

# SDN/NFV-based Smart Industrial Enterprise Use Case: Remote Asset Monitoring

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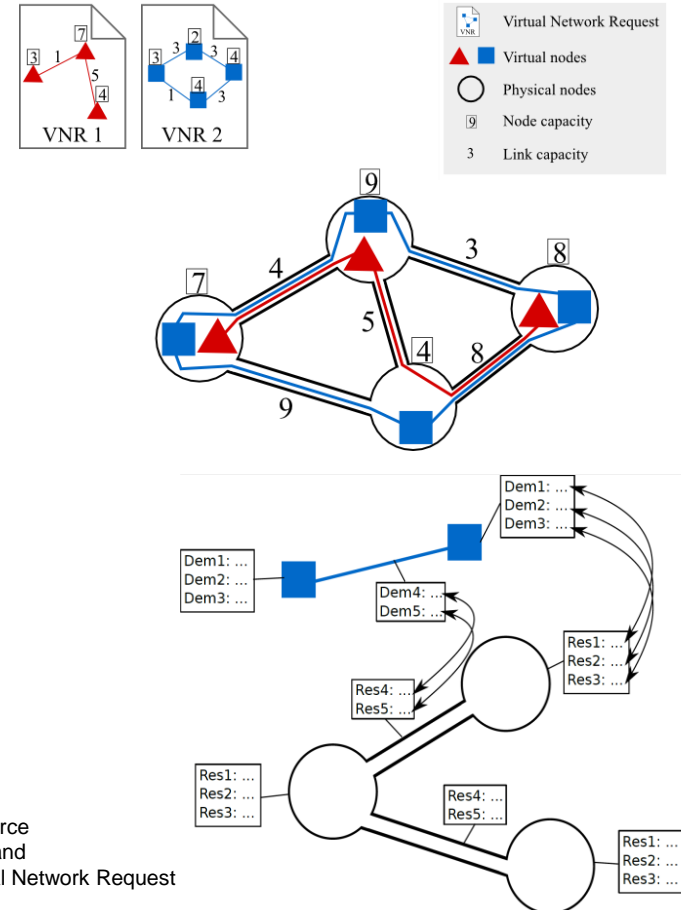
- Industry 4.0 enterprise applications will support the smart factory:
  - Data analysis
  - Autonomic decision making
- Monitoring, analysis, and management functions at different levels of the enterprise
- Remote asset monitoring is required when the administrators manage different distant locations:
  - Safety
  - Energy management
  - Utilization
  - Security
  - etc..



- IoT enables remote asset monitoring:
  - Installing wireless sensors throughout the factory
  - Integrating them via an Internet gateway
  - Deployment of data acquisition and analysis functions at the edge and central data centers, respectively
- Challenges:
  - Defining event patterns: sensing areas, thresholds
  - Application traffic characteristics and requirements
  - Autonomic, flexible, and location-aware function deployment

