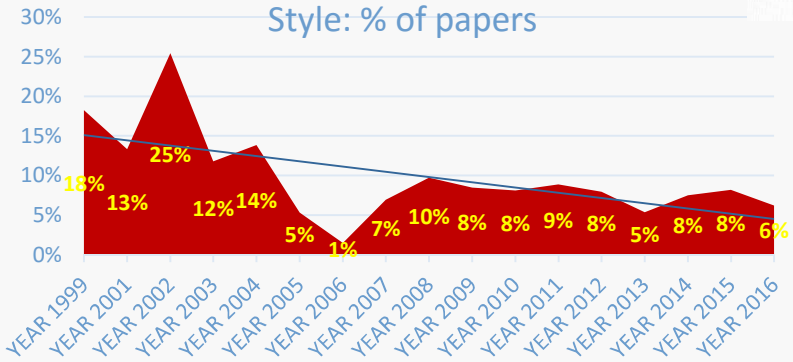


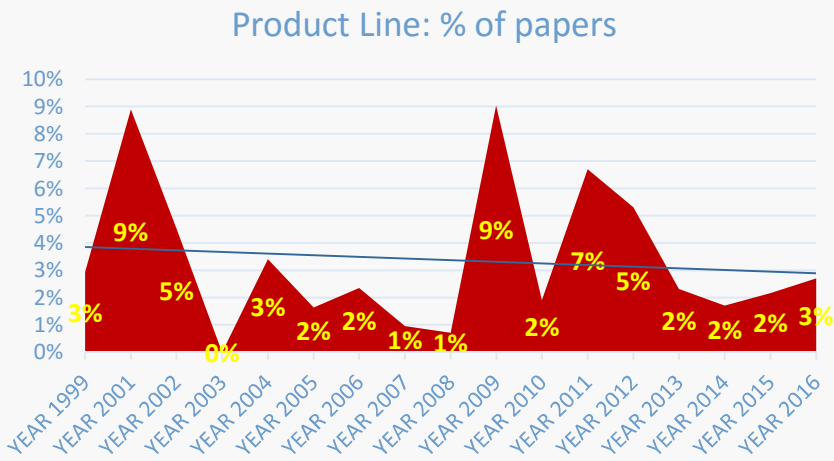


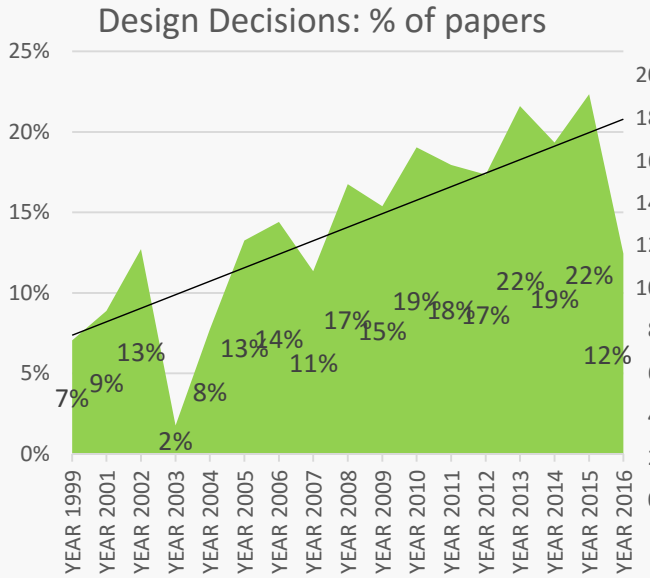


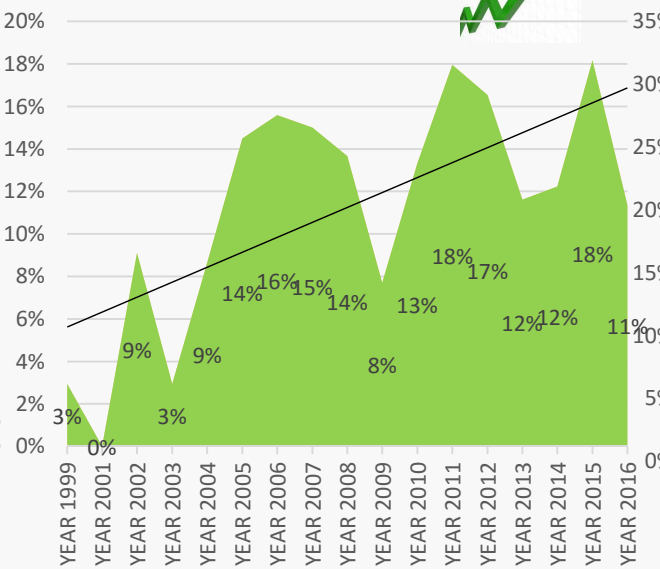
TRENDS

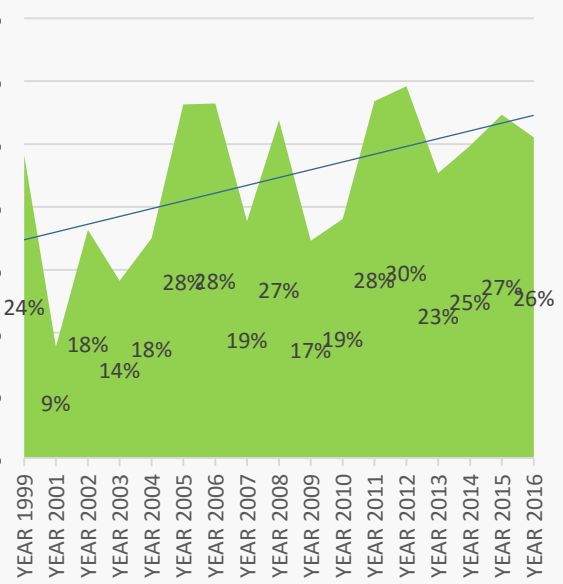
Overall View on Results: Trends 1999-2016 (down-up)



