



# CELTIC Event

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## CELTIC Keynote Presentation Nurturing the Smart Network On the Application of AI to Network Transformation



*Telefónica*

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# Smart in All Senses



- Fast
  - Not only for data forwarding
  - Management, verification, remediation...
- Stylish
  - Nice to use
  - Simple to understand
  - Straight to tune
- Above all, intelligent
  - Scalable
  - Adaptable
  - Multi-purpose
  - Suitable for integration

smart | smärt |

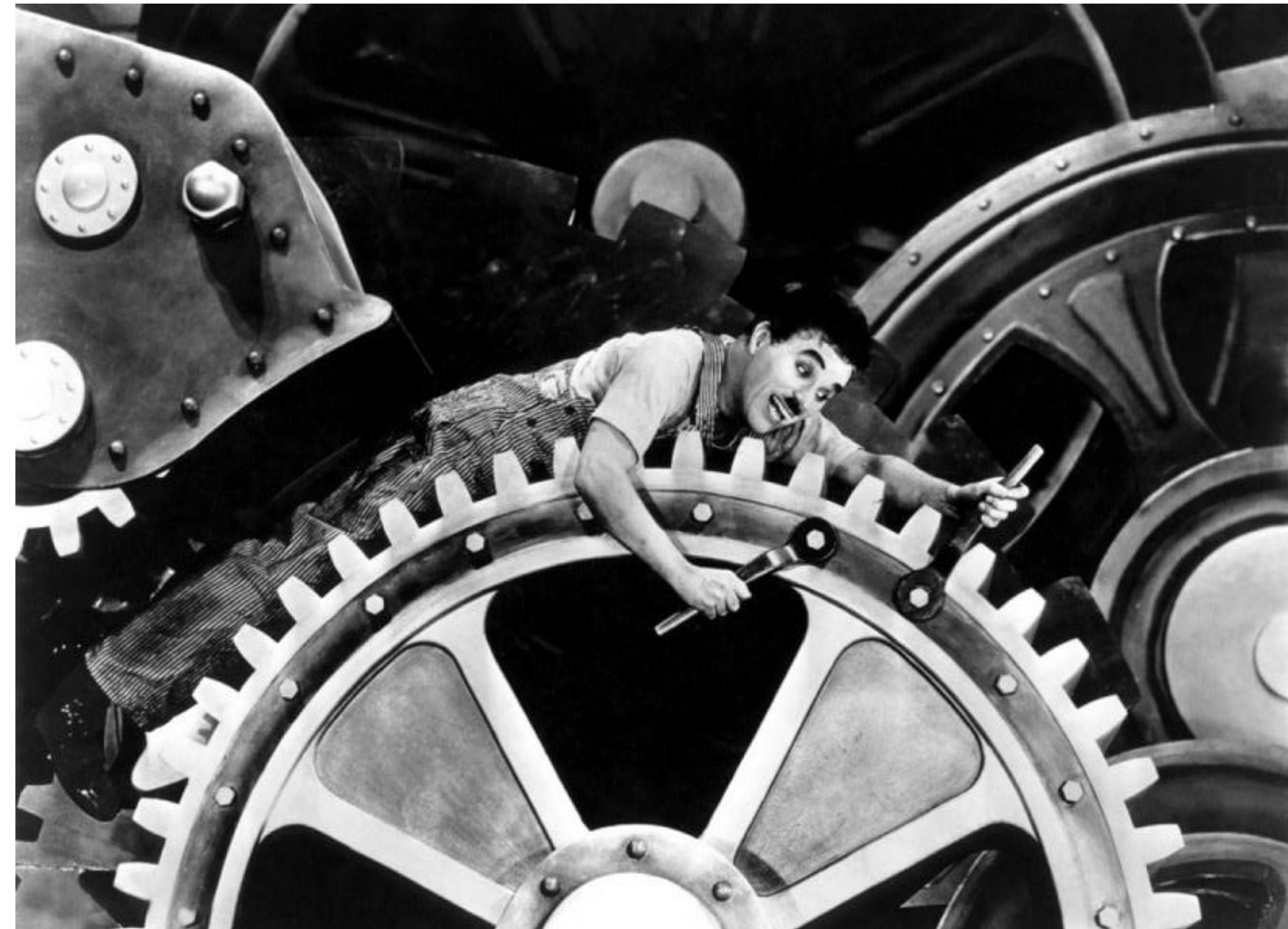
adjective

- 1 *informal* having or showing a quick-witted intelligence: *if he was that smart he would never have been tricked.*
  - (of a device) programmed so as to be capable of some independent action: *hi-tech smart weapons.*
  - *chiefly North American* showing impertinence by making clever or sarcastic remarks: *don't get smart or I'll whack you one.*
- 2 (of a person) clean, neat, and well-dressed: *you look very smart.*
  - (of clothes) attractively neat and stylish: *a smart blue skirt.*
  - (of a thing) bright and fresh in appearance: *a smart green van.*
  - (of a person or place) fashionable and upscale: *a smart restaurant.*
- 3 quick; brisk: *I gave him a smart salute.*
  - painfully severe: *a dog that snaps is given a smart blow.*

