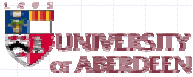# Intelligent Web Services for E-Business

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http://www.csd.abdn.ac.uk/~apreece

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# Context:   business  evolution

- After the .com boom & bust, e-business is reaching a steady state
- Successful models have emerged
  - B2C online shopping
  - B2C "clicks & mortar"
  - C2C Internet-unique
  - B2B portals
- Mature view: e-business is just <u>business</u>
- The evolution continues
  - m-commerce (3G) & t-commerce (DTV)
  - broadband saturation

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# It's not about technology, but...

- ◆ (I'm a technologist)
- ◆ The first generation of e-business applications are founded on 1980s & 1990s technology
  - ▪ Internet protocol suite
  - ▪ The Web: HTTP, HTML, XML
  - ▪ Security
  - ▪ Enterprise programming: Java, CORBA, DCOM

  (These have changed CS curricula forever!)

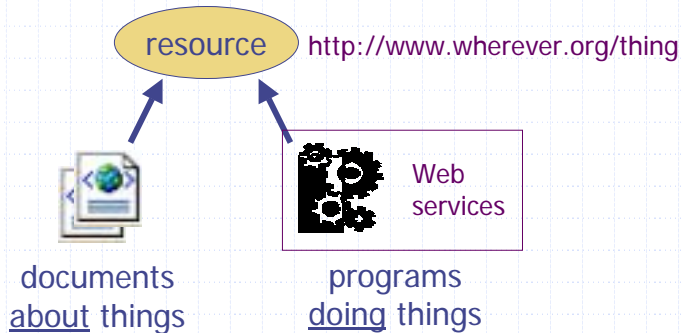- ◆ What are the technologies that will enable the next generation of e-business app?

# Next-gen e-business enabling tech

- ◆ Web services
  - ▪ open networks of services
  - ▪ describable & locatable, dynamically
  - ▪ interoperate through "business-level" protocols
- ◆ Semantic Web
  - ▪ automates Web usage
  - ▪ supports semantic interoperability (meaningful communication)
- ◆ Agent technology
  - ▪ negotiate, form coalitions, act autonomously
  - ▪ represent users' interests on the open network

# The Web today

◆ The Web is composed of interlinked resources
◆ Unifies static documents & invocable programs – everything has a URI

resource  http://www.wherever.org/thing

Web services

documents
<u>about</u> things

programs
<u>doing</u> things

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# Web Services

◆ Web Services are
  - Describable using standard schemas
    e.g. WSDL
  - Locatable using yellow pages / broker services
    e.g. UDDI
  - Invocable using high-level protocols
    e.g. SOAP

◆ Some observations
  - Course-grained distributed computing revisited
  - Emphasis on loose-coupling

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# Semantic Web

- ◆ Aim: to create a network of machine-processable resources
- ◆ Existing in parallel with the current World Wide Web
- ◆ Information is marked-up against semantic data models
- ◆ Enables software agents to carry out tasks on users' behalf
- ◆ Moving from a Web of "finding things" to a Web of "doing things"
- ◆ New Semantic Web services will exploit AI techniques – towards a "smarter" Web
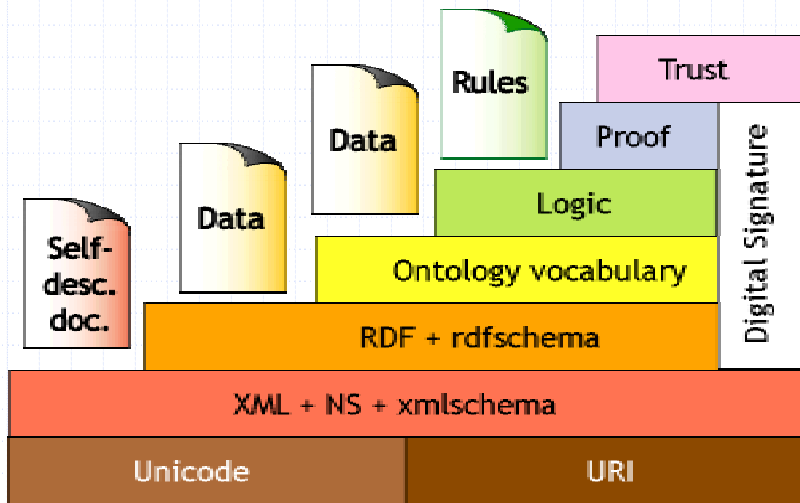
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# Web/Semantic Web example

