Service Oriented Architectures
Motivation and Concepts

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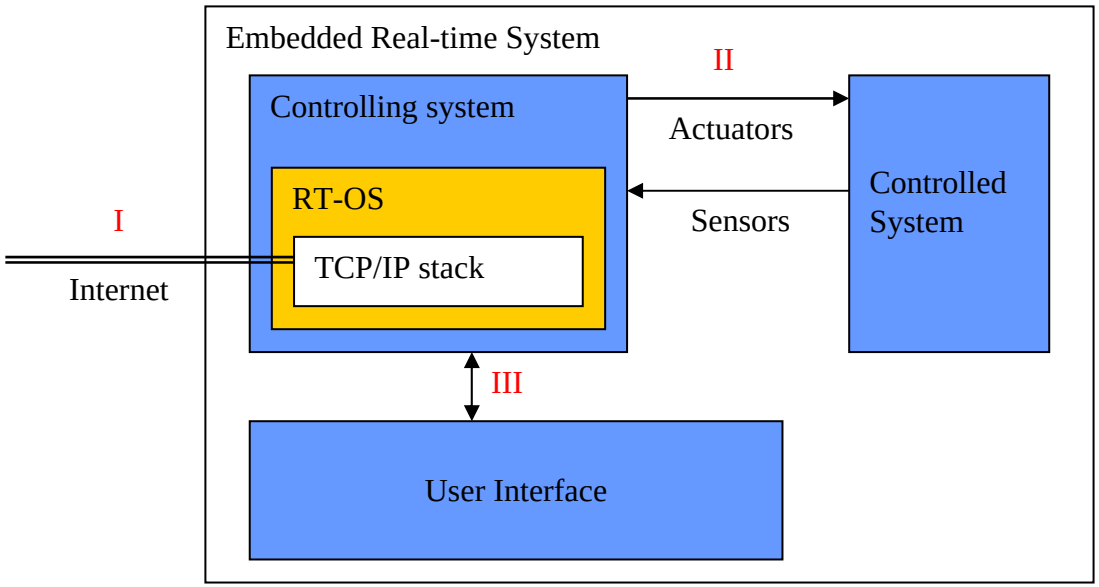
Just in case you thought...

- This presentation is *not* about web-services
- (though I might mention it occasionally)

Agenda

- Motivating examples
- SOA what?
  - some views from the web
- SOA elements and mechanisms
- Outlook, research targets

Example: classical embedded real-time system



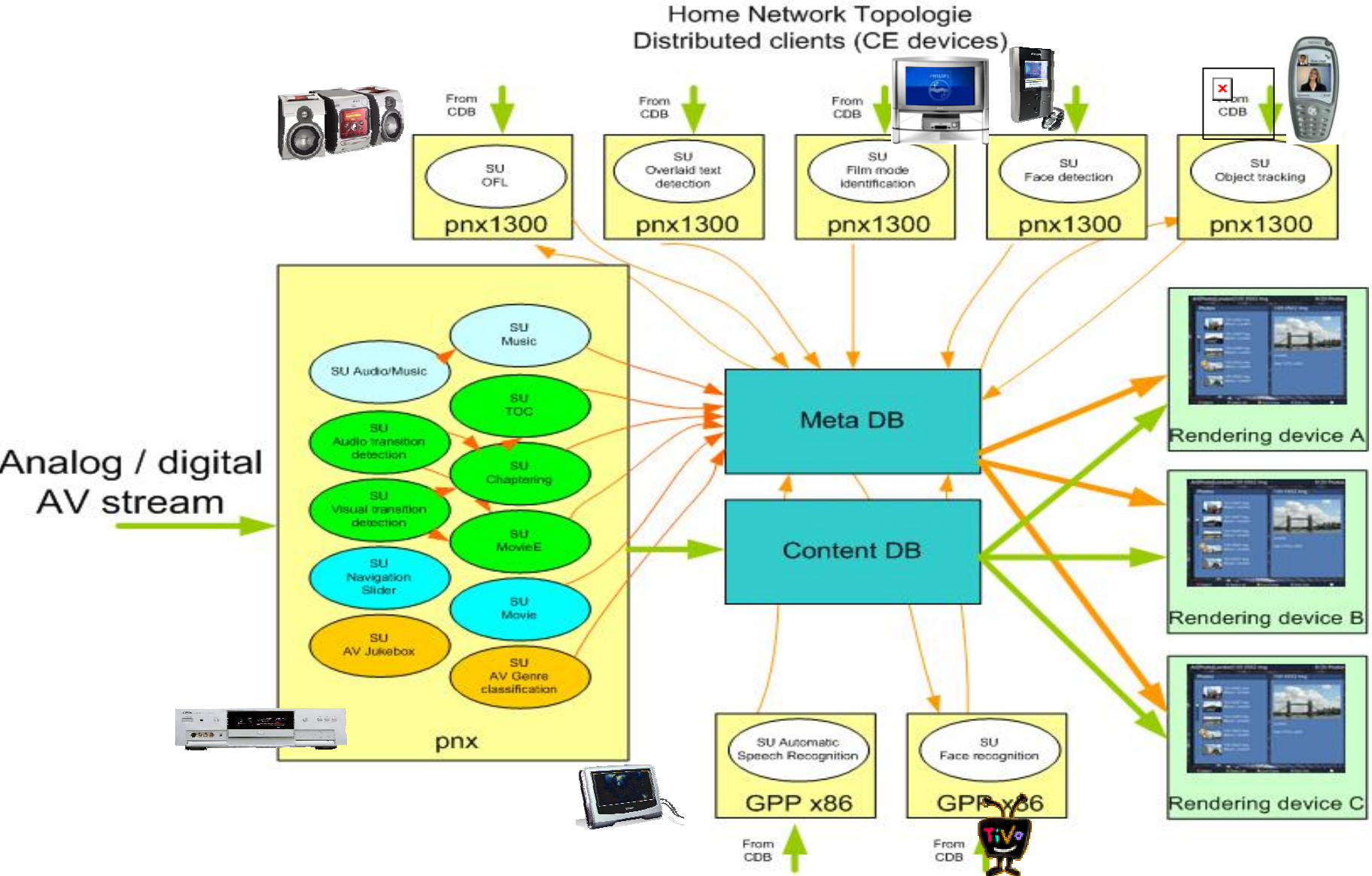
- Network options
  - I : just a connected device/system
  - II : remote sensing/control (could combine with e.g. fieldbus technology in practice)
  - III : remote monitoring and control