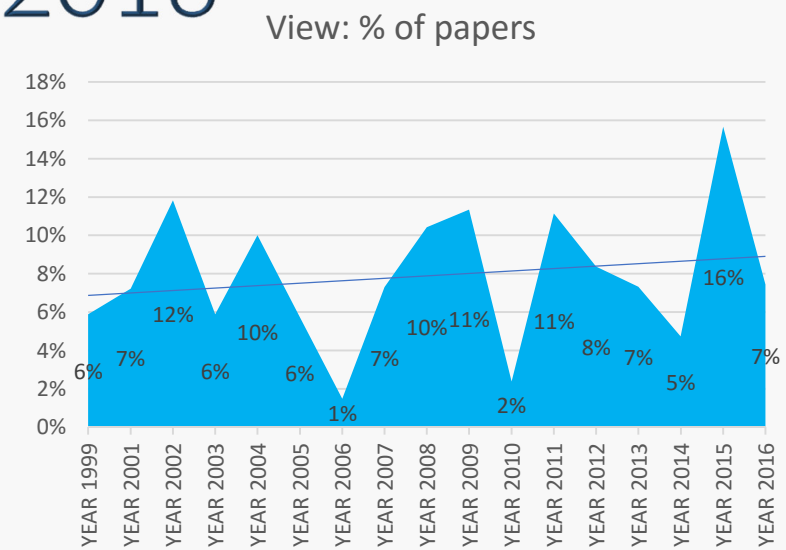


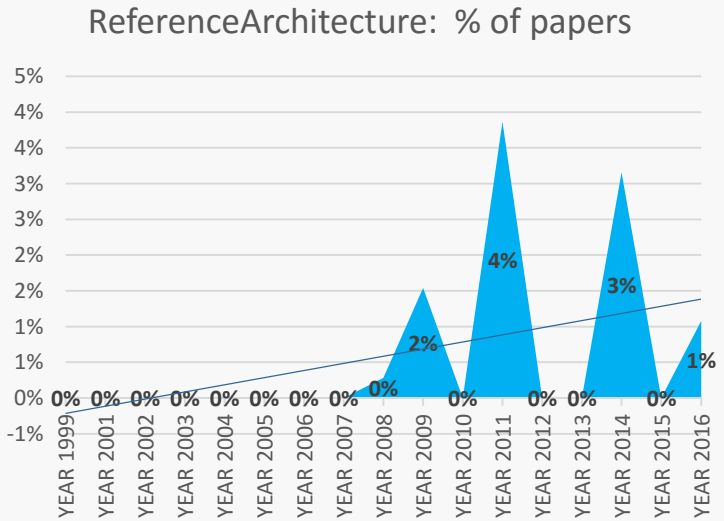




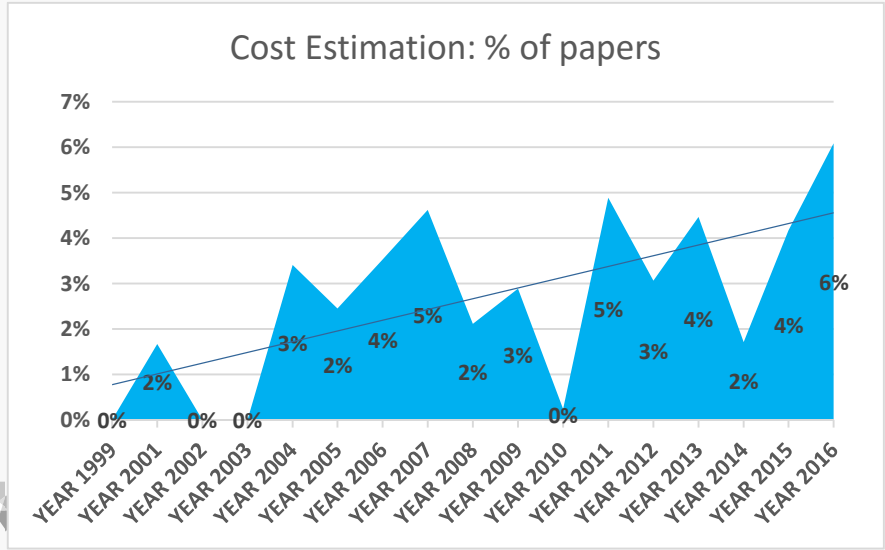


Overall View on Results: Trends 1999-2016





Reference Architecture
{much less than expected}

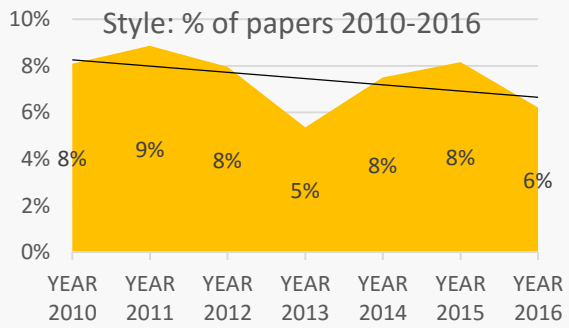


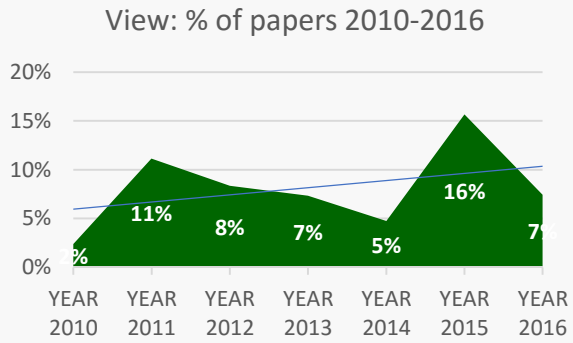
Cost estimation
{pick 6% in 2016}

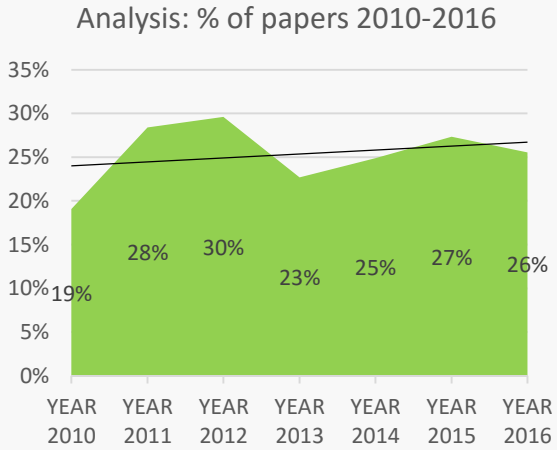
Overall View on Results: Trends 1999-2016 (emerging)

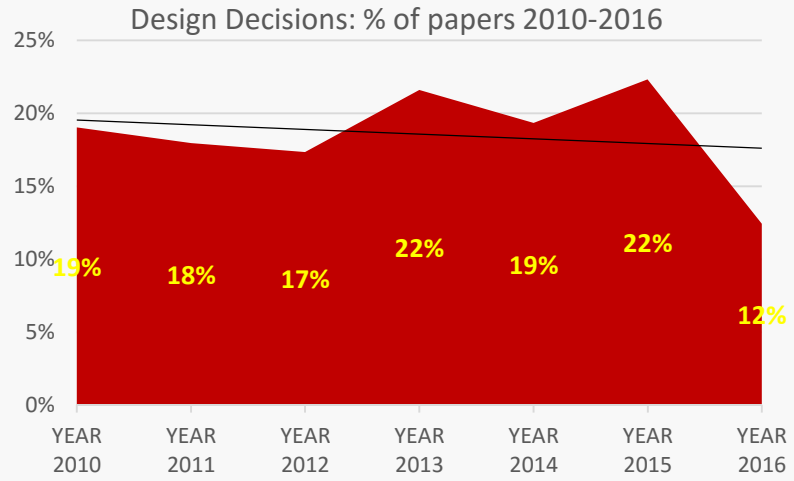
- Agile [0% -> 3%] {emerging since 2009}
- DevOps [0,5% -2%] {emerging since 2011}
- Tech Debt [0% - 2%] {emerging since 2012}
- CPS [0% - 2%] {emerging since 2012} (pick 4% in 2016)
- Ecosystems [0% -2%] {emerging since 2012} (pick 5% in 2016)
- Risk [0% -> 3%] (non null since 2005)

