Service-oriented architectures and AADL modeling

Oleg Sokolsky

Real-Time System Group

University of Pennsylvania

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Outline

- Motivation
  - Enhance AADL models with information on component interaction
- Service-oriented architectures
  - in embedded domains
  - based on approach of Ingolf Krueger (UCSD)
- Service orientation in AADL
  - Pre-pre-proposal…

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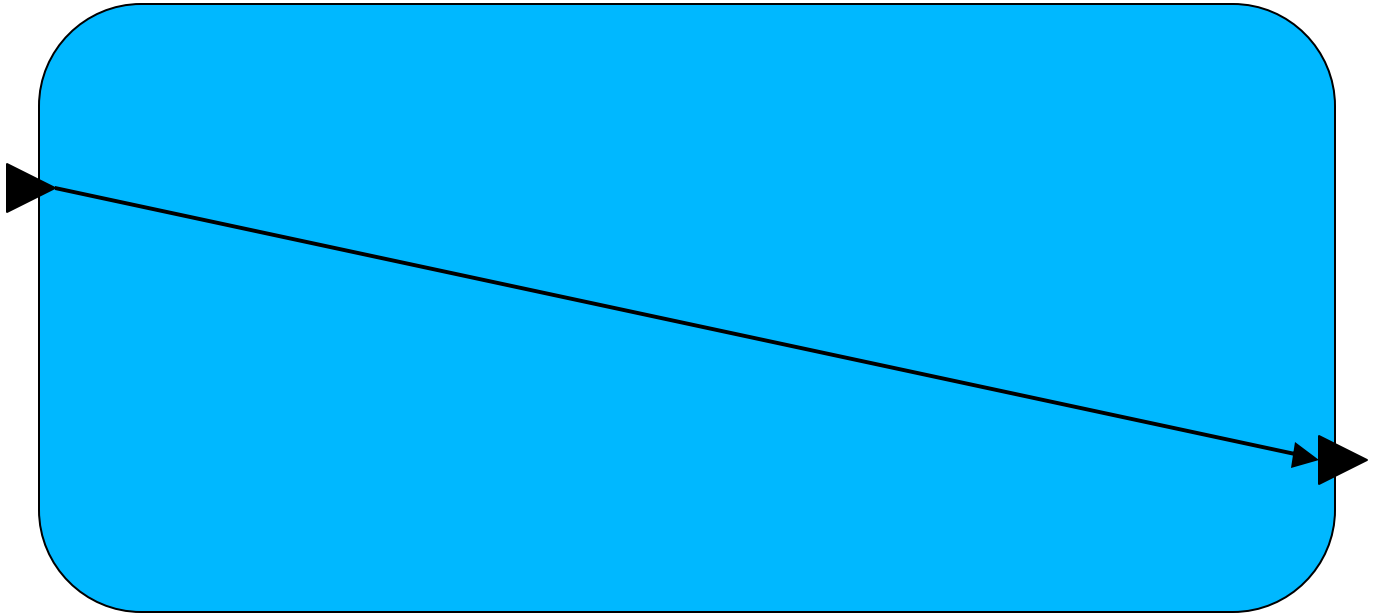
AADL: connections and flows