# Background: VNE

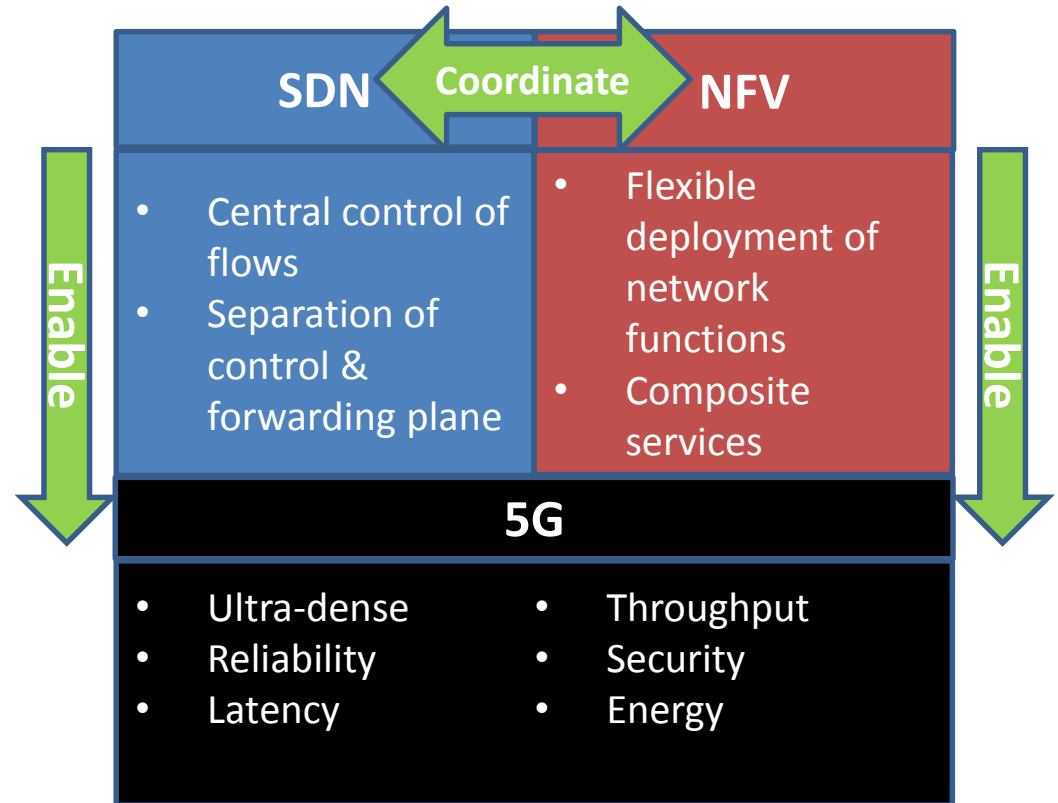
- Virtual Network Embedding: Deploying multiple Virtual Networks (VNs) on a single substrate network
- NP-hard problem - efficiency requires heuristics
- Most VNE algorithms are performance oriented and optimize for cost and admission ratio
- Model: Resource-Demand pairs
  - Virtual nodes or links pose demands for certain matched resources
  - Used for performance-oriented algorithms
  - Can be extended to model node capabilities and **location-awareness**



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# Background: Future Mobile Network

- Future mobile networks based on SDN/NFV
- Network functions pose qualitative constraints to the construction of a composite service
- Coordinated SDN/NFV enables 5G
- Industry as an application domain of 5G (in particular remote management)

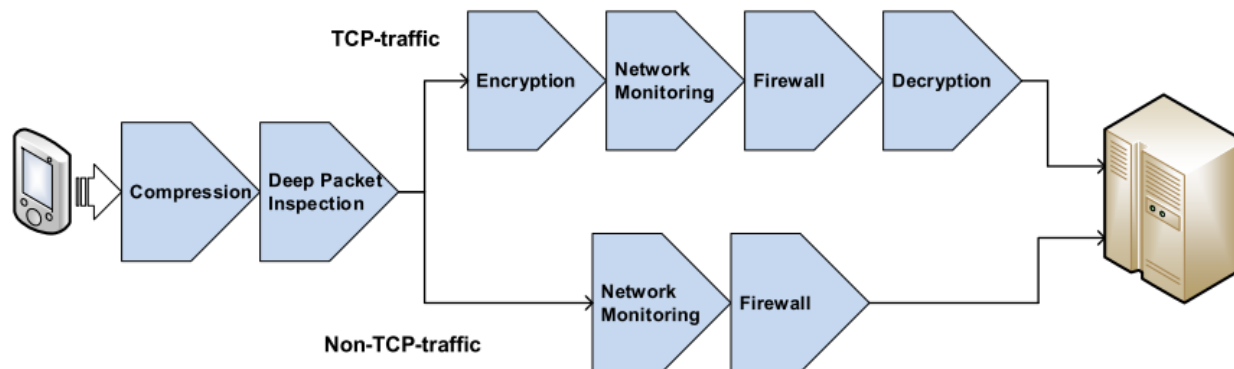


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# Background: NFV Mapping Problem