Example: in-home networks

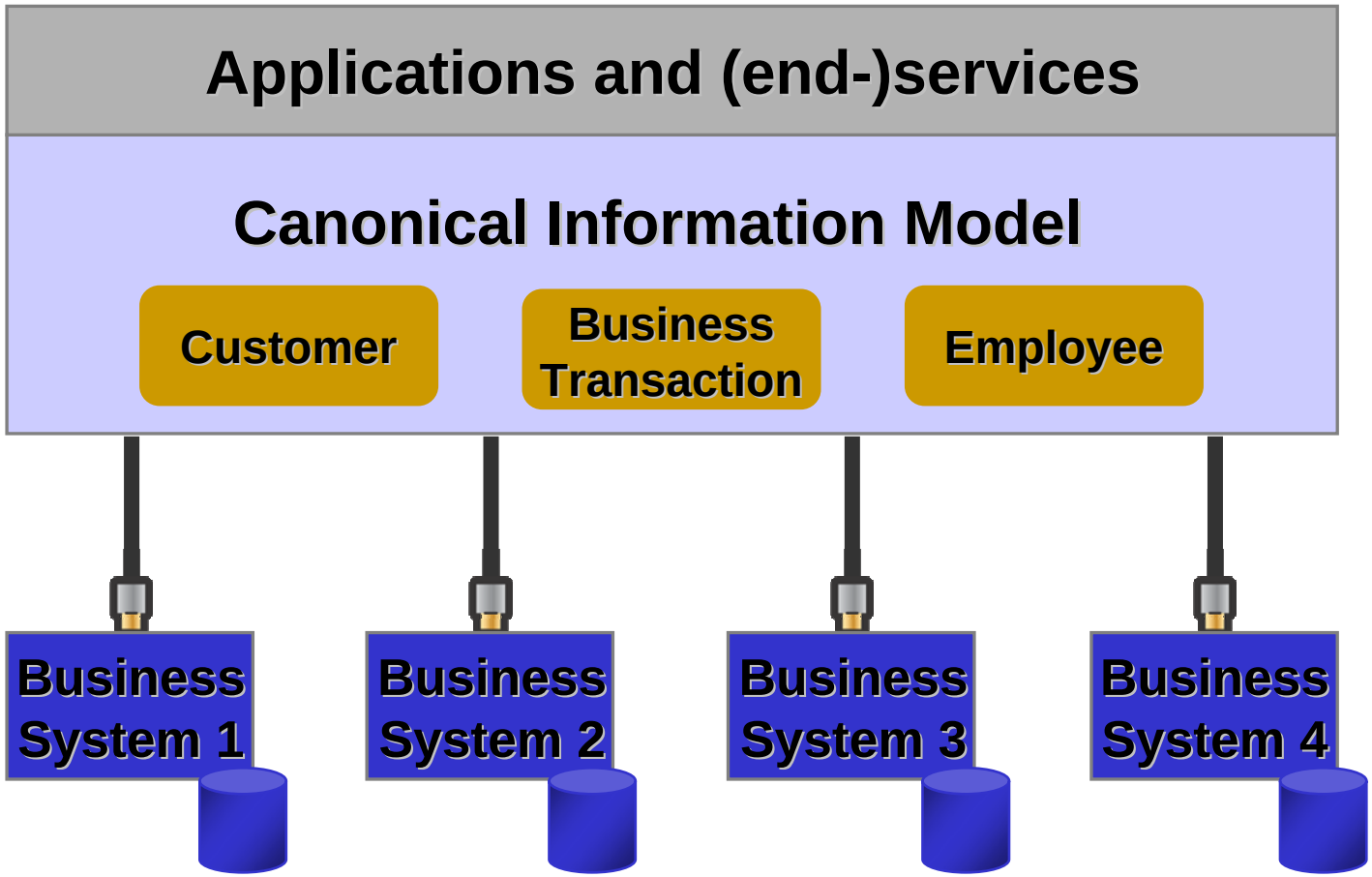
- Cassandra project within Philips research, in collaboration with CANDELA (ITEA), ISHARE (BSIK Freeband)

