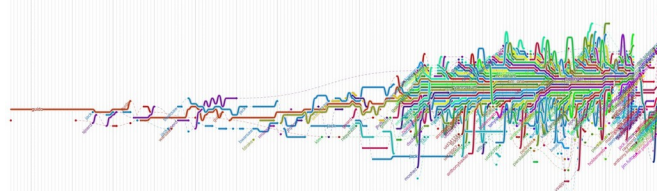


<https://www.alphagomovie.com/gallery>



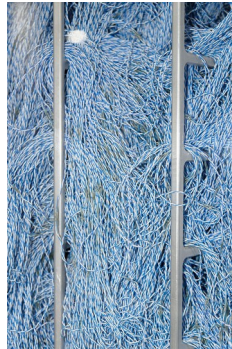
<https://hackernoon.com/complex-adaptive-systems-and-the-future-of-app-development-2bb0288f05e0>



<https://www.zdnet.com/article/cloud-computing-will-virtually-replace-traditional-data-centers-within-three-years/>

Are software systems complex or rather just complicated? And does it matter?

Jan Žižka, M.Sc.
Technical lead at Nokia
DMTS, Nokia Bell Labs



<https://en.wikipedia.org/wiki/Cray-1>



<https://www.mflbisonranch.com/copy-of-brittle-vs-non-brittle-envi>



<https://alexdimiceli.medium.com/complex-or-complicated-41b2937ed01b>

Agenda

- Introduce Jan to Lasaris
- Software systems
- Definitions of complex and complicated
- What is the difference and does it matter?
- Why to research complex software systems



<https://dailytravelpill.com/transfagarasan-highway-romania/>



Jan Žižka



- Born 1976, programming since 1989
- M.Sc. From Aalto university in Finland, Automation technology and robotics
- Researcher 2000-2005 in Workpartner project
- Working at Nokia since 1999 on mobile networks
- Distinguished Member of Technical Staff at Nokia Bell Labs
- HW, assembly, C, C++, Python, Go, (Rust), Linux, Cloud
- Married with 3 kids
- Urban skating, pole vaulting



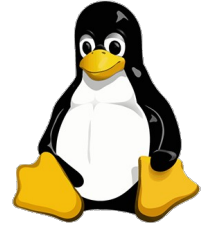
NOKIA



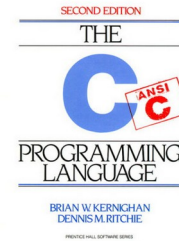


Jan Žižka

- OS and cloud technology development, tools and SW development practices
- FOSS in Cloud products
- Organizer of hackathons and internal SWDev conferences
- Supervised 12 diploma thesis
- Debugging tricky system problems
- Member of architecture and application steering groups
- Directly leading team of 6 very experienced developers
- Still coding on occasions :-)
- Mentoring (coding, unit testing, TDD, CI/CD, SCM)
- PoCs and cooperation with Webscalers (Google, Amazon, Microsoft, IBM, RedHat)
- Some small upstream contributions (binutils and gcc port for DSP56800)
- DevConf.cz 2019 talk on OS maintenance automation



<https://www.redhat.com/en/topics/linux>



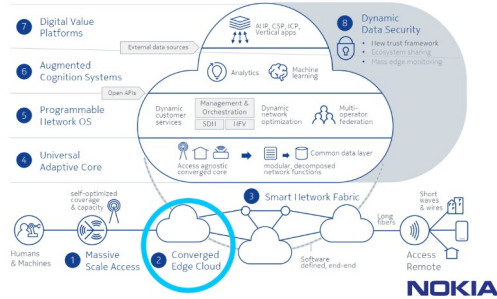
https://commons.wikimedia.org/wiki/File:Kubernetes_logo_without_workmark.svg

<https://img-cloud.megaknihy.cz/5153481-original/a672b5a1384d6818d122311627864185/c-programming-language.jpg>



