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Building Network-Wide AI by Data Flow Composition

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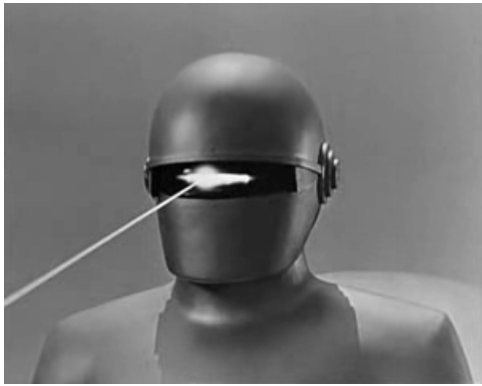
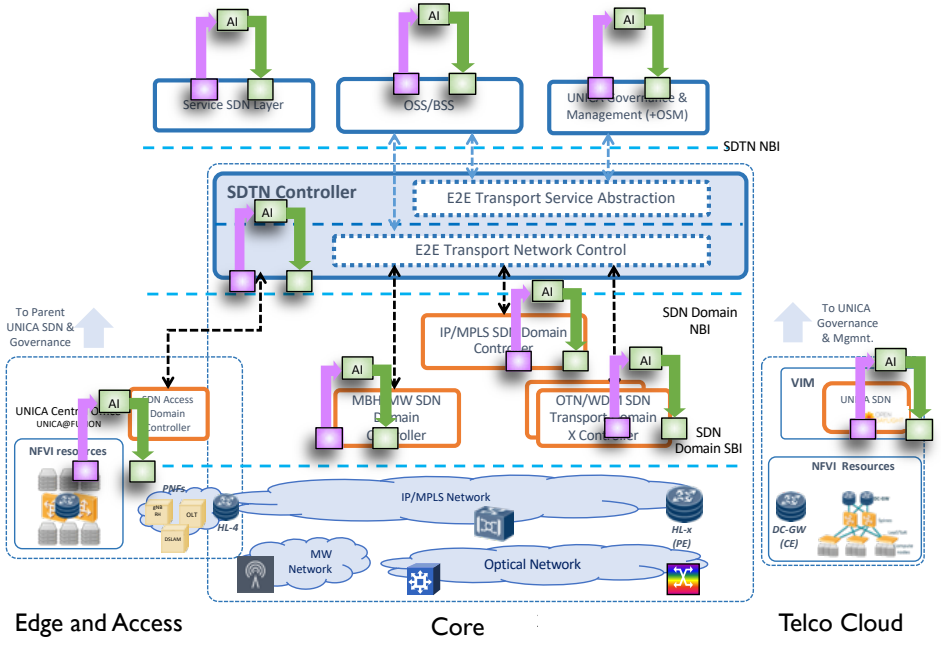
The Autonomous Network Aspiration

- Autonomous Networks are the natural conclusion of curren automation efforts
  - After automatic and autonomic
- Based on a definition of policies and goals
  - Network intents
  - Policy enforcement and propagation
- Detection and action
  - Dynamic identification
  - Adaptable response
- Extending the well-known closed-loop approaches
  - Using AI to derive further insights and improve policy mapping



