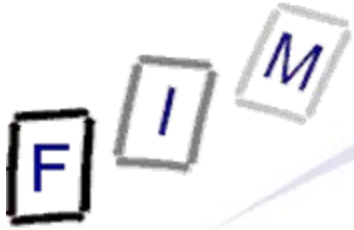

Mag. iur. Dr. techn. Michael Sonntag

XML in E-Business

ebXML, SOAP&WSDL&UDDI, XML for websites

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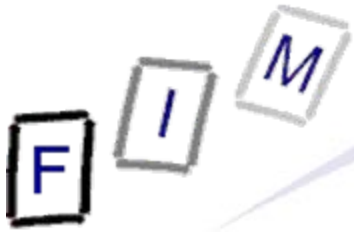

Questions?

Please ask immediately!

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Content

- Why XML?
  - → The need for automatic conversions
- We will cover four different groups of standards briefly:
  - → Business data interchange: ebXML
    - » Defining the data to be exchanged between companies
  - → Web services: SOAP, WSDL, UDDI
    - » How to transfer data, provide electronic services, integrate software
- Webservice example: Amazon ECS

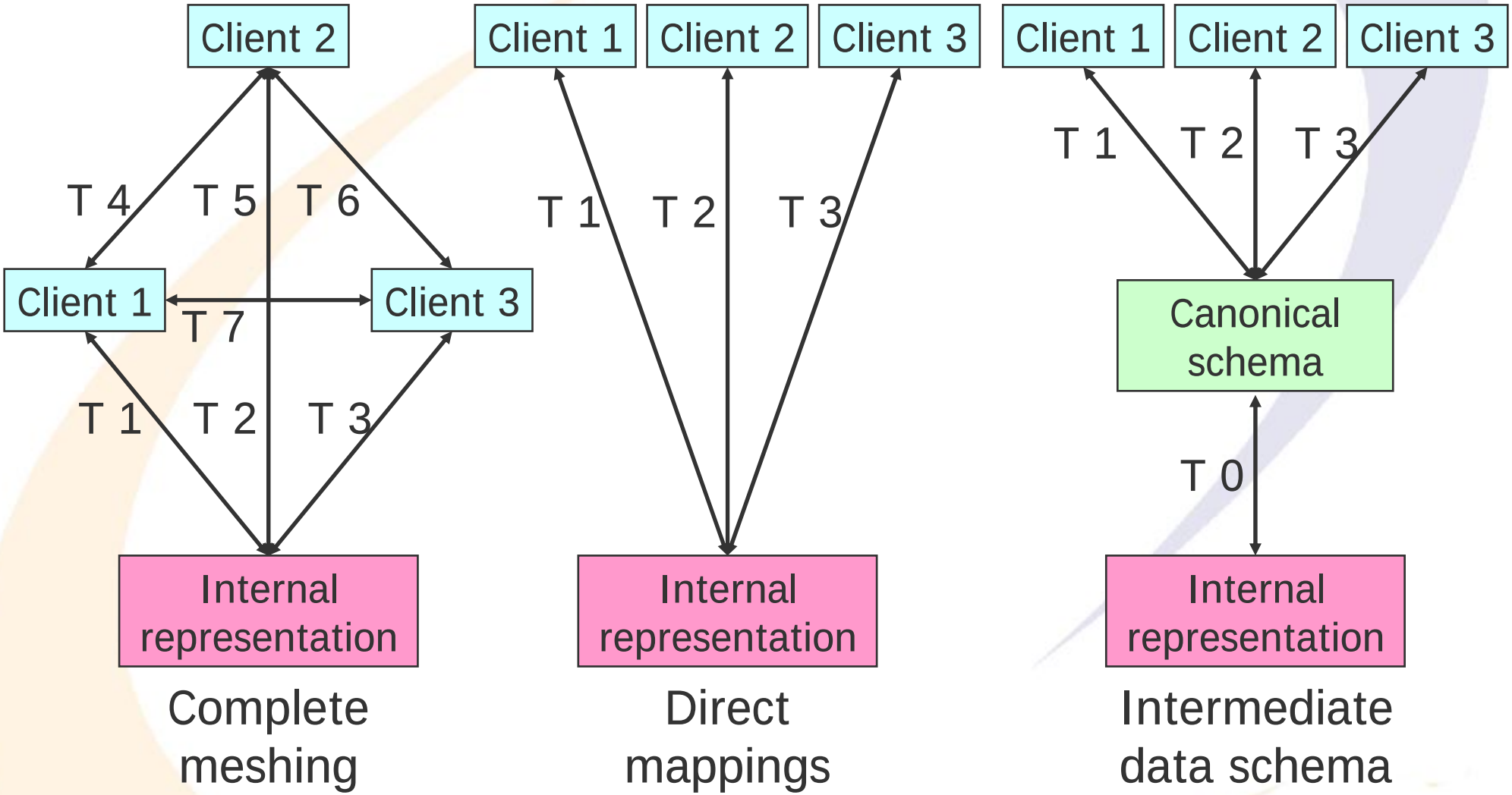
Why XML?

- HTML, EDI, ... have been sufficient in the past!
  - → HTML is a presentation language; therefore very hard to parse
    - » Syntax is quite open, different "versions"; changing layout, ...
  - → EDI is extremely complicated and difficult
- XML is a bit like relational databases
    - » RDB = Storage, XML = Transmission
  - → A framework for structured content
  - → But the actual rows resp. elements must be defined by the user!
- Difficulty: Mapping from one XML schema to another
  - → Syntax is rather easy: XSL for "rewriting"
  - → Semantics is much more difficult!
    - » Often not available in "usable" form; e.g. in a text document
    - » Semantic description possible today; semantic "rewriting" still far away
      - – Some early and easy examples possible through automatic deduction

The N^2 problem

- Each company has its own way of doing business and therefore also its own data schema
  - → Mapping data schemas to each other has a complexity of $O(N^2)$
  - → This is not feasible for more than very few partners!
    - » But how often must company A map data from B directly to C?
- Solution: Define your own "canonical" schema and convert all data to it (and then back to a different schema if required)
  - → Complexity: O(N); or more exactly O(2N) (from & to each partner)
- Still a difficulty: Exchanging the internal software, processes, etc.
  - → All transformations would have to be modified
  - → Solution: A single transformation from the canonical data schema to your own internal representation
    - » Practice: Database and schema identical at start; drift apart later on
    - » Important: Allow separation right from the beginning!

