Continuous delivery for critical telecom infrastructure

Department Seminar: Scientific Discussion Forum

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10-01-2023

Introduction

- Implementation Doctorate (*doktorat wdrożeniowy*)
- Continuous delivery of critical infrastructure for 4G and 5G mobile networks

- Supervisor — dr hab. inż. Malgorzata Rutkowska
- Auxiliary supervisor — dr Jerzy Tutaj
- Company — Nokia

- Commercial context
  - Continuous delivery is a well-established practice in b2c and non-critical software products
  - Companies struggle to embrace it for **business-to-business (b2b)**, **critical infrastructure** (e.g., telecom)
- Research context
  - Focus so far on proposing new and improving existing practices in product organizations
  - Little to no attention to **commercializing continuous delivery model** in specific business environment such as telco

Critical infrastructure

"Assets, systems, and networks (…) so vital to the United States that their incapacitation or destruction would have a **debilitating effect on security, national economic security, national public health or safety**, or any combination thereof." *[1]*

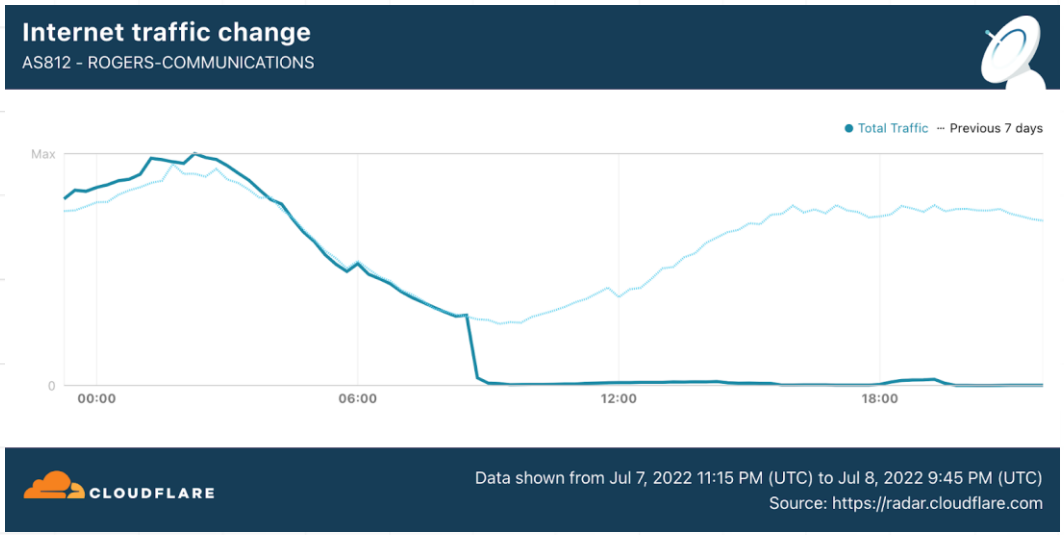
Telecom being "(…) **uniquely critical** due to the enabling functions they provide across all critical infrastructure sectors". *[2]*

"Critical infrastructure include (…) Communications and Information Technology (e.g., telecommunications, broadcasting systems, **software, hardware and networks** including the Internet)." *[3]*

Critical infrastructure: real world

July 8, 2022

ROGERS WIRELESS



[4]

…no phone calls (voice),
…no data transfer (no 3G, no LTE),
…no emergency calls (911),
…even operator's maintenance personnel had to buy competitor's SIM cards to get connected

August 11, 2022

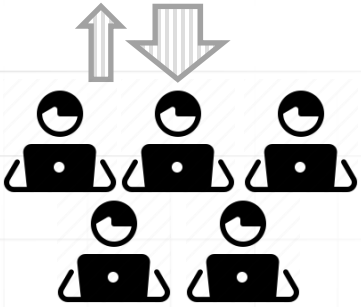
Canadian Radio-television and Telecommunications Commission

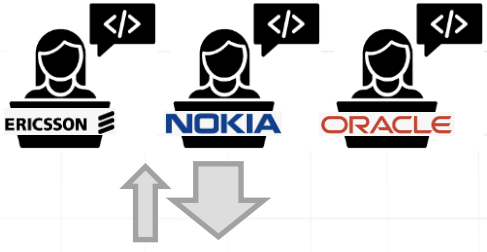
Rogers institute multiple measures to prevent recurrence, e.g.:

