Goals and Policies for Telephony

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Background

Stirling, Scotland

Pervasive Communication

- personal communication is increasing:
  - more pervasive and invasive
  - anywhere, any time, any how
  - land line, cell phone, email, voicemail, text messaging, instant messaging, social networks, ...
- the ACCENT initiative is empowering users to control their communications:
  - caller, callee
  - time, location
  - topic, role
  - technology, media
  - cost, quality ...

Telephony Features

- the traditional telephony solution is a feature:
  - call forwarding, call waiting, automatic call-back, ...
  - defined and supported by the network operator
- however, features lack flexibility:
  - low-level control
  - limited customisation
  - network-oriented, not user-oriented
- Internet telephony is growing (e.g. SIP, Skype):
  - the network deals only with signalling and transmission
  - advanced functionality can be placed in the endpoints
  - user customisation is much easier

Goals and Policies for Telephony

- goals/policies are written in the APPEL language
- goals are high-level objectives:
  - persistent, user-oriented
  - declarative rather than executable
  - can be realised through refinement to policies
- policies are high-level rules:
  - higher-level than features
  - infinitely customisable
  - executed in endpoints (customer equipment, servers)
  - typically in ECA form (Event, Condition, Action)
- hierarchical levels: goal → policy → feature

Policies and More

Policy Structure

- policy document:
  - ≥ 1 policies, variables, prototypes, resolutions, goals
- policy:
  - id, owner, target domain, ...
  - optional preference (*must, should, prefer, must not*, ...)
  - ≥ 1 policy rules (combined with *sequential, parallel*, ...)
- policy rule:
  - ≥ 0 triggers (combined with *and, or*)
  - ≥ 0 conditions (combined with *and, or, not*)
  - ≥ 1 actions (combined with *and, or, else, ...)*
- internally stored as XML (abbreviated in this talk)

Notify Arrival Policy

```
<policy id='Tell me when Bob arrives'
   owner='ken@stir.ac.uk' ...>
  <policy_rule>
    <trigger arg1='bob@stir.ac.uk'>present(arg1)
    <action arg1='ken@stir.ac.uk'
      arg2='Bob has arrived'>send_message(arg1,arg2)
```

No Emergency Forwarding Policy

```
<policy id='Never forward emergency calls'
  owner='ken@stir.ac.uk' ...>
 <preference>must_not
 <policy_rule>
  <trigger>connect
  <condition>
   <parameter>call_type
   <operator>eq
   <value>emergency
  <action arg1=''>forward to(arg1)
```

Policy Variables

- variables can be defined and used in policies:

```
<variable id='home' owner='ken@stir.ac.uk'
  value='1234567890' .../>

<policy ...>
  <action arg1=':home'>forward_to(arg1)
```

Prototype Policies

- prototype policies are like regular policies:
  - used to realise goals dynamically
  - high-level effects contribute to goals
  - optimal parameter values can be determined

Add Video Prototype

```
<prototype id='Add video' owner='ken@stir.ac.uk'
  effect='call_bandwidth += 512' ...>
 <policy_rule>
  <trigger>connect_incoming
  <condition>
   <parameter>medium
   <operator>eq
   <value>audio
  <action arg1='video'>add_medium(arg1)
```

Resolution Policies

- resolution policies resemble regular policies:
  - used to detect and resolve policy (action) conflicts
  - triggers are actions of regular policies
  - conditions and actions can use the preferences and variables of conflicting policies
  - operator *in* for preferences means 'in keeping with' (i.e. in a similar sense)
- resolution actions:
  - specific, like a regular policy
  - generic, choosing among conflicting policies

Forward-Reject Resolution

```
<resolution id='Forward-reject' owner='ken@stir.ac.uk'...>
  <policy_rule>
    <triggers>
      <and/>
      <trigger arg1='variable0'>forward_to(arg1)
      <trigger arg1='variable1'>reject_call(arg1)
    <condition>
      <parameter>preference0
      <operator>in
      <value>preference1
    <action>apply_stronger
```

Goals

Goal Approach

- goal refinement is handled through optimisation:
  - a numerical approach gives greater flexibility
  - individual and overall goals are evaluated numerically
- goals resemble normal policies:
  - goal achievement is assessed through some measure
  - no trigger as goals are persistent
  - one action to maximise/minimise the goal measure
- normally there are multiple goals:
  - an overall evaluation function combines goal measures
  - goals are realised through combinations of prototypes
  - where there is conflict, an optimum selection is made

Maximise Network Use Goal

- measures are typically weighted sums:
  - measures use current environment values
  - weights are determined by typical values
  - automated sensitivity analysis checks proposed weights
- measure of network use:

  0.0008×bandwidth×duration + 6.0×handled
- goal definition:

```
<goal id='Maximise network use'
  owner='ken@stir.ac.uk' ...>
  <policy_rule>
    <action arg1='network_use'>maximise(arg1)</action>
```