The N^2 problem



Automatic conversions

- The conversions from before should be made automatically
- This requires:
  - → Exact syntax definition (incl. charset, size of data elements, ...)
  - → Exact semantics definition
    - » Is "delivery date" the 'date of sending' or the 'expected date of receipt'?
  - → All definitions must be explicit, clear and unambiguous
  - → Platform independence: All software/hardware/platforms supported
- What would be nice in addition:
  - → Automatically verifying input and output whether it is syntactically correct and "makes sense"; as extensive as possible
  - → Easily extensible: Adding new data, messages, protocols
  - → Strict definition: If there exists a way, there should be only one way
  - → Simplicity: Learning curve should be low and flat
  - → Possibility for industry standards

- XML provides all of the issues above except the semantics
  - » Semantic standards based on XML exist; but they are not (yet?) in widespread use!
  - → XML Schema (or others, e.g. Relax NG) provide syntax definition
    - » This is itself XML and therefore fully automatic and unambiguous
    - » Validation completely automatic; depends only on degree of completeness/exactness of the definition
  - → Platform independence: Uses Unicode, which is available for all programming languages and systems
  - → Extensibility: XML Schema supports a kind of "object orientation" with subclassing; "procedural" extensions also possible
  - → XML is strictly defined and simple
    - » Many years without changes except error corrections and clarifications
  - → Industry standards available, e.g. ebXML or BizTalk

XML Basics

- XML is similar to HTML: Elements and attributes
  - → Difference: Always end tag; empty tags; attributes always "quoted" and always have a value; case sensitive
  - → No "interweaving": XML is always a tree (not a wood!)
- Namespaces are an important part to distinguish elements from different areas (here: different companies)
- Special handling of whitespaces and linebreaks
  - → Whitespace handling can be customized (e.g. if important)

```
<Order>
   <OrderNr>139</OrderNr><OrderingDate>11.11.2003</OrderingDate>
   <CustomerName>Michael Sonntag</CustomerName>
   <Items>
      <Item count="1" Nr="4711">Firewire harddisk (External)</Item>
   </Items>
   <DeliveryDate>2.1.2004, 10:30</DeliveryDate>
</Order>
```

Schema Basics

- XML Schema describes both the structure and the content
  - → Structure: Which elements are available and their nesting
  - → Content: Datatypes (e.g. string patterns, date, numerical types)
- Drawback: Quite complicated
  - → Even a relatively simple XML file has a long schema
    - » One reason is, that it specifies it to the last possible item!
  - → Schemas are not self-explanatory: Understanding a schema is difficult (but tool support is growing)

```
<xs:schema xmlns:xs=http://www.w3.org/2001/XMLSchema ... >
   <xs:element name="message"><xs:complexType>
      <xs:sequence>
         <xs:element name="from" type="xs:string"/>
         <xs:element name="to" type="xs:string"/>
      </xs:sequence>
   </xs:complexType></xs:element>
</xs:schema>
```

```
<message ...>
   <from>Michael Sonntag</from>
   <to>Rudolf Hoermanseder</to>
</message>
```

Converting XML

- XML manipulation is possible in many ways:
  - → Manually (i.e. string manipulation): Please avoid it!
  - → DOM/SAX: Programmatically (large changes or inserting new data)
  - → Stylesheets: These are itself XML and describe how to transform XML input into some (XML, HTML, text, ...) output
- Stylesheets = XSL (eXtensible Stylesheet Language)
  - = Transformation rules (XSLT)
  - + expressions language for targeting document parts (XPath)
- This is especially useful for mapping one document to another
  - → Order from company A is transformed to the canonical representation of an order for company B
  - → Extensible through custom functions (programs)
    - » This allows arbitrary content modifications
- Limitations: Input & output must be known exactly (→XML Schema!)

Converting XML

- Alternative: Use a mapping to objects
  - → E.g. JAXB: Maps Java objects to XML documents
    - » You could think about it as a serialization of Java objects into an XML document format instead of a binary one!
    - » Drawback: A definition of the mapping is needed
      - – Binding declaration
      - – Can be omitted if default conversion of XML schema is sufficient

XSL Basics

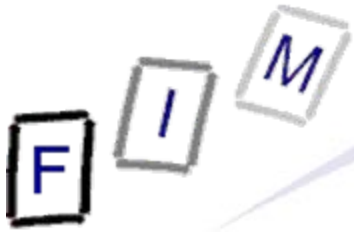
- Transformations possible in two ways
  - → Template rules (functional style): "Everything matching is handled exactly in this way"
  - → Programmatic rules (procedural style): "Now insert this part, then copy this if it matches, and finally loop over all such elements"
- Quite easy to learn, but difficult to master
- Also suitable for presentation
  - → Conversion to HTML (direct presentation in the WWW)
  - → Conversion to PDF (additional software required; e.g. XSL-FO)
- Integration with software also possible (variables, functions)

```
<xsl:template match="product">
<table><xsl:apply-templates select="sales/domestic"/></table>
<xsl:value-of select="@given-name"/><xsl:text> </xsl:text><xsl:value-of select="@family-name"/>
</xsl:template>
```

ebXML

- ebXML = Electronic Business XML
  - → Should be a successor for EDI
    - » EDI problems: ex(t/p)ensive software and hardware, difficult to implement, integration into existing software
  - → Is a comprehensive global framework
  - → For the exchange of business data
- Components:
  - → Business process models
    - » Includes e.g. parties and message sequences
  - → Message formats
  - → Repositories/Directories
- Main advantage: Simpler and cheaper
    - » But not necessarily simple and cheap!
  - → More suitable for SMEs