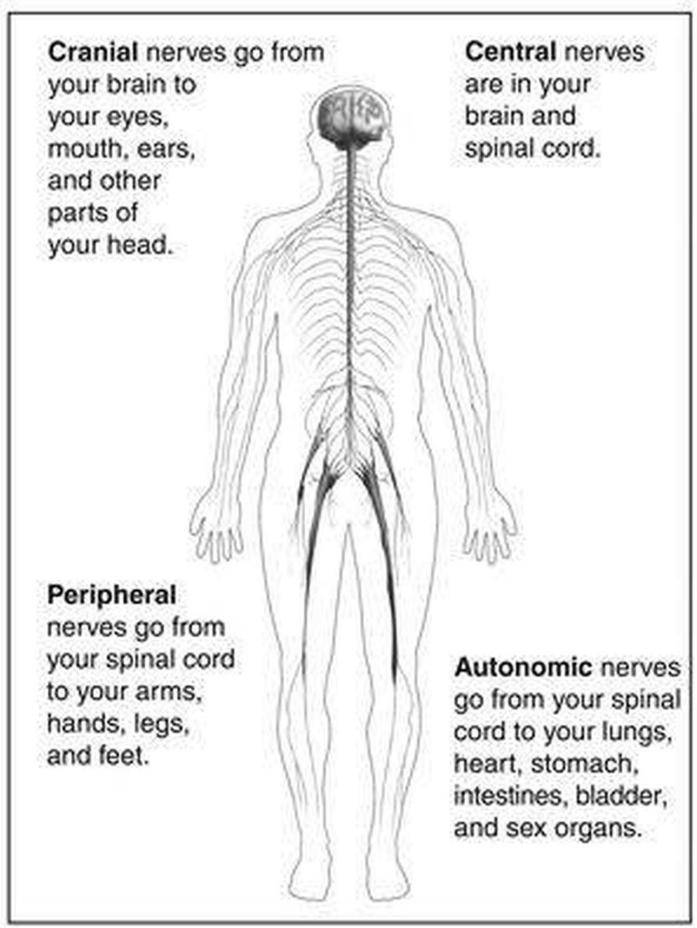
A Brave New World for AI

- Networks are critical and naturally distributed systems
  - A distributed AI for managing them
- Beware the network differential facts
  - Topology (and geometry!) awareness
  - The conservation principle
  - The *laser effects*
  - Openness
  - Integrity and auditability
  - Isolation
- Multi-domain and (close to) real-time
  - Depth: local vs holistic
  - Breadth: consider network segments
  - Mapping on the network management structure



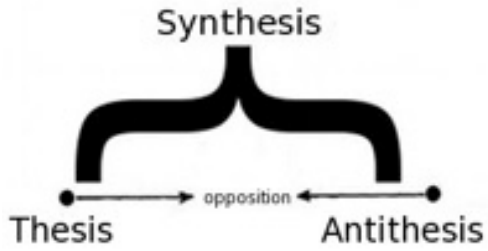
The Nervous System Paradigm

- Combine distributed architectures and holistic approaches
- Local loops
  - Detailed analysis
  - Fast response
  - Dynamic deployment
- Central loop(s)
  - Cumulated analysis
  - Integral view
  - Explicability
  - Local loop orchestration
- All using a common impulse for all kind of interactions
  - Central elements receive and process aggregate information
  - A common data infrastructure for forwarding and aggregation



The Ratiocination Loop

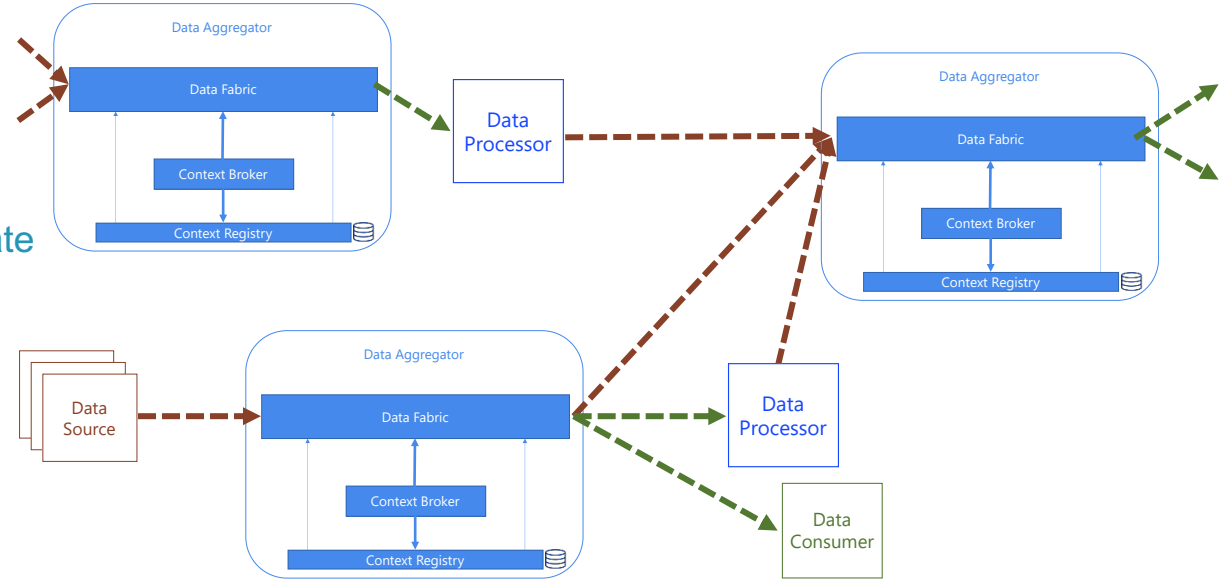
- The dialectic way
  - Thesis: Translate intent into action
    - Understanding intent statements
    - Mapping onto technologies
  - Antithesis: Support environment constraints
    - Policies provided by network management
    - The archetypal SLA enforcement
  - Synthesis: Conflict resolution
    - Among action requests
    - And with management constraints



