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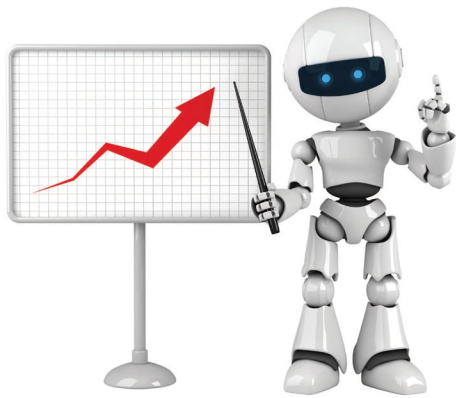
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# Reference Architecture and Application of Business Process Modelling for FinTech Industries

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# In this talk

- Main Motivation for Research into FinTech Industry
- Why Service Driven?
- Evolving a SOA driven reference architecture for financial cloud services?
  - SEF-SCC & BPD-SCC
  - Design Principles
  - Cognitive Architectures (predicting the future of software architecture)
- FinTech Cloud Applications: Domain and Feature Modelling
- Predictive Modelling & Technologies for Financial Cloud: AI, ML, Smart Devices, IoTs, Cloud, Blockchain Technologies
- Conclusion and Questions

# Leeds Beckett University

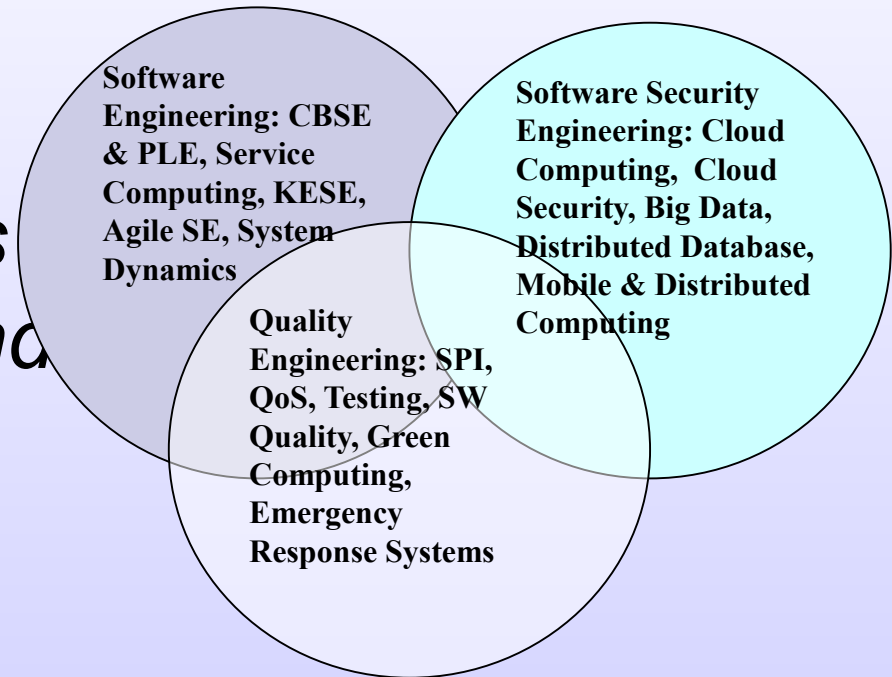


- Leeds Beckett is the fifth best uni in the country for producing CEOs
- Beckett breeds more business leaders than Oxford, LSE or Leeds Uni
- The data, released by Emolument, studied 26,000 graduates across the UK – and found that Beckett produces 3.1 per cent of the UK's CEOs, CTOs and Partners.



# Research Groups at Leeds Beckett

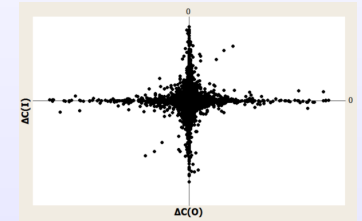
- *IT and Sustainability*
- *Assistive technologies, computer forensics and security*
- *AI, Machine Learning, Robotics*
- *Data Science, Software Engineering, SOA, IoT, and Cloud Computing*



Holistic approach  
to computer  
science research

# Current & Some Previous Projects

- Software Engineering – Reuse Framework, Component Model for Complex Systems, used in various Industries including Philips, Image Systems, Volantis Systems Research, etc., SPI, Testing, Software Product Line Engineering
- Software Engineering Framework for Service and Cloud Computing
- Cloud Computing and Big Data – Cloud Computing Adaption Framework (CCAF, IEEE SC 2016), Dynamic Service Component Model, Big Data and Resiliency Framework (FGCS 2015)
- Software Security Engineering Research: Vulnerability Techniques, Security Improvement, Design for Software Security



Example of a complex code analytics



# Main Theme

- Digital economy, digital currencies, and advancement in information technology have contributed to tremendous growth in the global economy and financialisation.
- The positive impact of technology on the financial services sector in the United Kingdom is unprecedented globally (The Rt Hon Liam Fox MP, Secretary of State for International Trade and President of the Board of Trade) UK FinTech State of the Nation
- In order to have contributed sustain this growth, a systematic approach is necessary for all aspects of the financial process and applications.
  - Holistic Approach to FinTech in the cloud
  - Software Engineering Framework for Service and Cloud Computing (SEF-SCC): Application to FinTech Cloud
  - Business Process Driven Approach to Service and Cloud Computing (BPD4SCC): Our Model
  - Requirements Engineering Framework for Cloud Computing
  - Design Approaches to FinTech Applications (Service components with SoaML, Containers, **Smart Contract with Blockchain**, etc)
  - Machine Learning Approaches to FinTech
    - **Refining, Improving & Reusing Service Requirements for Financial Services**
    - **Bug Prediction Models with Data Science Approach**



# **MOTIVATION FOR THIS TALK: FINTECH**



# Fintech: Ant Financial Services, China

**Figure 1. Ci Ren Ge Dan uses Ant Financial's services to receive and make payments for the tent store he operates at the foot of Mount Everest, 5,200 meters above sea level.**



**Figure 2. Zhang Yousheng, a herdsman, uses Ant Financial microloans to purchase calves and fodder.**



# Digital revolution vs. Challenges for Financial Service Sectors: FinTech Claims

- FINANCIAL TECHNOLOGY, ALSO known as fintech, is a fast-evolving field that has reshaped the financial industry.
- Financial service providers face **major challenges** when digitizing service for the future economy: Customers and Businesses vs. Low-cost vs. Fast vs. Risks vs. Trust vs. Intelligent Way of providing business services
- Ant Financial focuses on five technologies: Blockchain, AI, Security, IoT, and Computing (BASIC) or also known as AI, Blockchain, Cloud, Data Analytics (ABCD)
- Ant Financial has redefined digital financial services, specifically mobile payment and microloan services, and Ping An Technology has developed.
- The innovation of QR payment builds a point-of-sale transaction (offline payment) for remote villages in the foot steps of mount Everest. Decisions made instantly for microloans and car accidental damages with customer sent photos

# UK FinTech 1

UK FinTech (2019) State of the Nation,  
[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/801277/UK-fintech-state-of-the-nation.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801277/UK-fintech-state-of-the-nation.pdf)



**+1600**

*FinTech firms in the UK,  
estimates suggest this will more  
than double by 2030*

**42%**

*UK's FinTech adoption rate.  
Global average is 33%*

**82%**

*of incumbents expect to increase  
FinTech partnerships in the next  
three to five years*

# UK FinTech 2

- UK start-up into a global market leader in FinTech **worth over \$35bn.**
- The question now, is how can the UK keep up with the demand for the skills that will support the future success of FinTechs?
- Research from the **World Economic Forum** shows that emerging roles – such as, data analysts, AI and machine learning specialists, designers, and people who work in innovation roles – which currently account for 15% of the financial services workforce globally, are expected to account for **29% of the workforce by 2022.**
- Future of Technology Trends: Blockchain (identify management, Voting, etc), Drones (insurance claim validation in disaster situations), IoT (mobile banking, inventory and materials tracking, real-time asset monitoring (gold reserve, etc.), Robots (hotel and tourism service industry), 3D Printing, VR, AR, and AI.

# Main Finding of Fintech

- Their main findings

- ☐ Blockchain provides a new trust mechanism to transactions
- ☐ Deep learning and natural language processing technologies helped intelligent customer service robots achieve higher customer satisfaction rates than live service staffs
- ☐ AI Assessment of Claims and Risks for Insurance and Loans Sectors



# **WHY SERVICE DRIVEN?**

## Why SOA? Service Computing of Everything: Internet of Everything (IoE) for the Future of Business IT

The Future is here!

Why SOA? Multitude of devices, seamless data, intelligence, multitude of software, systems, services, and platform integration, and predictions. The Future is here!