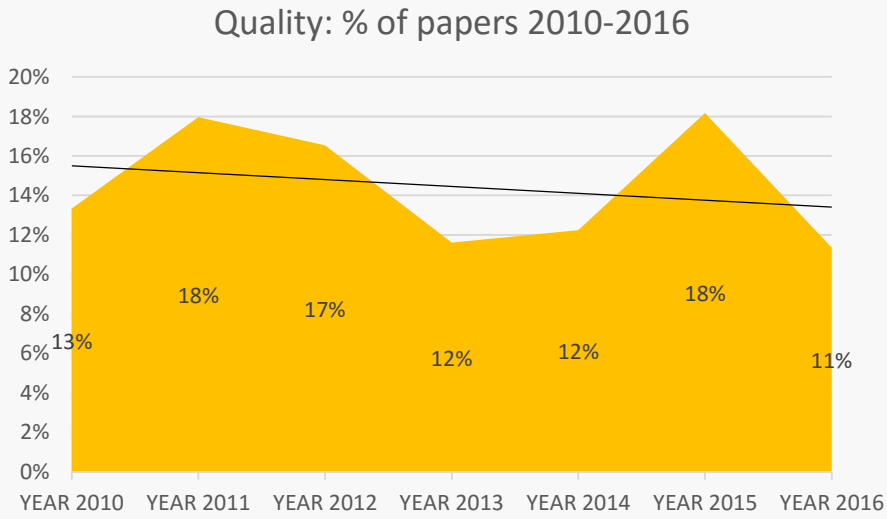
Overall View on Results: Trends 2010-2016





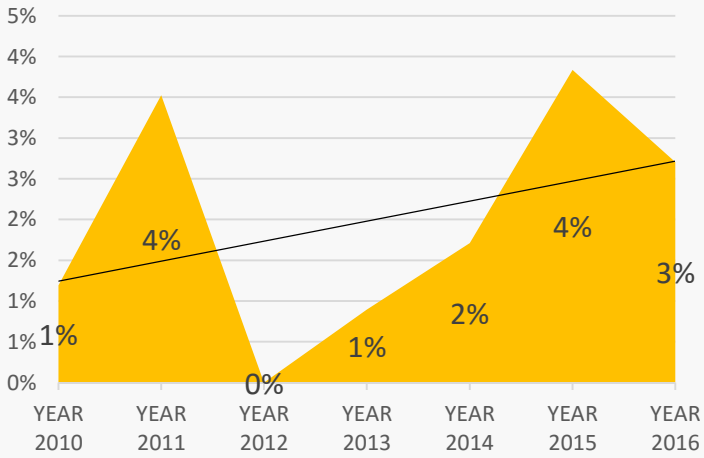




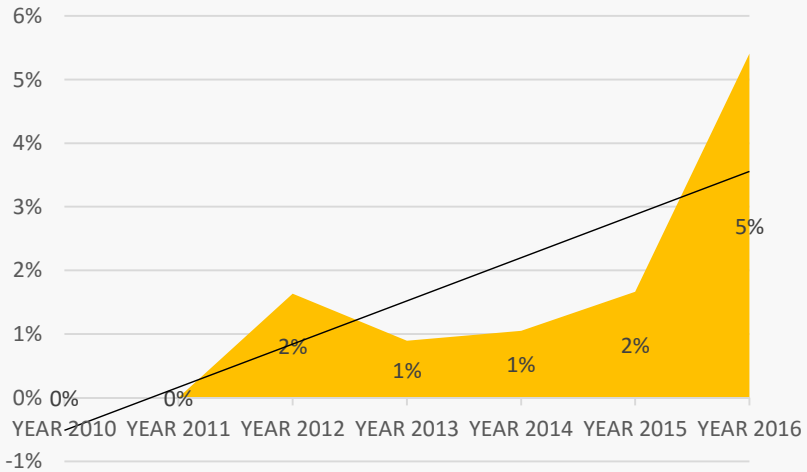


Overall View on Results: Trends 2010-2016 (emerging)