- "**Continuous monitoring** of services related KPIs for National and Regional data for all major change activities"
- "Adopting a **Continuous Deployment** program to improve SW quality and expedited delivery of corrections" [5]

Continuous delivery

~50 per day
new software code deployments



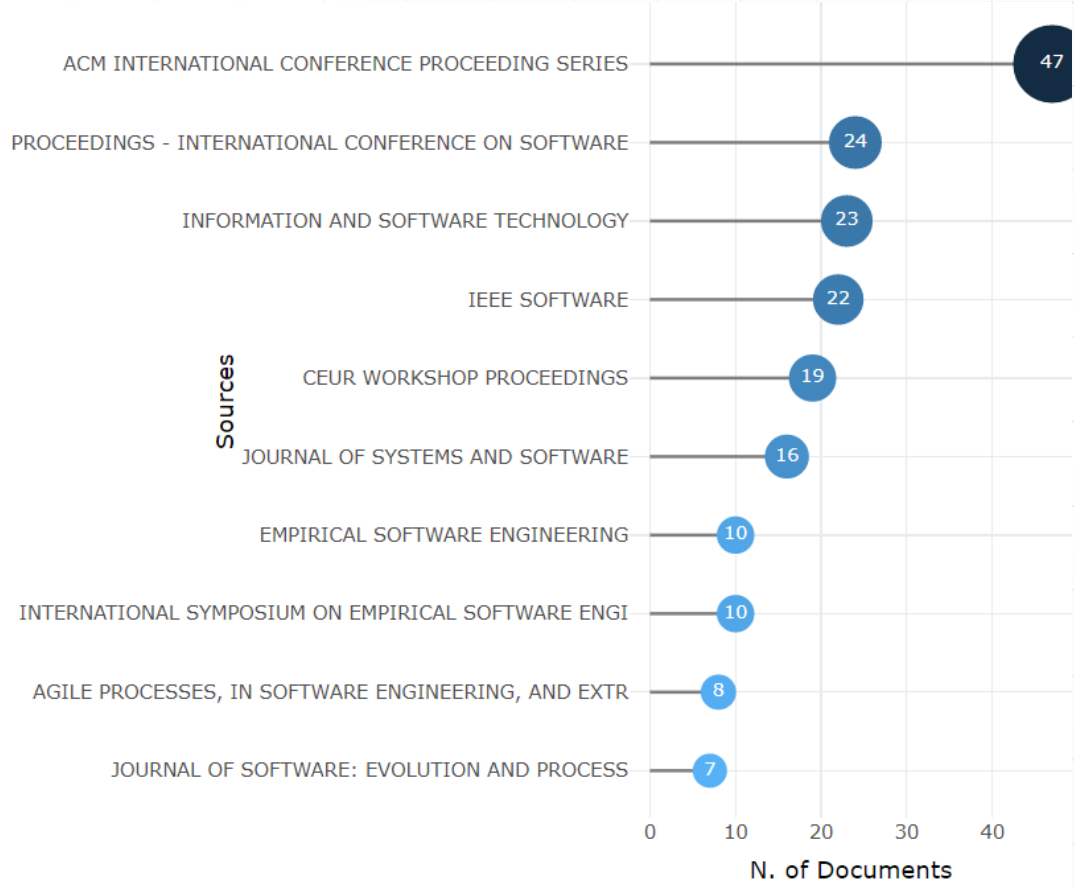


Motivation for this research

Non-critical system	Critical infrastructure
Business-to-consumer	Business-to-business-to-consumer
One-to-many	Many-to-one
You (producer) control production	Your customer controls production