http://www.csd.abdn.ac.uk/~apreece/index.html



http://www.csd.abdn.ac.uk/~apreece/index.rdf

# Semantic Web architecture



Trust

Proof

Rules

Logic

Data

Ontology vocabulary

Data

RDF + rdfschema

Self-desc. doc.

XML + NS + xmlschema

Unicode | URI

Digital Signature

[Semantic Web "layer cake" slide due to Tim Berners-Lee]

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# Agent technology

- ◆ Like Web services, agents are describable, locatable, invocable...
- ◆ Agents communicate through high-level messaging protocols (e.g. contract net, auctions, ...)
- ◆ Agents offer great flexibility in interactions
  – real loose-coupling
- ◆ Facets of agent technology are very promising for e-business apps
    - negotiation
    - explicitly representing beliefs, desires, intentions
    - trust & reputation

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# Intelligent Web Services

- ◆ Fusion of
  - **Web service technology**: open service networks
  - **Semantic Web technology**: semantic interoperability
  - **agent technology**: autonomy, negotiation, proxies
- ◆ Applications in
  - e-business
  - knowledge management
  - building a "smarter" Web

  also
  - e-science
  - e-governance

IEEE IS
Jan/Feb 2002
Preece & Decker (eds)

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# Case studies

1. Ontologies for value-added services

2. Coalition formation for virtual enterprises
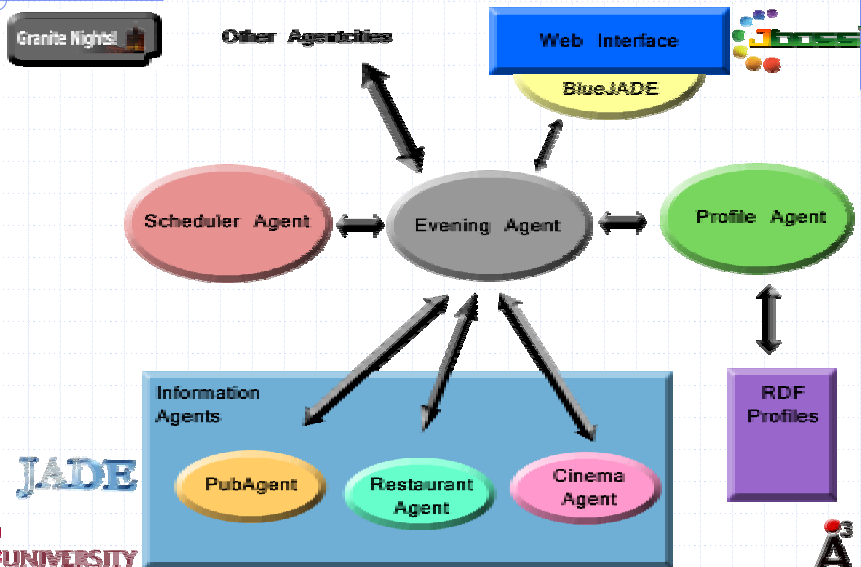
3. Agents supporting team-to-team work

# Granite Nights service

◆ Multi-agent system, allowing a user to schedule an evening out in Aberdeen

◆ Information agents:
- wrappers for RDF resources
- static or dynamically-generated from existing Web sources
- use standard ontologies wherever possible

◆ Profile agent: manages and recalls user preferences

◆ Scheduler agent: maps RDF data to finite domain constraints and produces valid instantiated schedules

◆ Evening agent: orchestrates the multi-agent system

◆ User interface agent: Web page gateway to system

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# Granite Nights architecture