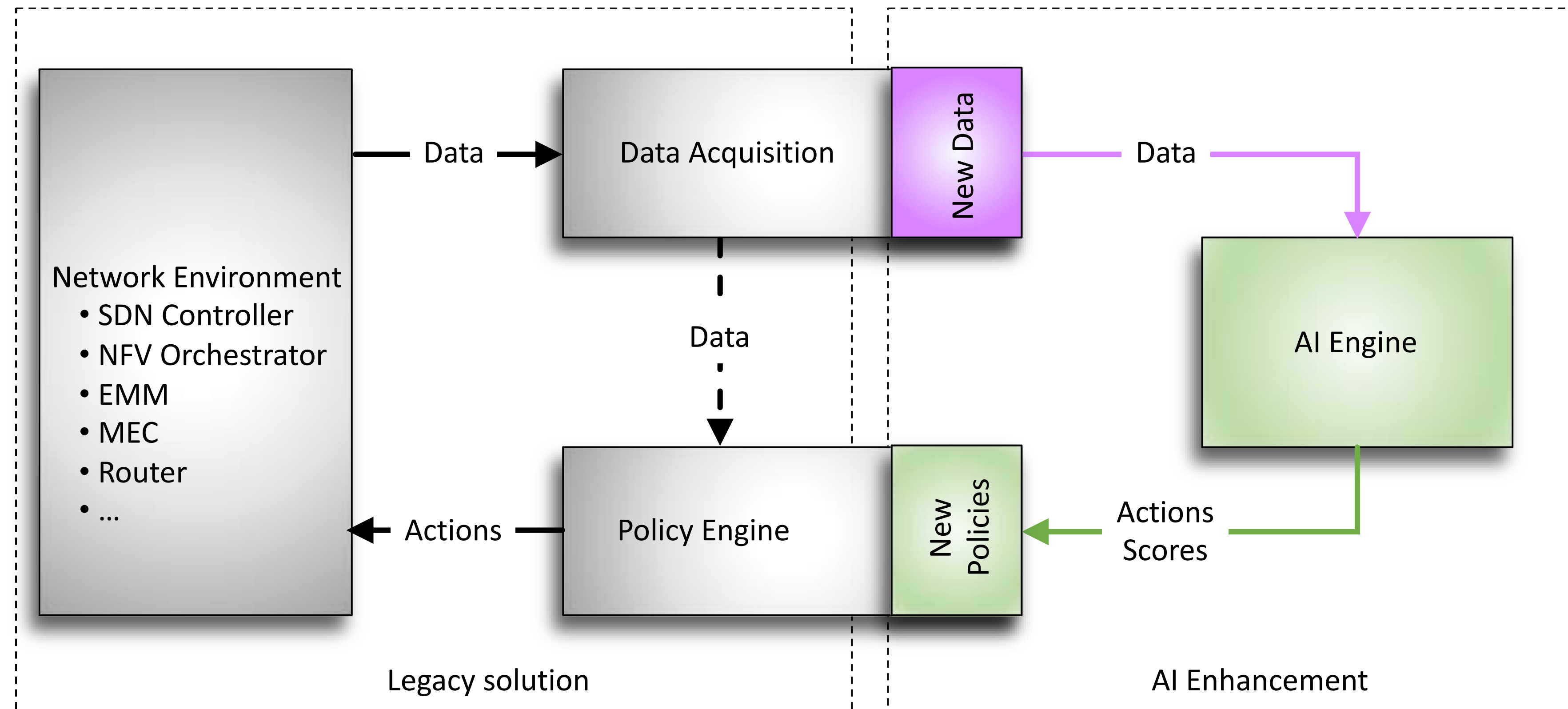


# The Raison D'être: Transformation

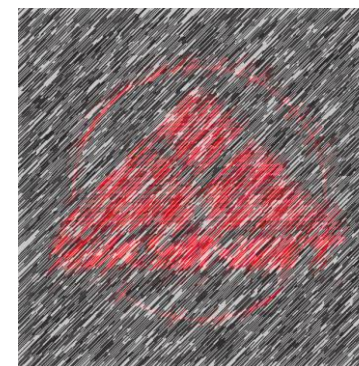
- Taking advantage of Software Network technologies
  - Elasticity
  - Homogeneity
  - Programmability
  - Abstraction
- In a changing network landscape