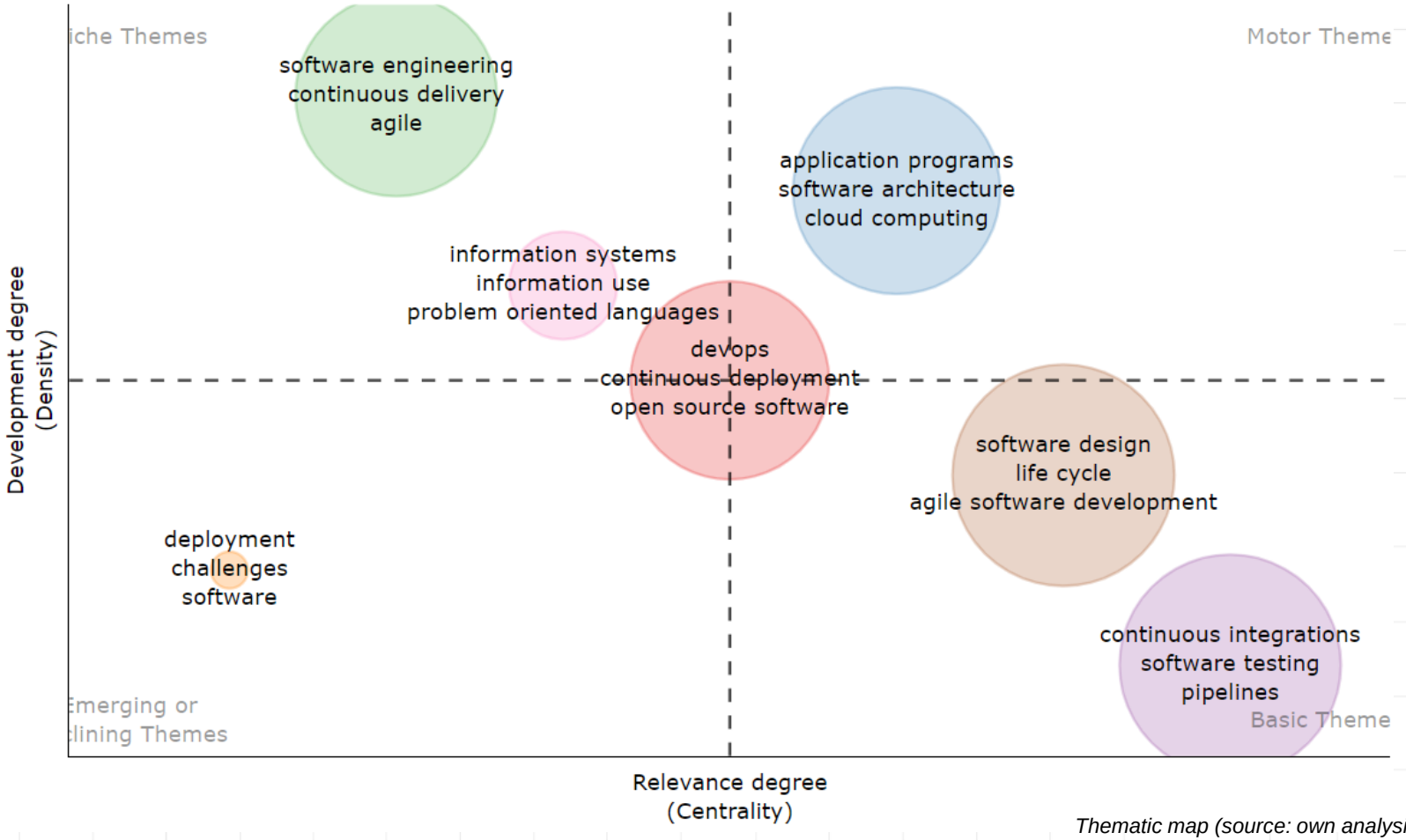
Literature review: data collection

	Web of Science™	Scopus
Initial screening	4244	5632
2012-2022 (Year Published)	2649	3313
software OR customer (All Fields)	567	1045
Proceeding paper, article, early access	566	1007
In English	561	984
Exclusions	399	508
Final set [8]	678	