- Devices share
  - functionality
    - e.g. media processing functions
  - resources
    - e.g. database, computational platform
  - content
    - e.g. video
- Accesssible as networked services (“service units”)

CASSANDRA distributed and decentralized content analysis in Connected Home / Planet

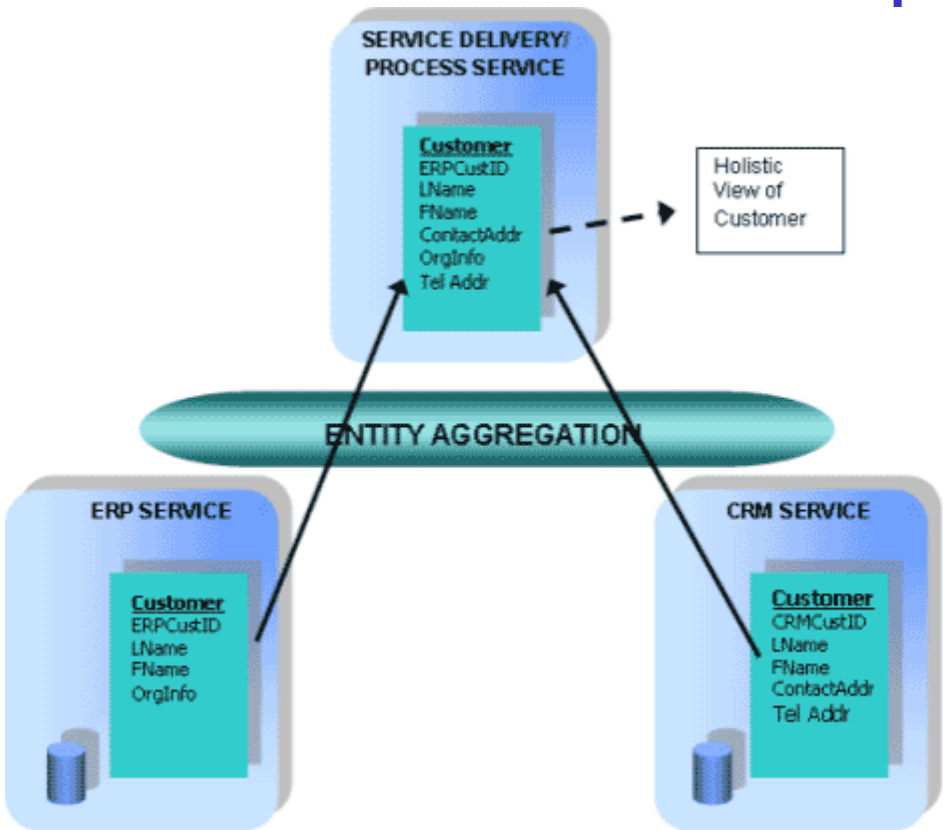


Example: integration of business applications



Microsoft: “Entity aggregation”

- Single view on an entity
- Horizontal partitions
  - service composition
- Queries across services
  - combine data & metadata



(MSDN article “SOA Challenges Entity Aggegation”)

Points of view on S.O.A.

1. *Portfolio view* [Business environment]
   - stand-alone applications with overlapping functionality
     - data-storage (name, address, ...)
   - .... need to:
     - have a unified view on data (Microsoft: ‘entities’)
     - build new functionality by combining existing applications (flexibility, agility)
2. *Solution view* [Embedded, networked environment]
   - packaged functionality
     - processing, storage, content
   - applications realized through unforeseen cooperations
     - e.g. consumer electronics
   - heterogeneity (platform, connectivity), mobility
   - need for embedded ‘decision taking’

Essentially,

1. A systematic approach to the *existing situation*
   - disparate applications
   - an uncontrollable evolution process
   - the wish to quickly and easily realize new applications *with existing material.*
2. The need to have effective plug-in and coordination support
   - external *policies* while the *mechanisms* are exposed by the (serivces inside the) devices

- ... similar issues, differences in granularity, goals

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Whatis.com, March 2005

- A service-oriented architecture (SOA)
  - defines how two computing entities interact in such a way as to enable one entity to perform a unit of work on behalf of another entity.
  - The unit of work is referred to as a service,
  - the service interactions are defined using a description language.
  - Each interaction is self-contained and loosely coupled, so that each interaction is independent of any other interaction.

NetworkWorldFusion.com, March 2005

- A service-oriented architecture is
  - a way of connecting applications across a network
  - via a common communications protocol.
- In theory, this lets developers treat applications as network services that can be chained together to create a complex business process more quickly.

webservices.xml.com, March 2005

- SOA is
  - an architectural style
  - whose goal is to achieve loose coupling among interacting software agents.
- A service is
  - a unit of work done by a service provider
  - to achieve desired end results for a service consumer.
  - Both provider and consumer are roles played by software agents on behalf of their owners.

Dr. Hao He

Wikipedia.org

- **Service-oriented architecture (SOA)** is
  - a software architectural concept
  - that defines the use of services to support business requirements.
- In an SOA,
  - resources are made available to other participants in the network as independent services
  - that are accessed in a standardized way.
- Most definitions of SOA
  - identify the use of web-services (using SOAP and WDSL) in its implementation,
  - however it is possible to implement SOA using any service-based technology.