Minimise Call Cost Goal

- measure of call cost:

  1.0×rate×duration

- goal definition:

```
<goal id='Minimise call cost' owner='ken@stir.ac.uk' ...>
  <policy_rule>
    <conditions>
      <and/>
      <condition>
        <parameter>day <operator>in <value>1..5
      <condition>
        <parameter>bandwidth <operator>gt <value>128
    <action arg1='call_cost'>minimise(arg1)
```

Goal Refinement

- goal refinement has static and dynamic phases
- static analysis (on definition):
  - identify which prototypes contribute to which goals
  - instantiate prototypes as if they were regular policies
- dynamic analysis (on a trigger):
  - receive a trigger from the managed system
  - determine environment values and relevant policies
  - filter goal-related policies
  - choose their optimum combination and parameters
  - detect and resolve conflicts among the selected policies
  - ask the managed system to perform policy actions

Overall Goal Evaluation

- the overall evaluation function might be:

  +network_use

  -call_cost

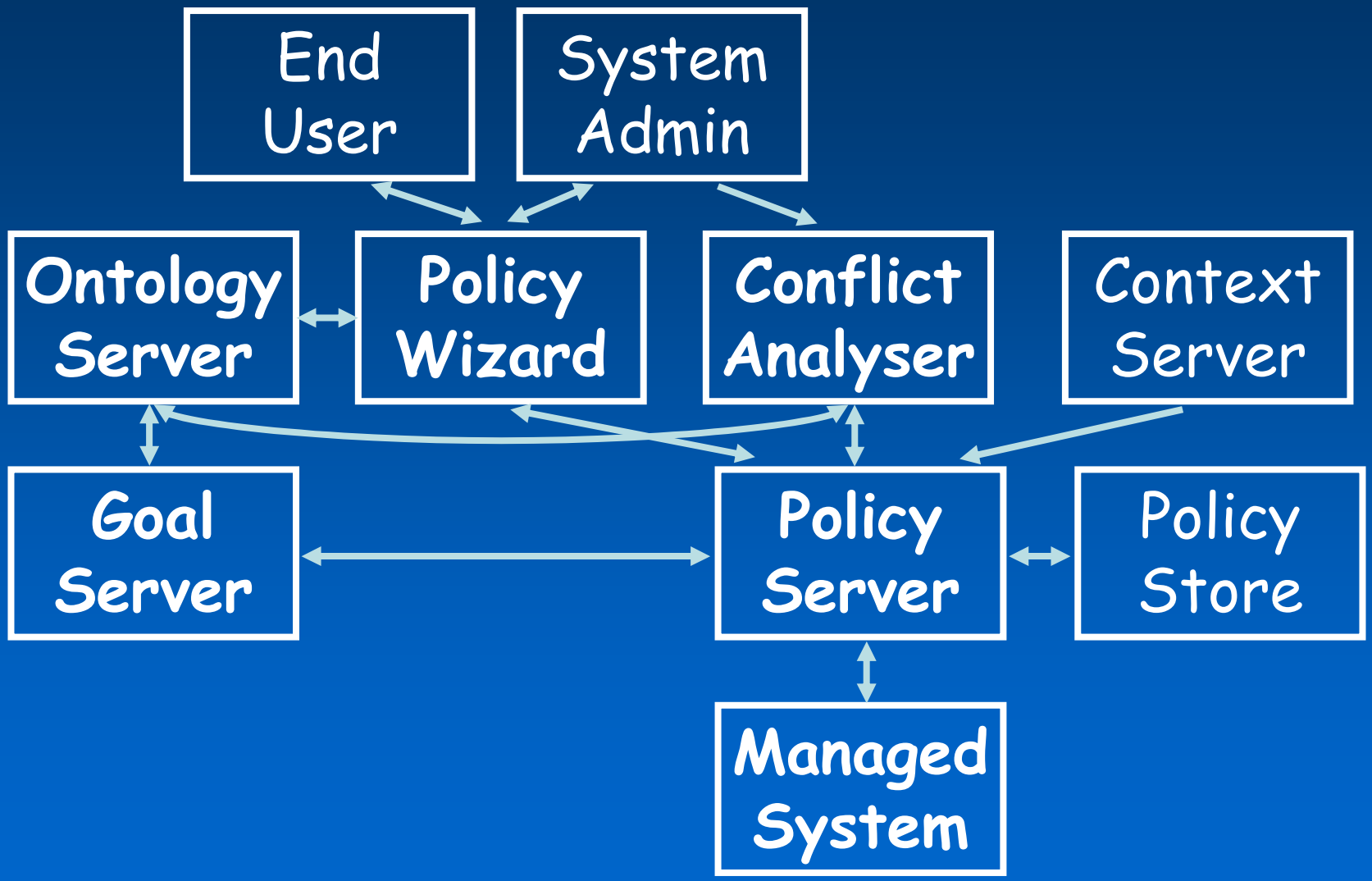
  +multimedia_use

  -interruption_time

- sample goals/prototypes/conditions might yield:
  - add a lawyer to the call (for contractual calls)
  - add limited video to the call (for moderate bandwidth)
  - set a call limit of 10 minutes (for reduced cost)
  - include a manager in the call (as video is in use)