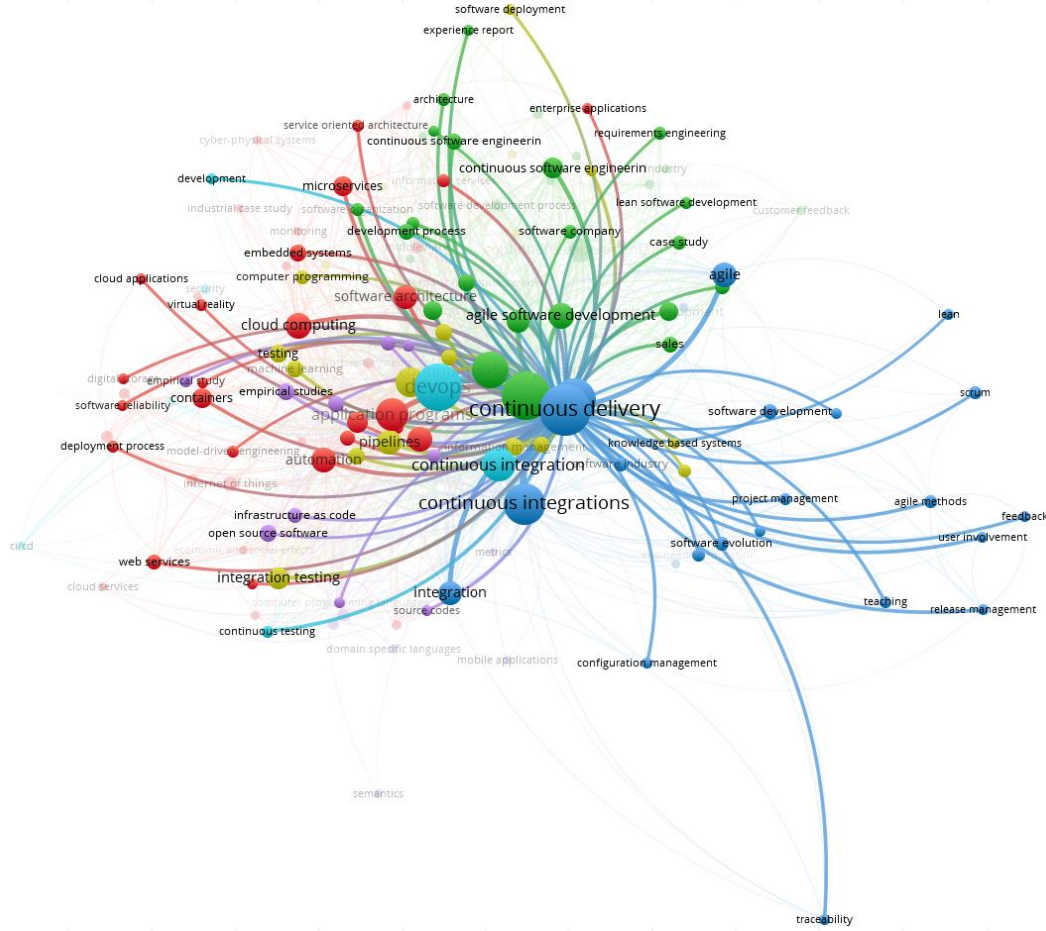
Most relevant sources (source: own analysis, Bibliometrix)

Literature review: research directions



Thematic map (source: own analysis, Bibliometrix)

Literature review



Keyword co-occurrence (source: own analysis, VOSViewer)

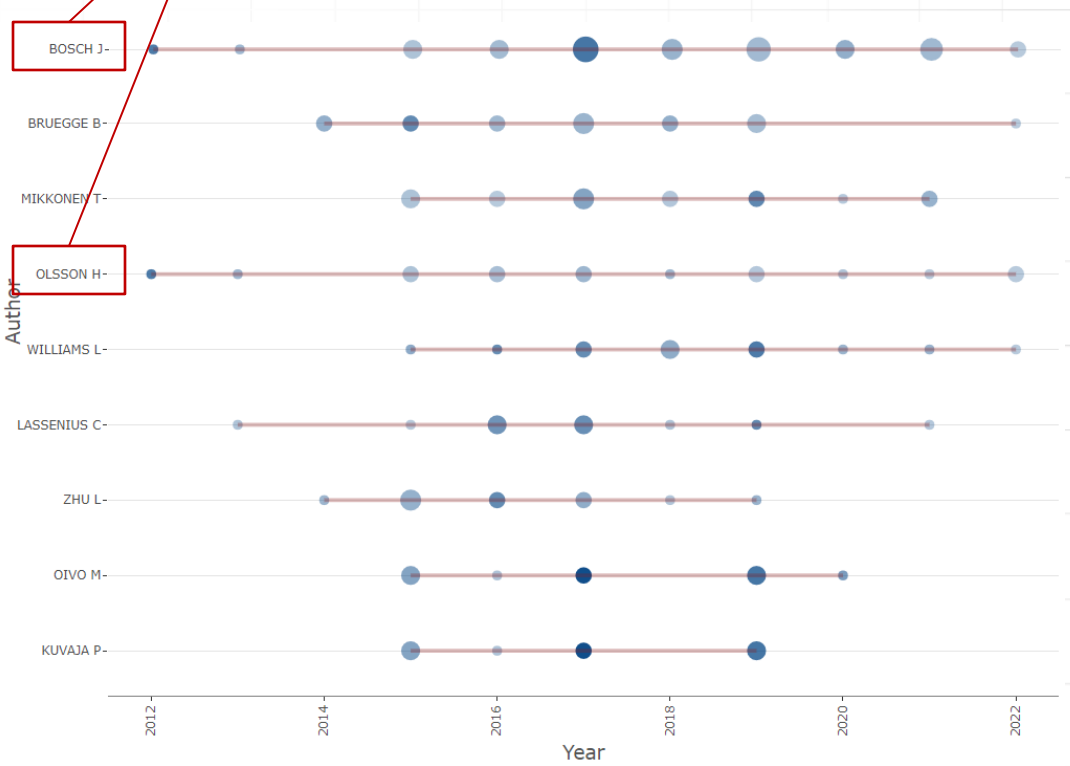
Word cloud (source: own analysis, Bibliometrix)