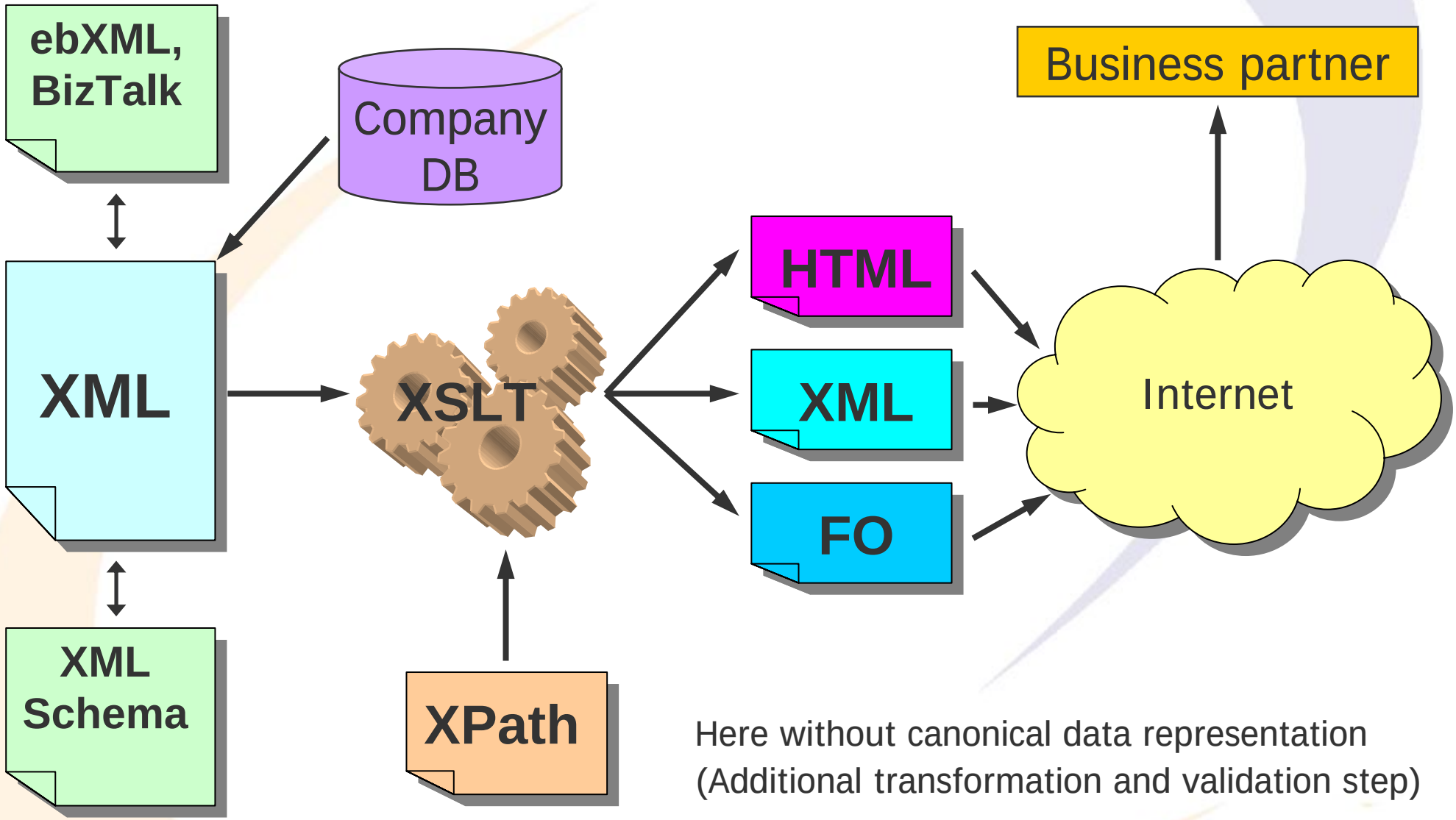
How to exchange a sequence of messages



ebXML Concepts

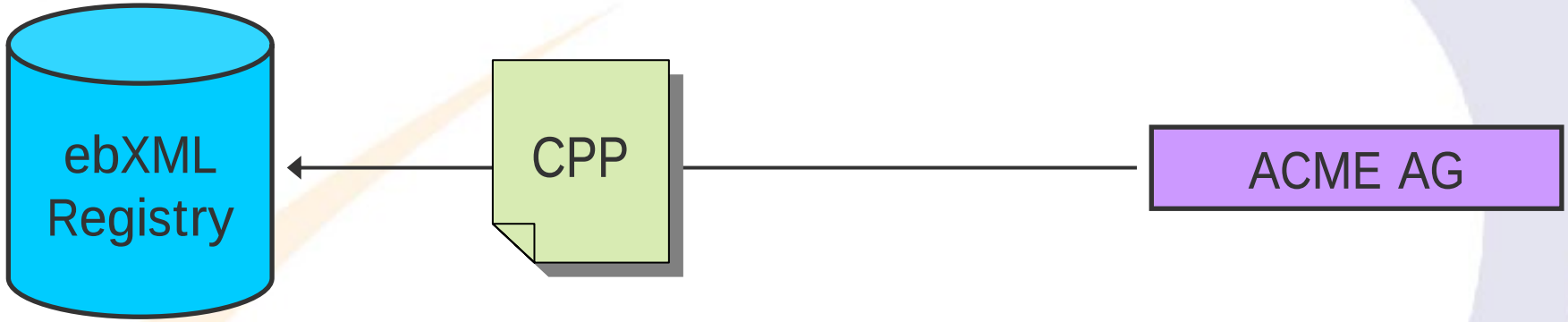
- Each company describes its business process
  - → Manually or from a standard definition
  - → E.g. "Buying something" = Send request, wait for acknowledgment, wait for acceptance, send invoice, send goods, ...
- Process and company data is stored in a registry
  - → Allows finding out what they do and how they do it
    - » In practice probably not public!
- Describing a business arrangement
  - → What processes were actually agreed upon to be performed
- Defined service for message exchange
  - → How to deliver/receive messages with non-repudiation, encryption, signatures, ...

XML in E-Business



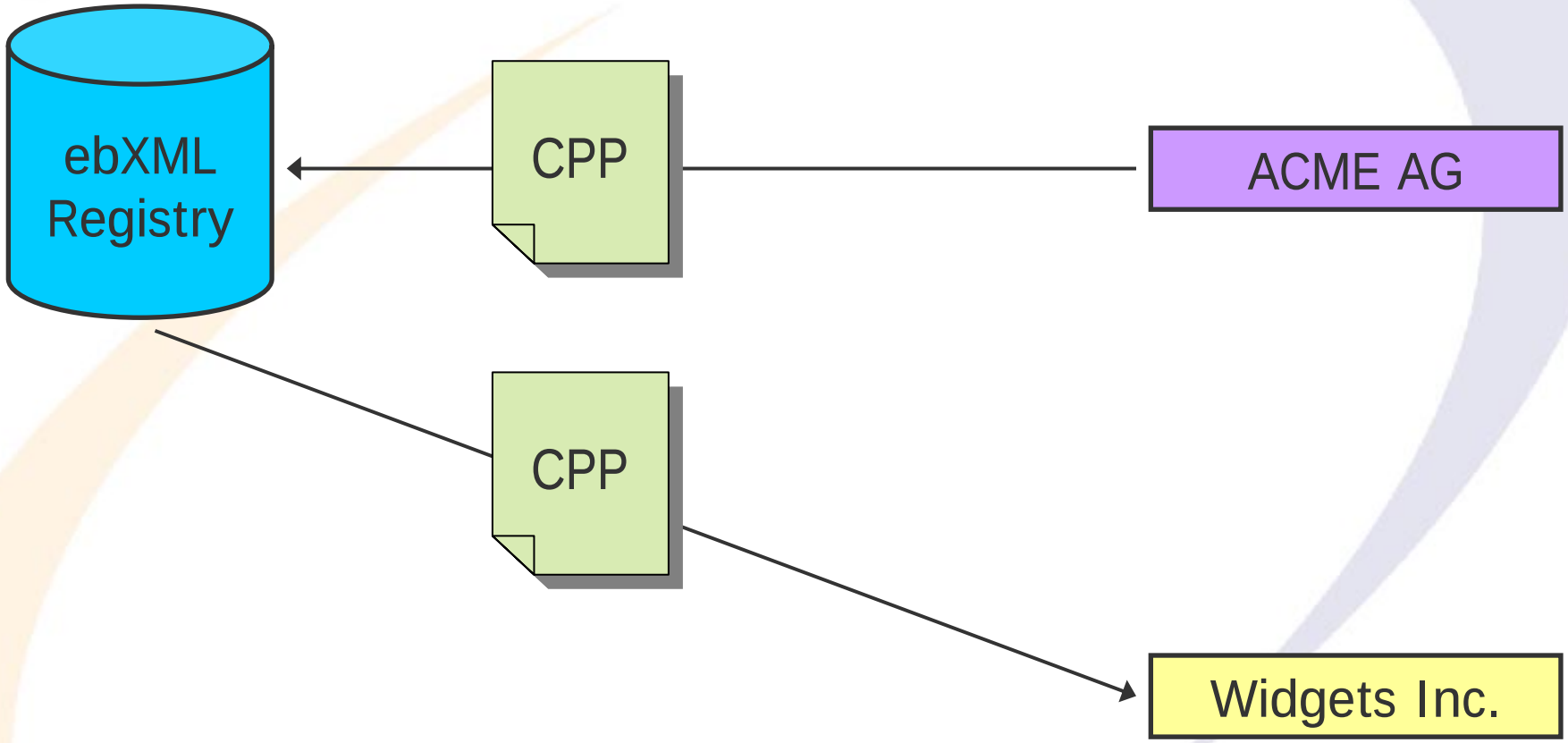
Here without canonical data representation
(Additional transformation and validation step)