  - Pervasive encryption
  - Internet stack evolution
  - And the advent of 5G



# The Essential Closed Loop



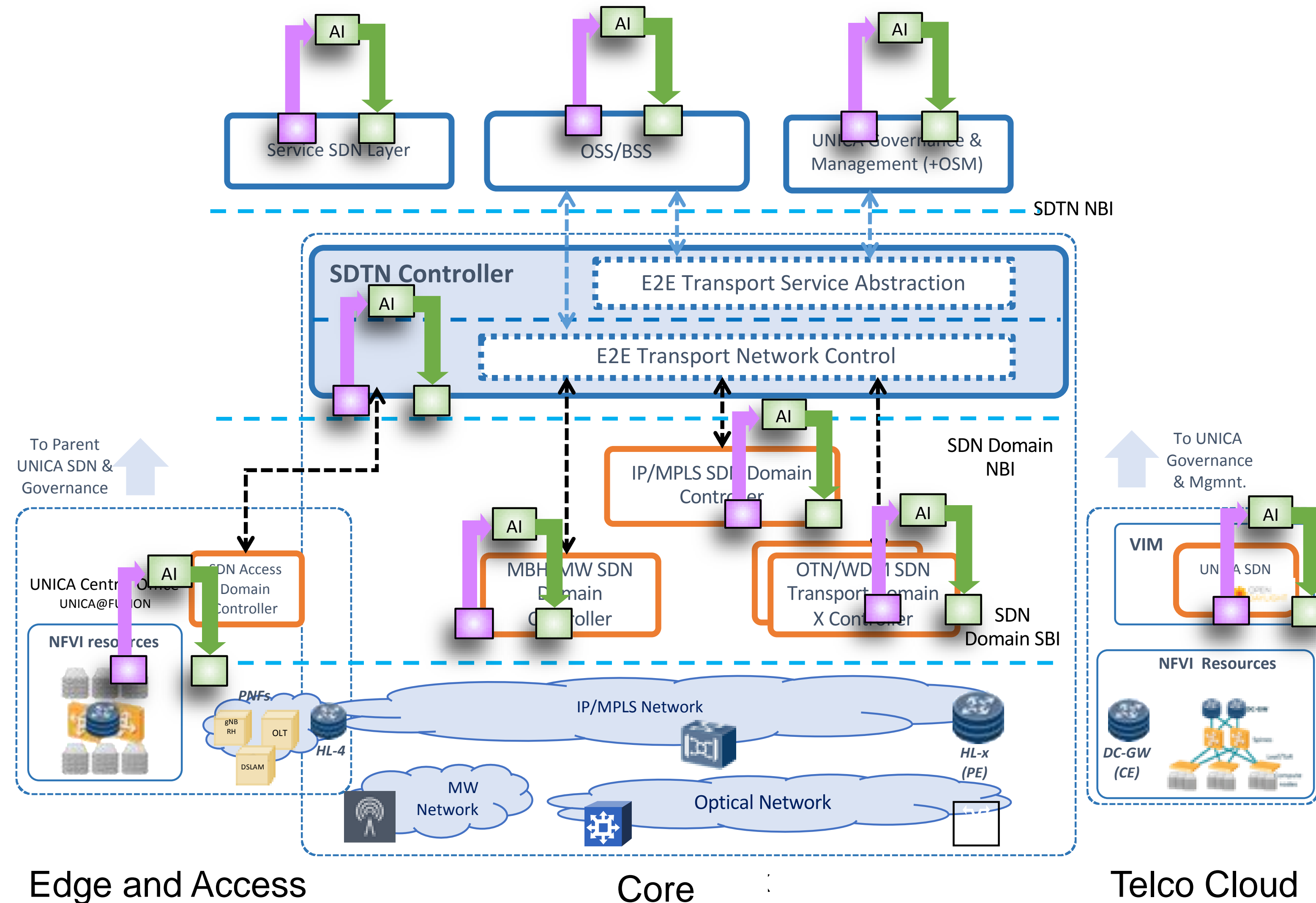
- Not a radical change
  - AI as a tool to improve policy enforcement
  - Apply extended capabilities, but do not expect Skynet