- **Technology-centric** research (e.g., cloud, microservices, automation)
- Focus on practices, processes, and change mgmt in **engineering organization** (e.g., agile, scrum, architecture/design) rather than on customer interface
- Strong relationship with **DevOps**
- Small amount of research in embedded systems

Literature review

- Bosch and Olsson lead research involving **real-world embedded systems** cases, including telecom
  - Stairway to Heaven
  - EMFIS
  - Cinders
  - HURRIER
  - Controlled Continuous Delivery
- Bruegge's cluster: interesting detour to academic teaching of continuous delivery practices to computer science students

High-quality research in **co-operation with business**, e.g., Ericsson, Saab.



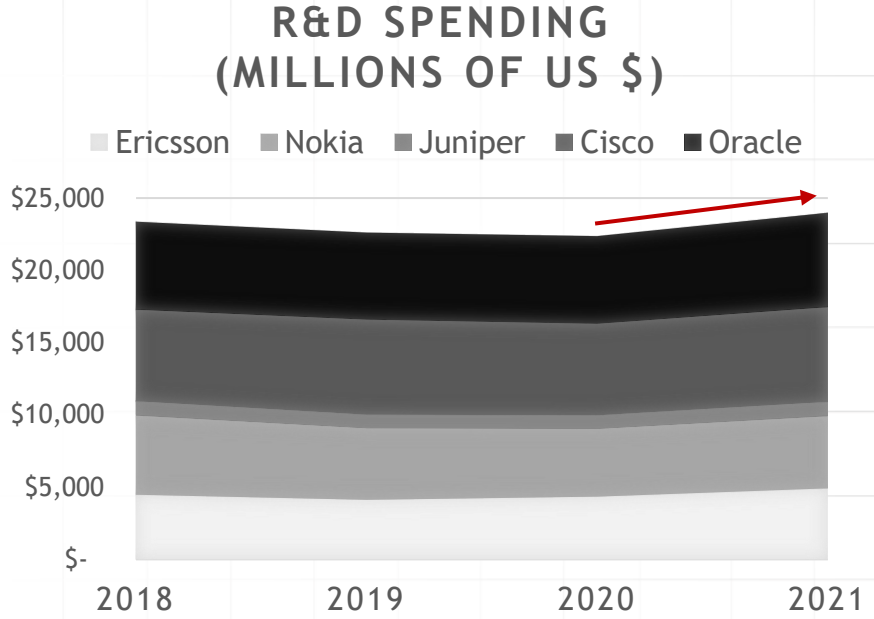
Authors' production over time(source: own analysis, Bibliometrix)

Industry view: supply and demand

- Operators' capital spending
  - Interest rates, recession fears
  - Significant 5G investments in 2020-2022
  - Expectation to generate **cash from 5G** [9]
- Vendor selection and openness
  - Open RAN, open interfaces allowing more **multi-vendor** strategies
  - **Geopolitics**, no in-house 5G in US
- Turning CAPEX into OPEX
  - Software-as-a-Service (networks on demand)
  - Network-as-a-Code (programmability on top of networks)
  - Less capital-intensive **cost structure**, especially important for smaller players