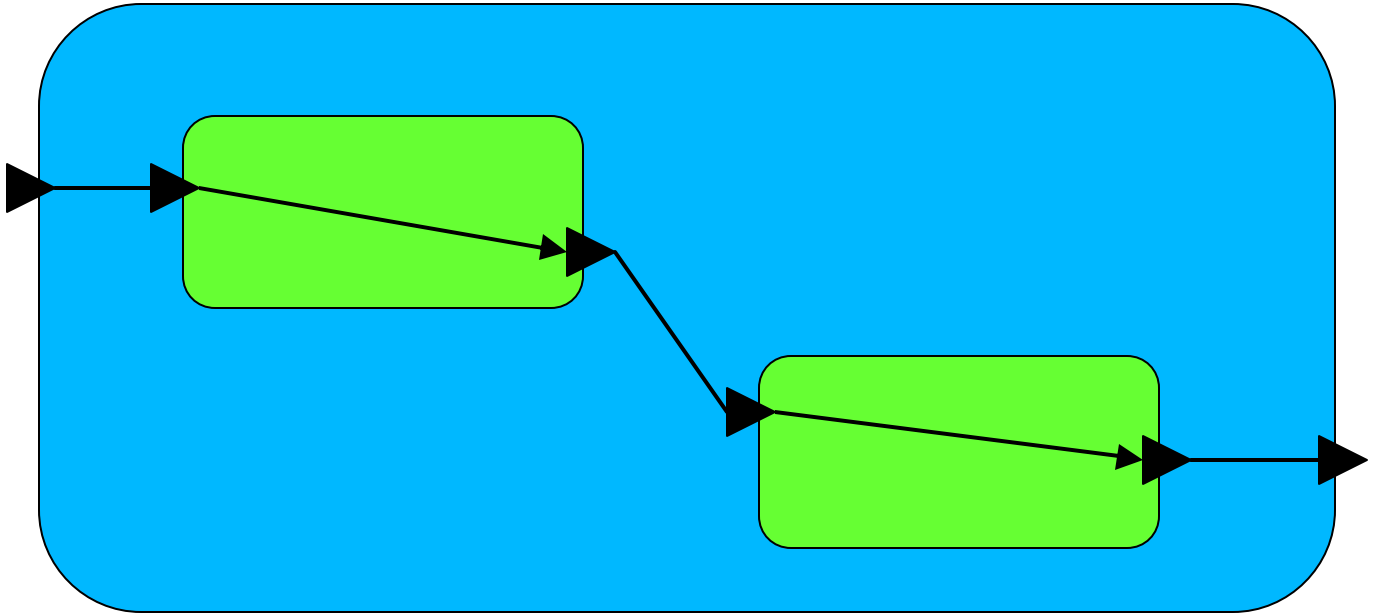
- Flows: abstraction of communication



- Associate QoS properties with flows
  - End-to-end delays, transfer rates, etc.

AADL: connections and flows

- Implementations map flows to connections



- Architectural checks enable validation of implementations

Motivation: flows vs. interactions

- Flows are very suitable for stream processing
  - Sense, transform/compute, actuate
- Flows are less appropriate for reactive systems
  - independent
  - unidirectional
- Component interactions in a reactive system
  - bi- and multi-directional
  - follow a protocol

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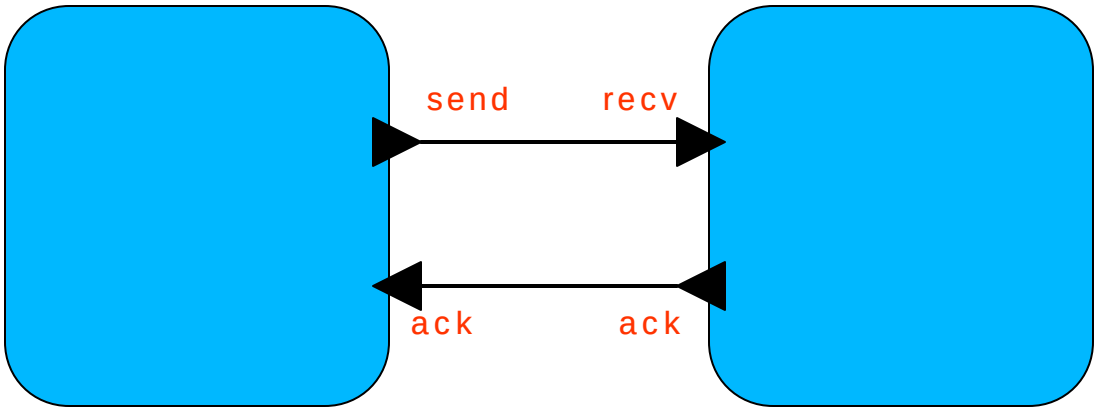
Related ports and connections

- We need to be able to specify that
  - A group of ports are semantically related
  - Connections on these ports are established together and provide a certain protocol
- Port groups serve this purpose to some extent



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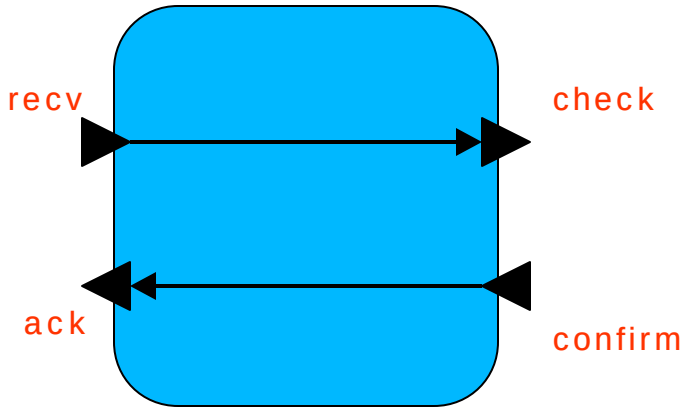
Interacting flows