Some other comments

- Sounds like: food-oriented lunch
- It appears to be about quickly changing contacts between components
- Not new....
  - where did CORBA go?
  - what about GRID?
  - toolbus, service bus – seem to address the same issues

Overloaded acronym.....

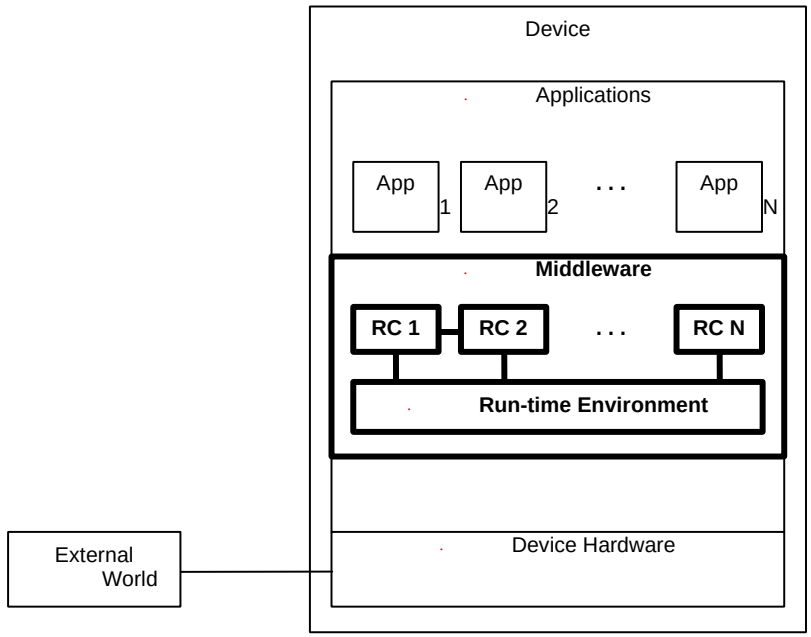
- Save Our Animals
- School Of The Americas
- School Of the Americas
- Semiconductor Optical Amplifier
- Server Of Authority
- Service Order Administration
- Service Oriented Architecture
- Ships On The Air
- Society Of Assassins
- Soldiers Of Agony
- Sons Of Aiur
- Source Of Authority
- Southern Africa Fund, Inc.
- Special Operations Aircraft
- Spring Over Axle
- Start Of Authoritative
- Start Of Authority
  State Oceanic Administration
- State Of Affairs
  Statement Of Activity
- Stimulus Onset Asynchrony
- Student Organization Accounts
- Subaru Of America
- Sulphate Of Ammonia
- School Of Assassins

CBSA

- Focus on component platform
  - docking ....
- Platform dependent
  - registration & lookup
  - language bindings, machine architecture
- Little awareness in the application of some non-functional aspects
  - mobility
  - distribution (often transparent)
  - security
  - timing, cost
- S.O.A. represents some sort of a next step

Example: Robocop Component Architecture

- ITEA projects ROBOCOP, Space4U



S.O.A. features (requirements)

- Interoperability
- Loose coupling
  - clear interfaces and dependencies
  - late binding
    - even at run-time:
      - advertisement, discovery
      - based on descriptions
  - avoidance of language, OS, ISA binding
- Composability
- Location transparency

- ..... network-exposed services
  - ‘network as system bus’

Drivers

- Ambient intelligence
  - how do we expect (spontaneous, automatic) cooperation of these many embedded devices?
    - optimizing towards user experience
    - optimizing towards resource use
    - not knowing each-other upon design time
- Re-use
  - at *deployment* level
  - need to deploy components such that they can be integrated in new configurations as such, at run-time
    - including support for non-functional properties

What is needed such that *future as yet unforeseen* cooperations are possible?