SOA is a formalised way of integrating applications existing traditional applications and legacy systems) into an enterprise architecture and hence suitability for connecting IoEs



# YESTERDAY. GADGETS ARE EVERYTHING





# TODAY: COMMUNICATION IS EVERYTHING



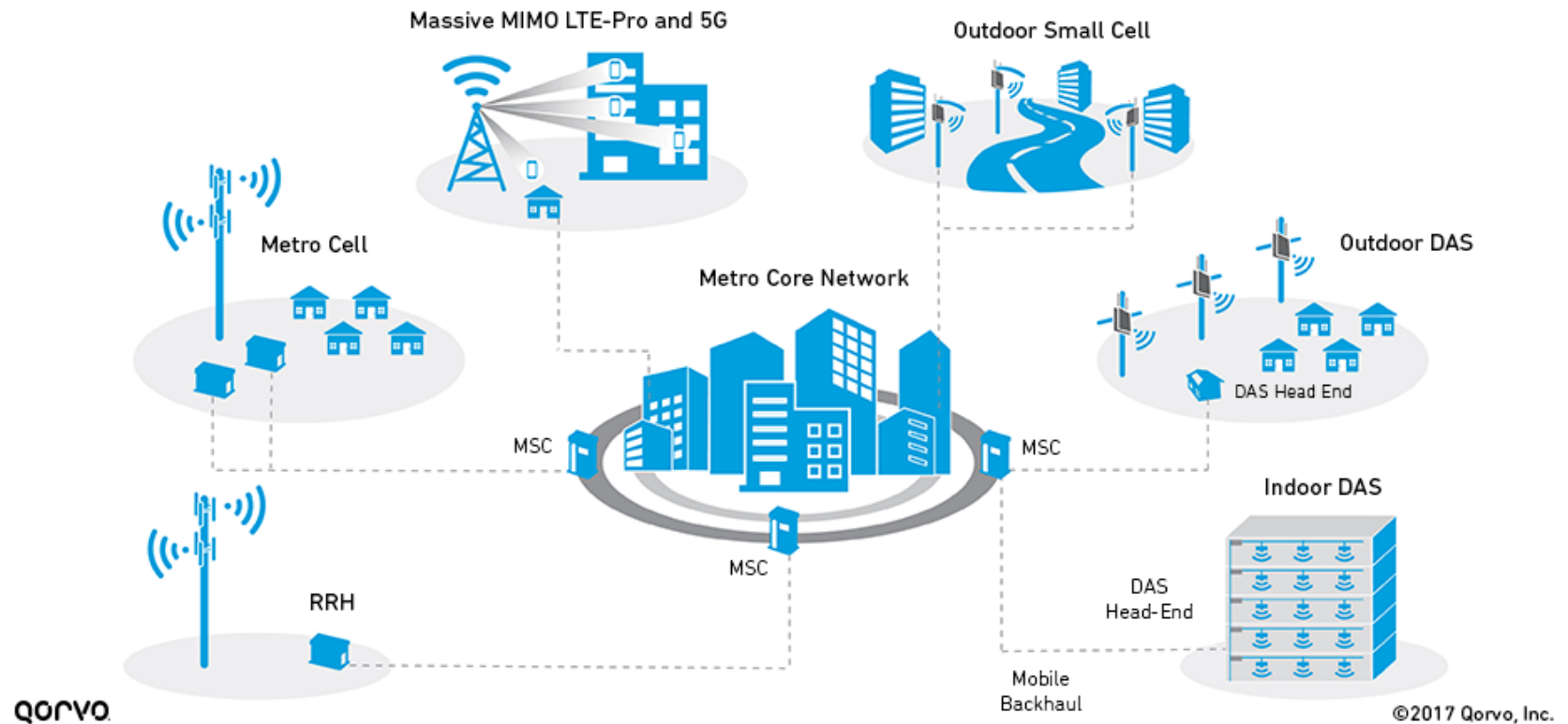
# Tomorrow: Service is Everything: they communicate, compose new services, and self recover themselves



# Connecting Services is Here with 5G

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## Wireless Infrastructure: A Heterogeneous Network



# Cybersecurity Risks with 5G

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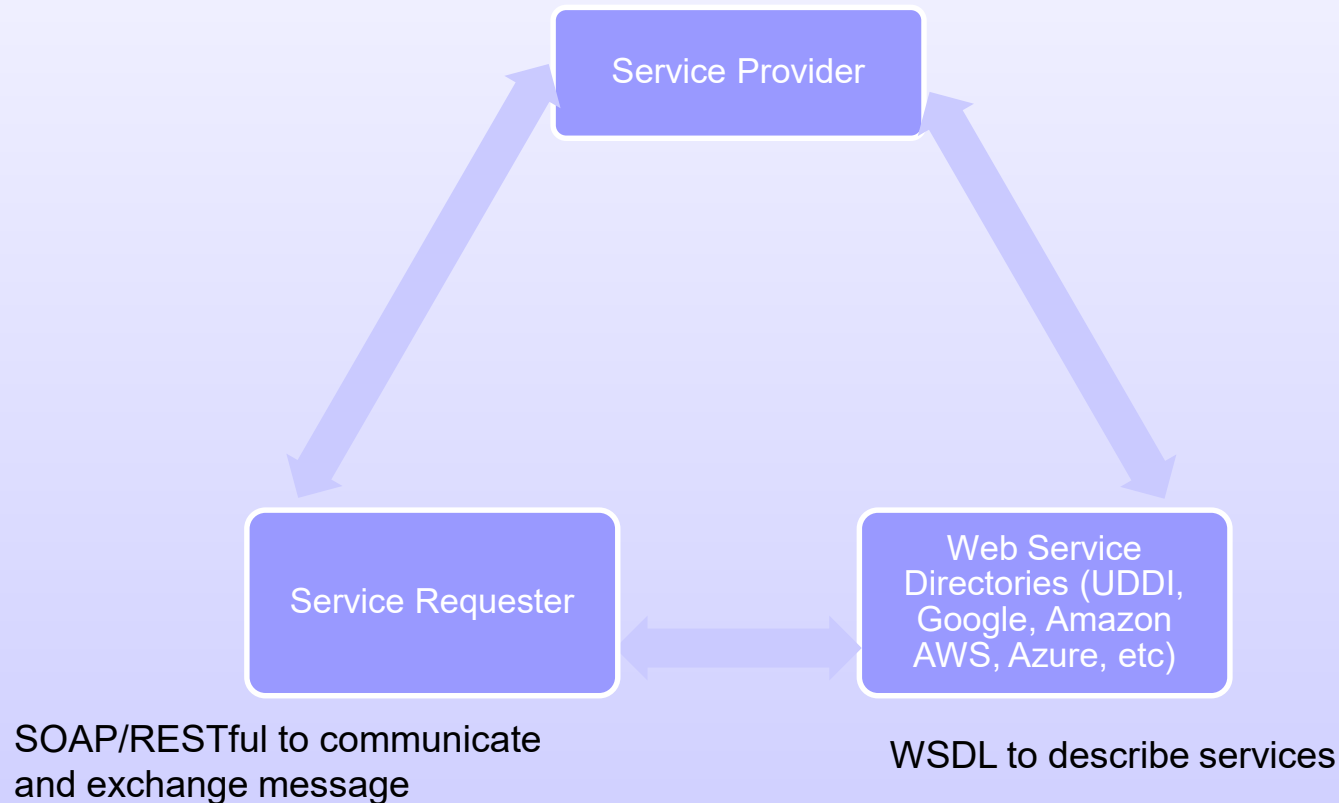
- ❑ 5G and 6G is great for connecting services with Cloud, Big Data Analytics with AI/ML/DL, Robotics, Blockchain, IoT Technologies
- ❑ However, if the application services are not engineered (design for security/Build-In Security (BSI)), we will have sever consequences similar to what we have seen in movies
- ❑ It could destroy power grid, transportation, financial services, simply every seconds of day-to-day life (Dr Ian Levy, Technical Director of the National Cyber Security Centre, BBC Click Interview, May 2019 (*the future of cyberwarfare*))
- ❑ 5G Click Interview
- ❑ Therefore, it is paramount to use Cybersecurity Improvement Framework



Why BPM (Business Process Management =  
BPMN+CMMN+DMN) for Financial Services and Financial Cloud  
Based Applications?

# **EVOLVING A REFERENCE ARCHITECTURE FOR FINTECH**

# Service-Driven IT is the Future: SOA Paradigm



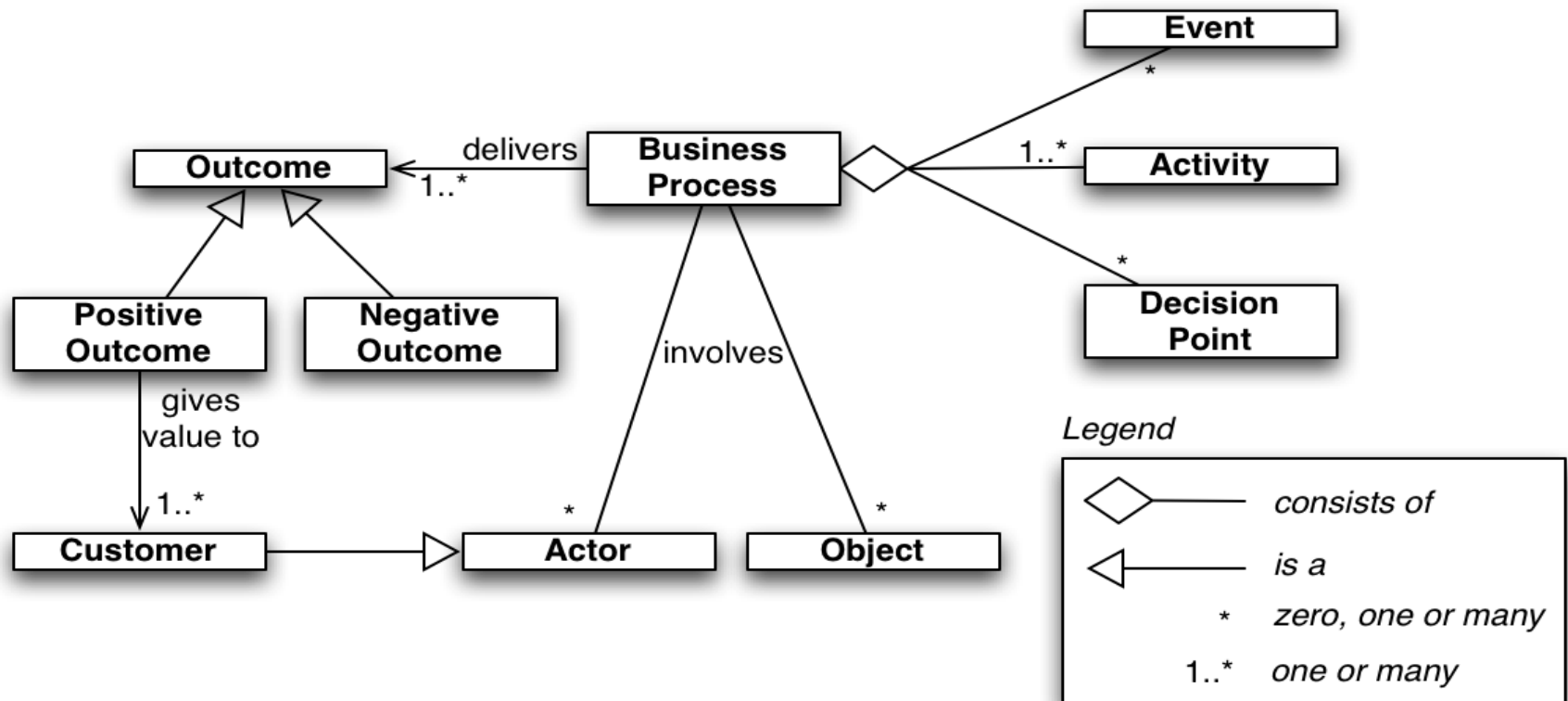
The main focus and purpose is customer driven methods, processes (applicable to both traditional as well as Agile based), and technologies

# Basic Principle of 3-tier Architecture Model



The top layer is called role-based Web access layer, which provides convenient, safe, barrier-free information access portal for all participants in the collaboration. Its specific functions include information browse, search, subscriptions. The middle layer is called application logic layer that reflects the interact logic among person, activities and information. Its specific functions include collaborative process management, information sharing and reuse, integration with existing systems. The bottom layer is data storage layer, whose main role is to change product data into knowledge wealth. Its specific functions include information capture, storage, sorting, enriching, structuring and summary.