- We need to be able to specify that
  - A group of flows establishes a protocol
  - Collectively provide certain QoS



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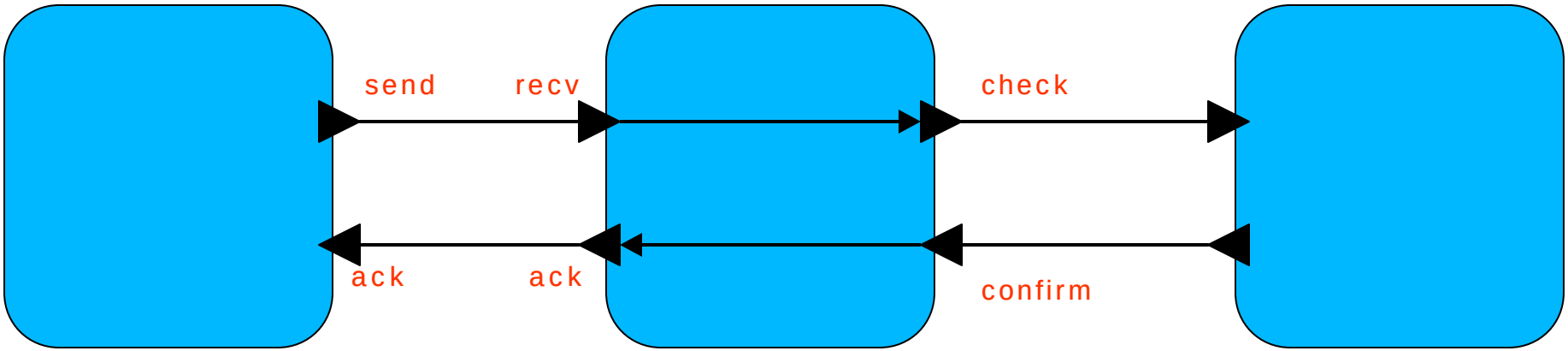
Refinement of interactions

- We need to be able to refine multi-party interactions into coordinated sequences (more generally, patterns) of connections and flows



The perverse beauty of UML

- One reason for UML popularity is the variety of supported views:
  - architecture
  - behavior
  - interaction
  - …
- Problem:
  - absence of rigor
  - too much diversity, too little unity

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Services

- A uniform way of distributed access to software functions in distributed systems
- “Web services” over Internet
  - Definition of functionality and interaction
    - WSDL
  - Abstraction of physical distribution
    - Portability
- Embedded systems domain
  - Open Services Gateway Initiative (OSGi)
    - Services on a LAN

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Services in the automotive domain

- Automotive Multimedia Interface Collaboration
  - Collaboration of eight major automakers
  - Specifications for
    - vehicle service interface
    - human-machine interface
    - off-board navigation services
  - Example services:
    - status: ignition, brake, door lock
    - odometer readings, engine oil pressure
    - vehicle location (GPS), identification, etc.

[E.C. Nelson, K.V. Prasad, "Automotive Infotronics: an Emerging Domain for Service-Based Architecture," Workshop on Service-Based Software Engineering, Sep 2003]

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Interaction in architectural modeling

- Services delivered by a software system are cross-cutting aspects of the architecture
  - Should be represented explicitly on the level of ADL
- Services as architectural building blocks
- Services are elicited from user requirements
- Design problem:
  - Explore multiple architectural configurations that implement a given set of services

[I. H. Krueger, R. Mathew, "Systematic Development and Exploration of Service-Oriented Software Architectures," Working IEEE/IFIP Conference on Software Architecture, 2004]

Definition

- Service:
  - Interaction pattern required to accomplish a specific task
- Many-to-many:
  - A component may provide more than one service, and multiple components may be involved in a service
- Consider services independently from components

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Service-oriented architecture

- A service is an interaction pattern between a set of roles
- Roles are “placeholders” for components
  - A component can play many roles
  - Component can switch between roles
- Architectural configuration
  - Mapping between roles and components