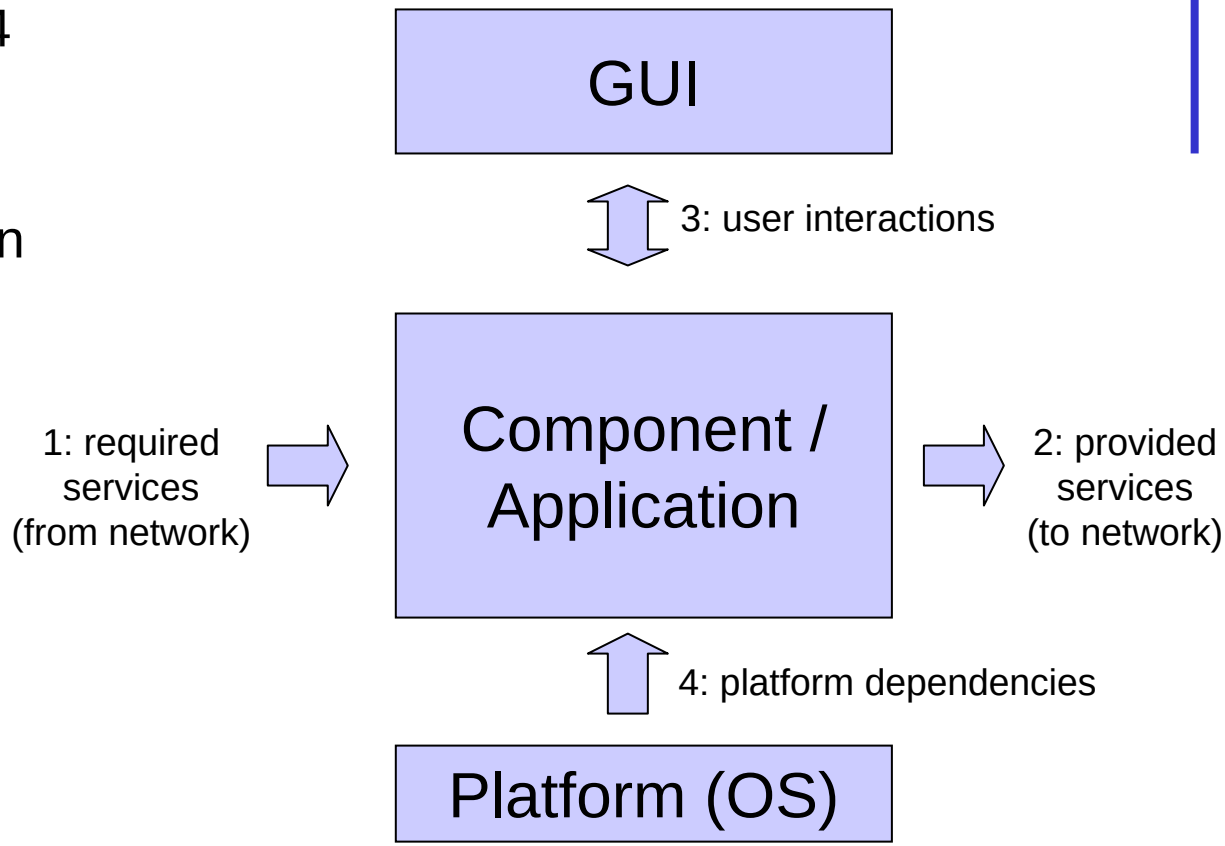
Service: working definition

- **Service**: *a contractually specified overall functionality (semantics) of an object.*
- **Service quality**: *non-functional properties of a service (e.g. speed, reliability, ...).*
- **Service interface (API)**: *actions ("primitives") and responses that make the service available; these responses can be autonomous ("events", "call-backs"). In addition, a specification that*
  - *describes their effect on state variables and parameters, as well as their results;*
  - *describes rules as how and in what sequence to call them;*
  - *describes the functional and non-functional properties of sequences of calls.*

  (i.e., the interaction or access protocol)
- **Service access point**: *location where the service is accessed*

Simplified view on running component

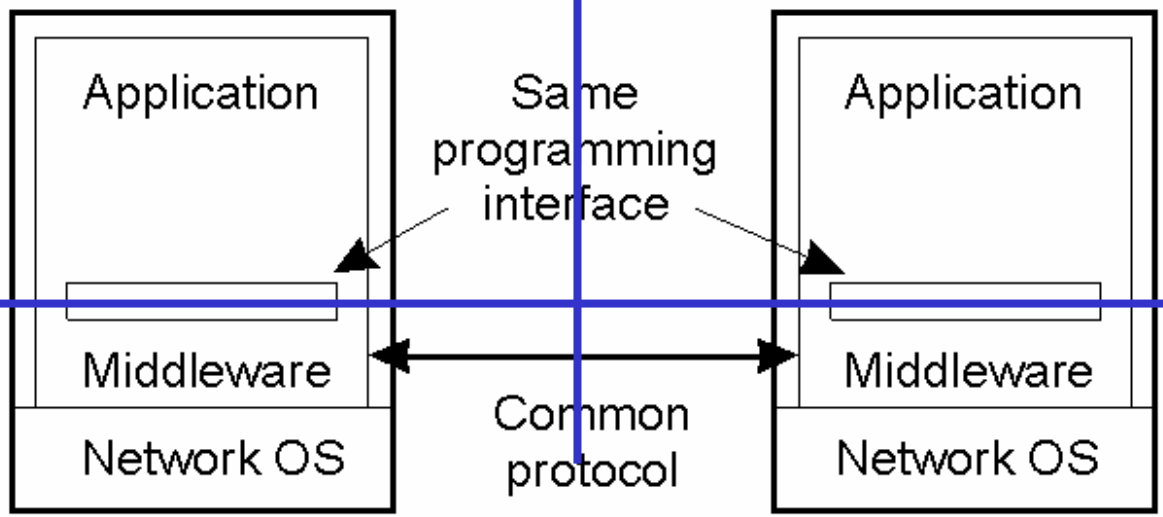
- Four dependencies
- Single processor application: 3, 4
- Client: 1, 3, 4
- Server: 2, 4
- (In fact: GUI can be a separate component)



- Example: DNS

Interoperability views

Interoperability focussed
on protocol; no language or platform
binding besides message structure
and semantics



Hide network details
by extending platform
services
Binding mostly through
libraries