https://commons.wikimedia.org/wiki/File:Jenkins_logo.svg

Mobile Networks Software systems

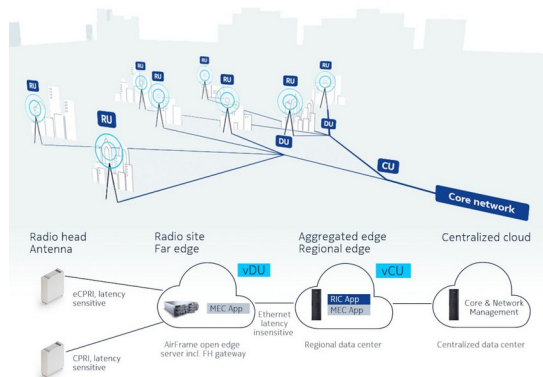


<https://www.nokia.com/networks/data-center/airframe-data-center/>



https://akavinet.com/product_single/product/93/homepage

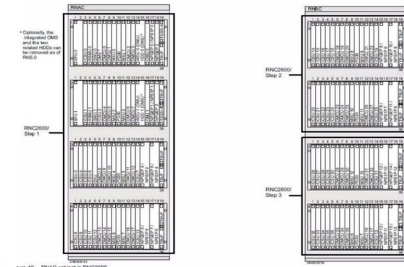
<https://www.ict-nn.com/nokia-and-google-cloud-partner-to-develop-new-cloud-based-5g-radio-solutions/>



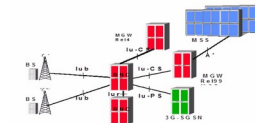
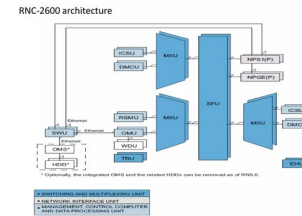
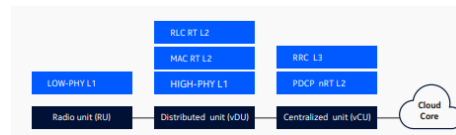
<https://www.nokia.com/blog/tap-into-the-next-big-thing-with-cloud-ran/>



<https://www.cnews.cz/nokia-na-5g-siti-dosahla-rekordni-rychlosti-47-gb-s/>



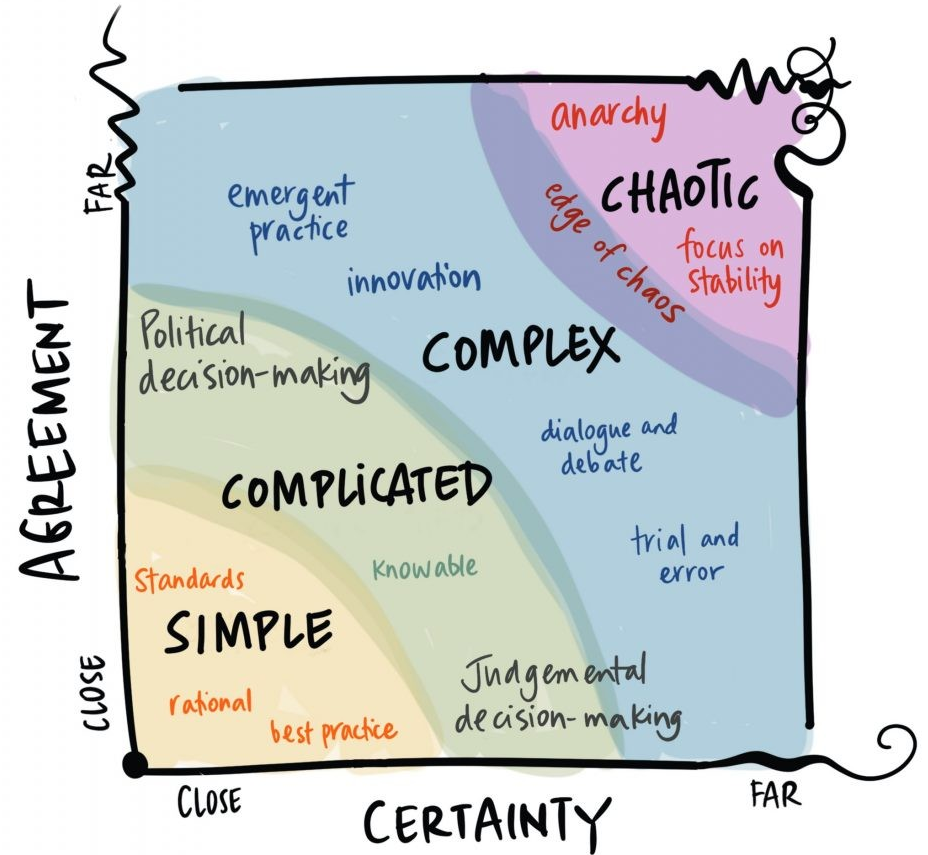
<https://www.slideshare.net/AhmedNabieh/introduction-to-nokia-rnc>



https://onestore.nokia.com/asset/213050?_ga=2.226323226.1064461734.1677924509-2112836381.1631172290

Complex or complicated?