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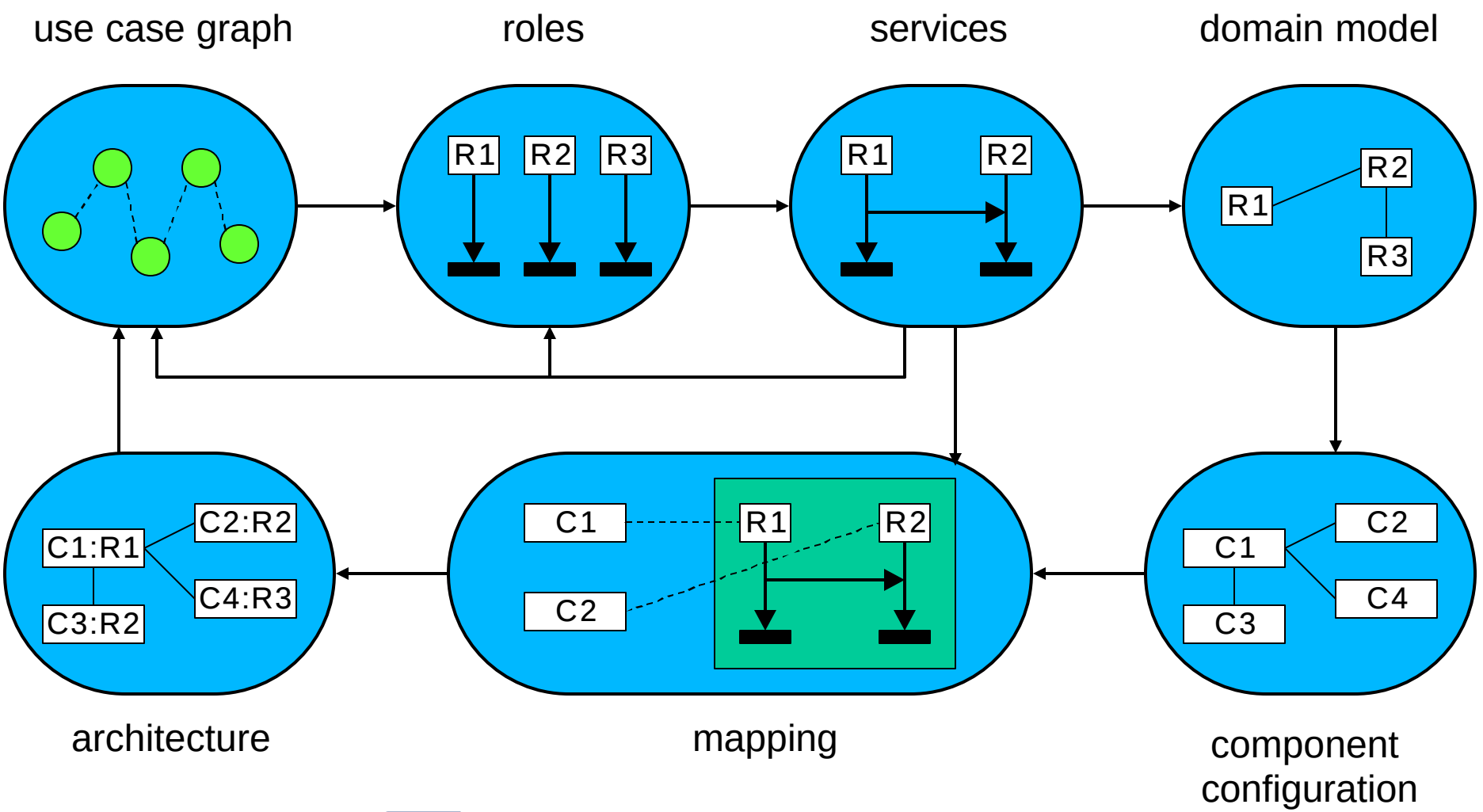
Service-oriented development



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AADL and service orientation

- Many key notions of service-oriented architectures are present in AADL
- A message set that comprise a service can be given by a port group
  - A stricter semantic interpretation is needed
- A two-layer architecture with mapping between the layers is given by software vs. platform components

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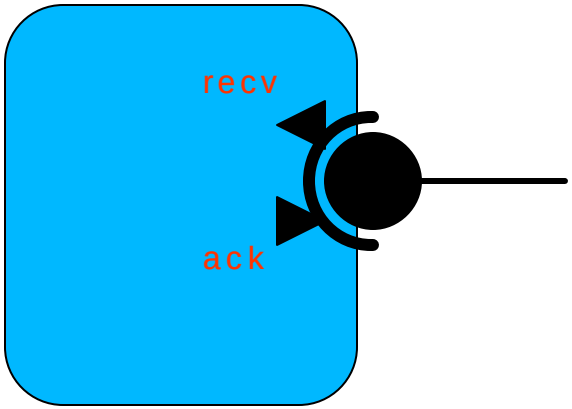
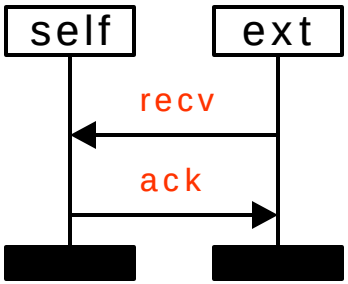
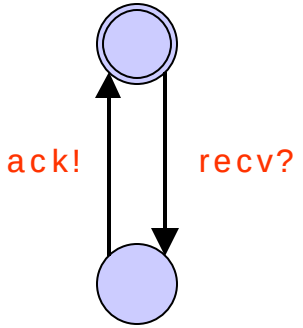
Services as existing features