# What is BPMN?





## Business Process Driven Approach to Service and Cloud Computing (BPD4SCC): Our Model

### Service Requirements with BPMN

- Initial process models: Actors/roles/Workflows
- Detailed workflows
- Service Task modelling
- UI prototyping
- Process Simulation:
  - Configure Resources need for tasks
  - Load profiles in sec/min/days/no.of instances
  - Start the Process Simulation as a Service (PSSaaS)

SOA Requirements with use case modelling, story cards, (Agile), Story Boards, CRC Cards, Feature-Oriented modelling

SOA Design with Service Component Models (Design Techniques using UML component model & SoaML)

SOA Implementation with SOAP/RESTful

SOA Test & Deliver

# Software Engineering Framework for Service and Cloud Computing (SEF-SCC): Application to FinTech Cloud

Method, Process, Framework, Architecture, Design Principles



Methods and Design Principles



Process: Business Process Driven Service Development Lifecycle (BPD-SDL)



Reference Architecture



Tools



**SE-SCC Services:** Software Engineering as a Service (SEaaS): SPMaaS, SPIaaS, SSREMaas, CCAFaas, SE for BD, SE for IoT, SE for Cyber-Physical Systems



Adoption Models



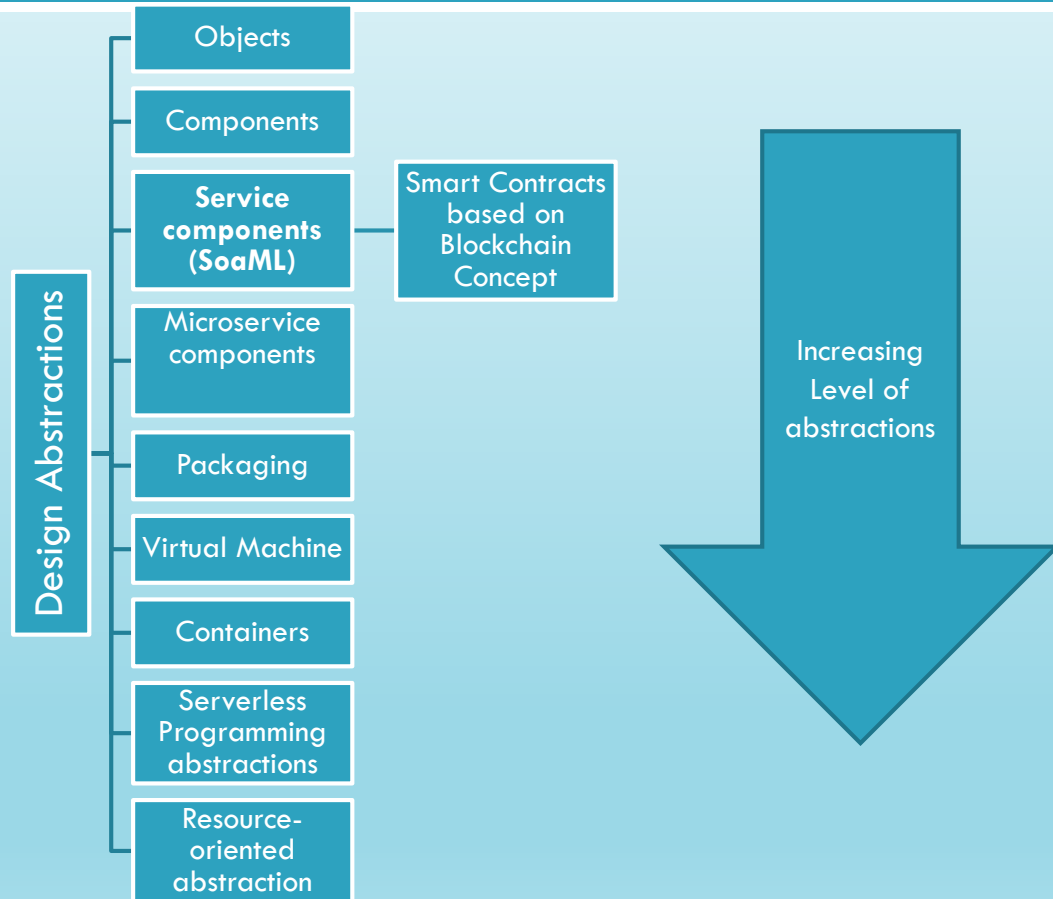
Evaluation & Applications

## Design Principles

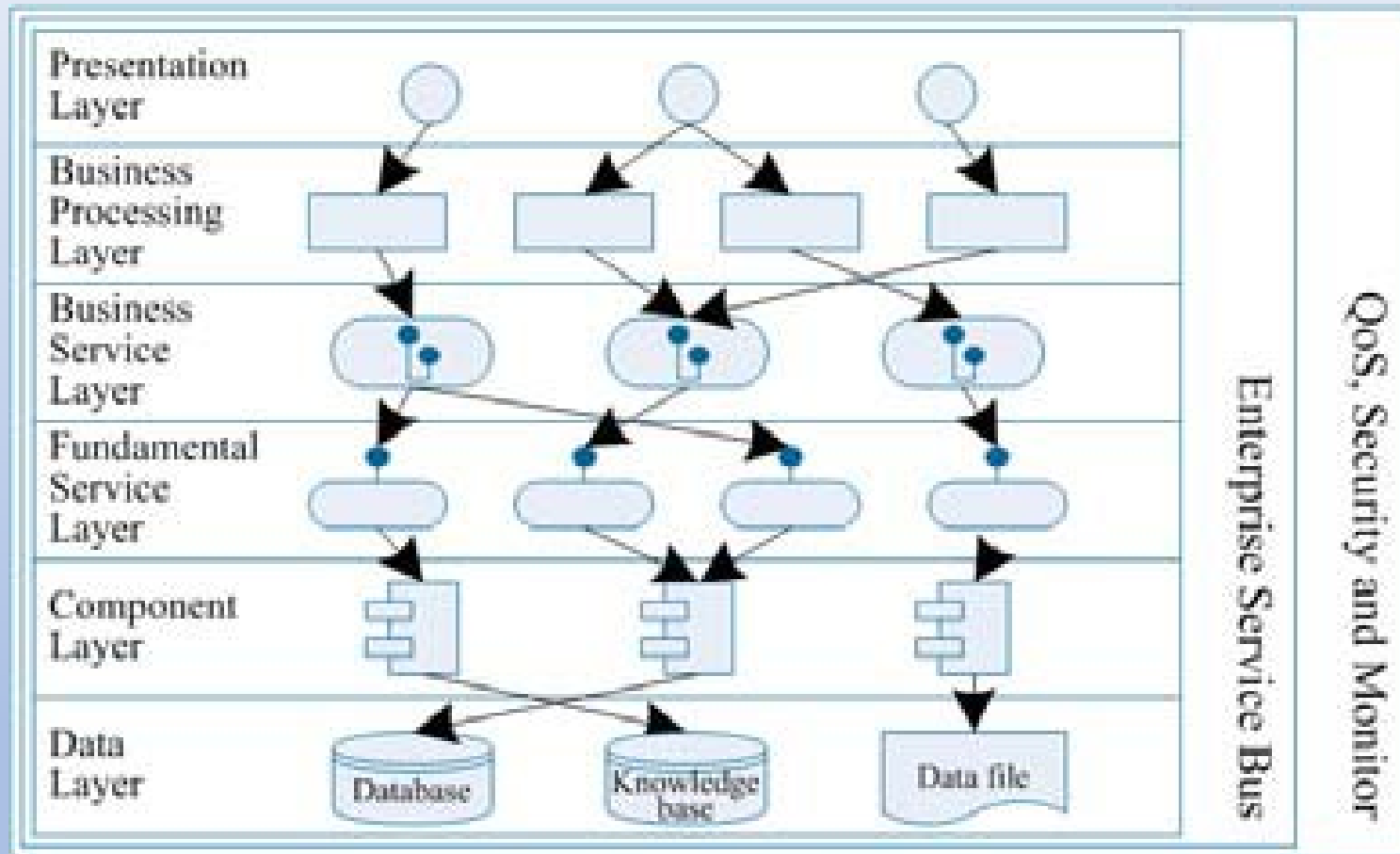
- Reuse of Financial Services with ML
- High Level Abstractions: Lightweight vs. Heavyweight abstractions: Service Components, Microservices, and Containers
- Privacy and Security: BPMN and SoaML Driven Validation before Implementation with Business Process Driven Service Development Lifecycle
- Smart Contract with Blockchain Technology
- Comparative Design Strategies
  - The Sherwood Applied Business Security Architecture (SABSA) is a framework for developing risk-driven enterprise information security and assurance architectures. It defines attributes such as reputation, operational efficiency, business continuity and brand perception. These attributes, and others, need to be protected through security controls.
  - <https://www.youtube.com/watch?v=qbFTg85I4eE>