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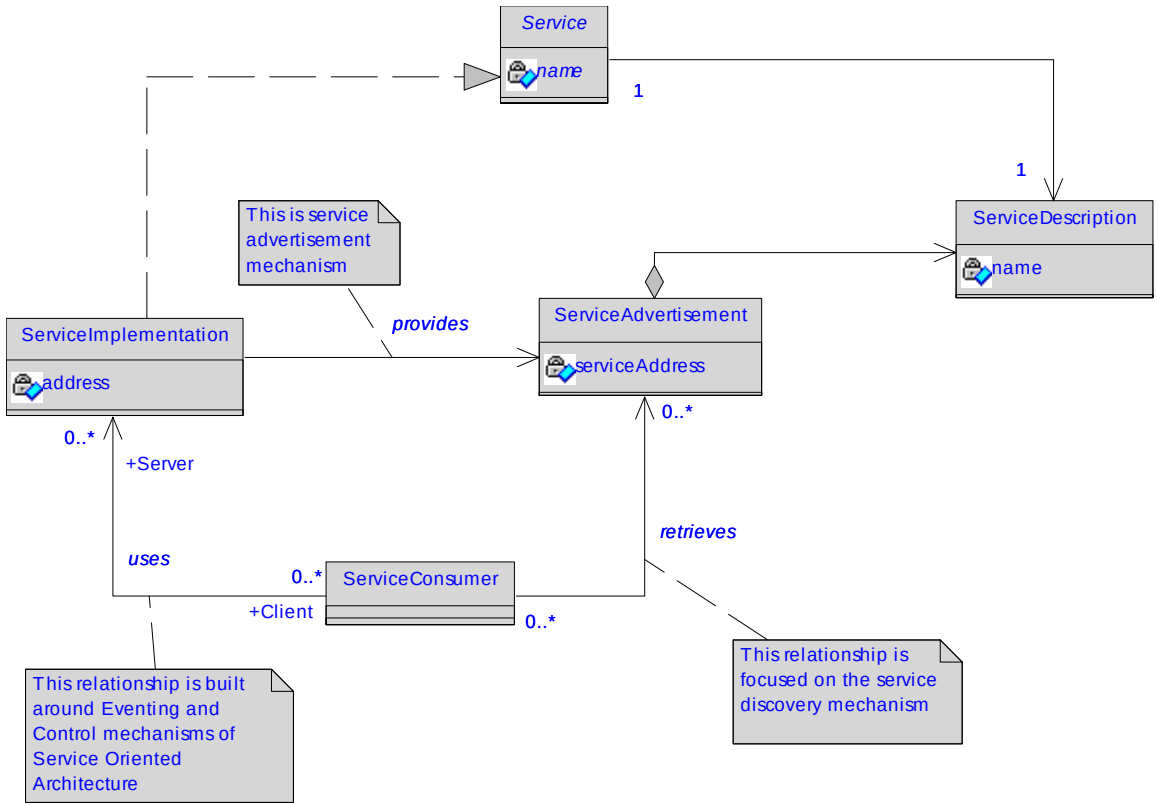
S.O.A. elements

- Roles
  - service provider, service consumer
    - note: a service is not a component; it may be *exposed* by a component
  - perhaps: broker (service), manager / controller (consumer)
- Services
  - interfaces
  - descriptions (schema's)
    - semantics
    - access points
- Interaction
  - discovery, advertisement
  - access: control & eventing
- Structural control ('orchestration')
  - setting up service compositions
- Protocols

Model



"publish-find-bind-execute"