# Granite Nights – input page



# Granite Nights – output page

## Dynamic info source (cinemas)

SCOOT® Busine

**Cinema details**
You searched for U G C Ci
Aberdeenshire

**U G C CINEMA ABERDEE**
QUEENS LINK LEISURE PAF
LINKS ROAD, ABERDEEN
AB24 5EN

Tel: 0870 1550502

View website

**Films showing**

B Mile *(15)* 🗨 Film Revie!
FRI,SAT,SUN,MON,TUES,WE
9:00PM,

Pianist, The *(15)*
FRI,SAT,SUN,MON,TUES,WE

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```
<s:Shows rdf:ID="ugc_PianistThe">
  <s:time>
    <s:ShowScheduleCollection>
      <s:consistsOf><s:ShowSchedule>
        <s:startTime>
          <c:Calendar><c:calendarDate>
            <c:Date>
              <c:dateDayOfWeek
                 rdf:resource="cal#Thursday" />
              <c:year>2003</c:year>
              <c:month>1</c:month>
            </c:Date>
          </c:calendarDate><c:calendarTime>
            <c:Time>
              <c:format rdf:resource="cal#24h"/>
              <c:timeHour>20</c:timeHour>
              <c:timeMinute>20</c:timeMinute>
...
<s:location rdf:resource="cinemas#ugc" />
<s:description>Certificate: 15</s:description>
<s:show>
  <s:CinemaPerformance rdf:ID="PianistThe">
    <s:title>Pianist, The</s:title>
```

---

## Static info source (restaurants)

Restaurant Agent