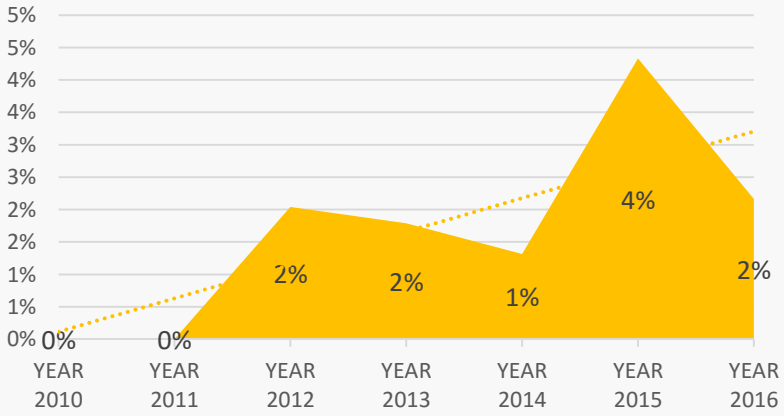
Agility: % of papers 2010-2016



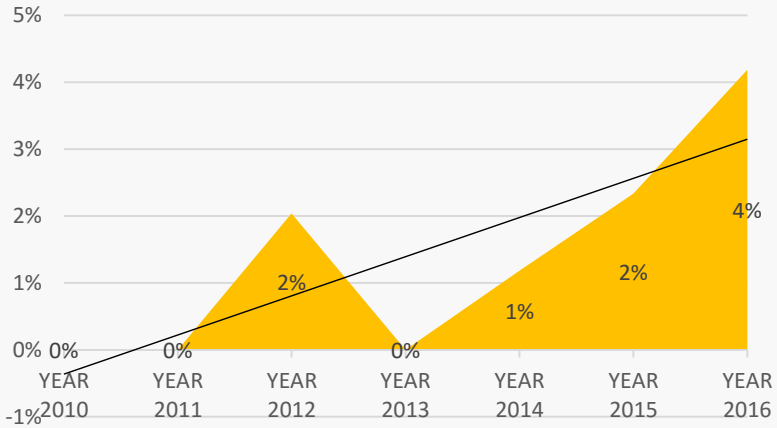
EcoSys: % of papers 2010-2016



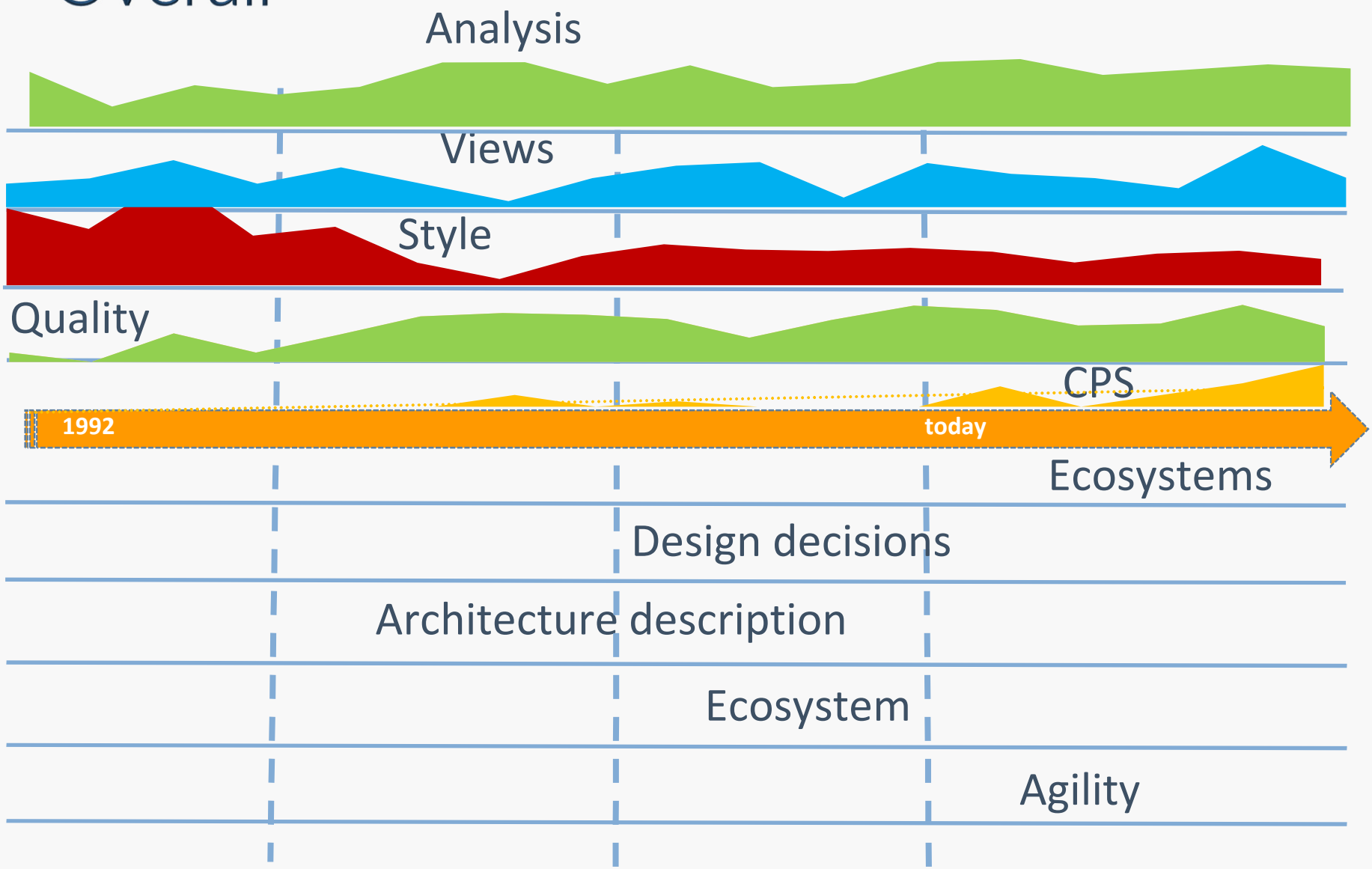
Technical Debt: % of papers 2010-2016



CPS: % of papers 2010-2016



Overall


Analysis
Views
Style
Quality
CPS
1992
today
Ecosystems
Design decisions
Architecture description
Ecosystem
Agility

? How the Software Architecture field evolved over time?

1

REFLECTIONS

looking at the near future from the past

Where we are today...

application domains: CPS, IoT, Smart mobile systems

type of (concern): Self-Adaptive, autonomous, dynamic, uncertain

process: DevOps & Agile

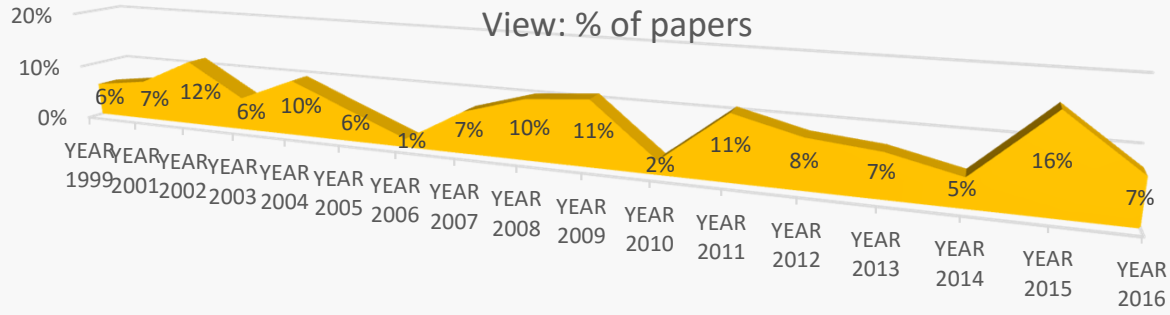
style: micro services

analysis: security, resilience

description: collaborative, MDE, decisions

Reflections

- Multi-View boom: trends and issues
- Practitioners' need for SA-based Analysis
- It is time to «collaborate»!
- CPS, IoT, Smart Systems: again from Software to System
- From dependable to resilient systems in the era of self-Adaptive and Autonomous architectures



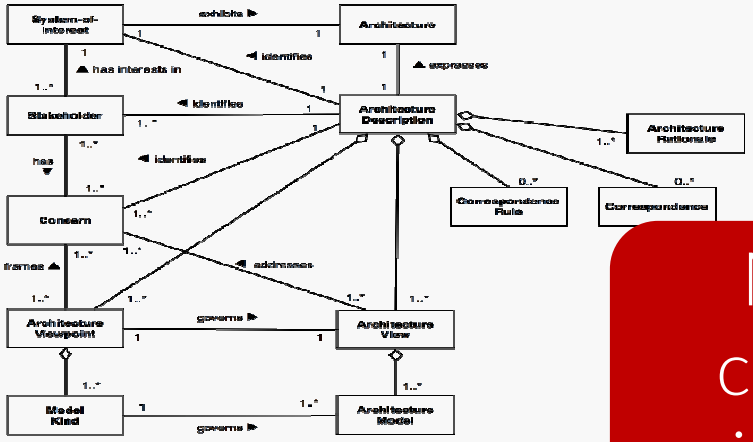
Multi-View Boom!

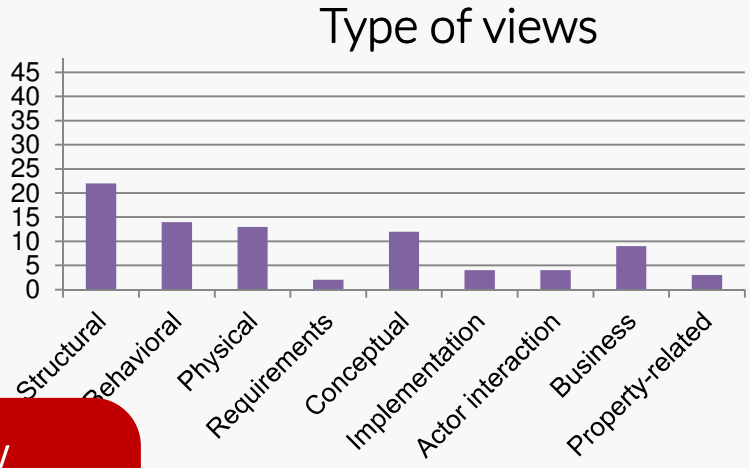
An industrial practice, being consolidated over 15 years!

