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Virtual Gateways in the DECOS Integrated Architecture

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Overview

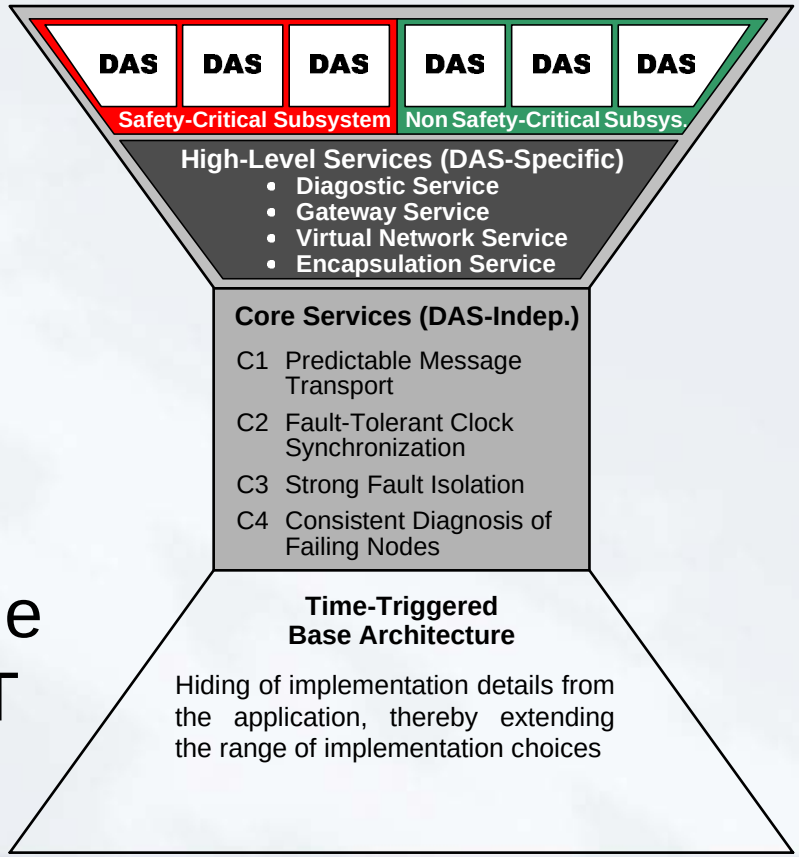
- DECOS Integrated Architecture
- Virtual Networks
- Virtual Gateway Service
- Operation of Virtual Gateways
- Execution of Virtual Gateway Service
- Exemplary Application in Typical Automotive System
- Conclusion

Federated and Integrated Architectures

- Federated architectures provide each application subsystem with its own dedicated computer system
  - Natural separation of application subsystems
  - Complexity control
  - Fault isolation between computer system
  - Service optimization
- Integrated architectures support multiple application subsystems within a single distributed computer system
  - Reduced hardware cost
  - Dependability
  - Flexibility