ebXML
Use case



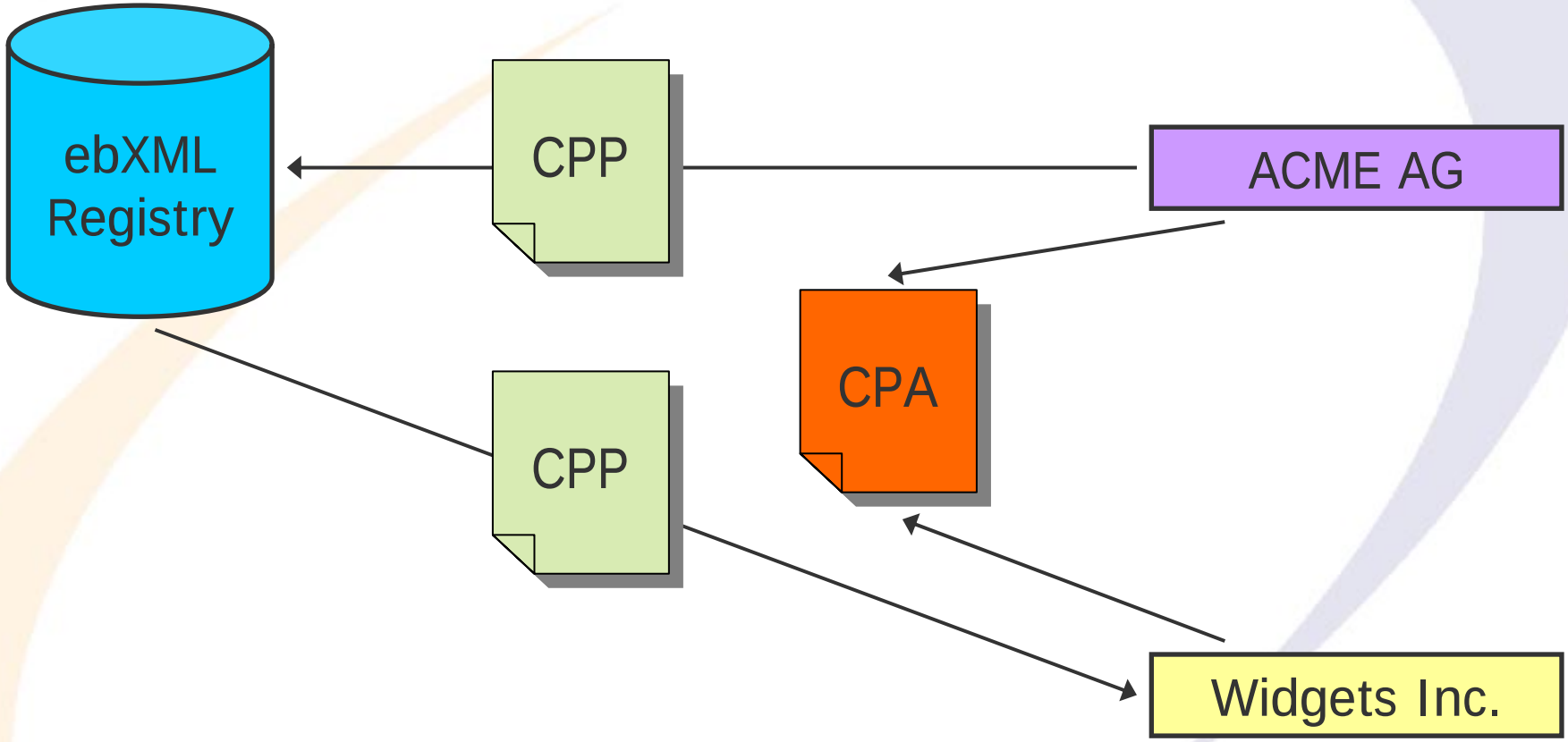
- The first company (ACME AG) provides information about the processes it can perform in a registry
  → This is a "CPP" (Collaboration Party Profile)