- Extend a port group with the description of interaction
  - MSC or interface automaton
  - Works for bi-party services

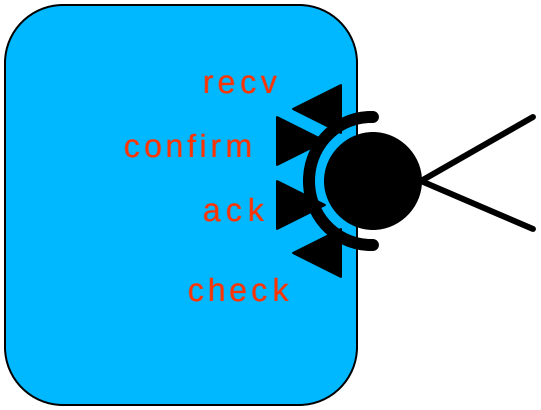


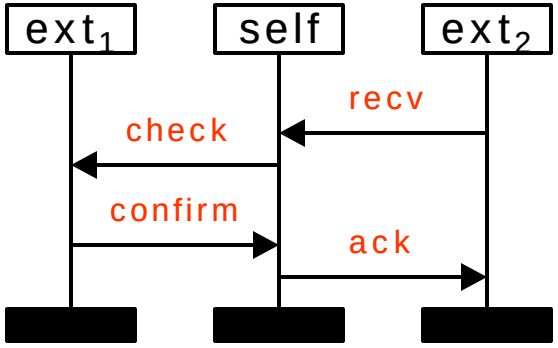


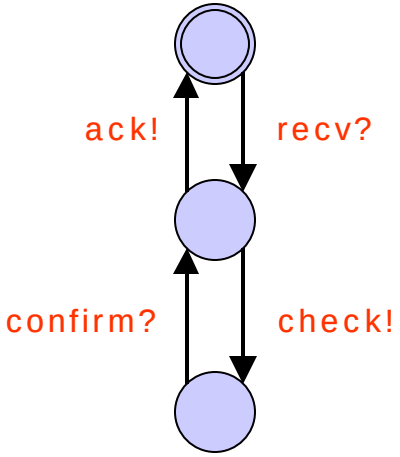


Services as modified features

- Allow multi-party interactions
- Relax the “single unit” requirement for external connections of a port group
  - Probably not a good idea