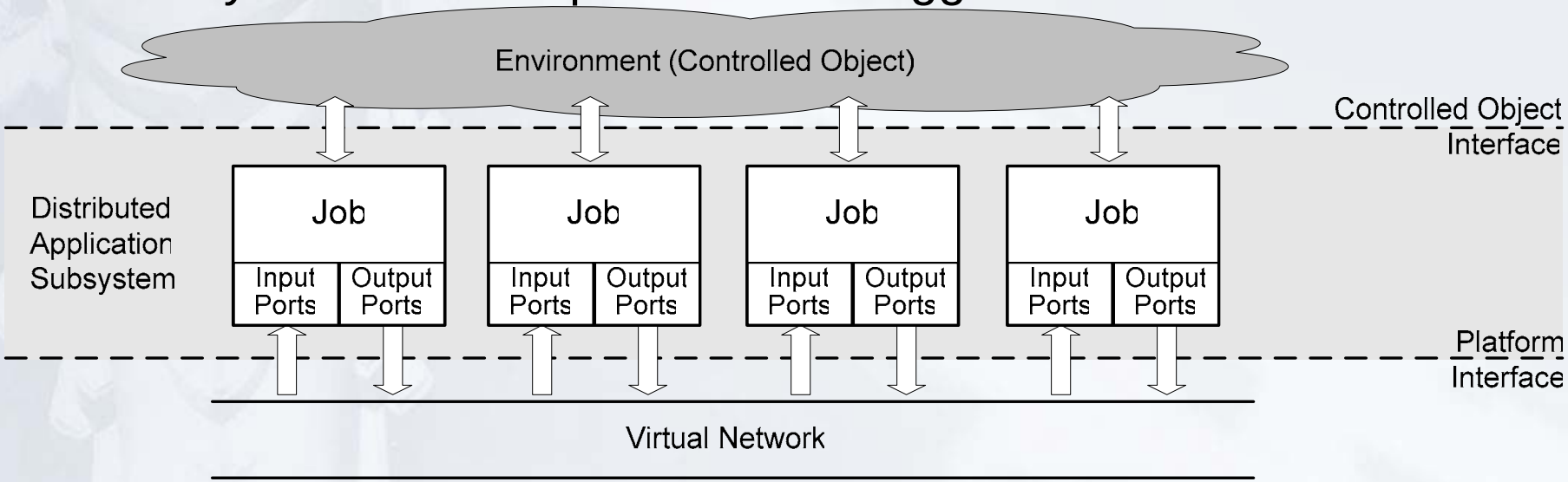
DECOS Integrated Architecture

- Distributed Application Sub-systems (DASs)
  - Nearly independent distributed subsystem
  - Exploit specific platform services
  - Infrastructure tailored to the needs of the DAS (e.g., TT or CAN communication)



Distributed Application Subsystem

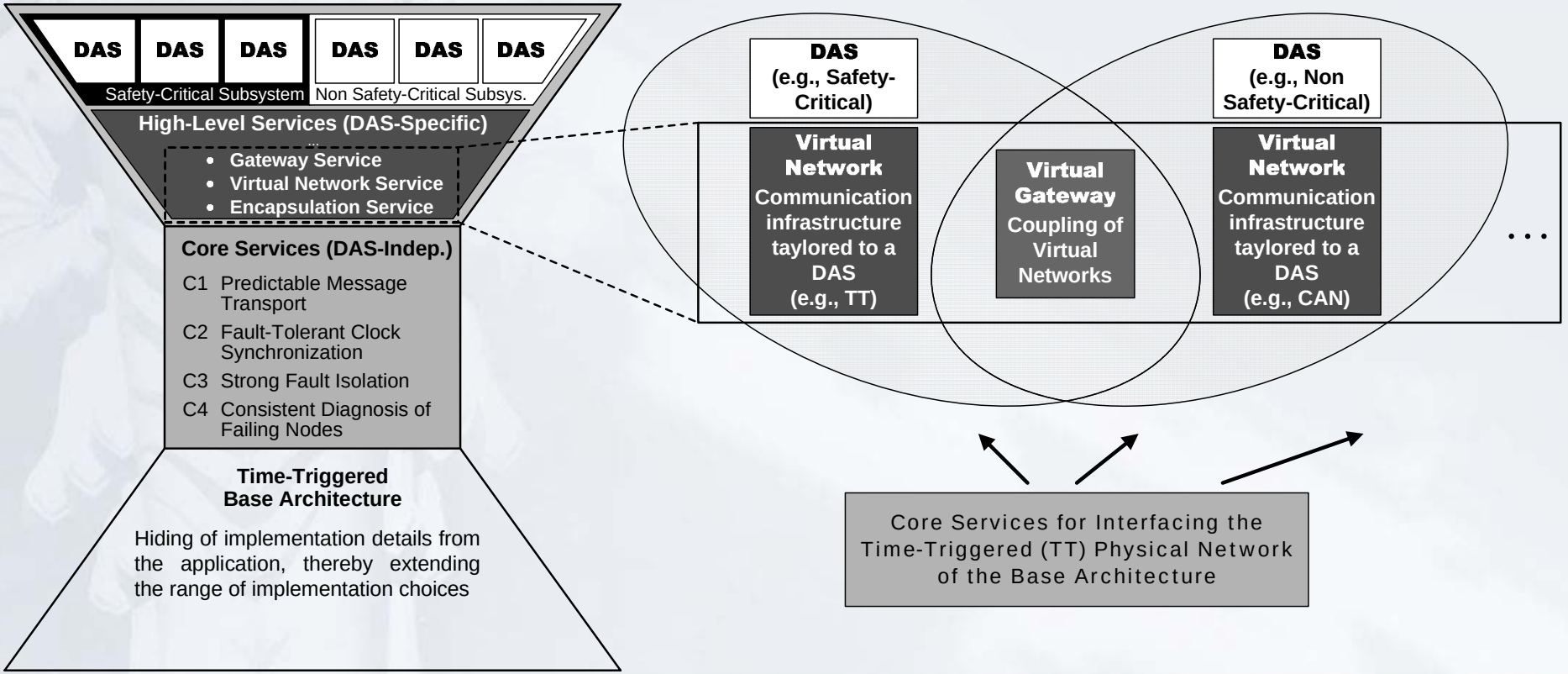
- Consists of jobs
- Interconnected through a dedicated virtual network, which is an overlay network on top of the time-triggered core network