Tool Support

System Architecture

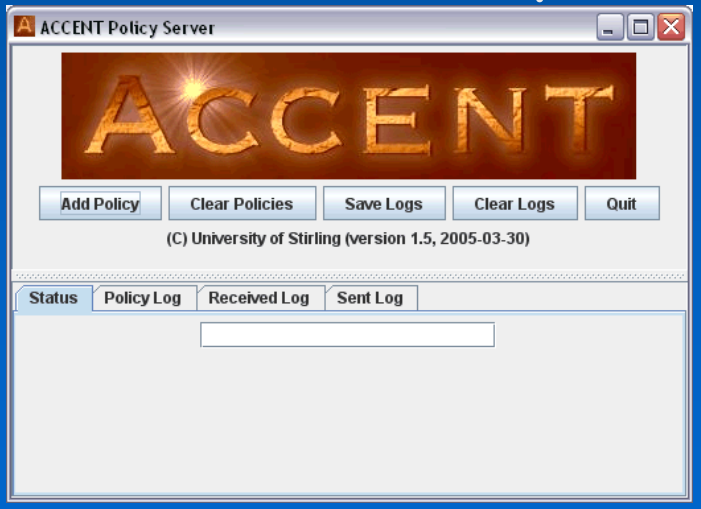


Managed System

- any system can be managed through policies:
  - an additional policy interface is required
  - notifies significant system events (e.g. call, hang-up)
  - performs policy actions (e.g. forward, reject)
- for telephony, interface modules exist for:
  - SER (SIP Express Router)
  - 7000 ICS (Mitel softswitch)
  - GNU GK (H.323 gatekeeper)
- performance overhead:
  - < 1 second (policies)
  - < 2 seconds (goals and policies)

Policy and Goal Servers

- the policy store is an XML database
- the policy server reacts to system events:
  - retrieves triggered and eligible policies
  - requests goal refinement
  - determines policy actions and resolves conflicts
- the goal server creates an optimal set of policies



Policy Wizard

- policy wizards support user-friendly definition:
  - inherently multi-lingual
  - near-natural language, interactive voice, digital pen

Applicability (label, owner, ...):

label Transfer a call to Jean
owner ken@stir.ac.uk
applies to ken@stir.ac.uk
valid from 2008-12-25 09:00
valid to 2009-01-06 09:00
profile In the office
status enabled

Preference (must, prefer, ...):

prefer

Rules (combinations, triggers, conditions, actions):

when a call is not answered after 10 seconds •••
or
when I am called •••
if the hour is after 13:00 •••
do forward the call to jean@plc.com •••
and then
do send a message to michael@uni.ac.uk about call to Mark •••

Offline Conflict Analyser

- policies are analysed offline for conflicts:
  - conflicting effects suggest likely problems
  - results can be manually tuned
  - resolution policies are automatically generated

Conflict Detected	Action 1	Action 2	Conflicting Affect(s)	Date Last Modified
☑	add_medium(audio)	add_medium(audio)	medium,privacy	Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	add_medium(video)	medium,privacy	Thu May 24 13:35:32 BST 2007
☐	add_medium(audio)	add_medium(whiteboard)	medium,privacy	Thu May 24 13:28:38 BST 2007
☑	add_medium(audio)	add_party	privacy	Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	connect_to		Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	fork_to		Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	forward_to		Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	log_event		Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	note_availability		Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	note_presence		Thu May 24 13:28:38 BST 2007
☑	add_medium(audio)	play_clip	medium	Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	reject_bandwidth		Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	reject_call		Thu May 24 13:28:38 BST 2007
☑	add_medium(audio)	remove_medium(audio)	medium	Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	remove_medium(video)	medium	Thu May 24 13:39:18 BST 2007
☐	add_medium(audio)	remove_medium(whiteboard)	medium	Thu May 24 13:28:38 BST 2007
☐	add_medium(audio)	remove_party		Thu May 24 13:28:38 BST 2007

Ontology Server

- definition of the APPEL policy language:
  - core and domain-specific schemas
  - supplemented by core and domain-specific ontologies
- the ontology server allows:
  - tool-independent access to domain information
  - other goal and policy tools to be domain-independent

Review

Application Areas

- core and domain-specific aspects are separated
- the approach is thus generic and extensible
- current applications include:
  - (Internet) telephony
  - home care systems
  - sensor networks
  - wind farms

Conclusion

- the APPEL policy language supports:
  - policies, variables, resolutions
  - prototypes, goals
- the ACCENT toolset provides:
  - policy and goal servers
  - context and ontology servers
  - conflict detection and resolution
  - user-friendly wizards
- the approach is generic, though illustrated here on (Internet) telephony