# Design Abstractions

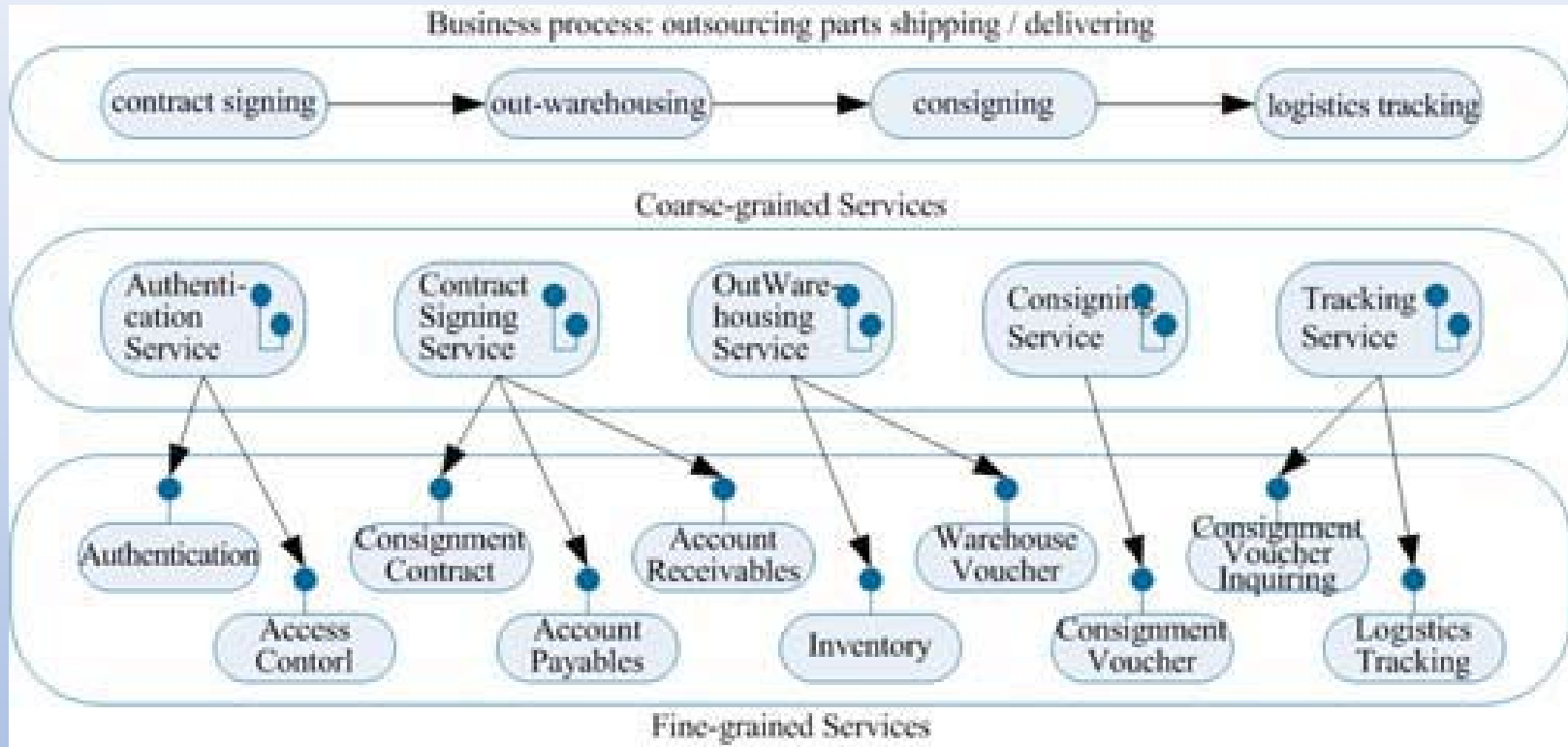
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# Concept of a generic SOA Based Reference Architecture: Aspect of Layering Abstraction

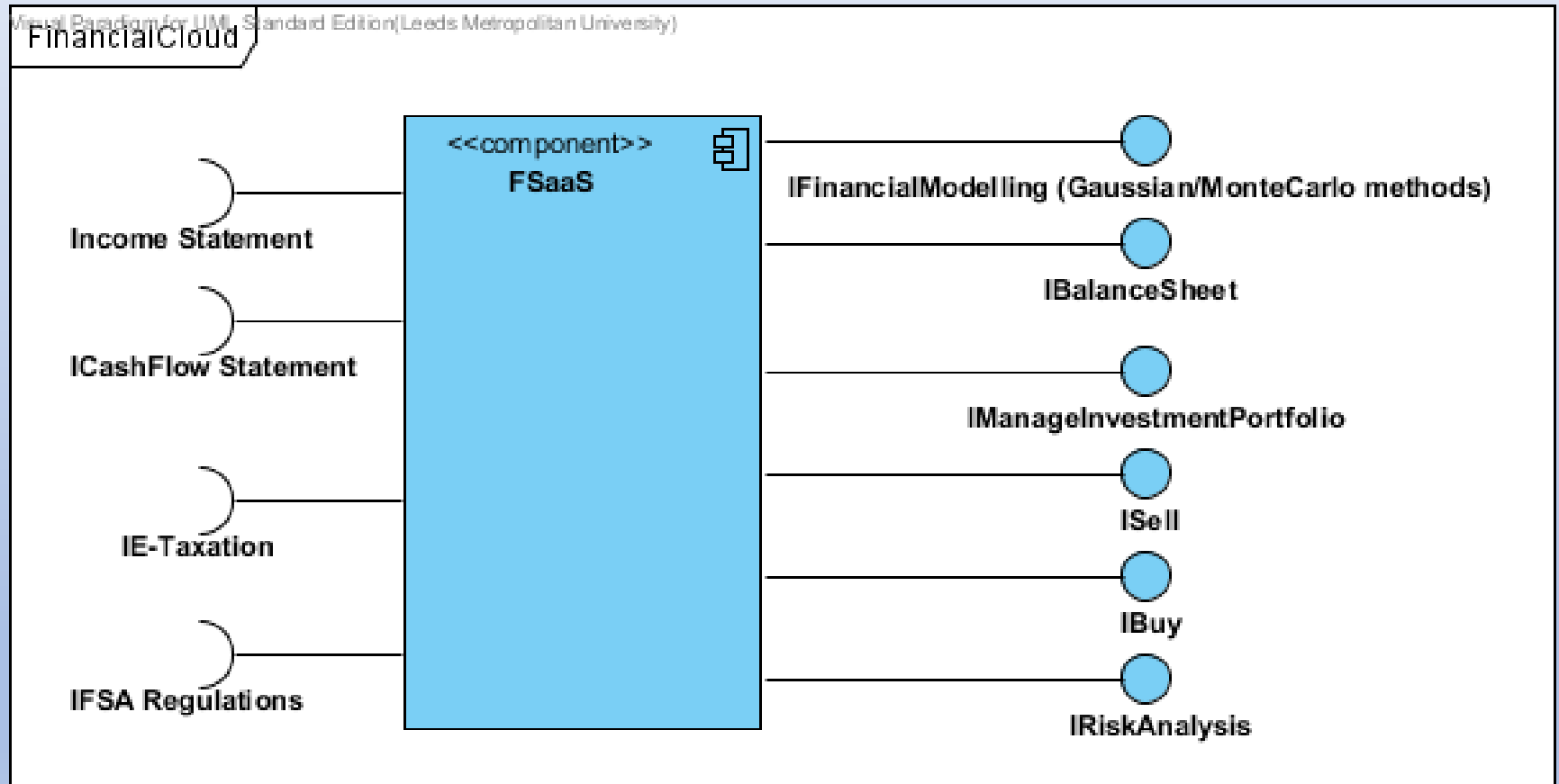


# Design Principle on web services granularity: An Example of outsourcing parts shipping / delivering process



If the granularity is too small, the service may be too specific to be useful. If the granularity is too large, it leads to a general application-specific service which cannot be reused. Then, the service should be broken into smaller parts.

# FAaaS (Financial Applications as a Service) Component Model



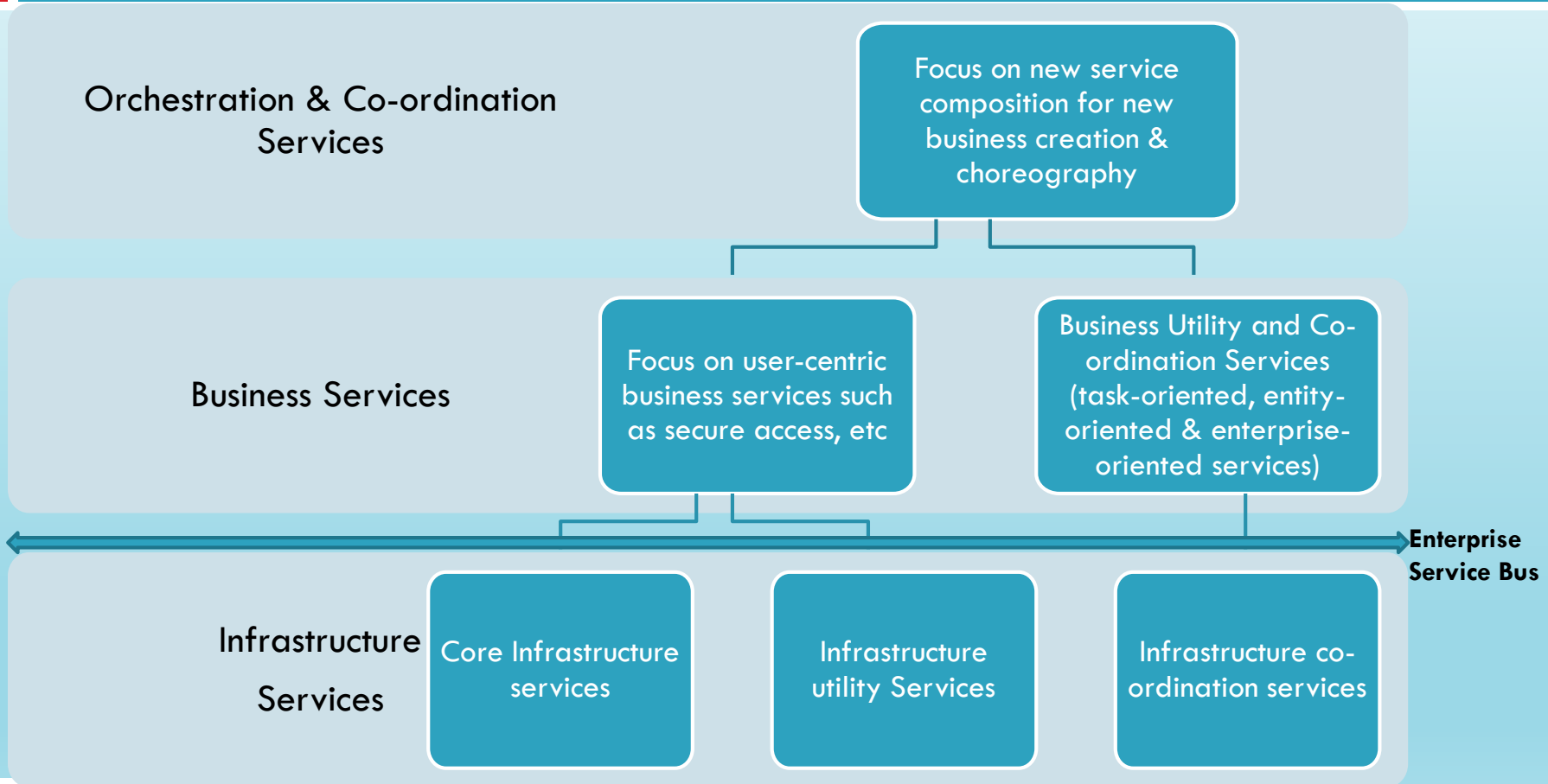
# Financial Accuracy & Predictive Mathematical Models & Algorithms