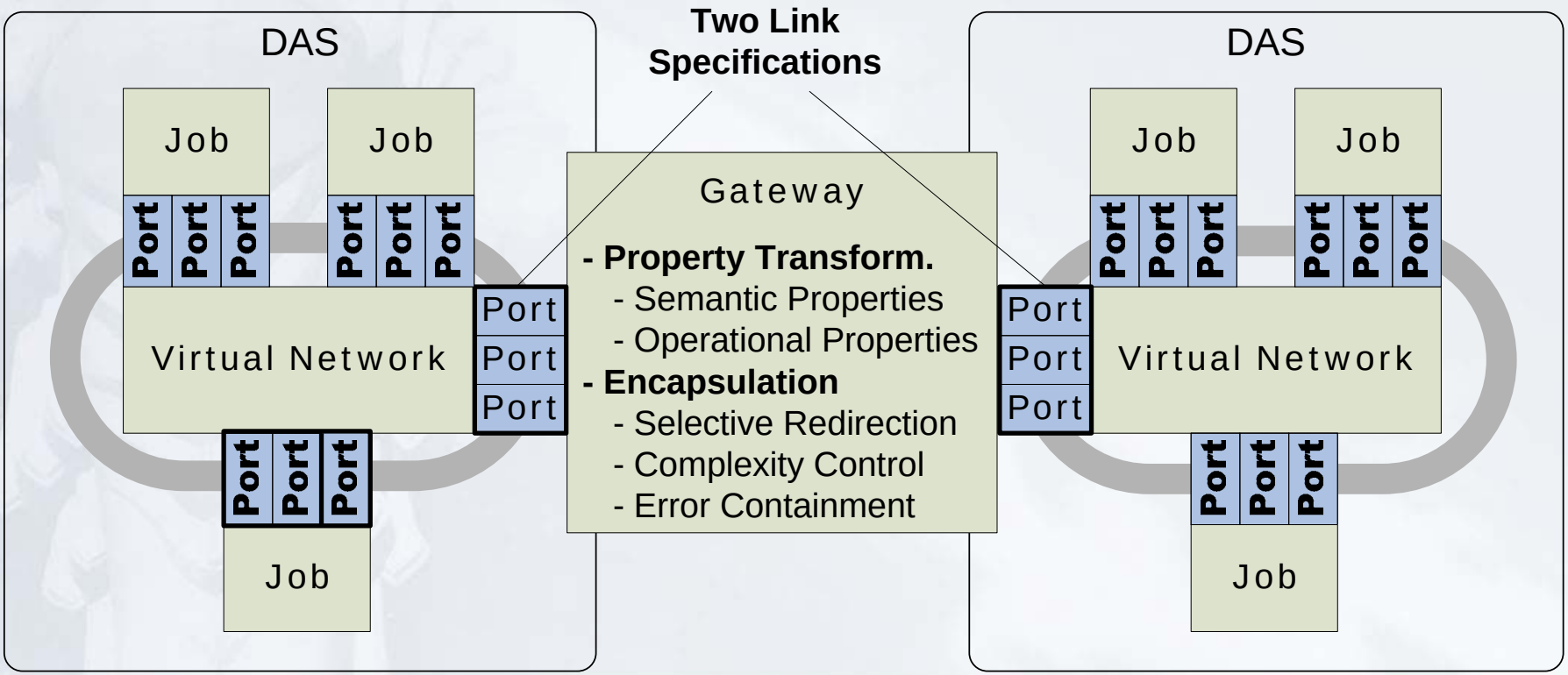
Virtual Gateways

- Virtual gateways support the interconnection of the virtual networks of two DASs
  - Improved quality of service
    - Example: Pre-crash systems
  - Exploit redundant sensors
    - Improve reliability
    - Reduce resource duplication
- Exemplary application: Sensor DAS