- The key issues are not in the engine
  - But in the data and action flows
  - Including distribution and placement of the engine(s)

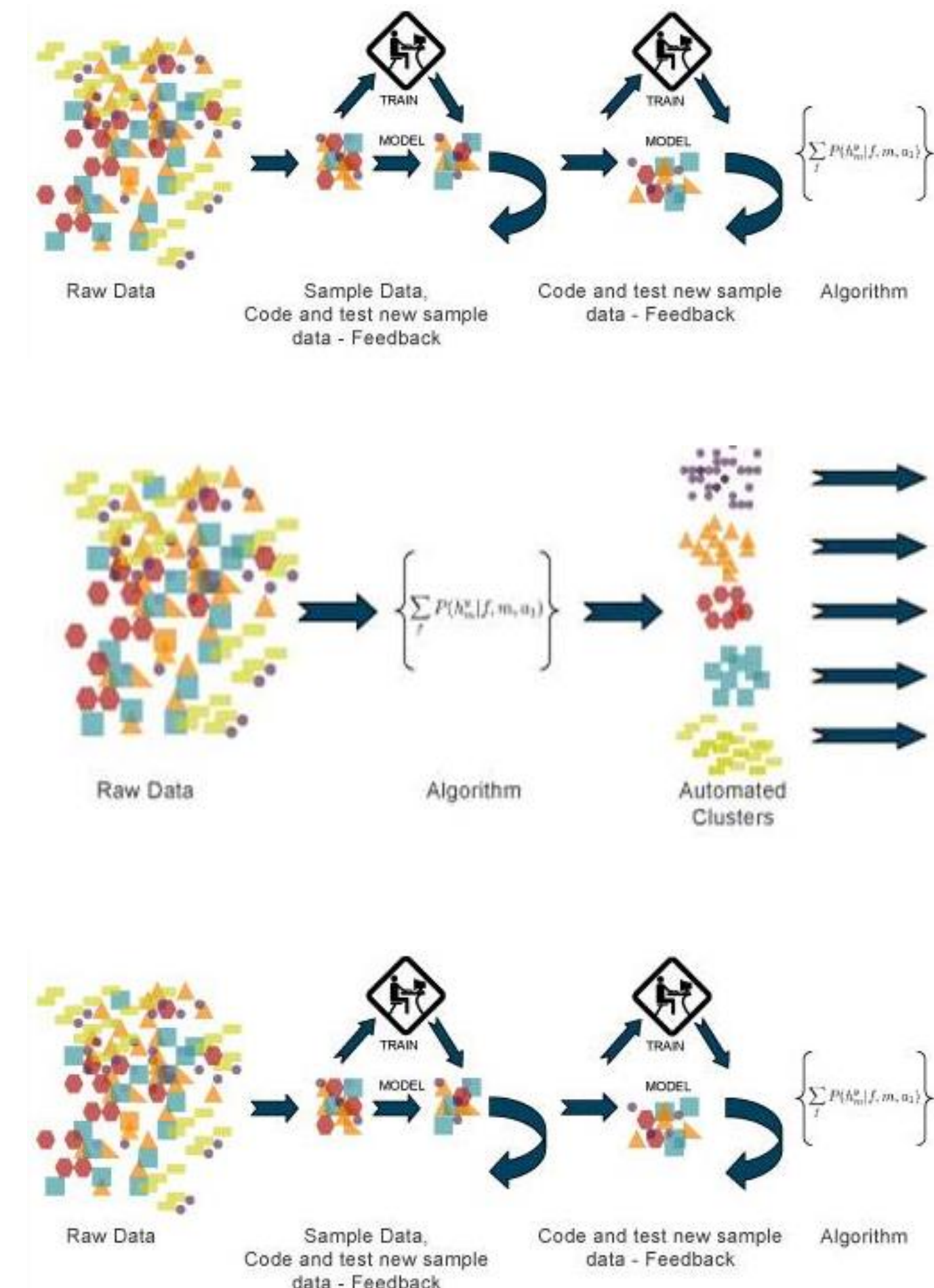


# At Any Layer and Segment



# A Double Loop for ML

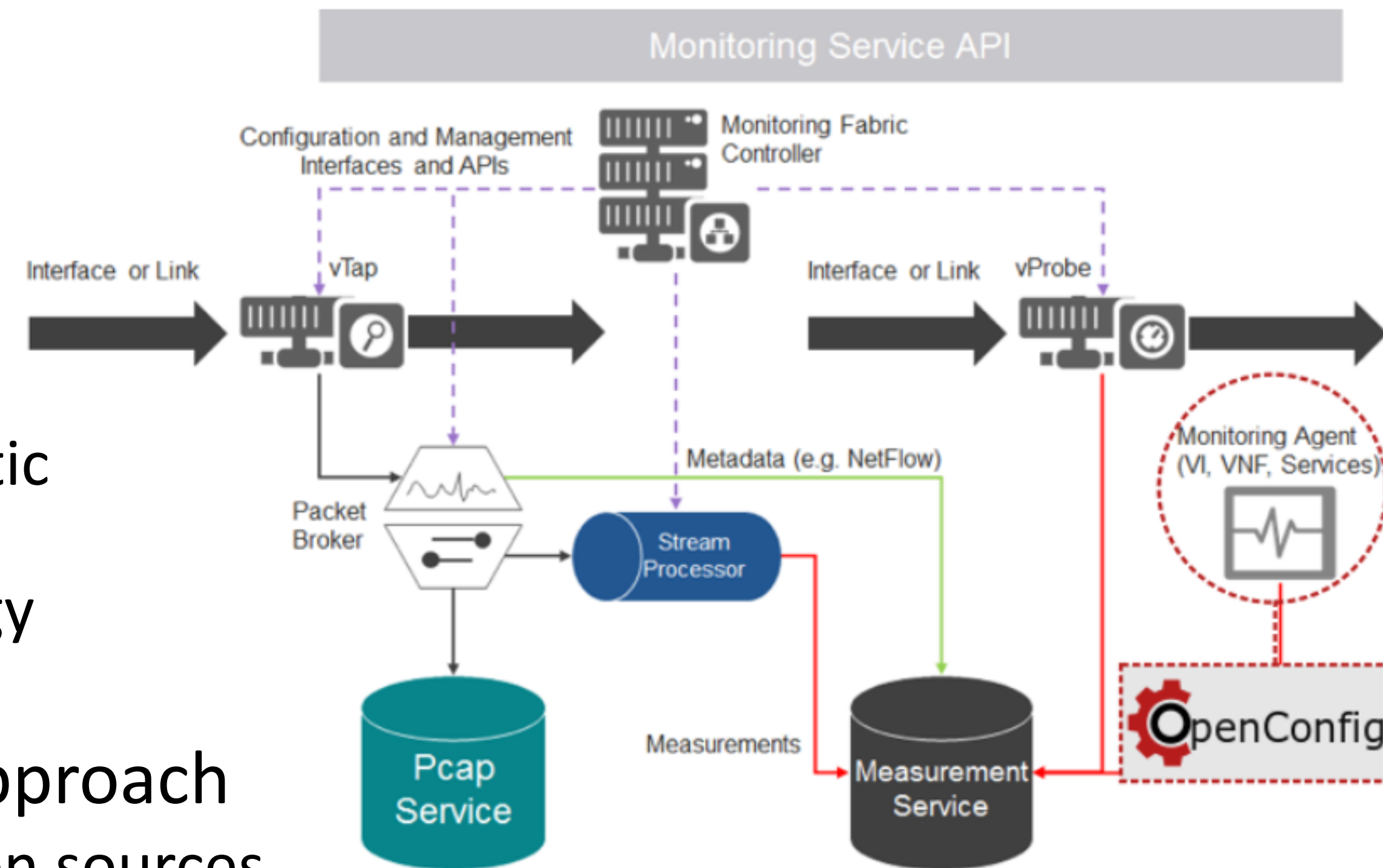
- A loop for application, a loop for learning
- The AI engine at the intersection of both
  - Using its actions stream as part of the data stream of the learning loop
- Different kinds of learning according with the action stream in the learning loop
  - As a closed loop: supervised
  - As an open loop: unsupervised
  - Composed with the application loop action stream: reinforcement
- And other mechanisms possible
  - Including the initial inputs from human experts