ebXML
Use case



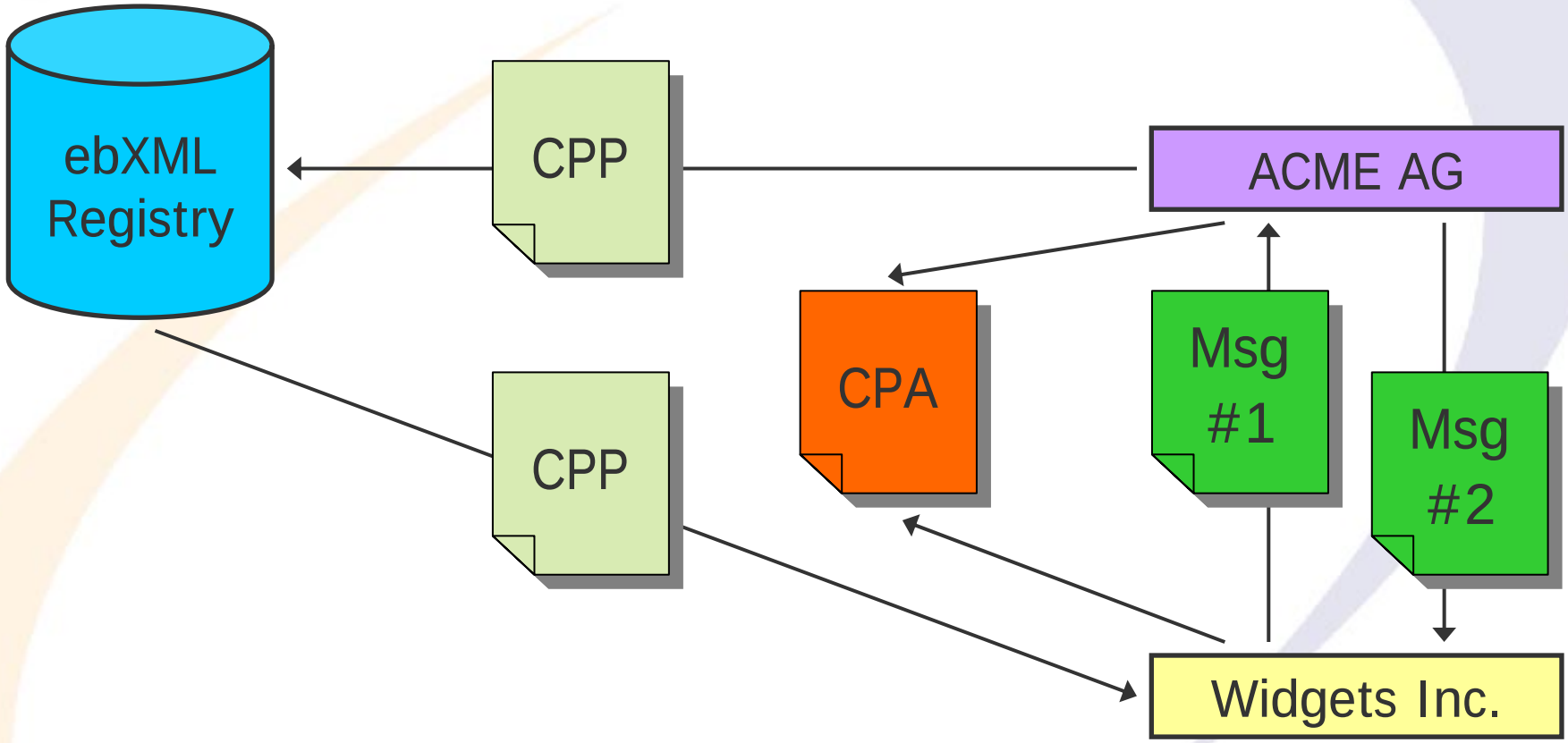
- The second company (Widgets Inc.) queries the registry and finds a suitable trading partner (=ACME)
  - → It retrieved the CPP and compares it with its desires

ebXML
Use case



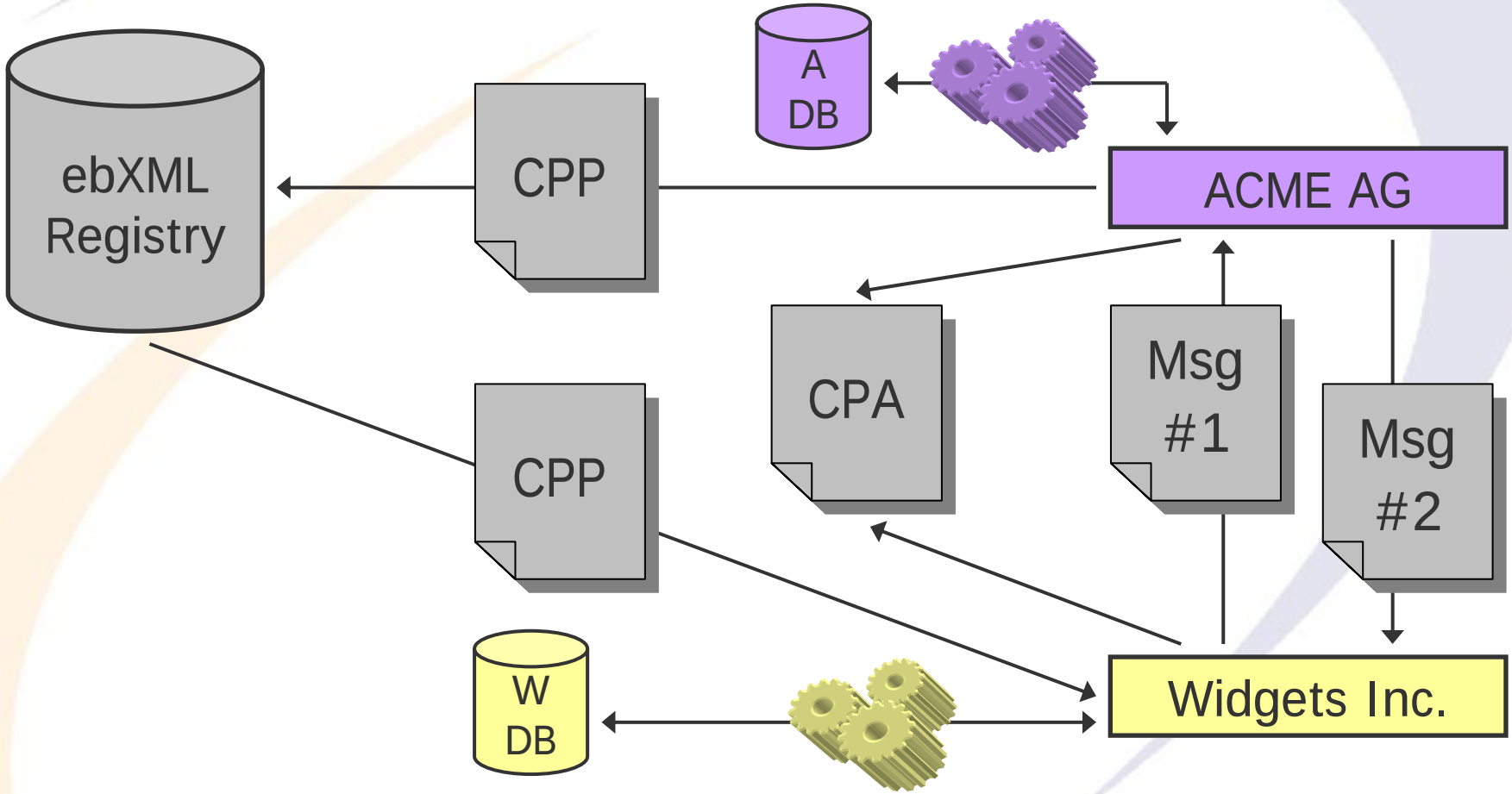
- Both agree on certain processes to be performed
  - → The result is a "CPA" (=Collaboration Protocol Agreement)
    - » This could be derived automatically if desired and both provide CPP's!

ebXML
Use case



- ACME and Widget exchange messages and perform the processes/protocols they agreed upon

ebXML
Important issues



- Documents shown are clearly defined, verifiable, secure, ...
- Software on both sides is standard and unmodified
  - → Both must provide a data mapping to their local systems only!