```
<res:Restaurant rdf:about="#lalombarda">
  <res:name>La Lombarda</res:name>
  <res:averageMealDuration>2
    </res:averageMealDuration>
  <res:address>
    <add:Address rdf:about="rest#lombardaaddr"/>
  </res:address>
  <res:atmospheres
   rdf:resource="res#CasualAtmosphere"/>
  <res:atmospheres
   rdf:resource="res#RelaxedAtmosphere"/>
  <res:caterings rdf:resource="res#ALaCarte"/>
  <res:caterings rdf:resource="res#HomeDelivery"/>
  <res:facilities rdf:resource="res#SmokingFacility"/>
  <res:typeOfCuisine
   rdf:resource="res#ItalianCuisine"/>
</res:Restaurant>
```

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# GNES - observations

- ◆ System is realistic and completely open
- ◆ Validation of current technology
  - agent platforms
  - RDF
  - existing ontologies
  - simple AI: scheduling, profiling
- ◆ Issues arising
  - agent platforms don't actually deliver that much
  - do we need complex ontologies?
  - needs to go further, and make reservations, etc
  - ideally would be fielded on a mobile device...

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# Case studies

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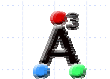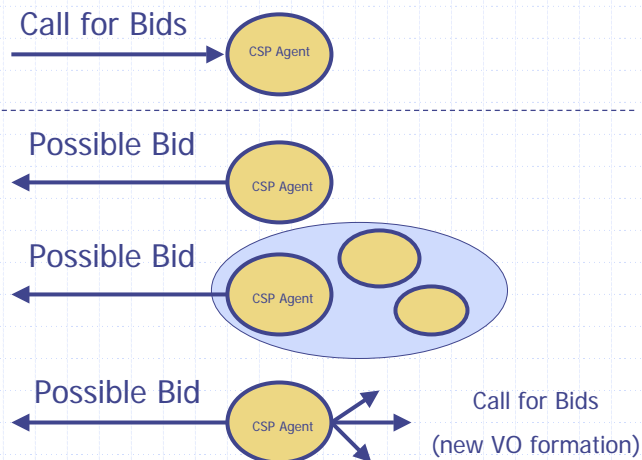
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# CONOISE project

- ◆ Constraint Oriented Negotiation in Open Information Services Environments
- ◆ Automate & investigate Virtual Organisation life-cycle:
  - formation
  - operation, including reformation
  - dissolution
- ◆ CONOISE@Aberdeen: using CLP to decide:
  - who to form VO with
  - when to reform VO
  - when to disband VO
- ◆ Scenario: multimedia service provisioning

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# Bidding to meet customer requirements

Call for Bids → CSP Agent

Possible Bid ← CSP Agent

Possible Bid ← CSP Agent
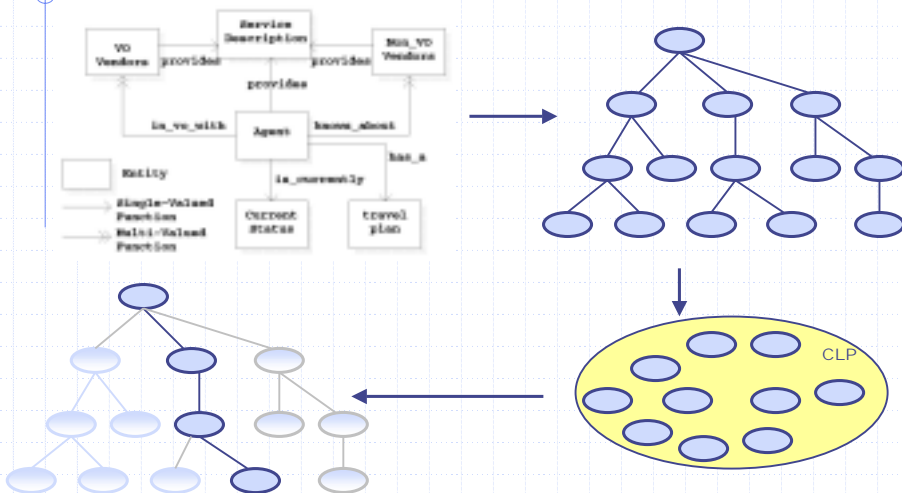
Possible Bid ← CSP Agent → Call for Bids (new VO formation)

# Constraints on bids

◆ Types of constraint
- user requirements / preferences (hard / soft)
  "monthly package including >= 50 text messages"
- domain restrictions (axioms on ontology)
  "all Quicktime content requires a Quicktime player"
- "small print" on instances
  "to get this price, must take the complete package"
- suppliers' existing commitments
  "40% of my bandwidth is committed to customer X"

◆ All of these constraints must be factored-in when generating a bid

◆ Sample bid

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# Intelligent VO formation/reformation

# CONOISE - observations

- ◆ This type of system is some way off
- ◆ Promising initial approaches
  - integration of constraint-solving & reverse auction
  - "watchdog" agents hold (challengable) reputation information
- ◆ Issues arising
  - user interfaces: how can users specify their desires, and understand what their agents do?
  - vendor support: how to help vendors get themselves online and bidding?
  - policing: how to ensure agents follow the rules of the marketplace, and how to sanction them if not?



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# Case studies

1. Ontologies for value-added services

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# I-X/KRAFT service

- Allows people to collaborate on shared tasks
- "Technology integration experiment" (TIE):
  - Edinburgh's I-X provides process panels allowing users to identify & delegate tasks
  - Aberdeen's KRAFT offers constraint solving
- Scenario:
  - Edinburgh user identifies a technical issue, delegates it to Aberdeen
  - Aberdeen resolves issue through constraint solving
  - Example: configuring a PC to user's requirements

# Interface (mock-up)



[Demo screencam]

# Summary

- The Semantic Web will open up currently-closed extranets
  - shared, common (simple) ontologies
  - Automated tasks using (a little) AI
- Virtual marketplaces of customer and vendor agents will appear
  - interfaces & transparency issues
  - trust, reputation, and policing issues
- Next phase of intranets and knowledge management: support communication and collaboration
  - instant messaging + structured problem-solving
  - managing team-to-team interworking

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# Credits & Questions?

- Work done at Aberdeen in collaboration with
  - Agentcities: Gunnar Grimnes, Pete Edwards
  - CONOISE: Stuart Chalmers, Tim Norman, Peter Gray
  - AKT: Kit Hui, Peter Gray, Derek Sleeman

## Questions?

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