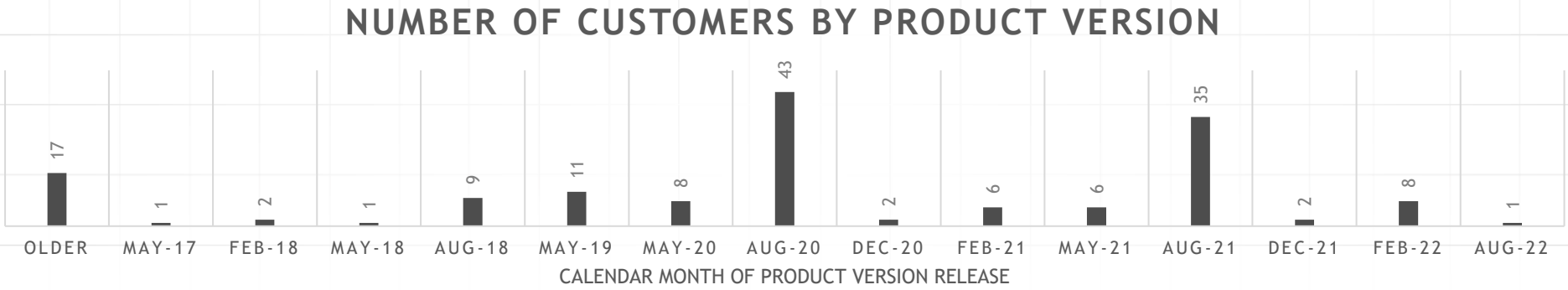
Industry view: supply and demand

- Vendors' R&D spending
  - Pushed to **new levels** post covid
- Exploration of new market segments beyond traditional telco
  - e.g., enterprises, **private networks**
- IT and telco closer together
  - Cloudified network functions
    Use of private and public clouds
  - Partnerships with **hyperscalers**
- Strategic importance of continuous delivery capabilities
  - Maturity and field experience

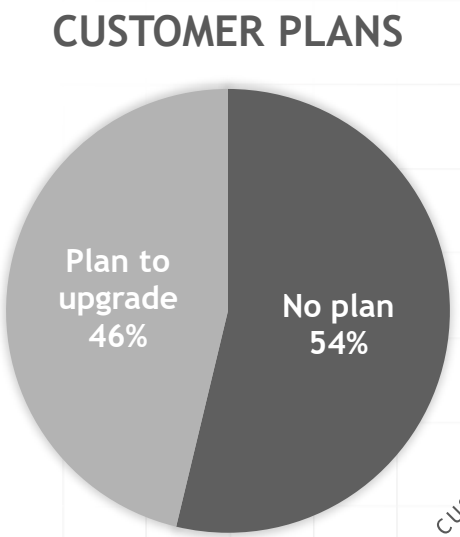


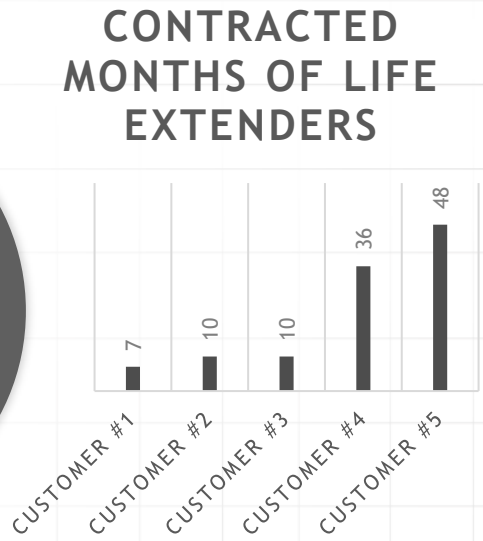
R&D spending by major telecom vendors (source: own analysis, Macrotrends.net)

Industry view: case study example



- **Delayed return** from R&D effort invested today (in 12..24 months)
- Return from latest releases further delayed by customers purchasing product **life extenders**
- >50% of customers without product **upgrade plan**





Source: own analysis of representative telecom product (case study)

Way forward: research methods

- In-depth interviews
  - Semi-structured
  - Question design based on [6], i.e., experience, opinion/value, feeling, knowledge, background/demographic, ~~sensory~~
  - Post-formed coding (expecting broad, non-uniform statements) [7]
  - Participant profiles: pre-sales, market services, product mgmt
- Quantitative analysis
  - e.g., go-to-market time, installed base, supporting systems coverage
- Surveys
  - e.g., customer readiness, product fit, process maturity
- Focus groups

Q&A

- Thank you for attention

- My contact details

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