CPP: Collaboration Party Profile

- Specifies what a party can do:
  - → Business Transactions: Models the processes and the roles
    - » Separate specification
  - → Delivery Channel: Message sending/receiving characteristics
  - → Document Exchange Layer: Encryption, signature, reliability
  - → Transport Layer: Transport protocol, endpoint address
- Contains:
  - → Contact information: Company can consist of several "parties"
    - » E.g. office supply and production supply departments
  - → Security details: What certificates/where to find, public keys, ...
  - → Message structure: What messages consist of
  - → Comments

CPA: Collaboration Protocol Agreement

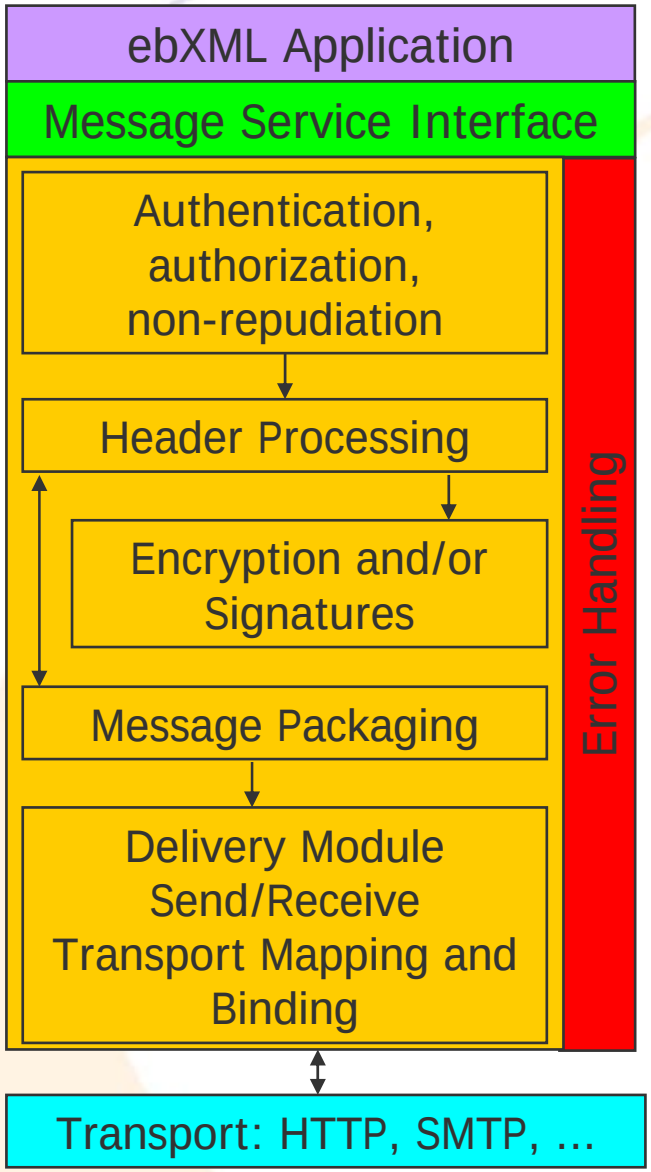
- Specifies what the parties will do:
  - → Describes the visible (i.e. external and enforceable) interactions between the parties
  - → Independent of the internal processes of all parties
    - » Mapping should be simple because everything exchanged is XML!
- Intersection of the CPP's of the trading partners
  - → Must be mutually agreed
  - → Automatically derived or manually negotiated
- Contains:
  - → Additional status value (proposed, signed, ...)
  - → Lifetime: Consent may be time-limited
  - → Constraints on conversations: E.g. at most ? concurrent, ? total maximum, …

Message transfer

- Secure and reliable exchange of messages between parties
  - → Message structure for packaging the actual content
    - » "Just another" kind of packaging
  - → Behaviour of message service handler (MSH)
    - » This is something "new"!
  - → Doesn't define a spec. interface (data format + semantics, not API)!
    - » Can be implemented in Java or C, with different names, etc.!
- Extension to SOAP and "SOAP Messages with Attachments"
- Optional: Reliable messaging
  - → Ensuring messages are delivered e.g. exactly once
  - → Ensuring information survives any single failure
- Optional: Message ordering
  - → Ensuring messages arrive in specific order (at application!)
- Optional: Multi-hop messaging (using intermediaries)

Probably the most-used part of ebXML!

Message transfer schematic



- → Message Service Interface: Defined by the actual ebXML implementation
  - » Independent from the application!
- → Header Processing: Creation/Parsing of ebXML headers
  - » Uses the CPA
- → Message Packaging: Final packaging of ebXML into SOAPwA (Enveloping, ...)
  - » Headers + Payload (= business content)
- → Delivery Module: Actual connection using certain protocols, incl. acknowledgments
  - » Persistence, retries, error notifications, ...

Implementations

- Some implementations (and applications) exist
  - → Mainly from large companies and for enterprise systems
  - → Case studies seem to be not that frequent currently
- Free software also partially available
  - → See: http://www.ebxml.org/tools/index.htm
- JAXR: Java API for XML Registries
  - → Can access XML registries, also supports ebXML and UDDI
- Still nothing for the "small company" out of the box
  - → But selected applications can be created probably rather easily from available parts
- Problem: Better than EDI, but still expensive to setup
  - → Integration, specification of documents, administration, …

Web services: SOAP, WSDL, UDDI

- UDDI: Universal Discovery, Description & Information Protocol
  - → For finding the location/available procedures to call
    - » "Yellow pages" of web services providing metadata about them
- WSDL: Web Service Description Language
  - → Describing the procedures available
- SOAP: Simple Object Access Protocol
  - → RPC (Remote Procedure Call) protocol over the Web
    - » Other styles also supported, e.g. free messaging

For all three "services" alternatives exist, but these seem to be those most widely used and the best candidates for the future!

SOAP
Simple Object Access Protocol

- Communication protocol for message exchange between applications via the Internet
  - → Usually sent via HTTP, but other transports possible (e.g. SMTP)
    - » Good: You can get around firewalls by this!
    - » Bad: You can get around firewalls by this!
  - → Stateless: Each message stands alone
  - → One-way: There is no response to a message
    - » The other side may, however, decide to send a new message, which might be semantically in reply to this one!
  - → Routing, reliability, etc.: Not addressed!
- Consists of up to three parts:
  - → Envelope: Marks this XML document as a SOAP message
    - » Header (optional): Context info, custom extensions
    - » Body (required): The actual call/response
    - » Fault (optional): Exceptions, errors, … that occurred during processing