- Models behind FAaaS are essential for the calculation, processing and presentation of financial computation in the Cloud.
- 1. Heston Model
- 2. Wiener Process
- 3. CIR (Cox, Ingersoll and Ross) Model
- 4. Runge–Kutta method (RKM)
- The use of all the models for FSaaS can match accuracy and optimize the performance.



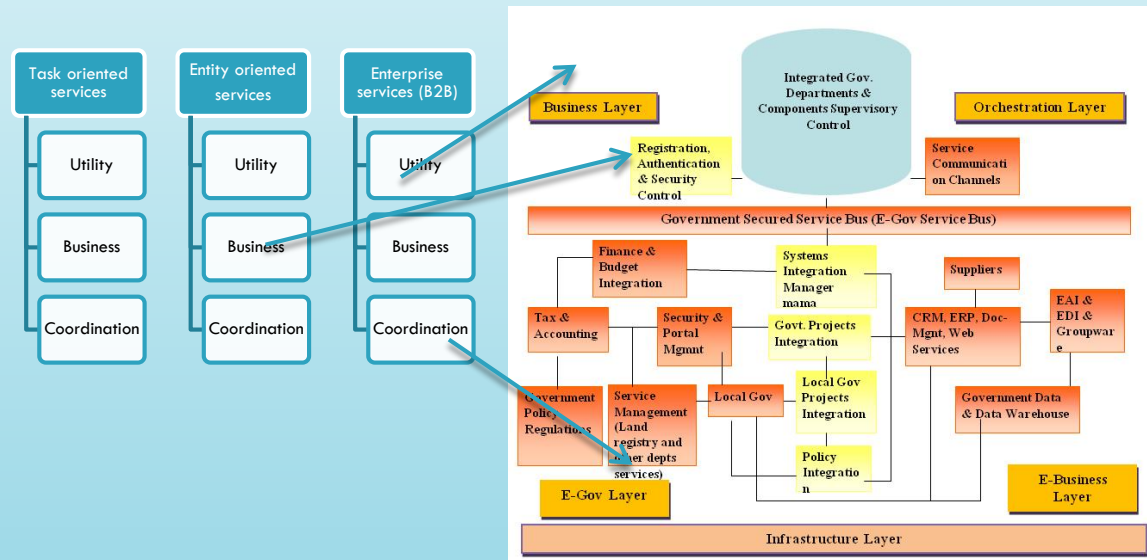
# SEF-CC Reference Architecture for Service Computing

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# Mapping Services to SOA Design

33



As an Architect, you will need to categorise services therefore you will be able to place them in the appropriate architecture layers on the right

# Reference Architecture for Financial Cloud

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Business Layer

Orchestration Layer

Registration,  
Authentication &  
Security Control

Consumer  
Banking  
Applications

Multi-channel service  
requests

Mobile, Cloud, IoT  
Sensors, Social  
Media, Email, QR  
code, vouchers,  
Drones, etc

Secure Enterprise Service Bus

Consumer  
Banking

Investment  
Banking

Predictive  
Modelling for  
Financial  
Services with  
Machine Learning  
& Deep Learning

Business Regulations with  
Smart Contract (AI and  
Blockchain Services)

Financial Services Algorithms for  
Decision Making

Insurance Services

Business Services (B2B,  
B2C, B2Gov, etc.)

Cryptocurrencies

Governance Services (FCA Regulations) with Smart  
Contract

Financial Services Layer

Financial Analytics Layer

Infrastructure Layer

Current Account  
Services

Savings &  
Deposit Services

Loan Services

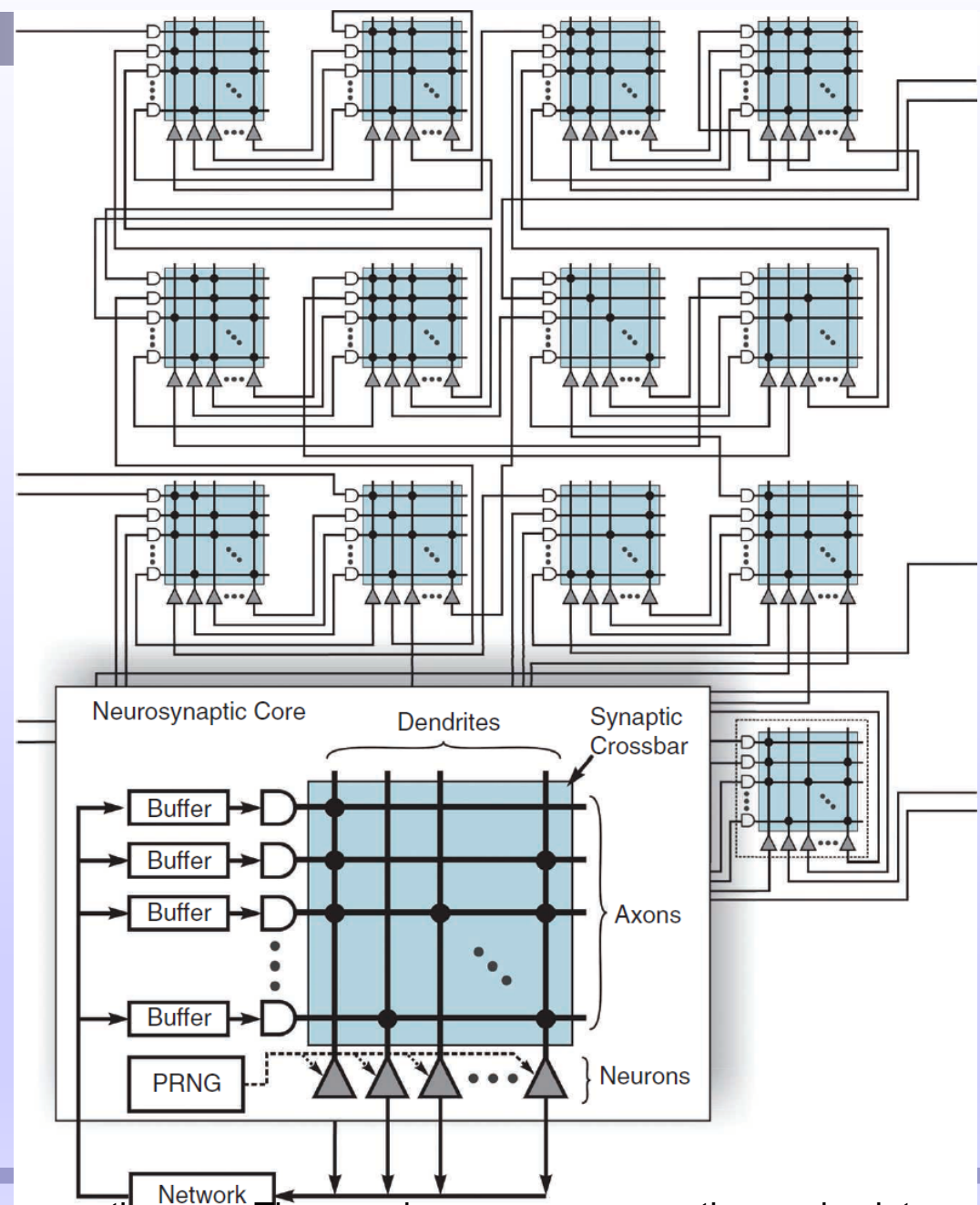
B2B, B2C,  
B2Gov



# **COGNITIVE ARCHITECTURES**

# TrueNorth: Neurosynaptic architecture

DeBole, V.M. et al. (2019) TrueNorth:  
Accelerating From Zero to 64 Million  
Neurons in 10 Years, IEEE Computer, May  
2019



The TrueNorth architecture, a network of neurosynaptic cores. The crossbars, neuron properties, and point-to-point connections are all configurable.