- The combination of network functions imposes a topology
- This topology is not fixed
  - Several variations might be possible
  - E.g., encryption before or after compression?
- This has effects on resource usage – some variations may be easier on resources than others
- Problem is somewhat similar to VNE

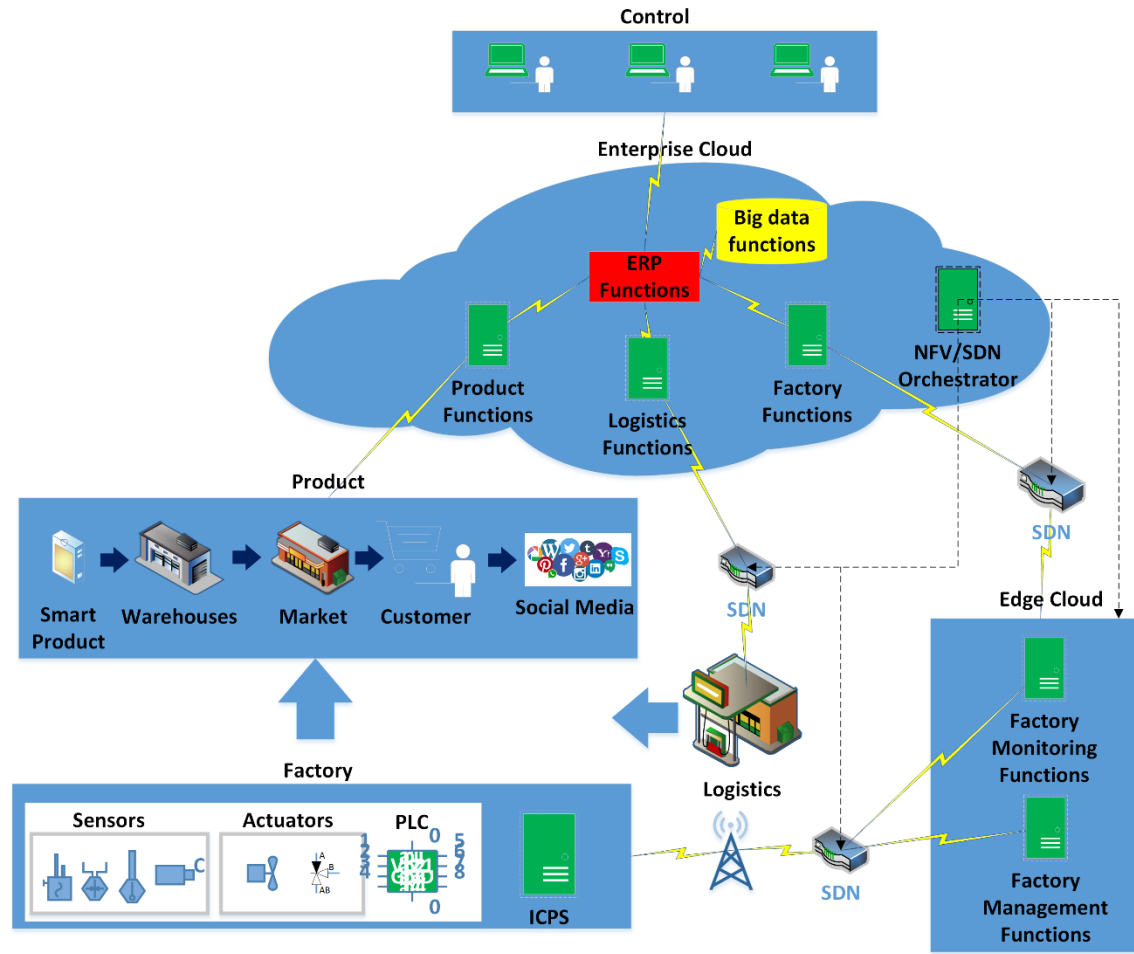


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- Combine VNE, NFV and SDN to:
  - Efficiently deploy industrial enterprise applications
  - Satisfy their requirements
  - Reconfigure the application in response to network events
- Steps:
  - Application model:
    - End nodes and locations
    - Requirements: throughput, latency, resilience
  - Wide-area industrial network model
  - Mapping algorithms for application and chain embedding:
    - Chain composition (function capacities and forwarding graphs), chain placement, communication flows (SDN)
  - Resilience algorithms (e.g. redundancy in chains)