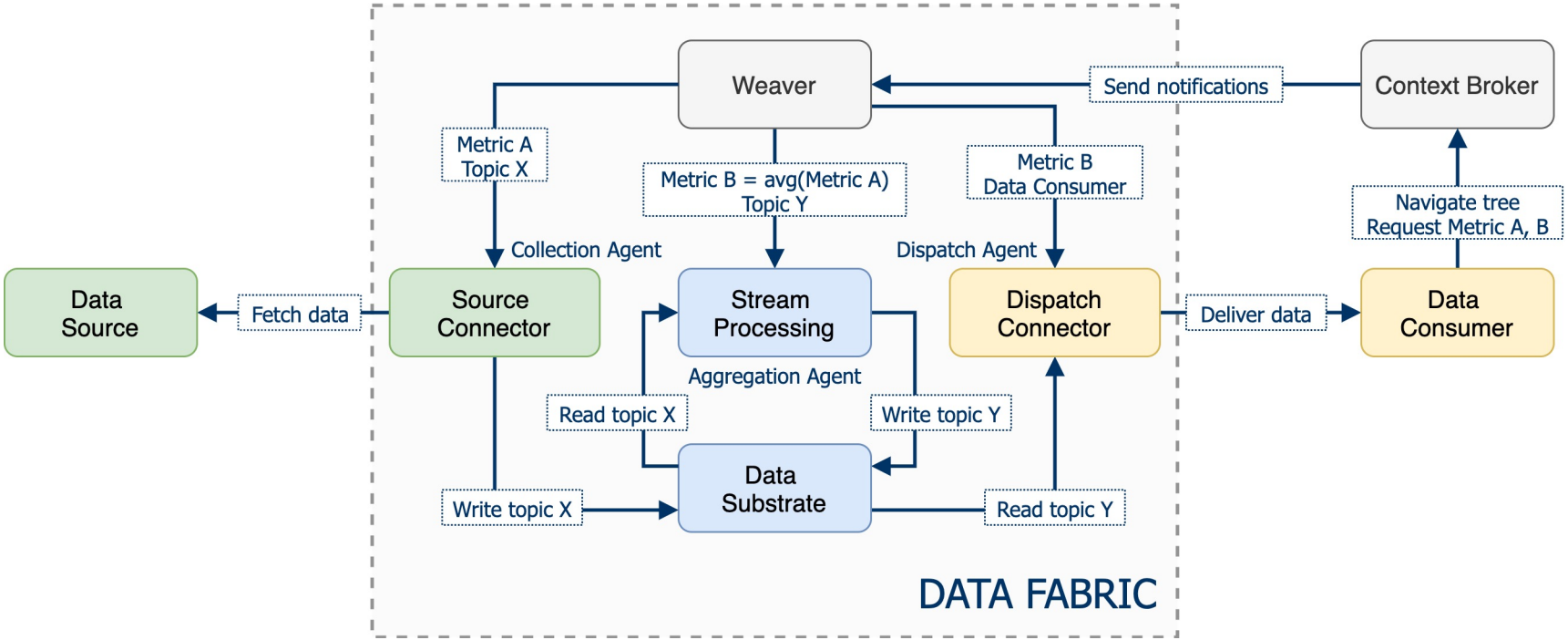
- Audit track and intelligibility
  - The who, the what, the when
  - And the why
- And security
  - Deal with adversarial AIs
  - And consider circuit breakers