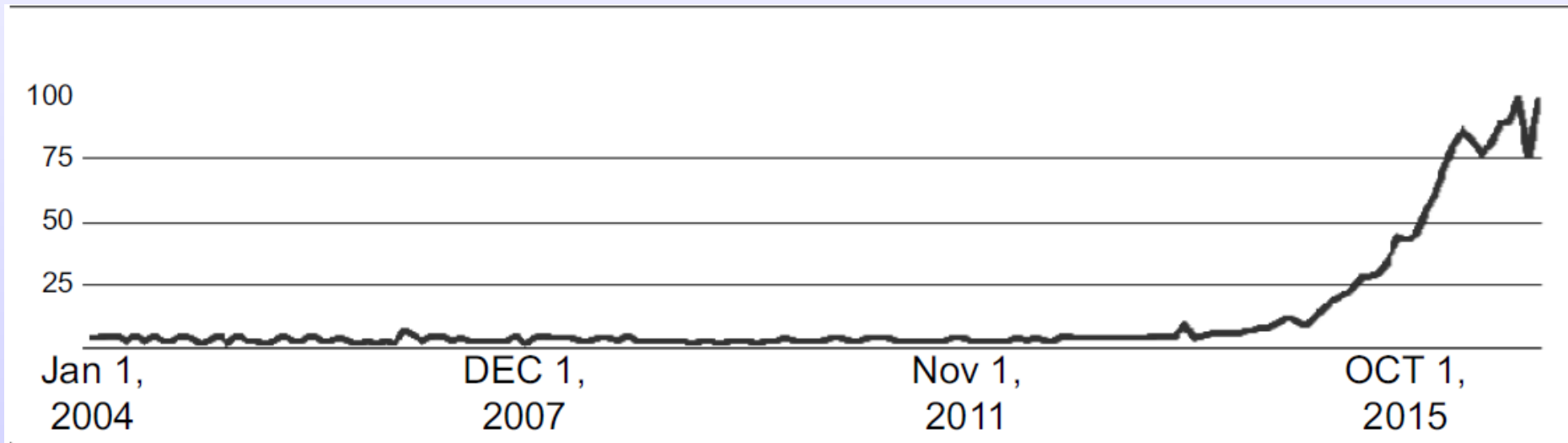


# FINANCIAL CLOUD APPLICATIONS & TECHNOLOGIES

# Improving the use of Current Technologies for FinTech Growth (Digital Transformation)

- It was inevitable that technology would meet finance and spawn fintech.
- The use of technologies like algorithmic machine learning, collecting massive amounts of data and interpreting them for decision-making or “crystal-ball” predictions (predictive analytics), and distributed ledgers (blockchain) in financial industry will give rise to innovative business models with increased levels of efficiency, productivity, cost-effectiveness while also improving on customer-centricity.
- The most important thing and also a great challenge for both fintech platforms and financial institutions is to adopt and implement a very pertinent, practical, and transparent strategy for digital transformation within the organization as well as in external engagements.

# FinTech Growth

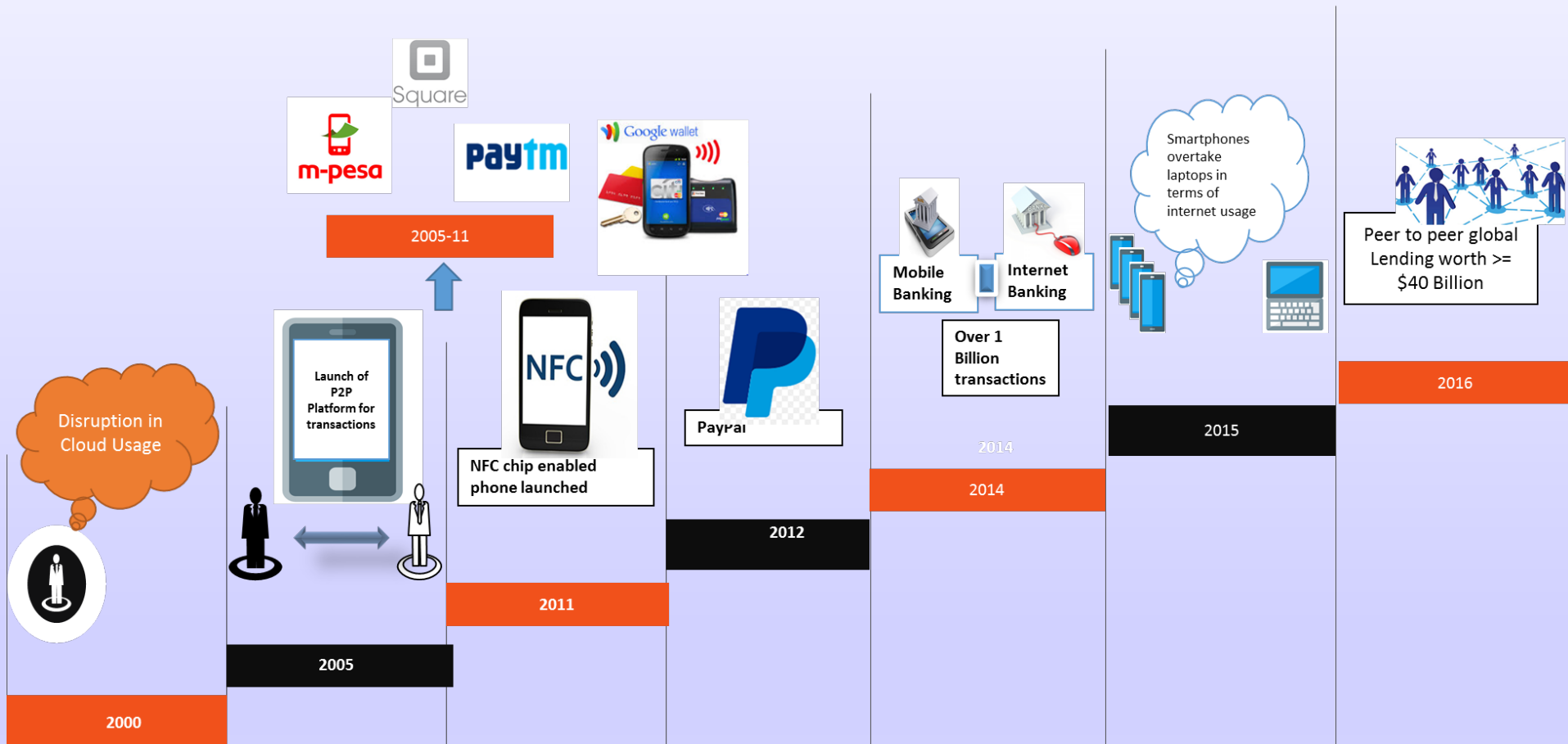




# Current Applications

- Crowdfunding
- Peer-to-Peer (P2P) Finances: Lending & Loan
- E-Banking
- E-Insurance
- E-Investments
- E & M-Commerce