- What is a **complex system**?
- What is **complicated system**?



Stacey Matrix adapted by S. Bradd and D. Finegood

Definition of complex system

“A Whole is Greater Than the Sum of Its Parts” *(maybe) Aristotle*

- Not universally agreed [1]
- Field specific

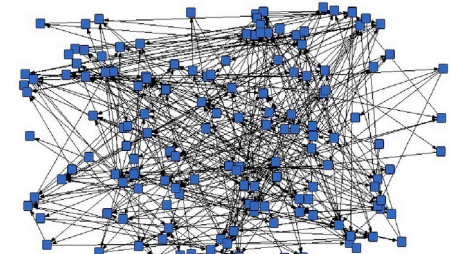
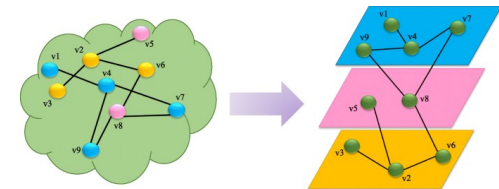


Figure. 4 An software network of C++ software system

<https://www.semanticscholar.org/paper/Using-Relative-Complexity-Measurement-Which-from-to-Meng-Lu/ba93dbf24173c05b50c8d78ceeea238d8497b78b>

- “layman”'s definition
 - **complicated** = **difficult** to understand but with time and effort, **ultimately knowable**, reproducible with high degree of certainty
 - **complex** = **many components** which may **interact** with each other, **self-organize** and **evolve**

- Thurner2018 [2]
 - Complex systems are **co-evolving** multilayer **networks**



<https://bdataanalytics.biomedcentral.com/articles/10.1186/s41044-020-00046-0>

Complicated software systems in practice

- Non-uniform
- Low on abstractions
- Hard to change



<https://www.econlib.org/its-complicated-grasping-the-sylogism/>

Aspects we can and want to improve

Complex software systems in practice?

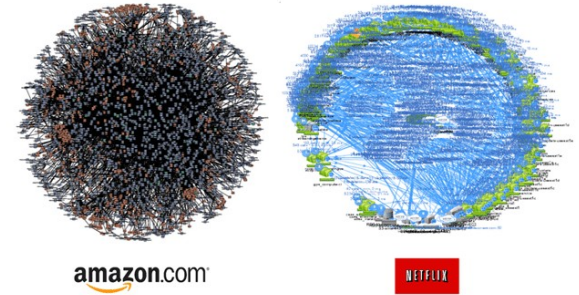
- Self-organized
- Evolving
- Interacting
- Redundant
- Out of equilibrium





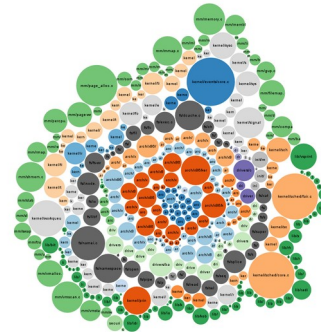
<https://www.alphagomovie.com/>

Software



<https://www.divante.com/blog/10-companies-that-implemented-the-microservice-architecture-and-paved-the-way-for-others>

- Code Complexity metrics
 - SLOC
 - Cyclomatic complexity, Halstead metrics
 - Code shape (nesting)
 - Coupling and cohesion
- Development complexity
- Network complexity
- Environment complexity
- Data complexity



<https://www.youtube.com/watch?v=5iFnzr73XXk>

<https://unix.stackexchange.com/questions/223746/why-is-the-linux-kernel-15-million-lines-of-code>

SCOPUS

Term	Computer Science		All	
	complex	complicated	complex	complicated
<n>	535,819	70,590	4,660,459	509,299
“<n> system”	26,399	1,065	82,942	4,164
“<n> software”	2,852	106	3,853	210
“<n> software system”	1,299	16	1,597	30

6. 3. 2023 SCOPUS covered 87M+ documents

SCOPUS

<n> AND evolving OR self-organization

Term	Computer Science		All	
	complex	complicated	complex	complicated
<n>	7,352	(526)	33,880	(2,542)
“<n> system”	867	(15)	2,392	(43)
“<n> software”	86	-	111	-
“<n> software system”	52	-	60	-