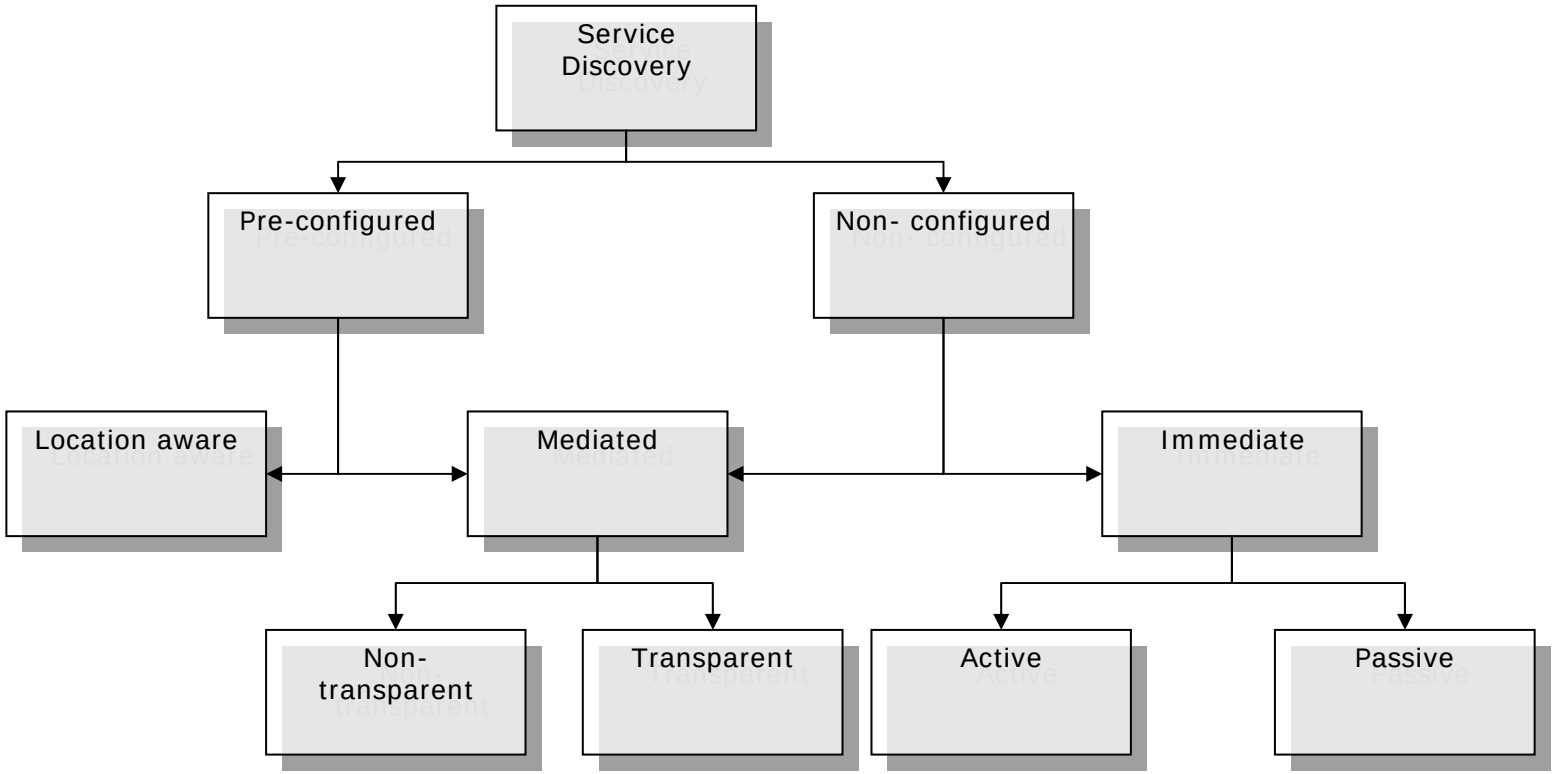
Sample technologies

- Let's practice some acronyms
- Web-services
  - UDDI, WSDL, SOAP, XML
- Universal Plug'n Play
  - SSDP, GENA, SOAP, XML
- GRID technology
- Technologies to build S.O.A.
  - CORBA, DCOM
    - though these are much more tightly coupled
  - MOM, e.g. IBM MQ systems

Purpose of service discovery

- Locate appropriate service provider
  - “distributed query processing”
- Obtain details about service interface and quality
- Obtain service access point (address of)
- Decide upon (negotiation) interaction details
  - security, other qualities
  - access rights, payment, ...

Taxonomy of service discovery

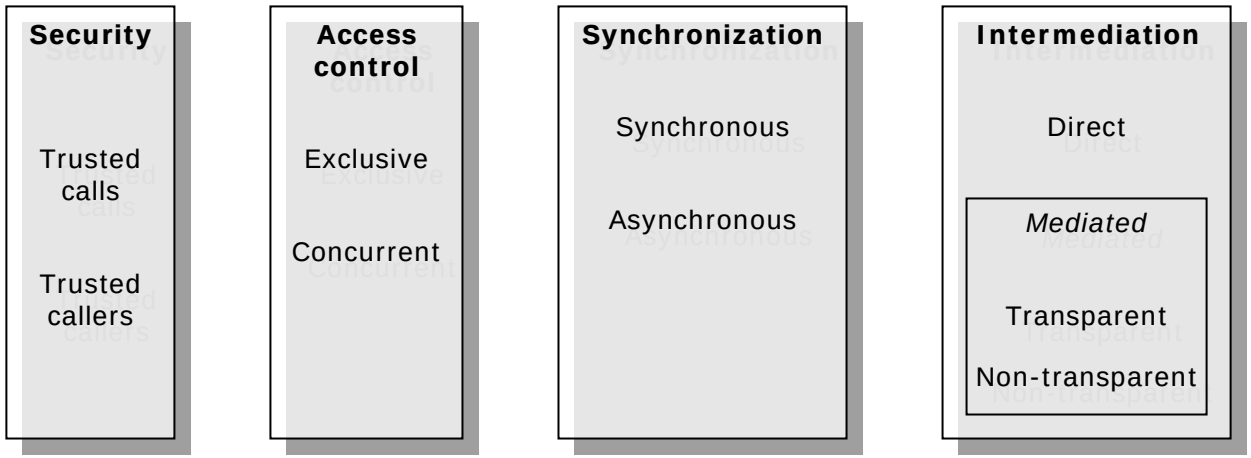


- from "*JESA Service Discovery Protocol*" by Stephan Preuss, Networking 2002, LNCS 2345

Examples

- SSDP (simple service discovery protocol)
  - non-configured, immediate, active
    - both provider (advertisement) and consumer (discovery)
    - note: either one passive gives polling inefficiency
- UDDI (Universal Description, Discovery and Integration)
  - configured (?), mediated, non-transparent
- SLP (Service Location Protocol)
  - non-configured, mediated, non-transparent & immediate passive (service)