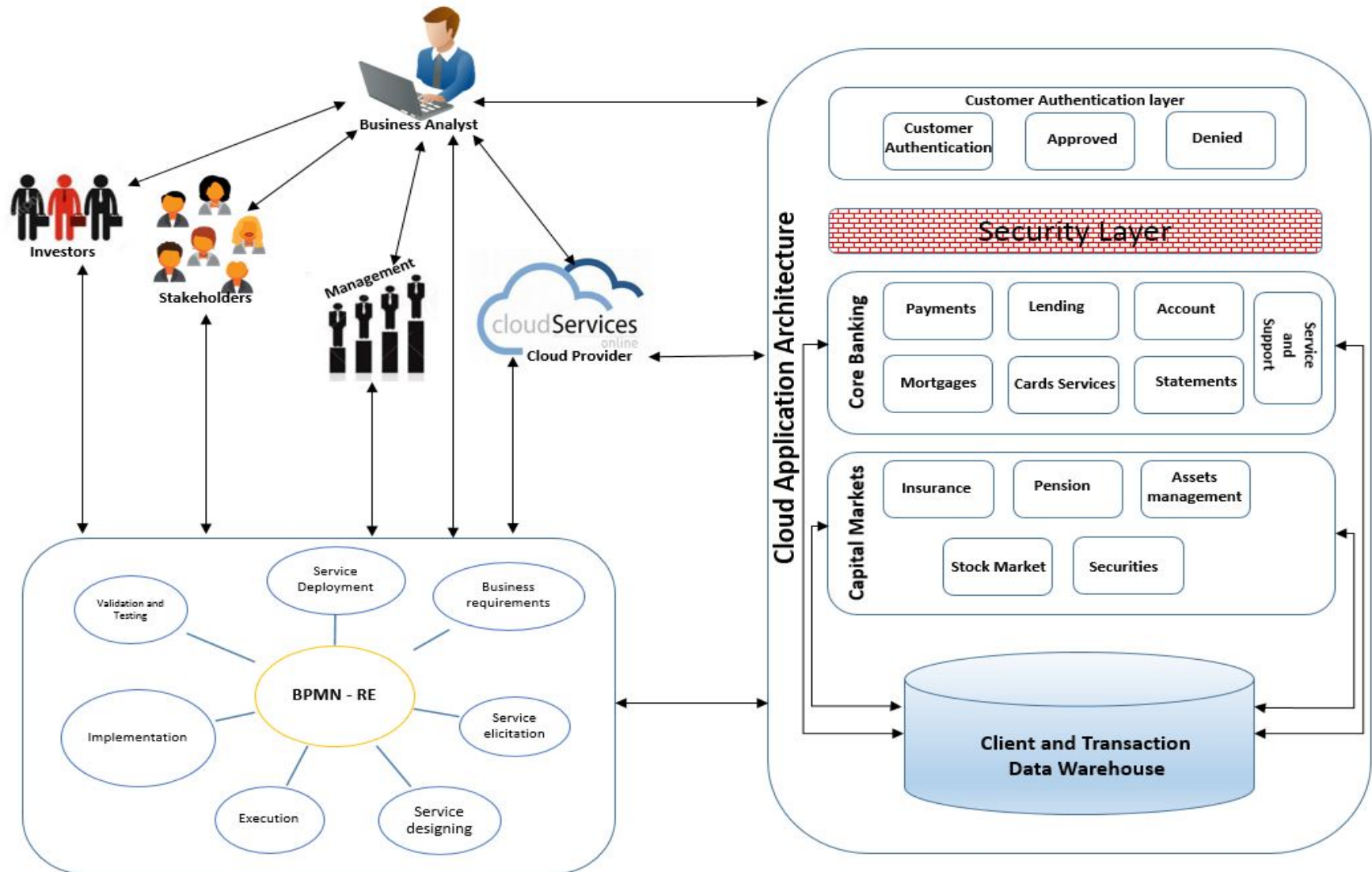
# FinTech



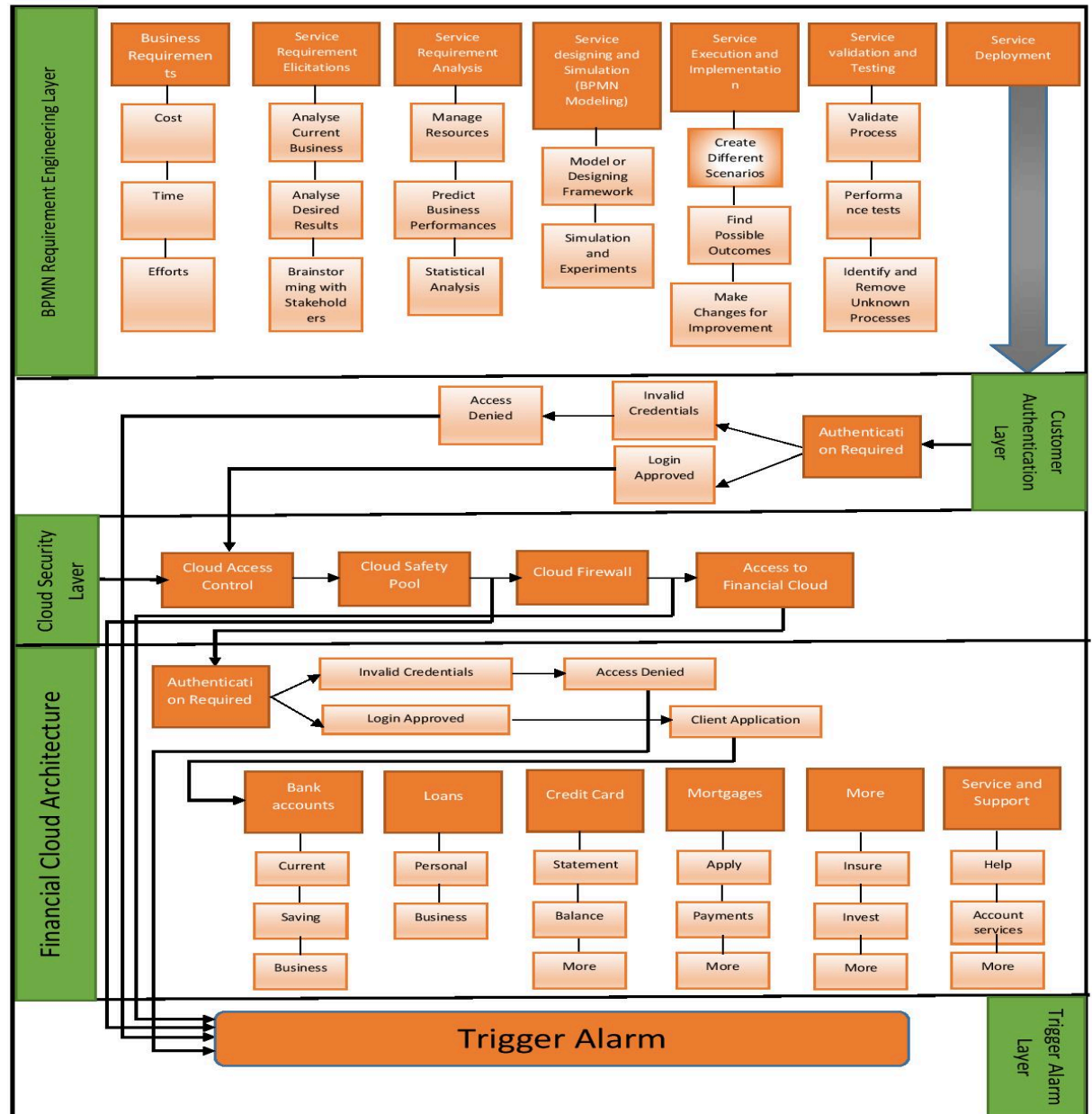
# Technologies

- E-Commerce
- Machine Learning and AI
- Big Data Analytics
- Predictive Analytics for Decision-Making (Crytal-bal)
- Blockchain
- IoT
- Cryptocurrencies (Bitcoin vs Ethereum (ETH))

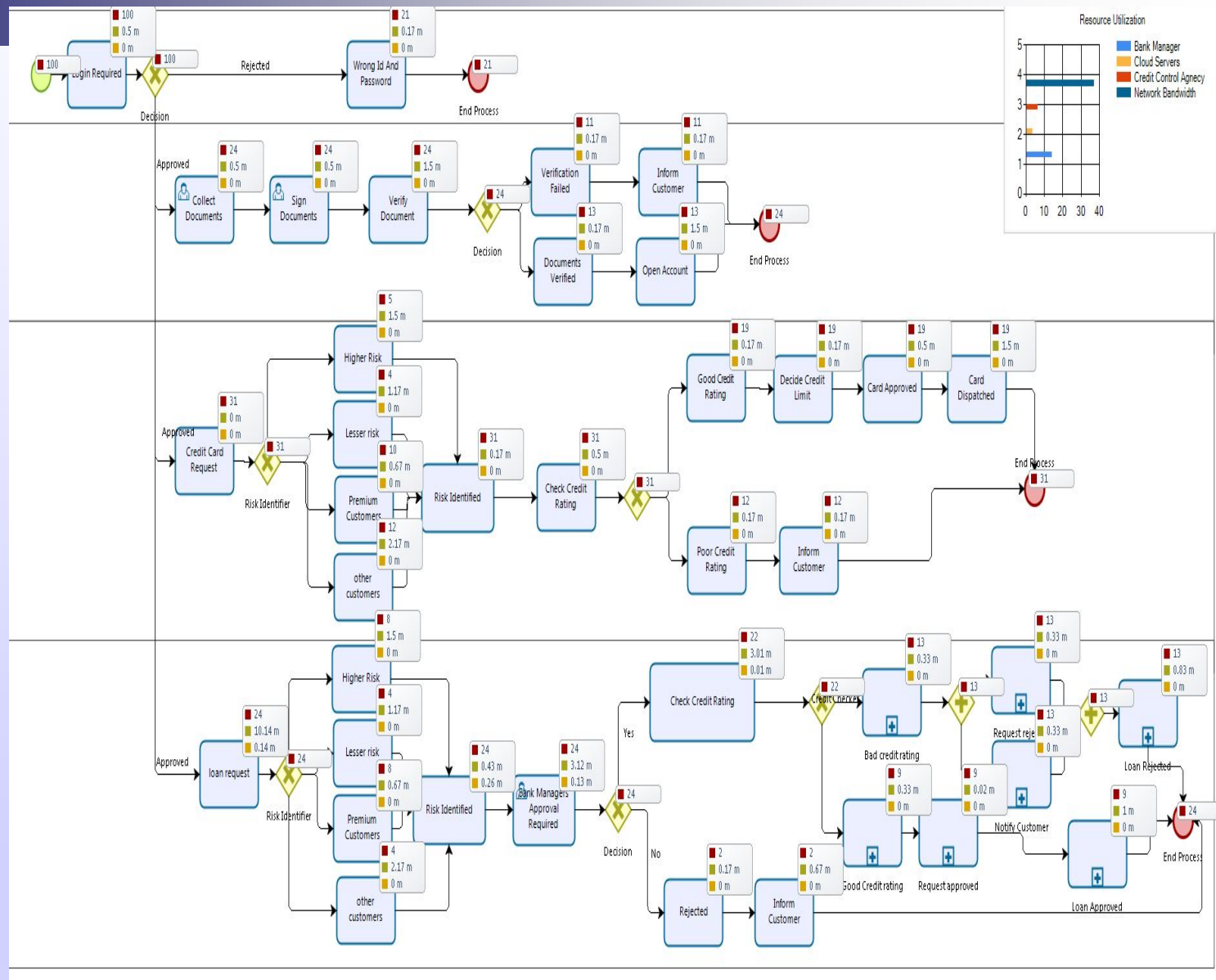
# Integrated Financial Cloud Services



# Financial Cloud Services



# Simulation View of the Financial Cloud Services





# **MACHINE LEARNING TECHNIQUES TO REQUIREMENTS EVALUATION AND SOFTWARE DEFECT MANAGEMENT WITH REUSE AND KNOWLEDGE DISCOVERY**