6. 3. 2023 SCOPUS covered 87M+ documents

Move #37

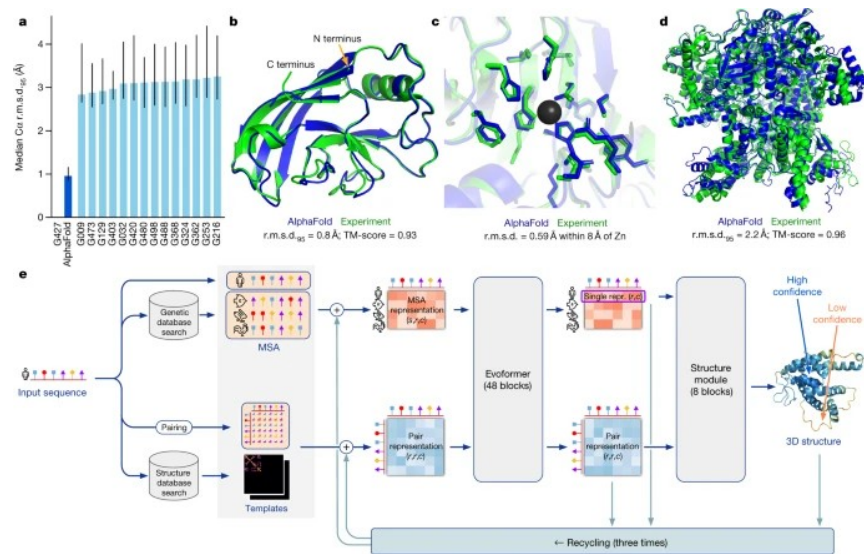


Starts at 49:22

<https://www.youtube.com/watch?v=WXuK6gekU1Y>

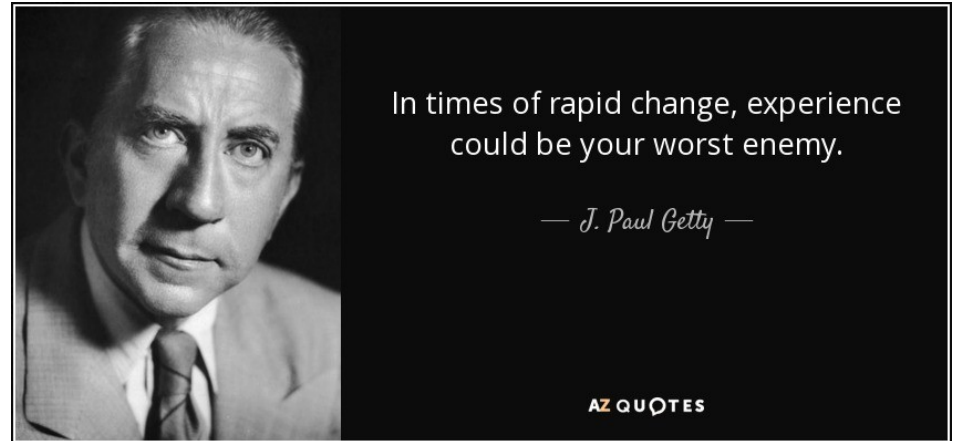
Why to research complex software systems?

- To find underlying principles
- To learn from complex system emergent behaviors
- To find different forms of complex software systems



Complex or Complicated? Does it matter?

- Yes it does
- Complicated can be simplified
- From complex systems we can learn
- Adjectives are necessary
- Underlying principle is possible
- Forms of complex software systems to be explored
- Unique position of software



<https://www.azquotes.com/quote/108954>

Current complex software systems are still mostly static creations,

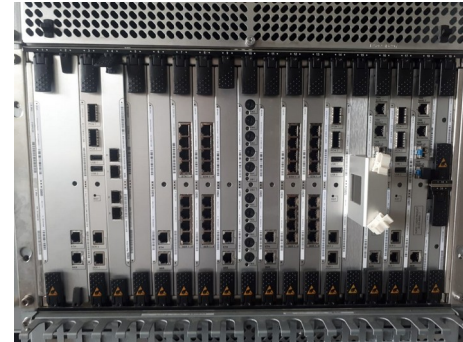
but ...



<https://www.nobleword.co.uk/what-can-ants-teach-us-about-business/>



https://www.reddit.com/r/ThingsCutInHalfPorn/comments/6gdoe2/ant_colony_4150x3111/



https://akavinet.com/product_single/product/93/homepage

... software is unique as it can be changed and evolved with virtually zero energy.