# The Data Stream

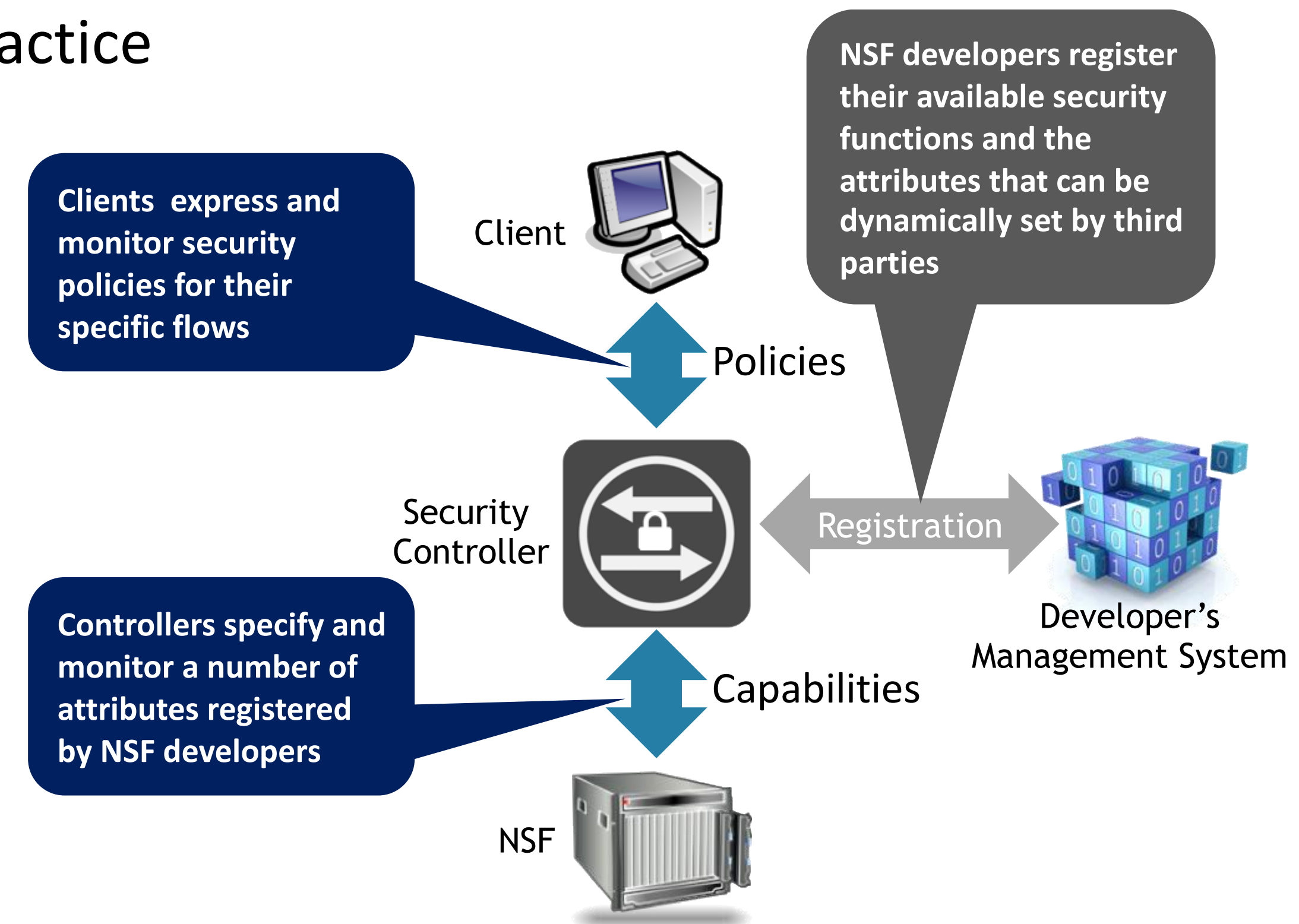
- No matter how intelligent: Crap in means crap out
  - Usable: Adaptation (formats, scales...)
  - Sufficient: Topology (sources, aggregators...)
  - Safe: Provenance (origin, timestamps...)
  - Steady: Continuity (pace, availability...)
- Not just data
  - Metadata becomes essential, including semantic mappings
  - What seems to claim for a data stream ontology
  - Not that far away: data modeling is a first step
- An enhanced data fabric seems the logical approach
  - Supporting resource, orchestration and function sources
  - Combining current network monitoring tools and recent telemetry developments



# The Action Stream

- OAM actions at a wide variety of different domains
  - Challenging for current network management practice
- Initial strategies
  - Domain specific
  - Recommendation systems
  - Autonomic protocols

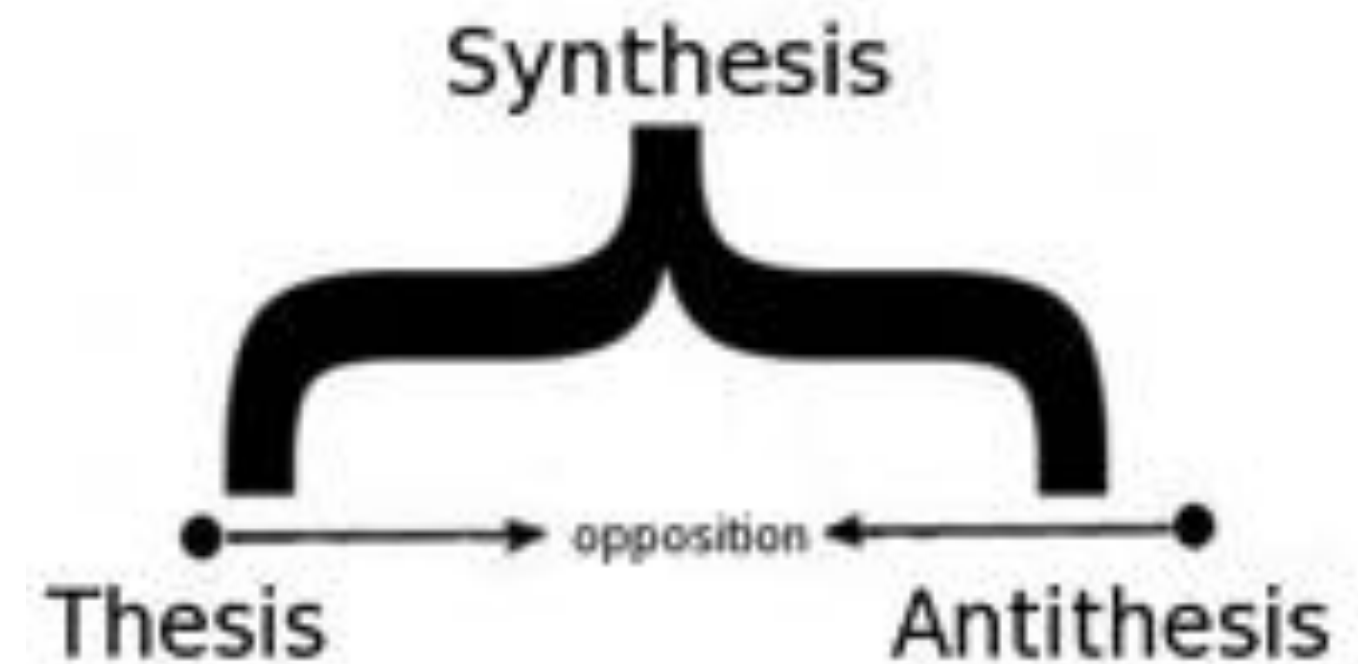
- Capability models
  - Reusable functionality description
  - Abstractions of network element functionalities usable as building blocks
  - Combined to provide more powerful features
  - Registration mechanisms to support CI/CD
  - Inter-domain collaboration for E2E management