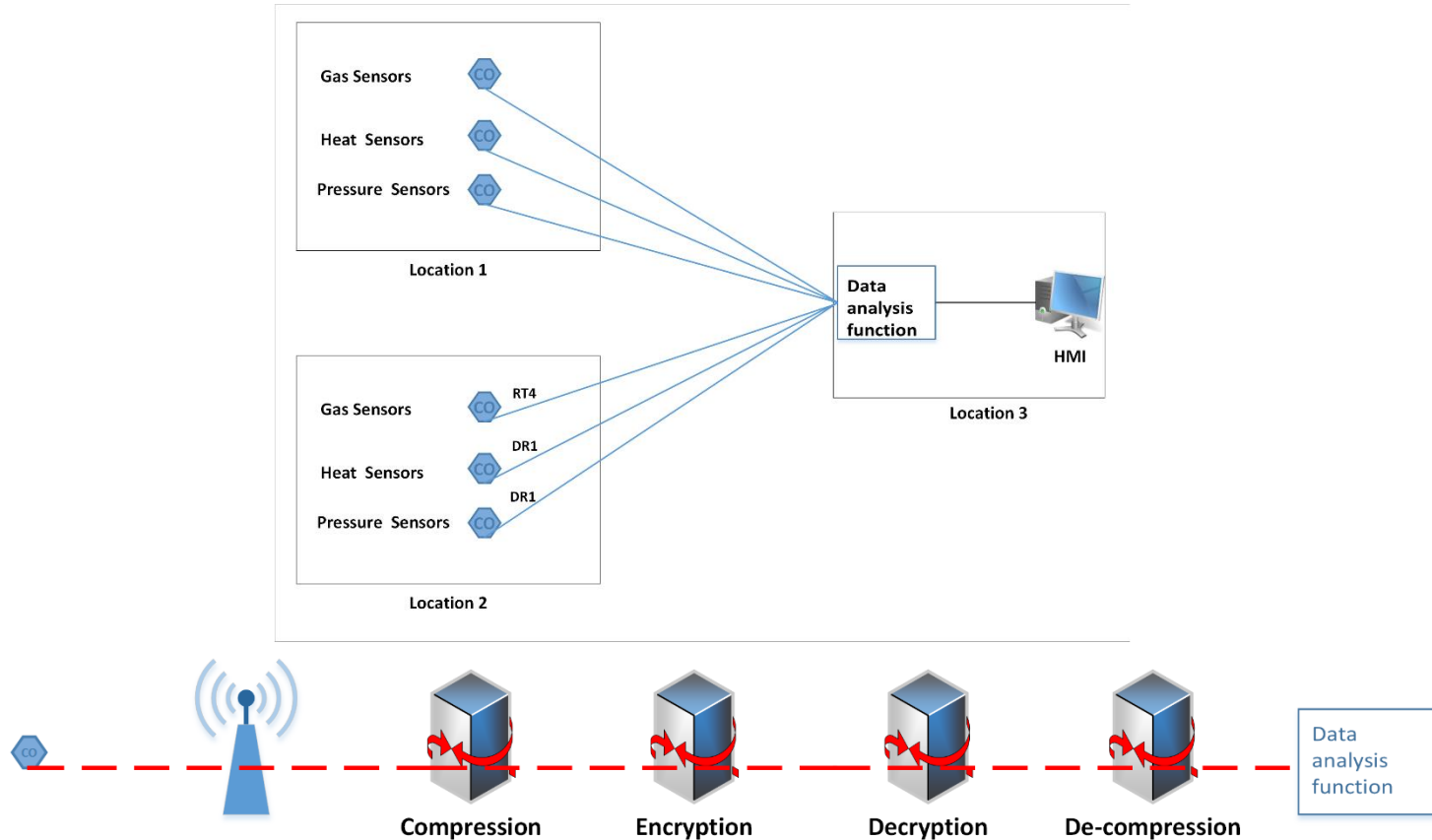
# Virtual Smart Enterprise - Overview



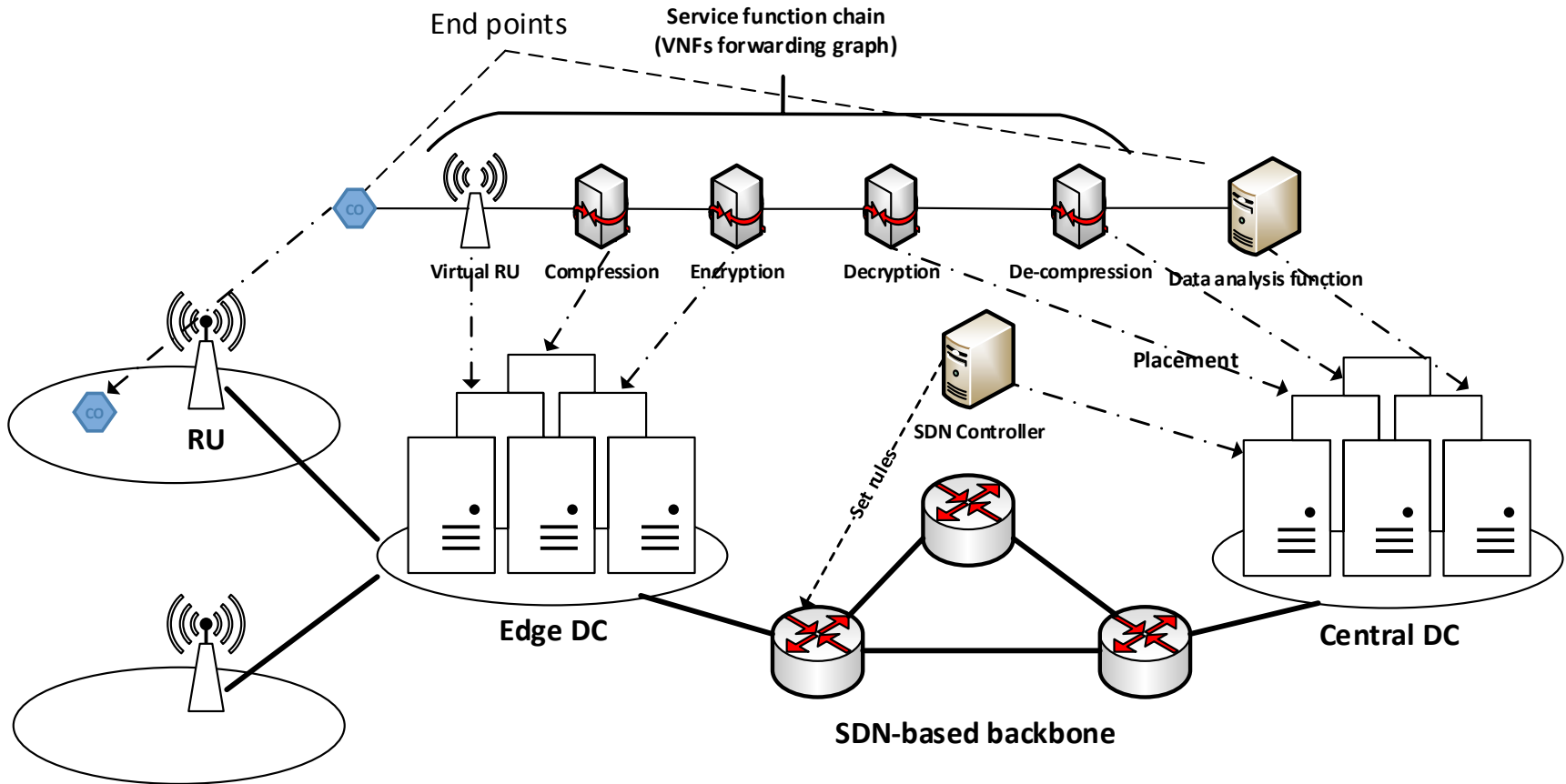


# Use Case – Remote Monitoring

## Application Profile and a Composed Chain



# Use Case – Deployment over 5G



- Monitoring traffic specifications (cycle time, load)
- Application resilience requirements
- Safety deadlines
- Chain end-to-end delay demand
- Chain throughput
- Handling security threats such as..
  - Discloser of production data
  - Manipulation of monitoring data and decisions
  - etc..

through appropriate security functions in the chains, e.g., forcing encryption between edge and central DC?

- Benefits:
  - Flexible and centralized remote monitoring of a large industrial enterprise
  - Early notification and reaction to safety problems
  - Guaranteed deadline for detecting problems
  - Flexible deployment and configuration of monitoring functions
- Risks: safety problems due to performance degradation in the cloud



- IoT & 5G enable remote management in future industries