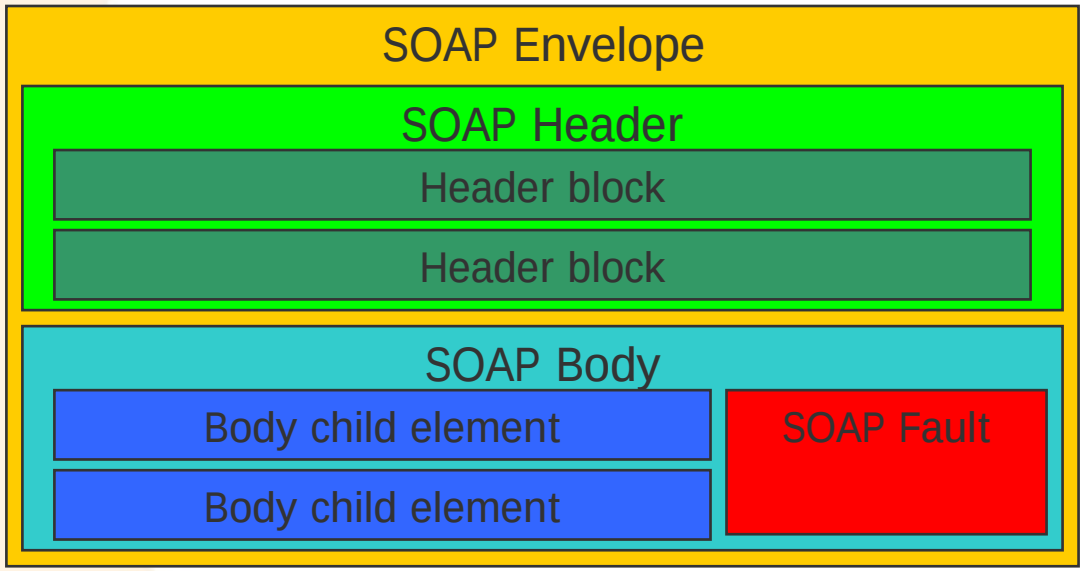
SOAP
Message structure

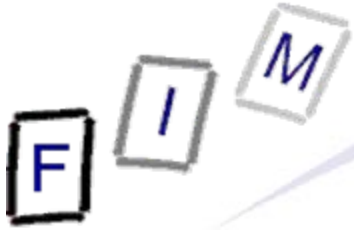
- <?xml version="1.0"?>
  <soap:Envelope xmlns:soap="http://www.w3.org/2001/12/soap-envelope"
  soap:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
  <soap:Header> ... ... </soap:Header>
  <soap:Body> ... <soap:Fault> ... </soap:Fault></soap:Body>
  </soap:Envelope>

Either:

→One or more child elements

→Or a single fault element





SOAP Intermediaries

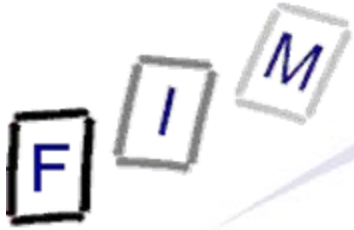
- SOAP messages may be sent over several "hops"
  - → These are called "intermediaries"
  - → The last recipient is the "ultimate receiver"
- SOAP does NOT specify how these are selected!
  - → No routing; e.g. a header element could contain a route, but each intermediary would have to understand it and act accordingly!
- Processing of header blocks depends on the role of the "node"
  - → Role "next": Header block is intended for the next intermediary
    - » Must be examined, but not necessarily processed!
  - → Role "ultimateReceiver": Intermediaries must ignore this block
  - → Role "none": May not be processed
    - » But might be referenced from a different header block!
  - → Which role a node plays is defined by the application!
    - » Additional roles can be defined by the application

SOAP
"mustUnderstand" and "relay" attributes

- Special header attributes:
  - → A header block marked as *mustUnderstand* MUST be processed
    - » If it is not understood, a failure message must be created!
    - » The message may not be processed any further
    - » This is intended for important information about block handling
      - – E.g. requiring that it be encrypted before sending it onwards
  - → A header block marked as *relay* MUST be relayed if it is NOT processed by this intermediary
    - » If it is processed, it MUST always be removed
      - – Another header block could however reinsert it!
    - » If it is not processed, it must be passed on to the next recipient
      - – Default would be to remove it, if it is targeted at this intermediaries role!

SOAP Faults

- Describes error during processing of the header or the body
  - → Must contain code and reason
    - » Code: May contain subcodes
    - » Reason: Textual description, perhaps in several languages
  - → Can contain node, role (of the node) and detail
    - » Node: The node that generated the fault (important for intermediaries)
    - » Detail: Application defined information; can be any XML content
- The only child element within a SOAP body
- Some faults are predefined
  - → VersionMismatch, MustUnderstand, DataEncodingUnknown
  - → Sender: Incorrect message; do not resend
  - → Receiver: Recipient problem; may be resent identically



SOAP
HTTP Binding

- Theoretically SOAP need not be represented as XML
  - → It just hast to adhere to the "XML Infoset", which is more or less the "content" and "style" of XML (its abstract data set)
- Similarly, SOAP need not be sent by HTTP (e.g. SMTP possible)
  - → This is the main protocol, however
  - → GET: Send a simple request and expect a SOAP reply
    - » No SOAP request possible, only a simple URL
    - » The "object" identified by the URI should stay the same (read-only)!
  - → POST: Sending a SOAP request and expecting a SOAP reply
    - » The "object" identified by the URI can also be modified (read-write)!
  - → In both cases the SOAP reply (=complete XML document) is just sent instead of the HTTP content (after the HTTP headers)
    - » This also applies to the request for HTTP POST

SOAP
Example messages

- Connection test message ("Ping") from a real system
  - → Described using WSDL
  - → Transmitted by SOAP over HTTP
- PingPong.wsdl: Description of this call
- Ping.txt: Sending a RPC command
  - → SOAPAction: Specific additional SOAP header; describes action
  - → POST command: Wants to send additional details
    - » In this case: Procedure parameter "message" of type string
      - – Value: "Hello"
- Pong.txt: Reply to the command
  - → New SOAP message with the parameter "result" of type string
    - – Value: "Test.ping.Ping2ResponderAgent responds to Hello"

PingPong.wsdl, Ping.txt, Pong.txt

WSDL
Web Service Description Language

- For describing the syntax of web services and their locations
- Consists of the following elements:
  - → Definitions: Root node for defining several services
  - → Service: Specifies the ports which can be used for bindings
    - » Connecting ports and bindings
    - » Port: Single endpoint address for a binding (e.g. URL)
  - → Binding: How an operation is invoked
    - » Protocol and data formats for the operations and messages
    - » How to encode the parameters; RPC or messaging
  - → PortType/Operation: Description of the action(s) ("Procedure name")
    - » Specifies input and output message
  - → Message: Definition of the data communicated
    - » What will be sent over the network as a unit; data types of content
  - → Types: Defines complex data types used (e.g. in messages)