# The Human in the Loop

- The dialectic way
  - Thesis: Translate intent into action
    - Understanding intent statements
    - Mapping onto technologies
  - Antithesis: Support environment constraints
    - Policies provided by network management
    - The archetypal SLA enforcement
  - Synthesis: Conflict resolution
    - Among action requests
    - And with management constraints
- Audit track and intelligibility
  - The who, the what, the when
  - And the why
- And security
  - Deal with adversarial AIs
  - And consider circuit breakers



# The Architectural Mapping

- Networks are critical and naturally distributed systems

- A distributed AI for managing them

- The nature of distribution

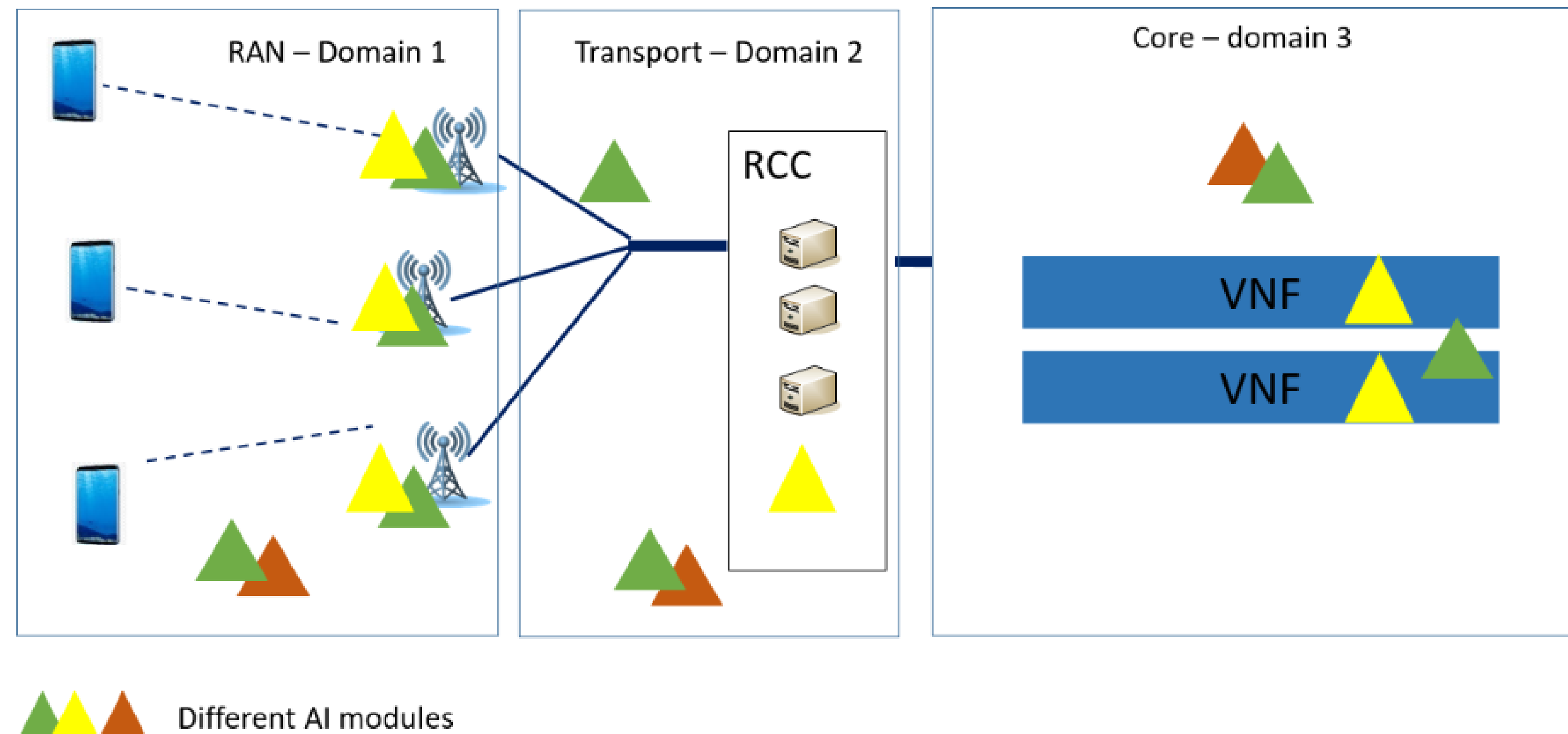
- Aggregation of knowledge
- Accumulation of decisions
- Cooperative vs independent vs selfish
- Fixed vs mobile vs roaming

- Topologies

- The mapping on the network topology
- Depth and breadth
- Nervous system approaches