- Performance and security challenges when cellular and WANs are involved
- NFV/SDN support flexible function deployment
- Orchestrated SDN/NFV required for large systems
- VNE for flexible composition, mapping, reconfiguration of the function chains
- Must consider the main requirements: throughput, delay, resilience, security
- A main challenge: complexity of the embedding problem

- 1) A. Fischer, R. Kühn, W. Mandarawi and H. De Meer. **Modeling Security Requirements for VNE algorithms.** *Valuetools 2016, 10th EAI International Conference on Performance Evaluation Methodologies and Tools*, 2016.
- 2) W. Mandarawi, A. Fischer, A. M. Houyou, H-P. Huth and H. De Meer. **Constraint-based Virtualization of Industrial Networks.** In *Principles of Performance and Reliability Modeling and Evaluation: Essays in Honor of Kishor Trivedi on his 70th Birthday*, page 567--586. Publisher: Springer International Publishing, Cham. 2016.
- 3) B. Doll, D. Emmerich, R. Herkenhoener, R. Kuehn, and H. de Meer. **On Location-determined Cloud Management for Legally Compliant Outsourcing,** pages 61-73. Springer Fachmedien Wiesbaden, Wiesbaden, 2015.
- 4) M. T. Beck, A. Fischer, F. Kokot, C. Linnho-Popien, and H. De Meer. **A simulation framework for virtual network embedding algorithms.** In *6th International Telecommunications Network Strategy and Planning Symposium (Networks 2014)*, pages 1-6. IEEE, Sept. 2014.
- 5) A. Fischer, J. F. Botero, M. T. Beck, H. De Meer, and X. Hesselbach. **Virtual network embedding: A survey.** *IEEE Communications Surveys and Tutorials*, 15(4):1888-1906, 2013.
- 6) G. B. A. Mandvariya, „**Key use cases of the Industrial Internet of Things,**“ 14 November 2016. [Online]. Available: <https://industrial-iot.com/>. [Zugriff am 05 June 2017].
- 7) „**How to analyze machine and sensor data,**“ [Online]. Available: <https://de.hortonworks.com/hadoop-tutorial/how-to-analyze-machine-and-sensor-data/>. [Zugriff am 05 June 2017].
- 8) „**ETSI NFV,**“ [Online]. Available: <https://osm.etsi.org/>. [Zugriff am 05 June 2017].