But still…

Multi-View & Multi-stakeholder

IEEE Std 1471 (2000) ->
ISO/IEC/IEEE 42010:2011



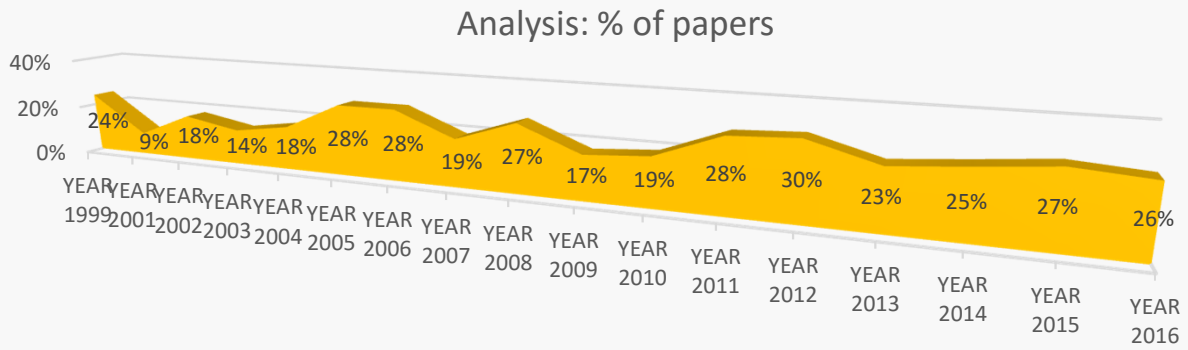


Multi-view consistency: missing feature

Using multiple views has become standard practice in industry!! [TSE2013]

- 85% uses multiple views

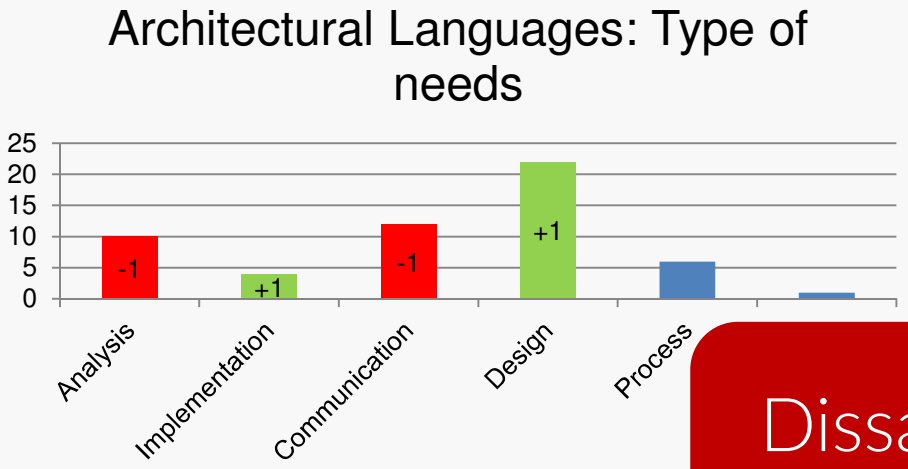
	Useful in past projects							Useful for future projects						
	-2	-1	0	+1	+2	No exp.	Blank	-2	-1	0	+1	+2	Don't know	Blank
Support for multiple architectural views	2	2	4	11	18	2	9	1	0	4	5	27	1	10



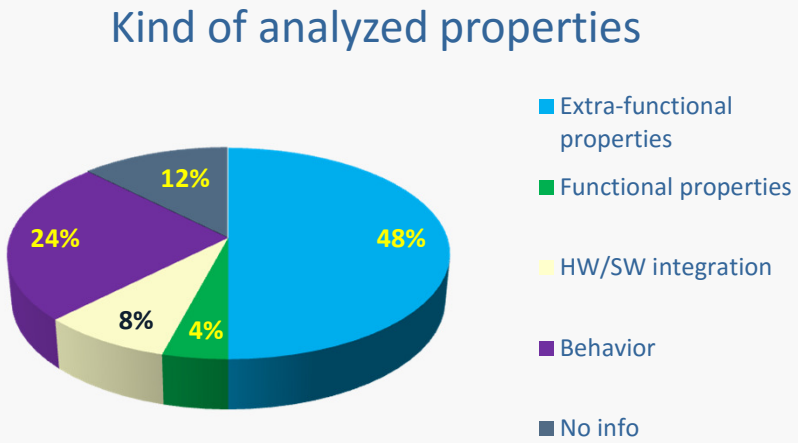
Practitioners' need for SA-based Analysis

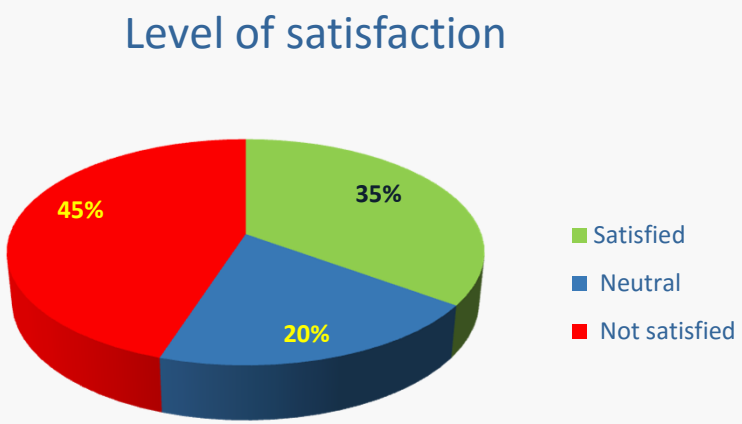
Analysis is a big need… and practiced… but practitioners are quite unhappy!

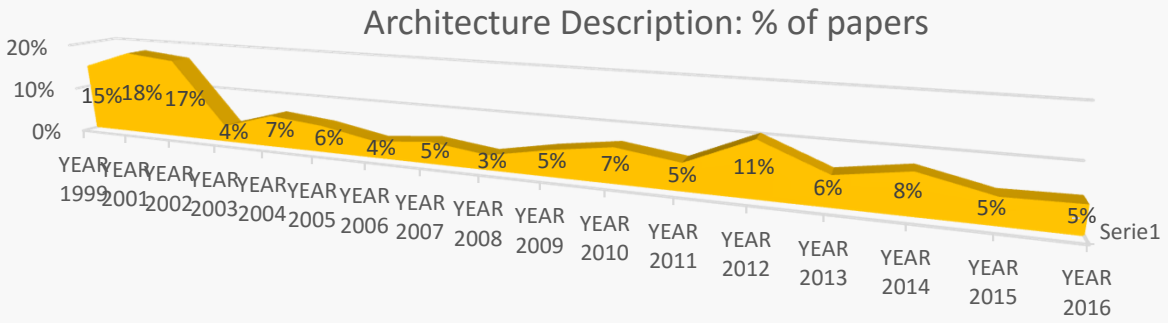
Practitioners' needs for Analysis [TSE2013]