- Protocols

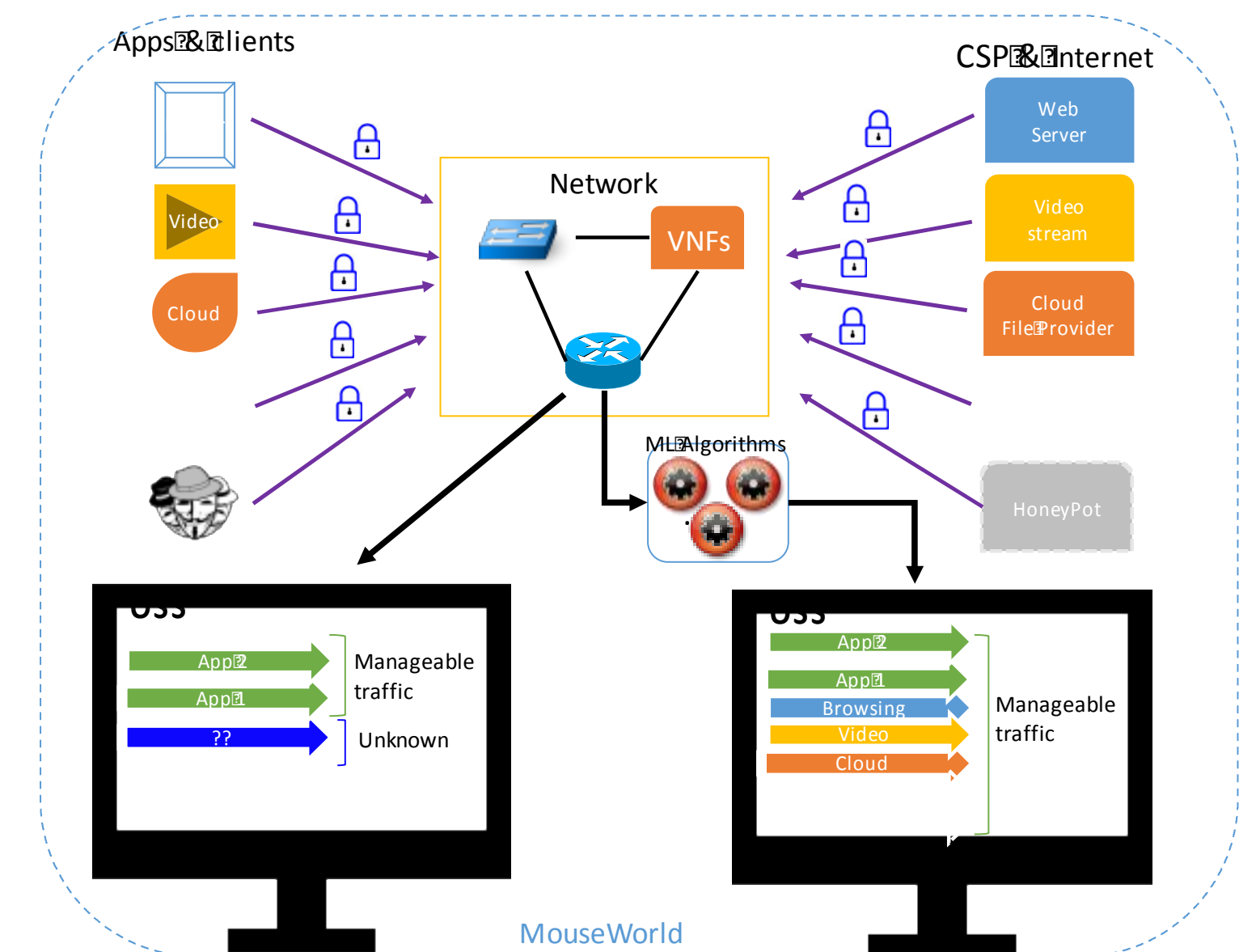
- Specific knowledge and policy exchanges
- Reuse stream mechanisms
- Apply good-ole BGP and others of its kin





# Data Thirst

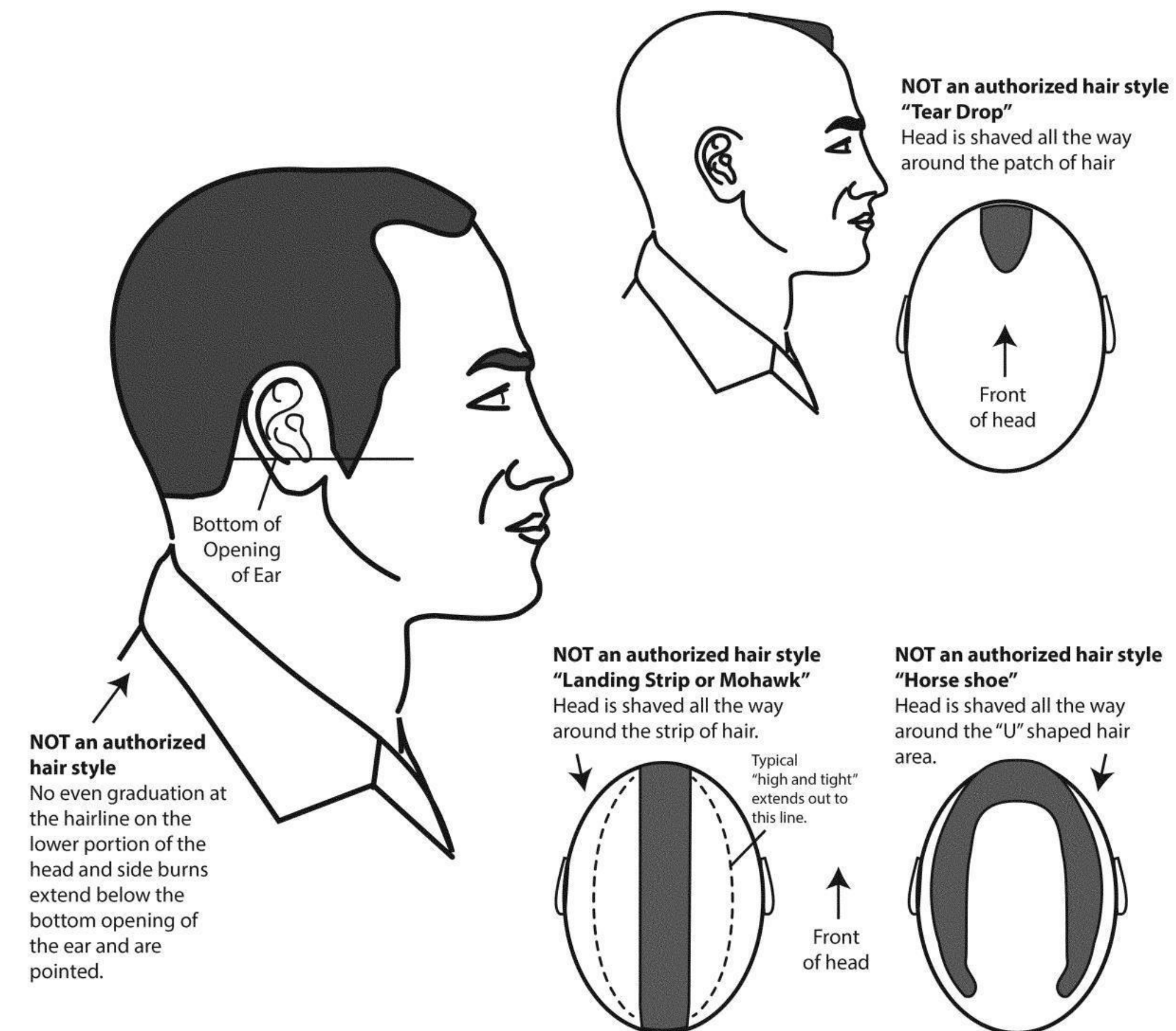
- Serious lack of usable datasets
  - For training or validation
  - Data as an asset
  - Privacy concerns
  - None or limited tagging
- Generation of synthetic datasets
  - Traffic samples generated in a controlled way
  - Configurable mixes of synthetic and real traffic
- And metadata management
  - Different scenarios, from high loads to security threats
  - Training and validation loops
- Relying on Software Network principles
  - Repeatability and reproducibility
  - Controlled variations