Hidden Virtual Gateway Services

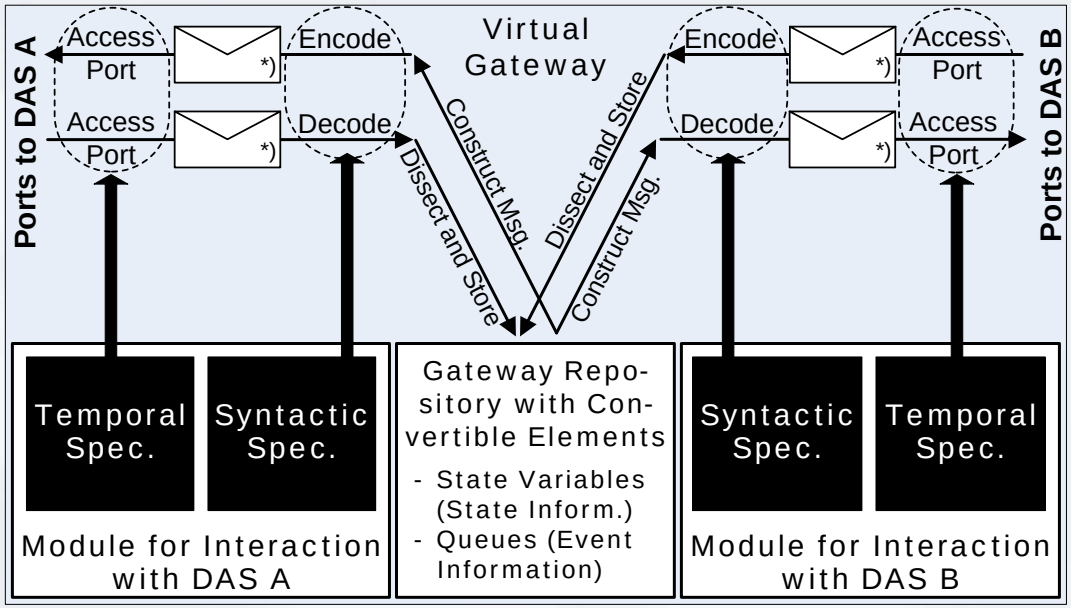


Role of a Virtual Gateway



Operation of Virtual Gateways

- Each message is regarded as a compound structure
- Part of a message that is subject to selective redirection is denoted *convertible element*
- Received messages are dissected into convertible elements
- Sent messages are constructed out of convertible elements
- Convertible elements are stored in a real-time database



*) message buffer: queue for event information, state variable for state information

Gateway Repository for State and Event Information

- Real-time database
- Central data structure of a virtual gateway
- Temporally accurate convertible elements with state information
- Queuing of convertible elements event information in order to maintain state synchronization

Information Semantics	Convertible Element Data	Meta Information	
		Variable	Description
Convertible Element with State Semantics		d^1_{acc} b^1_{req} t^1_{update}	temporal accuracy interval update request point in time of last update
Convertible Element with State Semantics		d^2_{acc} b^2_{req} t^2_{update}	temporal accuracy interval update request point in time of last update
⋮			
Convertible Element with Event Semantics		b^{k+1}_{req}	request for convertible element instance
Convertible Element with Event Semantics		b^{k+2}_{req}	request for convertible element instance
⋮			

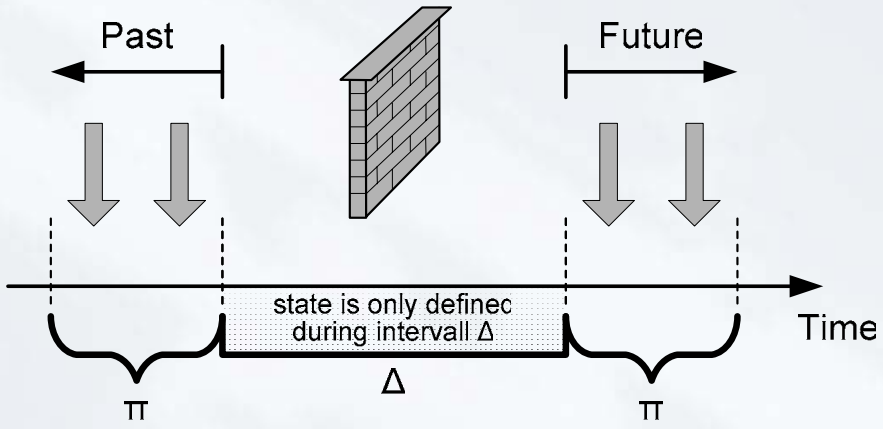
Interaction with Virtual Networks

- Gateway sends and receives messages at two virtual networks
- Link specification for each virtual network consists of:
  1. Syntactic specification defines structure of message and is used to parse incoming messages / construct outgoing messages
  2. Temporal specification defines the interaction protocol
  3. Transfer semantics for conversion between event and state information
     - state information through accumulation of event information
     - event information derived from successive state information values