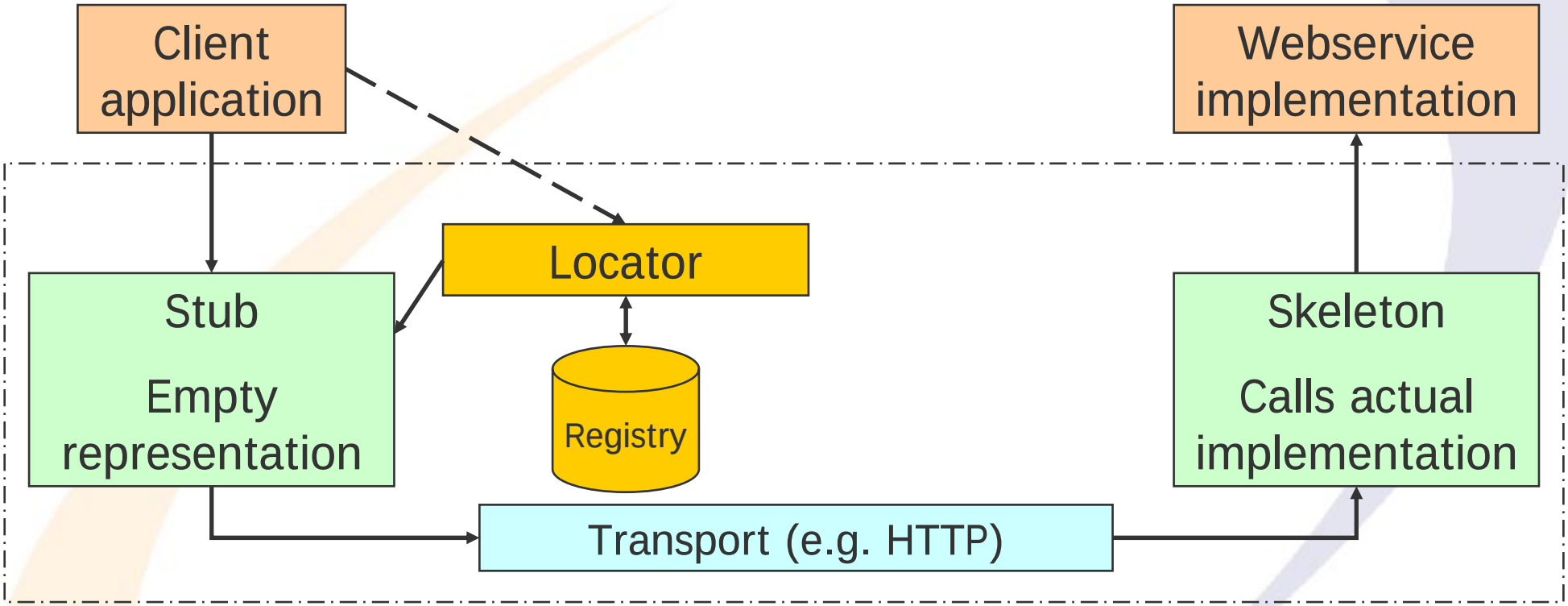
WSDL

- Four kinds of transmission
  - → One-way: Send a message; no response received
  - → Request-response: Send and wait for result
  - → Notification, Solicit-response: Reverse op.; not completely specified
- Bindings defined for SOAP, HTTP and MIME
  - → HTTP: Pure; different from SOAP transported by HTTP!
  - → MIME: E.g. sending it directly in E-Mail attachments
- From WSDL necessary classes can be generated automatically!
  - → Stub (Proxy): On the client side; called by the application
    - » Packs everything into XML (from the native programming language)
  - → Skeleton: On the server side; called by the SOAP implementation
    - » Calls the actual implementation (or is replaced by it)
  - → Helper classes: For any datatypes specified, locating endpoints, …
- This makes RPCs over SOAP transparent for the application!
  - → With some restrictions: error handling, acquiring the endpoint

WSDL and programming

- AXIS: One Java XML framework for web services
  - → Supports WSDL and SOAP (with attachments)
    - » And some other goodies!
    - » Full-blown and universal; many dependencies
      - – Smaller implementations with reduced feature set exist too
  - → From WSDL description, Java code is generated automatically
    - » Only the actual "servicing code" must be filled in
- In general the following parts are required (unless optimized!)
  - → Stub: Client side representation
    - » Packages everything into a SOAP message and unpacks the result
  - → Skeleton: Server side representation
    - » Unpackages the request, calls the actual implementation and packages the result (or the error) into a SOAP message
  - → Locator
    - » For locating the server to call (explicitly, UDDI, manually, etc.)
  - → Additional classes (e.g. custom types, interfaces)

Stubs and skeletons



- Stub must look exactly like the actual implementation for the client
- Skeleton calls the actual implementation with exactly the same parameters and accepts all results (incl. all exceptions, errors, ...)
- The whole subsystem must be invisible to client and application

Universal Discovery, Description & Information

- Inquiry and discovery
  - → Four core types
    - » businessEntity: Information about the parts publishing the data
      - – E.g. Name, description, contact information
    - » businessService: Describing a particular family of technical services
      - – E.g. Purchase: Submission, confirmation, notification
    - » bindingTemplate: Technical information on a a single service
      - – E.g. entry point, content specification
    - » tModel: Descriptions of specifications for services or taxonomies
      - – E.g. webservice type, protocol, category system; could be WSDL
      - – Not contained within the registry itself; this contains only pointers to it!
  - → Everything is accessed by unique identifiers (UUID)
- Security
  - → Access control through a policy
  - → Supports XML signatures to verify integrity/publisher

UDDI

- Replication
  - → Support for messages to keep several registries with same content
- Subscription
  - → Publishing: Uploading information to a registry
  - → Subscribing: Notification on changes within the registry
- Internationalization: Mostly provided by XML already
  - → Uses the "xml:lang" attribute
  - → Supports language dependent collation
- UDDI provides both data structures and API!
  - → Inquiry, publish, …: WSDL specification
  - → Communication with registry: To be implemented with SOAP

Web service example: Amazon.com

- Allows users to interface and extract lots of data
  - → One-way service only: Retrieving/Querying data only
    - » One exception: Sending a shopping cart back to Amazon so visitors to your site can directly purchase goods selected on your site!
  - → One (of several) extension: Search engine integration (Alexa.com)
    - » Web search, URL information, crawl metadata (size, checksum, links, images, ...), web map (list of in- and outbound links)
      - – US$ 0,30 per 1000 requests
- Available data:
  - → Product data: availability, price, size, image,....
  - → Customer content: Reviews, wish lists, lists
  - → Seller information: General info and customer feedback
    - » For third-party shops/sellers affiliated with Amazon
  - → zShops and Marketplace product data

Web service example: Amazon.com

- Several restrictions apply, e.g.
  - → No copying of content (selling, redistribution, price extraction, ...)
  - → Usage restrictions (violence, illegal activities, request size, ...)
  - → Frequency limit (1 call/second per IP-address)
  - → Caching limited to 24 hours
- Incentive to use it
  - → Percentage of sales made through this
    - » Put some recommendations on your website, insert a "local" shopping cart and hope your visitors buy from Amazon later
- Interface: REST (=HTTP GET) or SOAP
  - → Result: XML
    - » REST: XSLT transformation with provided stylesheet also supported

More info: http://www.amazon.com/webservices/

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