# QoS Metrics to Measure for FinTech



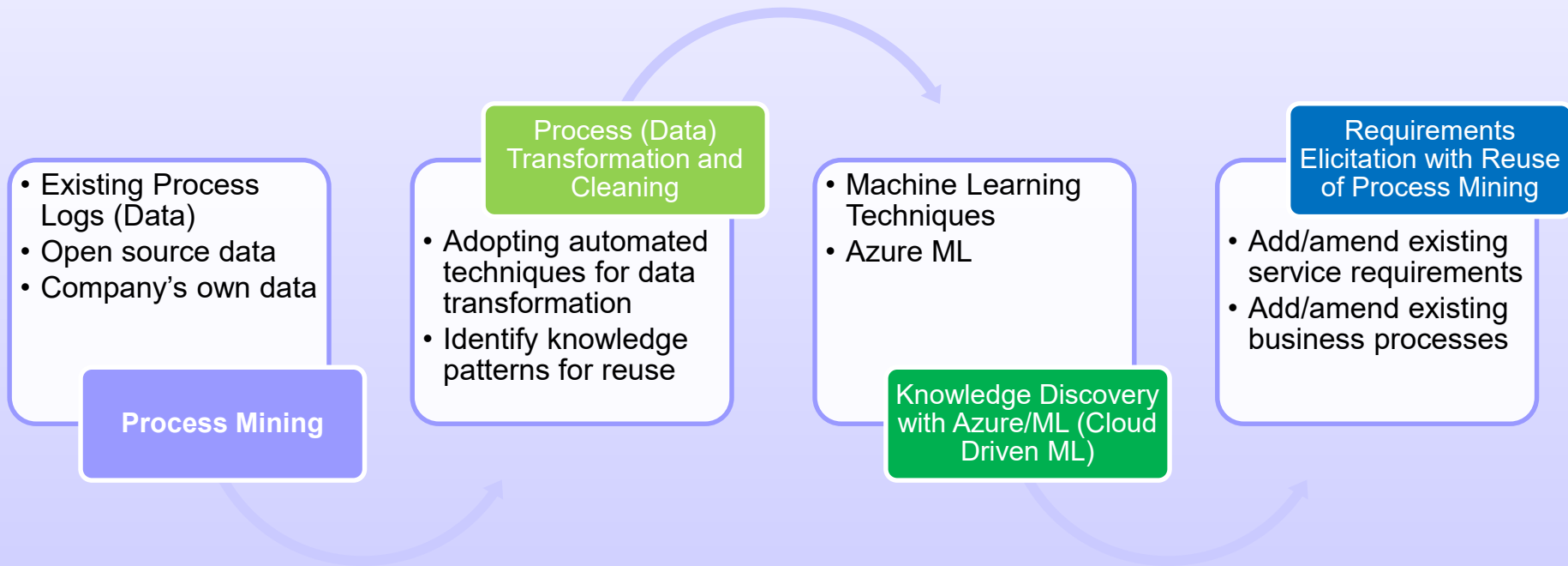


# Business Process Intelligence for Process Innovation

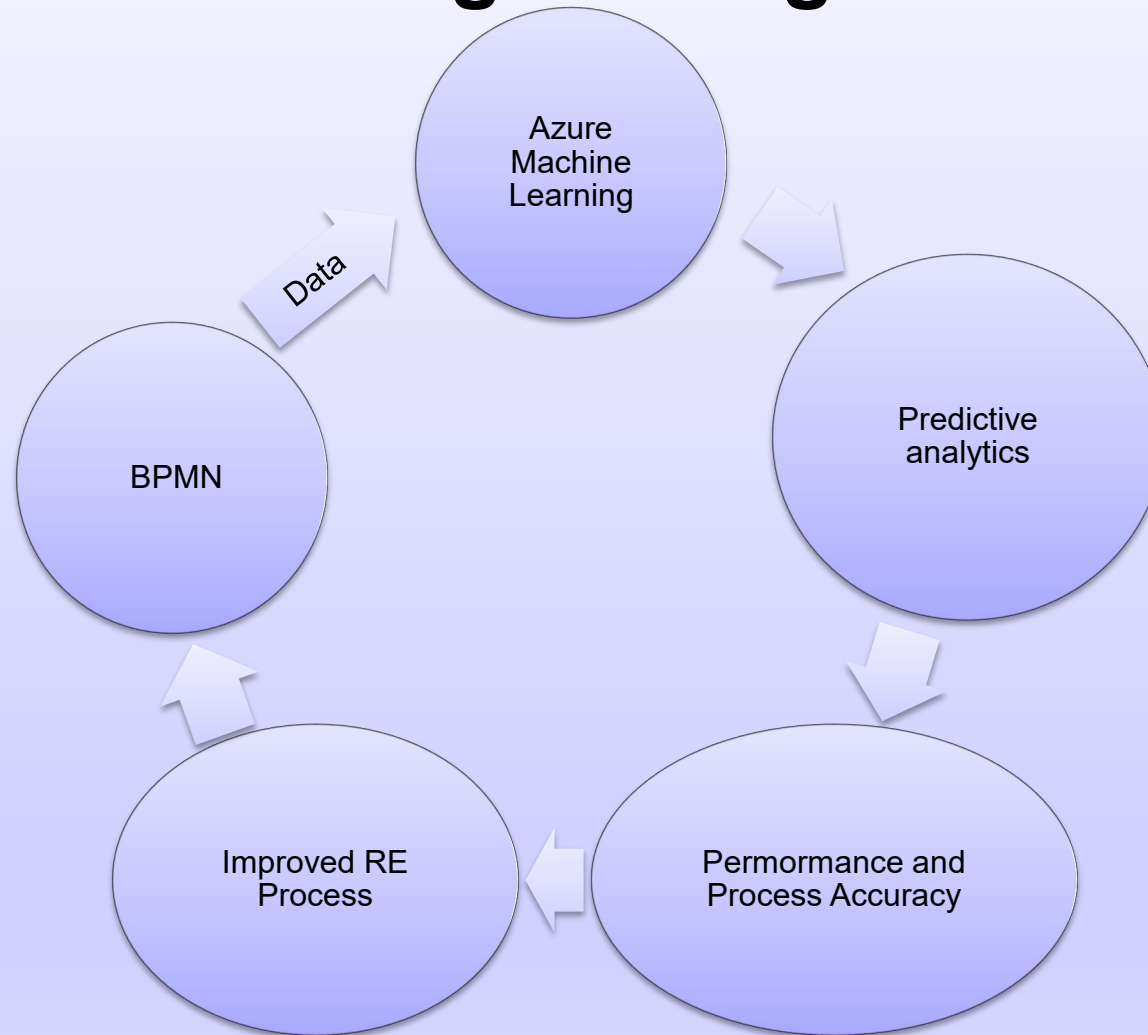
The screenshot displays a web browser window with the URL <https://data.4tu.nl/repository/uuid:7e326e7e-8b93-4701-8860-71213edf0f8e>. The page is titled "Dataset BPI Challenge 2017 - Offer log" and is part of the 4TU Centre for Research Data repository. The left sidebar contains navigation links: Home, Upload datasets, Personal page, Search in Data, and Search in "info". The main content area shows the dataset details, including the title "BPI Challenge 2017 - Offer log", creator "Gerd van Dongen, B.F. (Boudewijn)", contributor "Eindhoven University of Technology", date accepted "2017-02-06", date created "2016-01-01 through 2017-02-01", date published "2017", and description "This event log pertains to a loan application process of a Dutch financial institute. The data contains all offers made for an accepted application in the event log 10.4121/uuid:5f3067df-f10b-45da-b98b-86ae4c7a310b. All of the events in this log are also in the BPI Challenge 2017 event log (10.4121/uuid:5f3067df-f10b-45da-b98b-86ae4c7a310b). This subset is provided for convenience and the IDs are persistent between the two datasets." The page also includes a "metadata for event log" section with fields for doi, name, description, and language.

Event Logs Data of Loan Application Process for a Dutch Financial Institution between 2012-17 as part of BPI Challenge, <https://tinyurl.com/bpic2017>

# Machine Learning for Process Mining: Improving Efficiency of the Business Processes

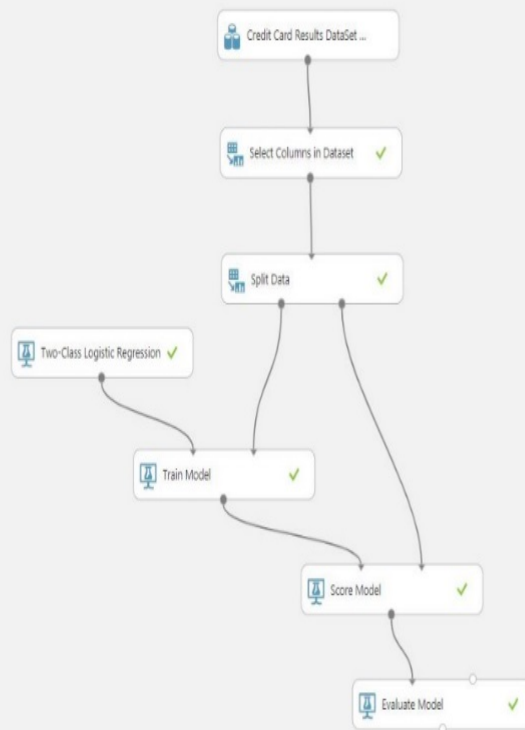


# Machine Learning to Improve Requirements Engineering Process

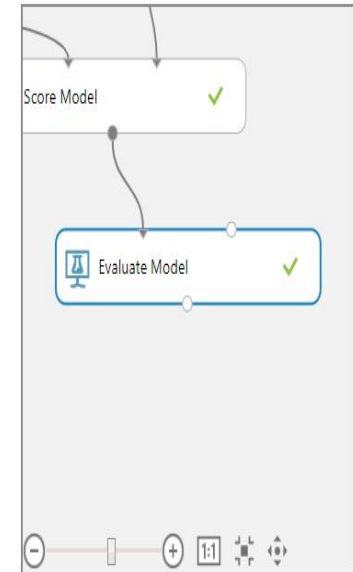
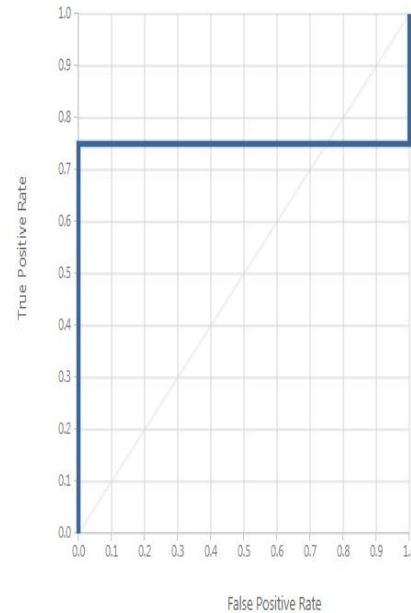


# New Business Process Discovery

Experiment



Experiment > Evaluate Model > Evaluation results



True Positive	False Negative	Accuracy	Precision	Threshold	AUC
2	2	0.714	1.000	0.5	0.750
False Positive	True Negative	Recall	F1 Score		
0	3	0.500	0.667		
Positive Label	Negative Label				
Y	N				

# Key points

- FinTech is emerging and needs to adopt new technologies quickly
- Decisions making is a huge challenge for financial applications and services where AI, ML, Deep Learning can help making decisions and predictions faster
- Smart contract with Blockchain Technology can help building trust with application of BPM and business risk framework

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