Building the Nervous Data Infrastructure

- Rely on aggregation nodes
  - Sources feed data
  - Consumers receive them
  - Aggregators map and integrate
- Based on metadata
  - Dynamic composition
  - Transport protocol agnostic
  - Telemetry data models
  - Knowledge ontologies
- Compositional patterns
  - Any element can play any role
  - AI / ML supported anywhere

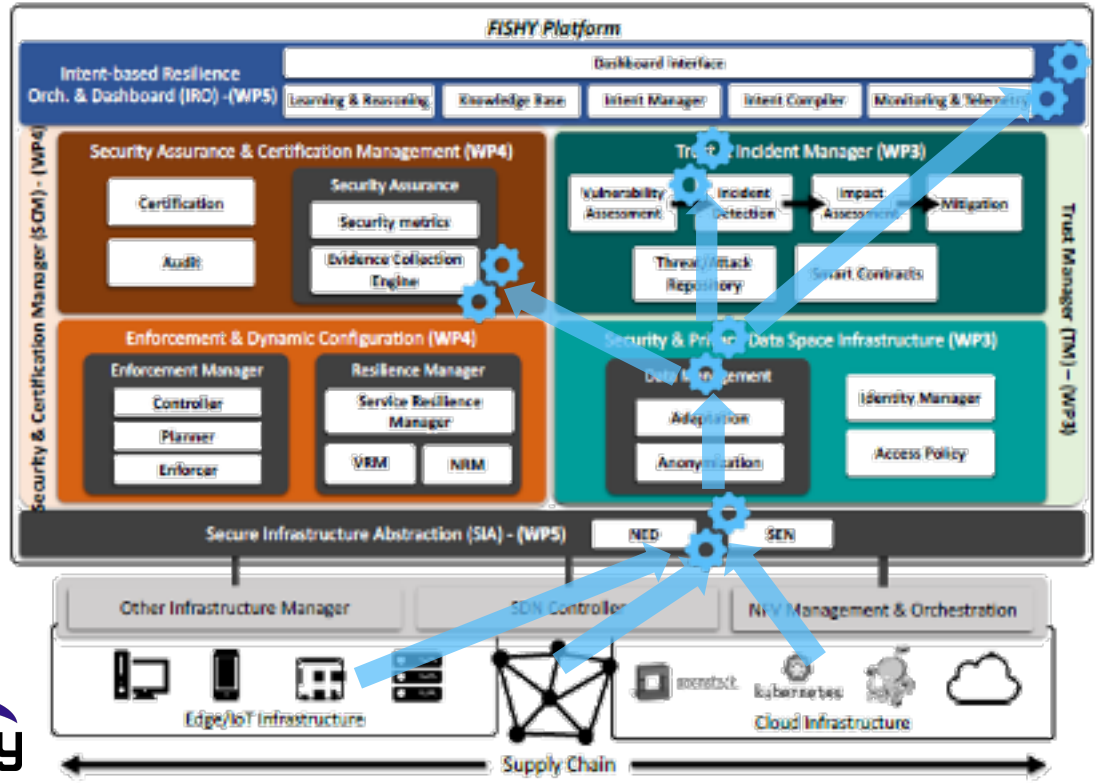


The Core Element: 5Growth Data Aggregator



Autonomous Security at the ICT Supply Chain

- Data consumers and processors
  - Intent-based Orchestrator and Dashboard
  - Assurance and Dynamic Configuration
  - Trust and Incident Management
- Several potential layers of data aggregators
  - Security Data Space Infrastructure
  - Secure infrastructure Abstraction
  - Intent-Based Resilience Orchestrator