Dissatisfaction with ALs



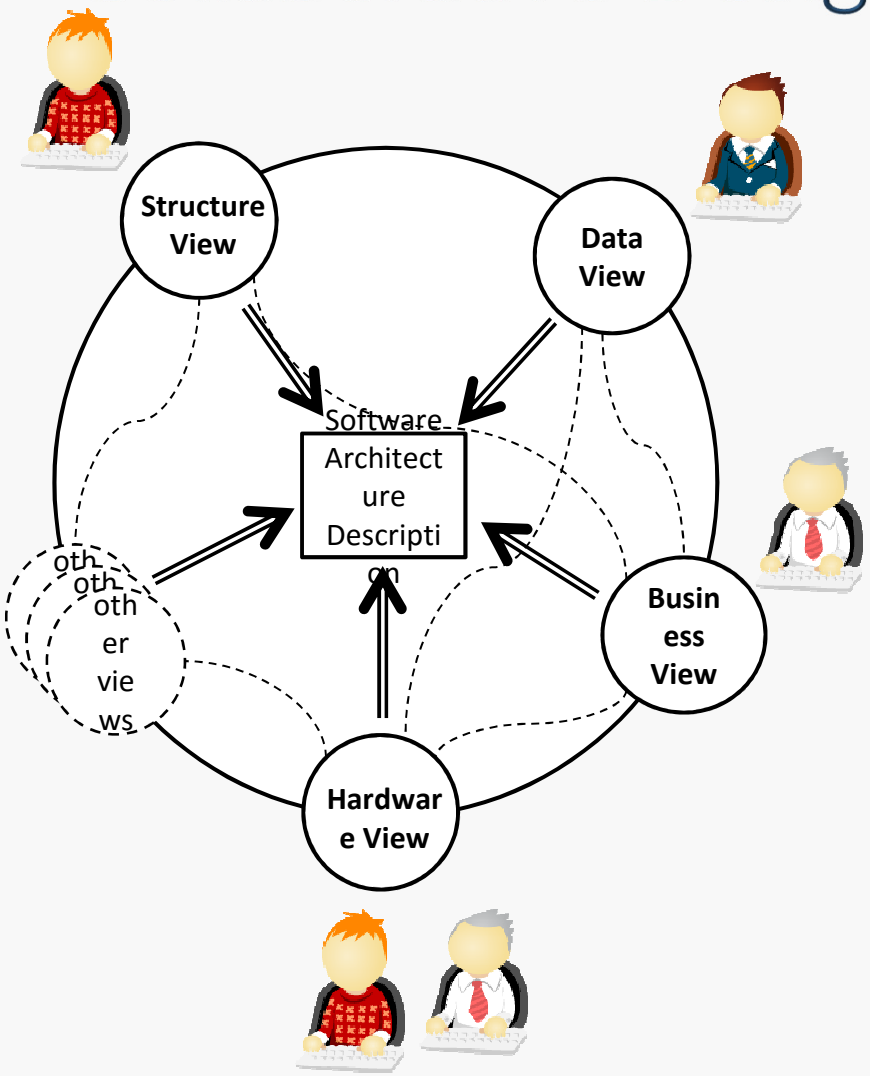




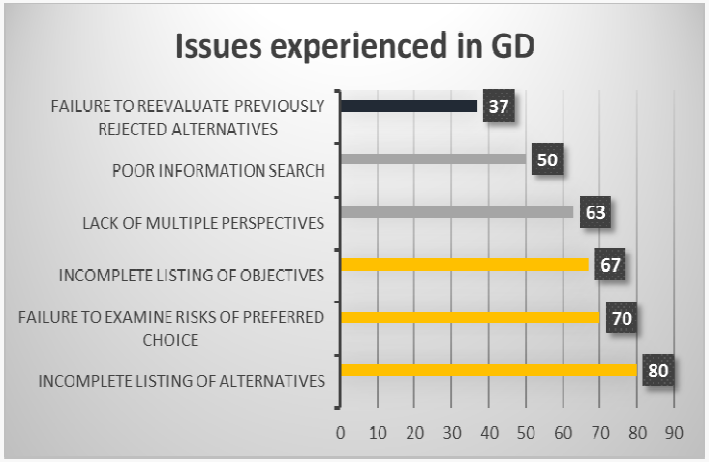
It is time to «collaborate»!

Architecting = Group Decision Making and Collaborative Architectural Design

Collaborative Design

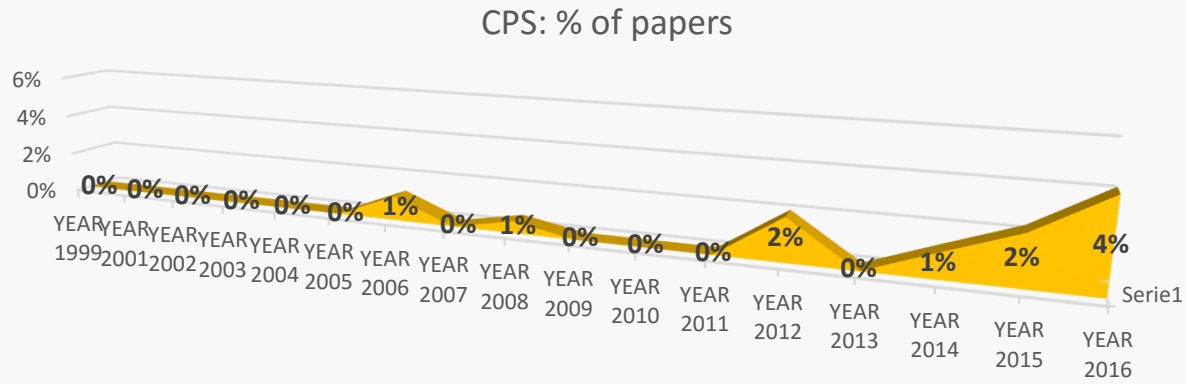


- 5-10 people involved in decision making
  - 21 different macro-roles represented [WICSA2014]



Need:

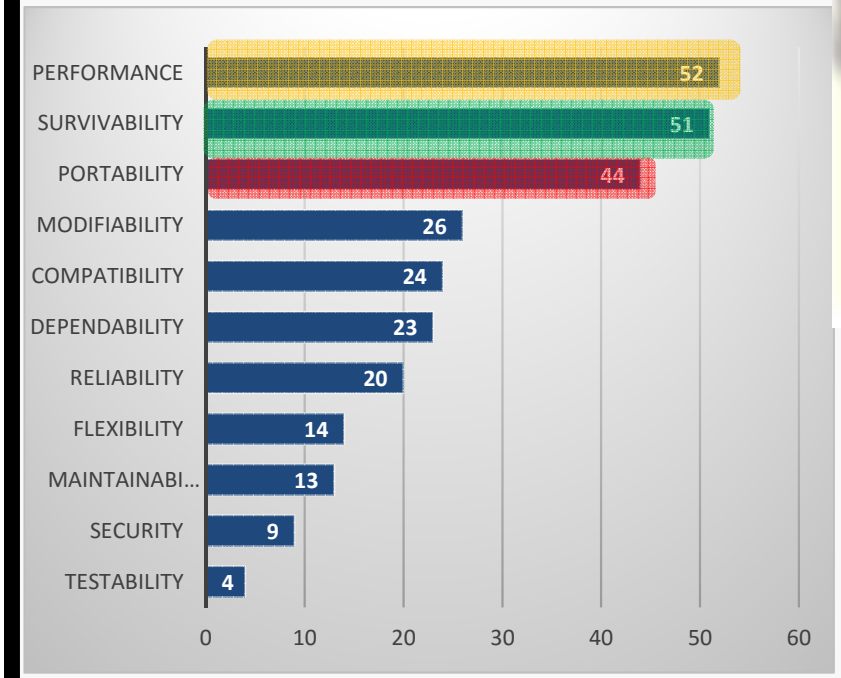
- Collaborative (group) decision making
- Collaborative Design