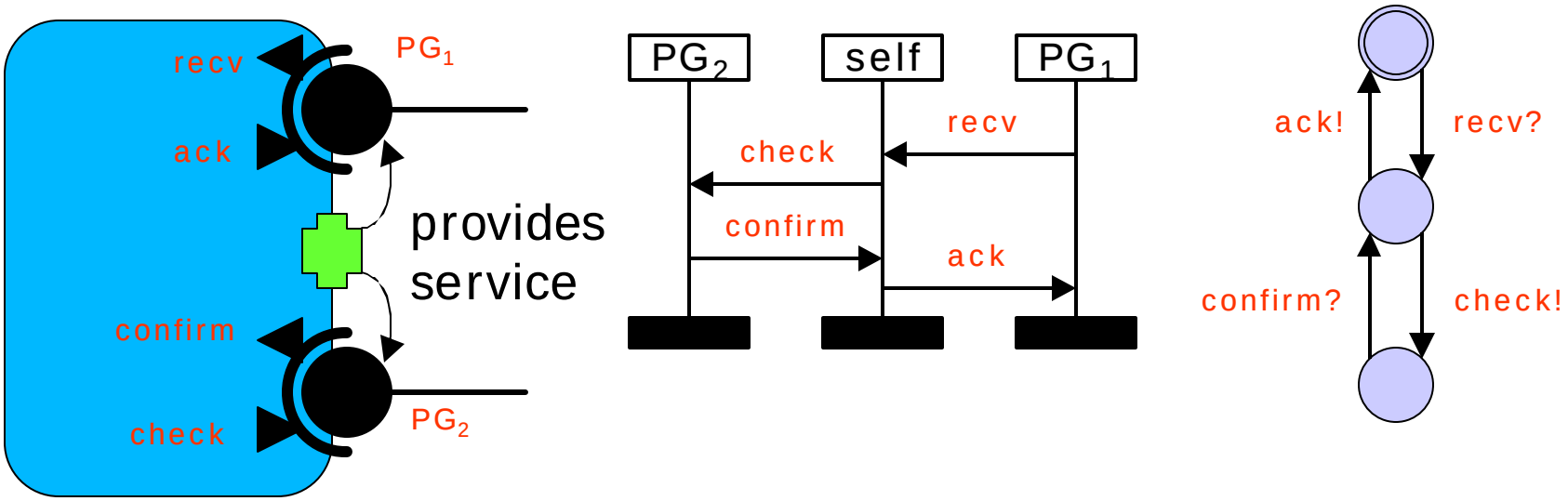






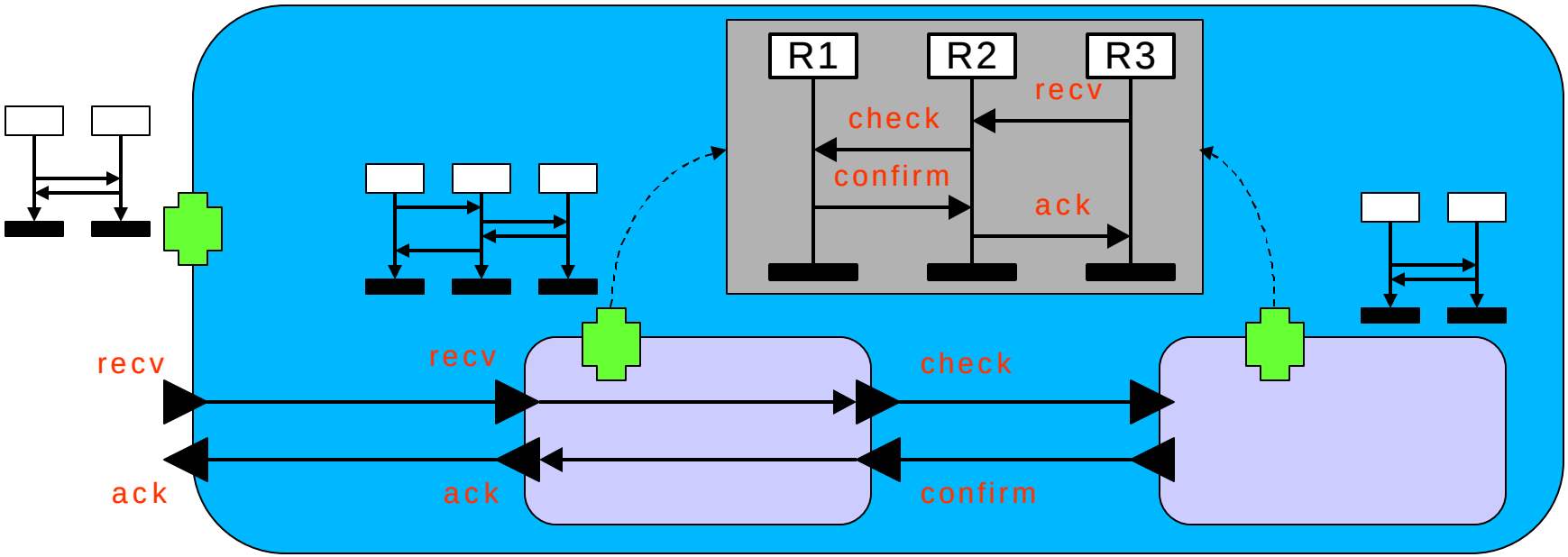
Services as new features

- Introduce a service feature that has references to ports involved in the interaction
- Is there a difference between “provide service” and “require service”?



Service implementations

- Set of rules to enable architectural checks:
  - Subcomponents properly participate in services of the containing component implementation
  - Subcomponents enable service features of the containing component



Interactions and behavior

- Specification of interactions is complementary to specification of component behaviors
- Component behavior can be used to check that the component will comply with the protocol

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Summary

- Interactions between components in the system can and should be modeled on the architectural level
- The notion of a service encapsulates component interactions as a feature
- New architectural checks can further improve design exploration

- Comments?

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