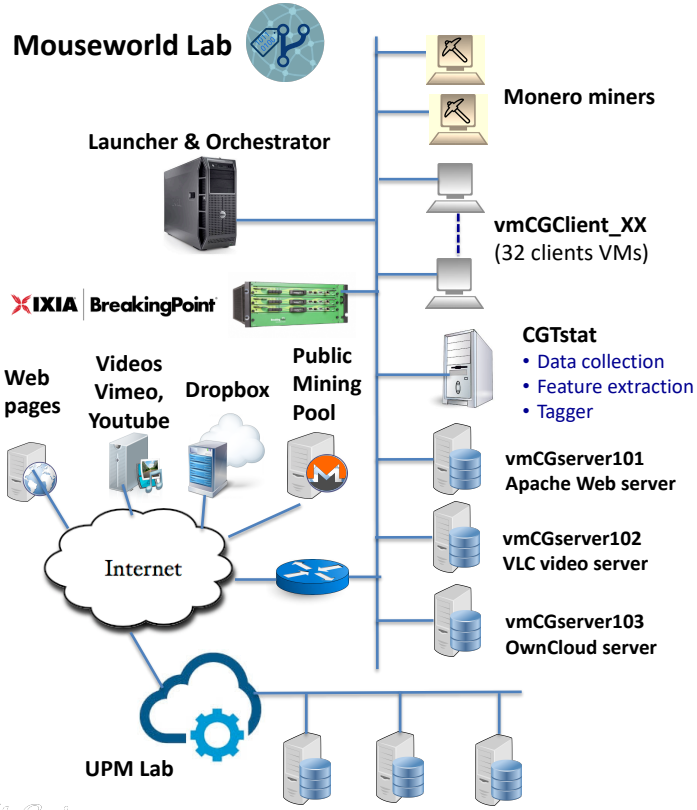


FISHY

Replication in the Digital Era

- Digital twins are digital replications of physical entities that enable data to be seamlessly transmitted between the physical and virtual worlds
  - Facilitate the means to monitor, understand, and optimize the functions of the replicated entities
- Originally applied in manufacturing industry processes and machinery
- Main elements
  - Sensors and actuators, so that digital twins can replicate the real twin behavior
  - AI, in order to make fast and intelligent decisions on behalf of their real twin.
  - Communication, to interact in near real time with the environment, real twins, and/or other digital twins
  - Representation, from a 3D avatar to a graphical dashboard, depending on the application domain
  - Trust, for real twins to trust their digital twin
  - Privacy and security, including the resolution of regulatory and political issues

The *Mouseworld*, Synthetic Traffic and beyond



- Originally conceived as an environment for security experimentation
  - Later applied to AI/ML training and validation
  - Suitable to evolve into a network digital twin
- Able to incorporate applications, functions and topologies
  - Virtualized network functions
  - Emulators of physical network functions
  - Traffic traces (network data) to be injected.
- Using a model-based approach
  - Simple reconfiguration
  - Differential analysis of alternate scenarios
- Repeatable and controlled conditions and variants
  - SDN/NFV
  - Data infrastructure orchestration

Making the Autonomous Closed-Loop Feasible

- Signal flows in networked architectures
  - Matching controllers to plants
- The nature of distribution
  - Aggregation of knowledge
  - Accumulation of decisions
  - Cooperative vs independent vs selfish
  - Fixed vs mobile vs roaming
- Communication issues
  - Metadata distribution
  - Specific knowledge and policy exchanges
  - The reuse of stream mechanisms
  - Aggregator orchestration
- The application to the other kind of signals
  - The issue of an *Action Infrastructure*