Update of Gateway Repository: Sparse Time Base

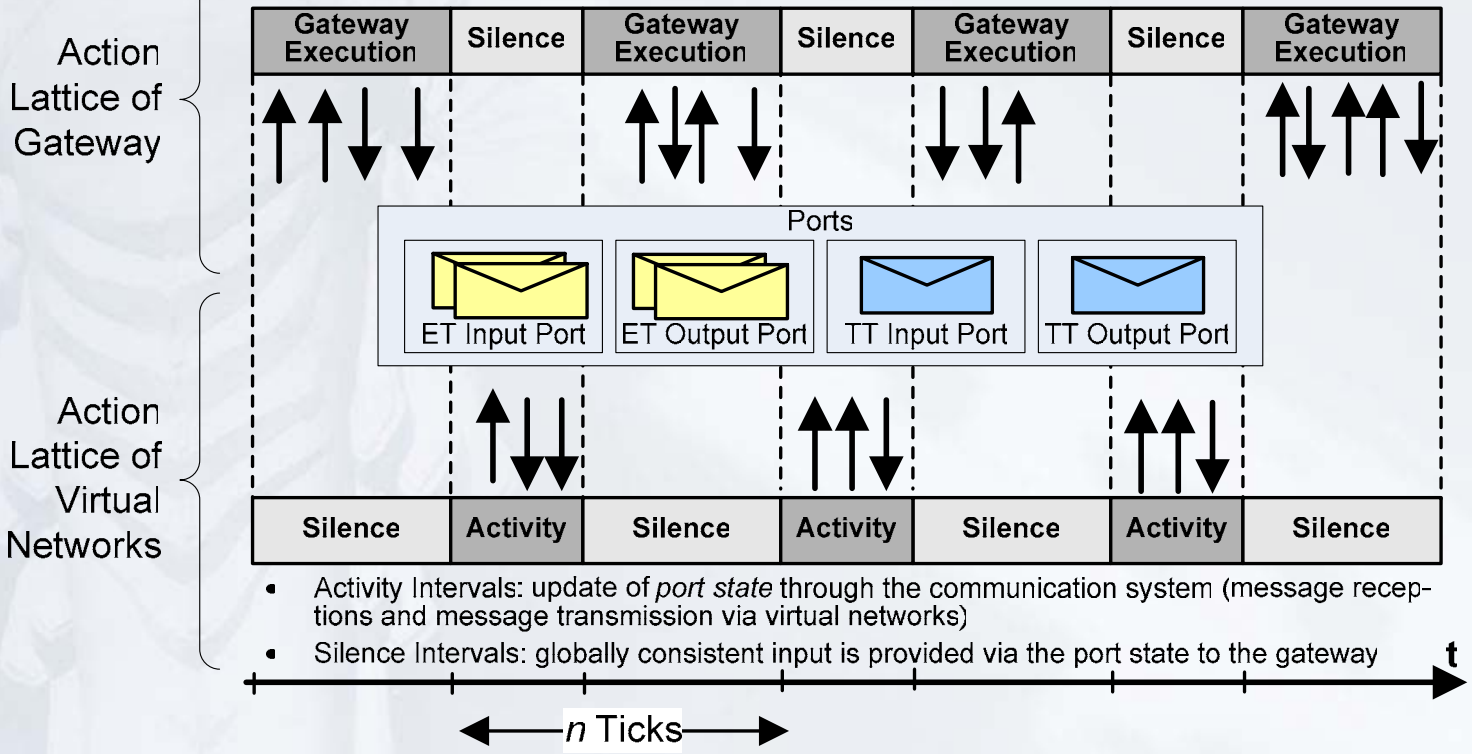
- In abstract system theory (Mesarovic, 1989), the notion of state is introduced in order to separate the past from the future
- Sparse time model: partitioning of the continuum of time (durations of action and silence)
- Action lattice

- Interval of silence
  - Interval when the distributed state of the system is defined