# Standards Taking Shape



- Elements required for interoperability
  - Framework components
  - Stream protocols, APIs and models
  - Topology and knowledge sharing
- ETSI
  - ENI as the focal point
  - ZSM as a management enabler
  - NFV as a facilitator
  - Discussions on a group on secure AI application
- IETF/IRTF
  - NMRG discussing AI-enhanced management
  - ANIMA as enabler for different stream mechanisms
  - YANG as the substrate of stream models



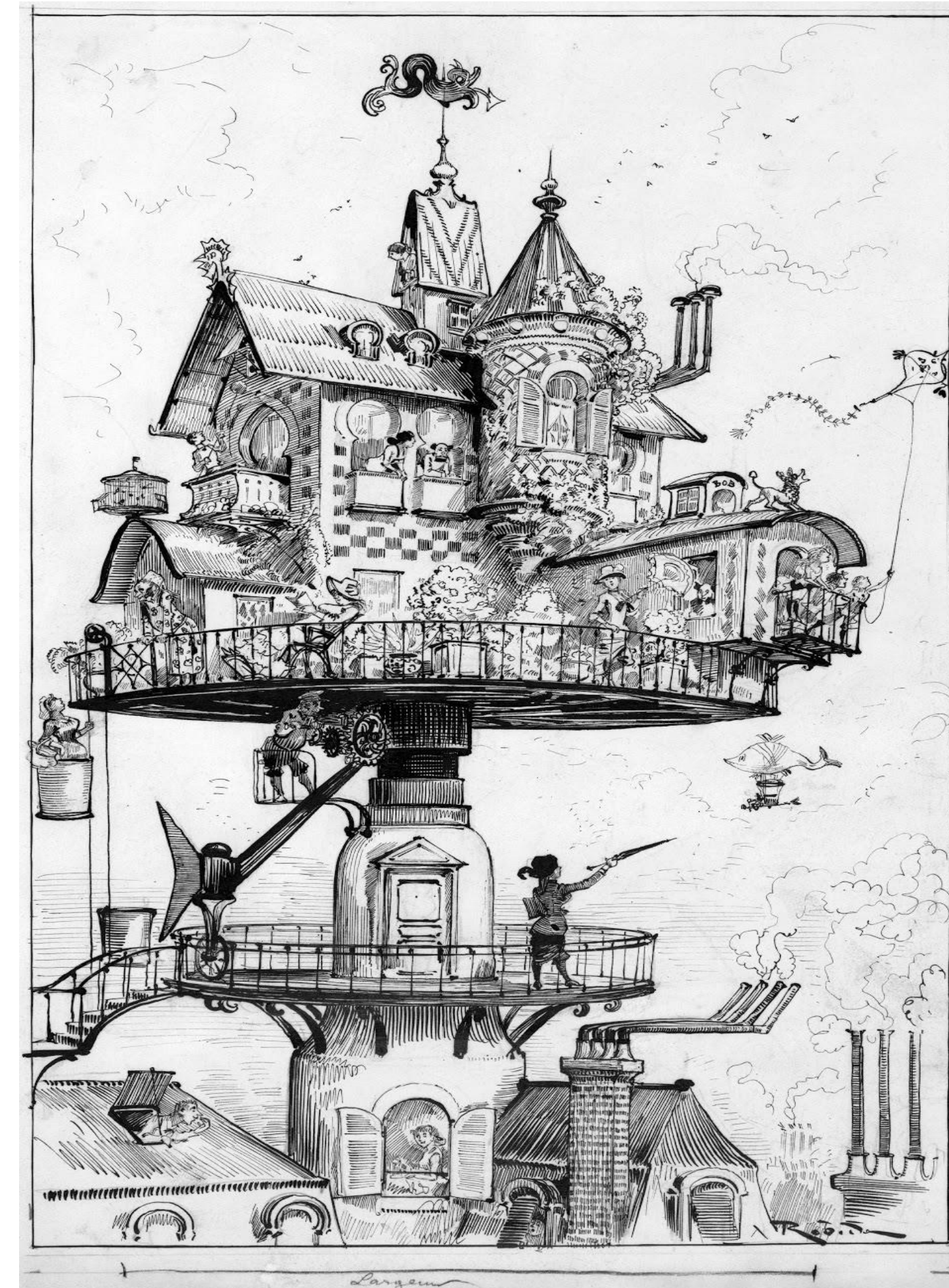


# The Challenges Ahead

## A Matter of Balance



- Network heterogeneous and distributed nature and a holistic view of services and infrastructure
  - Topologies, protocols and models for distributed AI elements
- User requirements and operational policies
  - Intent dialectics and elastic policy enforcement
  - Compositional mechanisms to combine requests in multi-tenant environments
- Regulatory matters and security
  - Data sovereignty and identity management for all entities
  - Non-repudiation and accountability
- Closed loop operation and infrastructure criticality
  - Keep humans in the loop, retaining ultimate understanding and control
  - AI intelligibility and security mechanisms to guarantee proper operation
- Sensing and acting
  - Open and extensible mechanisms for data and action streams
  - Converged data models for definition and monitoring
  - Converged control action representations





# Contact Info

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