Control Mechanisms



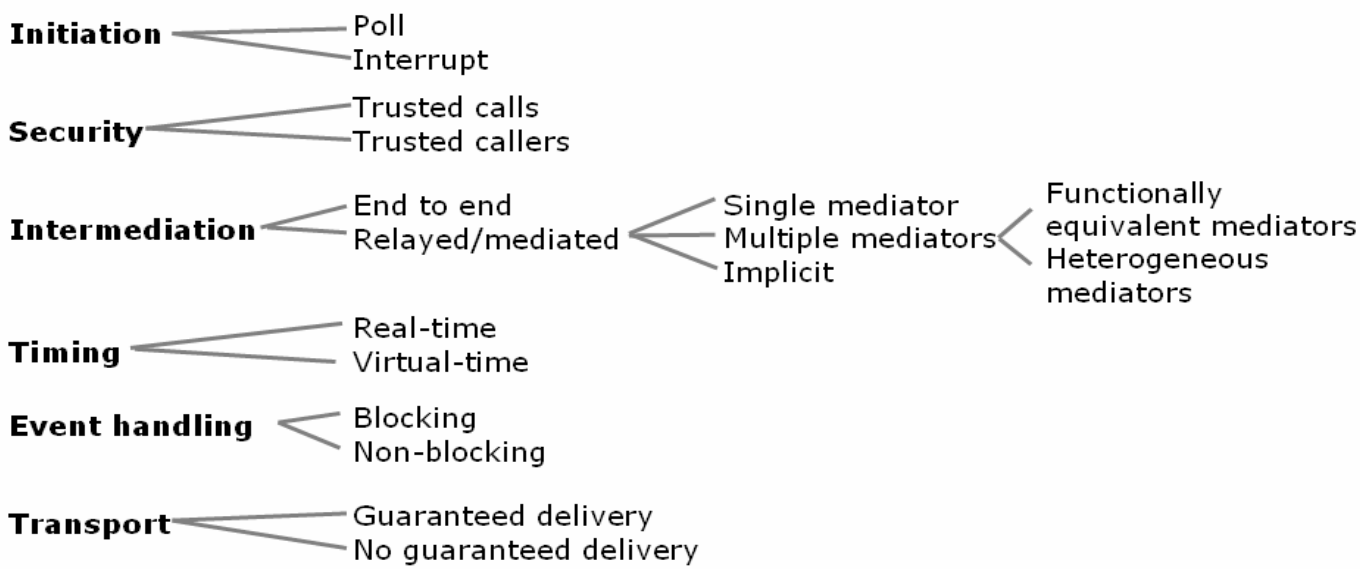
- Typically: from service consumer to service
- Mainly: remote calls

Examples

- SOAP/HTTP
  - synchronous, non-transparent mediation / immediate
- Corba, RMI
  - synchronous, immediate
  - Corba: also mediated via broker

Eventing mechanisms

- Typically: from service to service consumer
  - can be realized as a “reverse service”
- Covers ‘data driven’ interactions
- Similar issues as for control



Examples

- GENA/HTTP
  - interrupt, non-blocking, virtual time, guaranteed delivery
- Real-time traffic/RTP
  - (interrupt), blocking, real-time, non-guaranteed

Service Oriented Applications

- **Serviceoriented.org**: *"Service oriented applications are composed of the run-time loose bundling of services. It is said that these services are orchestrated to solve some problem."*

- Set up a 'graph' of collaborating services
  - e.g. connect a content providing service to a player
- ... or just another layer – (broker-like)
  - given a collection of services found on the network....
  - ....realize a new service
  - ... as in the Entity Aggregation view

Orchestration

- System topology
  - hierarchical (layered)
  - arbitrary

- Service – service connections
  - mediated
    - only via controller
  - direct
    - controller can set up connections, typically using the event mechanisms

Usage patterns

- Reconciliation and aggregation
  - see earlier examples: different data formats
- Partitioned data
  - combine similar data from different sources
    - e.g. UK & Dutch locations of Royal Dutch Oil
- Augmentation
  - add meta-data obtained from analysis
    - e.g. the VCA application, using face recognition to enrich the video stream
- Distributed processing
  - different functions on same data, concurrent operations
    - e.g. the mentioned VCA-application
  - distributed resources

Examples

- BPEL: Business Process Execution Language – E.g.
  - Accept the name, postal address, and e-mail address of a user.
  - Look up the current weather forecast for the user by zip code.
  - Download information about the address the user has provided.
  - Send an e-mail with the collected data to the user's provided e-mail account.
- Research issue

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Debates and taxonomies

- Stateless / Statefull services
- Interaction styles
  - publish & subscribe
  - ‘forward’ call sequence
  - data and control flow
    - push / pull
- Granularity of services
- Hierarchical or flat control

- Major worry: granulairy / performance balance!

Challenges

- Focussed service discovery
  - in combination with locality, qualities, ownership, membership, ...
  - ... just general queries
- Embedded decision procedures
  - interpretation of descriptions, selection, learning
- Security, privacy, ownership
- Evolution path
  - include legacy, even currently developed legacy

Challenges

- Service development
  - self-containedness, granularity, performance
  - interfaces exposing *mechanisms* for non-functional properties
- Application development
  - ‘language’ having S.O.A. elements as primitives
  - specify policies
  - deal with mobility and connection failure as *regular behavior*
    - time/space separation
  - exception handling
  - analysis: visualization / simulation

Conclusions

- S.O.A. represent a next step in component based software architectures
  - composition *after deployment*
  - cooperation *via the network*
  - explicit '*information faces*' of components
  - application as *orchestration*
- Though perhaps not new, S.O.A. enforces focus on
  - thinking about components as part-of-a-whole
  - sharp semantic boundaries, including non-functional properties
    - just extending Parnas' principle