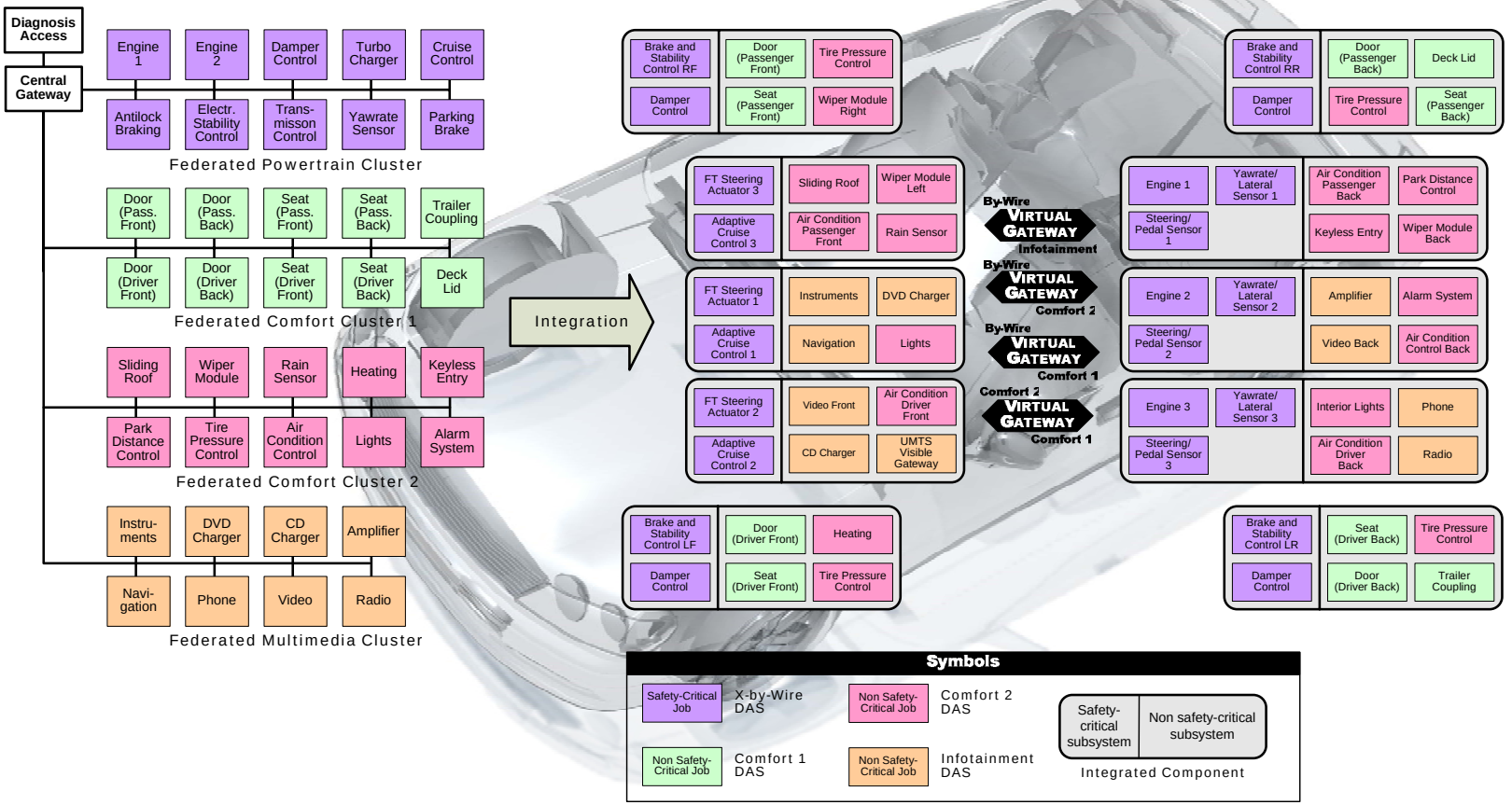
Update of Gateway Repository (2)

- Activity Intervals: update of *port state* through the gateway
- Silence Intervals: prevents concurrency with the update of the port state through the virtual networks.



- Activity Intervals: update of *port state* through the communication system (message receptions and message transmission via virtual networks)
- Silence Intervals: globally consistent input is provided via the port state to the gateway

Automotive Example



Conclusion

- Virtual gateways are a key mechanism for combining advantages of federated and integrated architecture
  - Functionally federated, physically integrated
  - Encapsulation of DAS with dedicated virtual networks
- Virtual gateways for the coupling of virtual networks
  - Exploit redundancy to reduce cost and improve reliability
  - Improve quality of service
- Virtual gateways as an architectural service
  - Generic service that is parameterized by application requirements in order to simplify application development
  - Selective redirection of information between virtual networks through controlled import and export
  - Property transformations
- Update of real-time database on global sparse time base