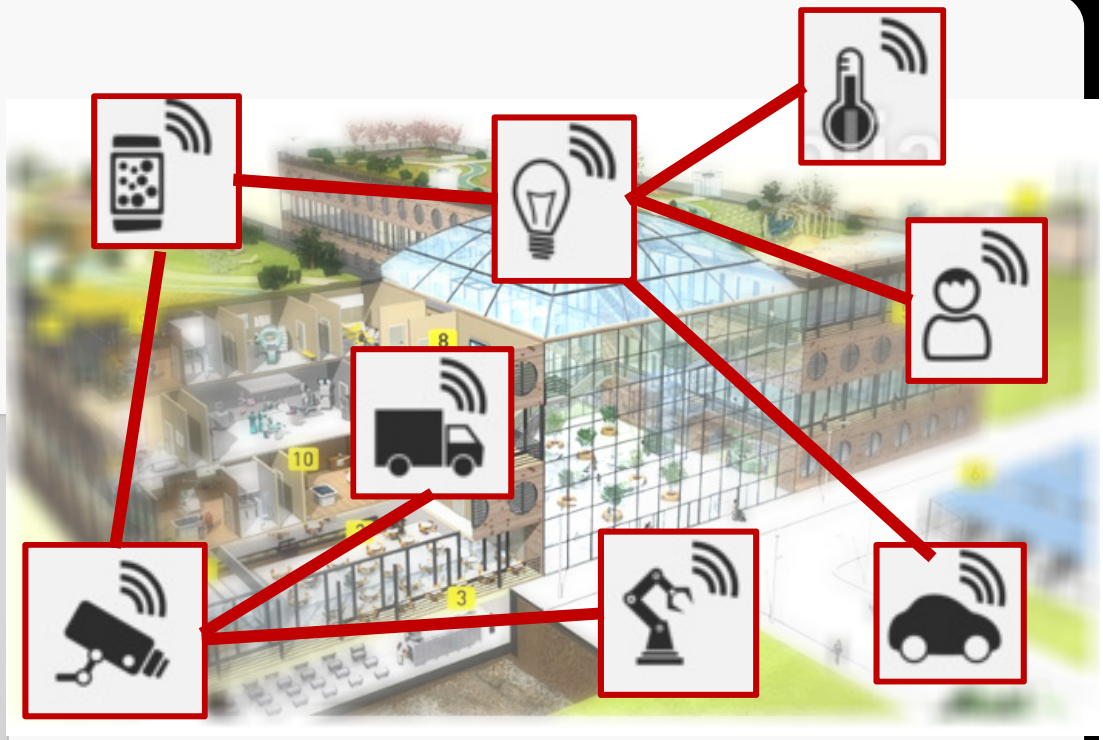
CPS, IoT, Smart Systems: From Software to System Architecture

New views, new challenges

CPS, IoT, SmartS

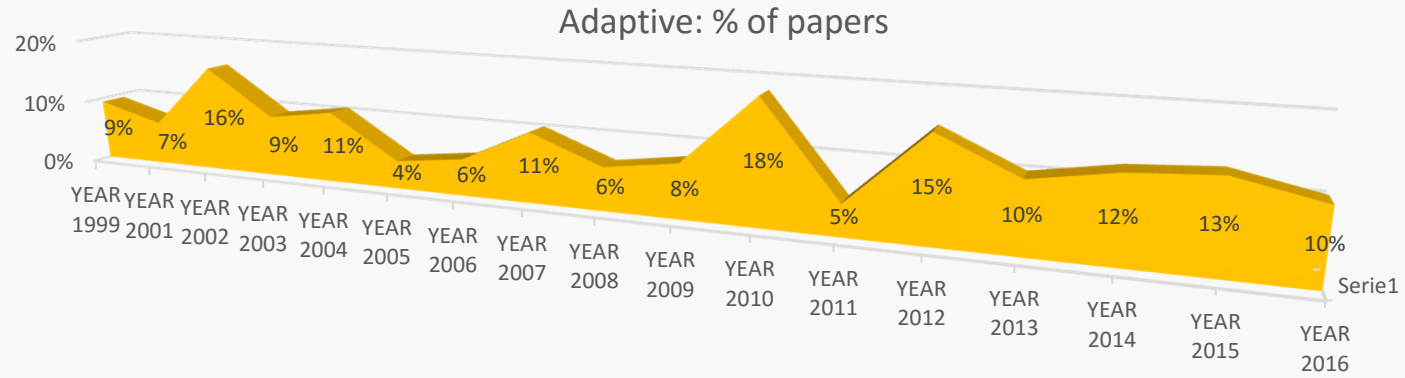


[SANCS2015]



Need:

- Sensors and Actuators
- New Modelling Languages
- Control theory
- Physical components



From dependable to resilient systems in the era of self-Adaptive and Autonomous architectures

Self-Adaptive applications shall self-fix themselves?

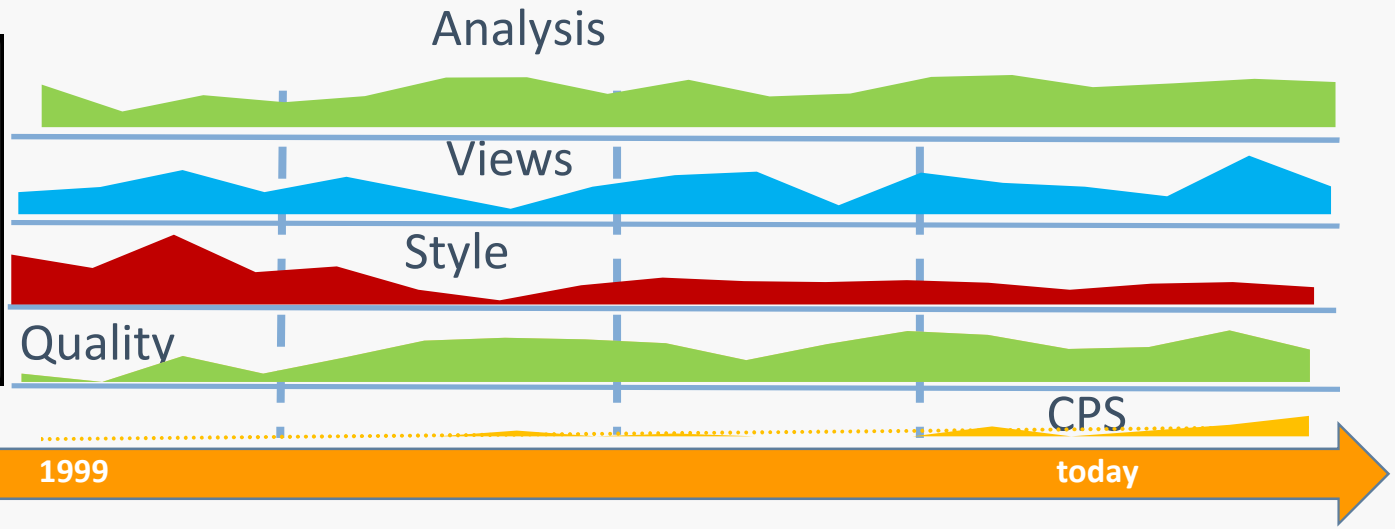
Concluding

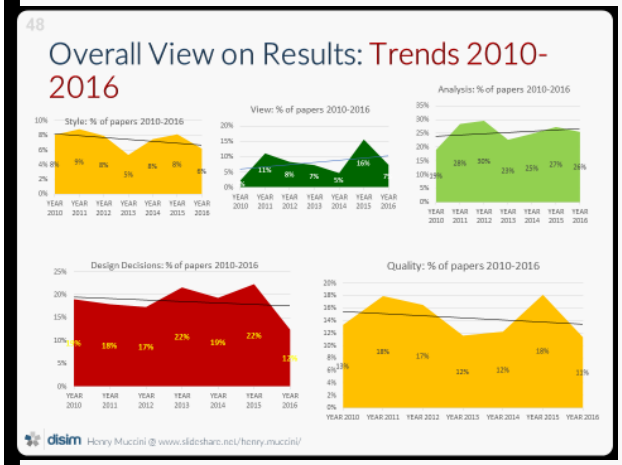
2 Data mining... in numbers

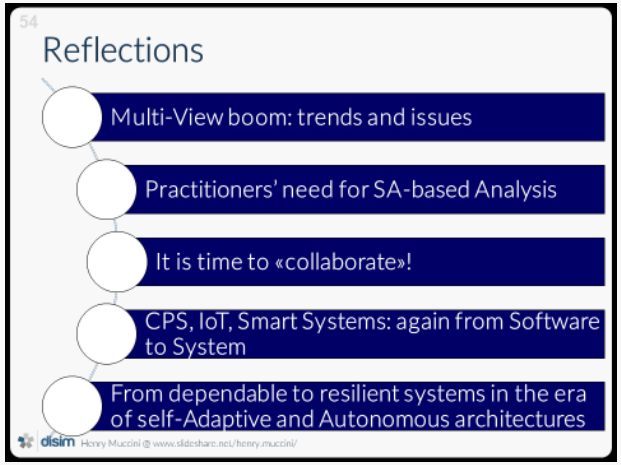
What: 4 conferences, 42 editions, 1999-2016, 811 articles analysed

How: topics search

- Search of topics and synonyms in
  - Title
  - Keyword
  - Abstract

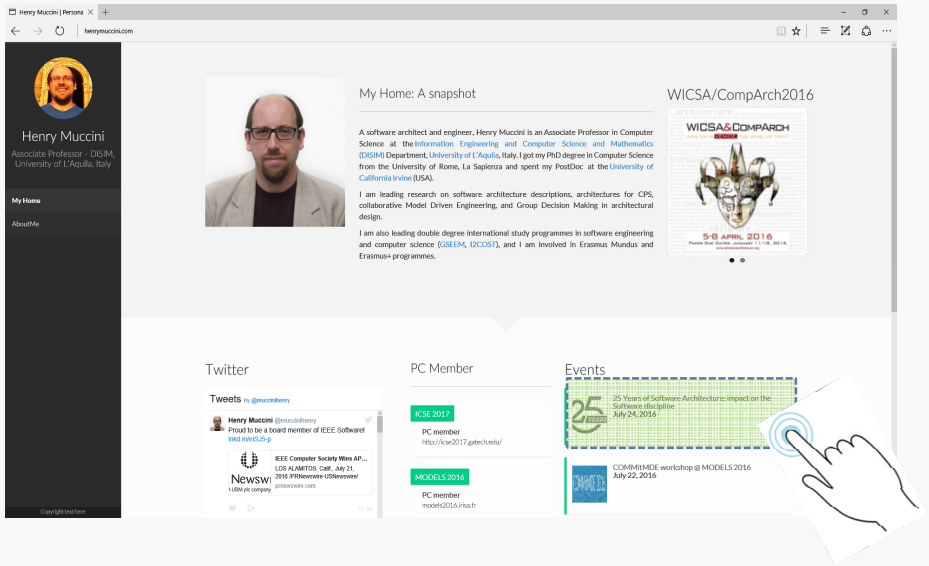




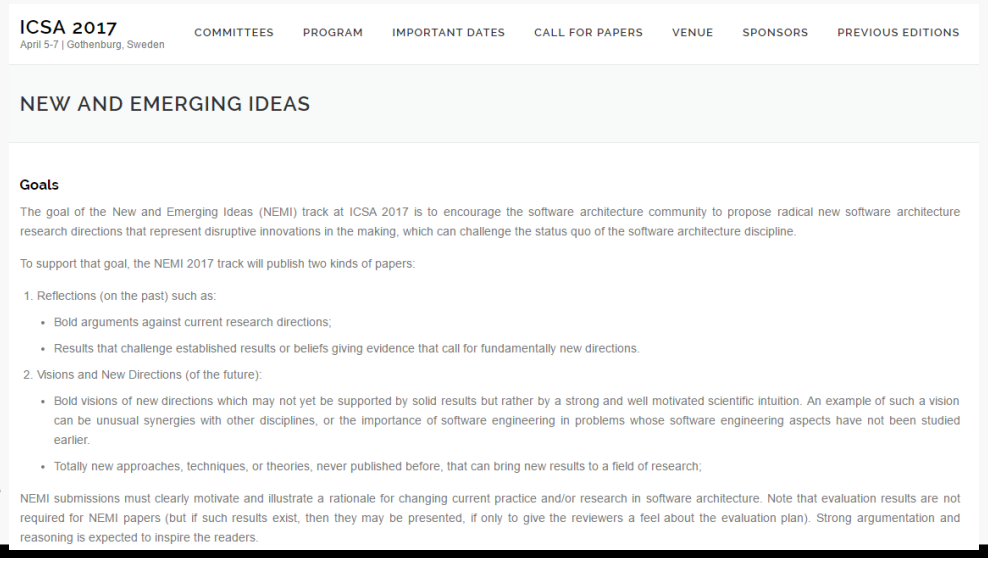


Keep in touch...

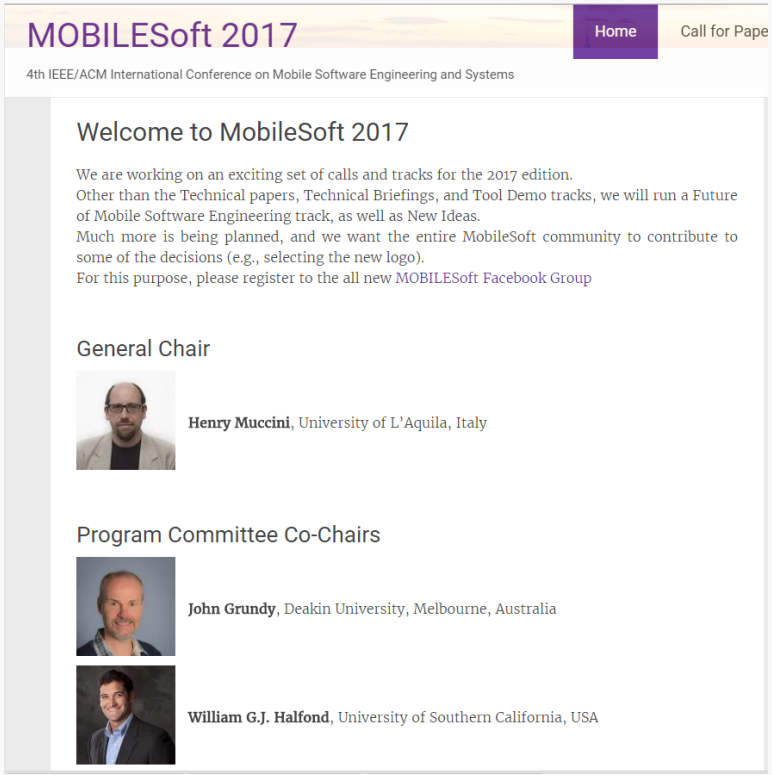
www.henrymuccini.com



www.softwarearchitecture.org



http://mobilesoftconf.org/2017/



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[WICSA2014] V. Smrithi Rekha, Henry Muccini: A Study on Group Decision-Making in Software Architecture. WICSA 2014: 185-194

[TSE2013] Ivano Malavolta, Patricia Lago, Henry Muccini, Patrizio Pelliccione, Antony Tang: What Industry Needs from Architectural Languages: A Survey. IEEE Trans. Software Eng. 39(6): 869-891 (2013)

[SANC2015] Ivano Malavolta, Henry Muccini, Mohammad Sharaf: A Preliminary Study on Architecting Cyber-Physical Systems. ECSA Workshops 2015: 20:1-20:6

Exploring the Temporal Aspects of Software Architecture

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disim

Keynote at ICSOFT 2016